TM 5-2430-200-24

Maintenance Manual

Deployable Universal Combat Earthmover (DEUCE)

30/30 (Model DV100)

NSN: 2430-01-423-2819

PIN: 7RR00003-Up

DISTRIBUTION STATEMENT A: Approved for public release; distribution is unlimited.

Headquarters, Department of the Army

March 2001

CHANGE NO. 1

HEADQUARTERS, DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 18 MAY 2008

TECHNICAL MANUAL

MAINTENANCE MANUAL FOR DEPLOYABLE UNIVERSAL COMBAT EARTHMOVER (DEUCE) 30/30 (MODEL DV100) NSN 2430-01-423-2819 PIN: 7RR00003-UP

DISTRIBUTION STATEMENT A - Approved for public release; distribution is unlimited.

TM 5-2430-200-24, 01 MARCH 2001, is updated as follows:

1. File this sheet in front of the manual for reference.
2. This Change, in part, is a result of various configuration changes and updates to include: recoil alert system, site gage covers added to rollers and rear idlers, changed and rerouted hydraulic hoses, incorporated Two Level MAC, updated various Part Numbers and NSNs.
3. A vertical bar in the outer margin of the page or between columns in a double column format indicates new or updated text or illustrations. Pointing hands are frequently used to highlight illustration changes.
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By Order of the Secretary of the Army:

GEORGE W. CASEY, JR.
General, United States Army
Chief of Staff

Official:

JOYCE E. MORROW
Administrative Assistant to the
Secretary of the Army

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Important Safety Information

⚠ WARNING

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance, or repair on this product until you have read and understood the operation, lubrication, maintenance, and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to your or other persons.

The hazards are identified by the "Safety Alert Symbol" and followed by a "Signal Word" such as "WARNING" as shown below:

⚠ WARNING

The meaning of this safety symbol is as follows:

Attention! Become Alert! Your Safety Is Involved.

The person servicing the product may be unfamiliar with many of the systems on the product. This makes it important to use caution when performing service work. Knowledge of the system and/or components is important before the removal and disassembly of any component is attempted.

Because of the size of some of the product components, the service person should check the weights noted in this manual. Use proper lifting procedures when removing any components.

The following is a list of basic precautions that should always be observed.

Safety Signs

Read and understand all warning signs on this product before operating, lubricating, or repairing this product. Replace any damaged, illegible, or missing warning plates, signs and decals.

Protective Equipment

Always wear a hard hat, protective glasses, protective shoes and other protective equipment, as required by job conditions, when working around this product. In particular, wear protective glasses when pounding on any part of the product, or its attachments, with a hammer or sledge. User welder's gloves, hood/goggles, an apron and other protective clothing appropriate to the welding job being performed. Do not wear loose clothing or jewelry that can catch on parts of the product. Wear eye and face protection when working with hydraulic or air lines.

Threat of Nuclear, Biological, and Chemical (NBC) Contamination

The DEUCE incorporates a CARC painted exterior. The materials used in the DEUCE are metal, rubber, plastic, fabric and glass. In the event of NBC contamination, the decontaminates for these surfaces and materials are listed in Army FM 3-5. For decontamination procedures, refer to Army FM 3-7. The DEUCE Parts Manual, TM5-2430-200-24P, contains a list of the types of parts that are susceptible to damage from NBC exposure.

ElectroMagnetic Pulse (EMP) Exposure

The components listed and designated as EMP susceptible may be damaged by EMP exposure. If the machine is exposed to an EMP incident, verify proper operation and repair as necessary. The DEUCE Parts Manual, TM5-2430-200-24P, contains a list of the types of parts that are susceptible to damage from EMP exposure.

Pressurized Items

1. Relieve all pressure in oil or water systems before any lines, fittings, or related items are disconnected or removed. Always make sure all raised components are blocked correctly and be alert for possible pressure when disconnecting any device from a system that utilizes pressure.

2. Lower the blade or other attachments to the ground before performing any work on the machine. If this cannot be done, make sure the blade or other attachment is blocked correctly to prevent it from dropping unexpectedly.

3. Loose or damaged fuel, lubricant, and hydraulic lines, tubes and hoses can cause fires. Do not bend or strike high pressure lines' or install ones which have been bent or damaged. Check lines, tubes and hoses carefully. Do not use your bare hand to check for leaks. Pin hole leaks can result in a high velocity fluid stream that will be invisible close to the hose, tube or line. This fluid can penetrate the skin and cause personal injury. Use a board, or a piece of cardboard to check for leaks.

Mounting And Dismounting

Use steps and handholds when mounting or dismounting a machine. Clean any mud or debris from steps, walkways or work platforms before using. Always face the machine when using steps, handholds and walkways. When it is not possible to use the designed access system, use ladders, scaffolds, or work platforms to perform safe repair operations.

Hot Fluids And Parts

1. To avoid burns, be alert for hot parts on machines which have just been stopped, and hot fluids in lines, tubes and compartments.

2. Be careful when removing fill caps, breathers and plugs on the machine. Hold a rag over the cap or plug to prevent being sprayed or splashed by liquids under pressure. The danger is even greater if the machine has been stopped because fluids can be hot.

Lifting

Use a hoist when lifting components which weigh 23 kg (50 lb) or more, to avoid back injury. Make sure all chains, hooks, slings, etc., are in good condition and are of the correct capacity. Be sure hooks are positioned correctly. Lifting eyes are not to be side loaded during a lifting operation.

Repair

1. Disconnect the batteries and discharge any capacitors before starting to work on the product. Attach a “Do Not Operate” tag in the Operator’s Compartment.

2. If possible, make all repairs with the machine parked on a level, hard surface. Block the machine to prevent it from rolling while working on or under the machine.

3. Do not work on any machine that is supported only by lift jacks or a hoist. Always use blocks or jack stands to support the machine, before performing any service or disassembly.

4. Be careful when removing cover plates. Gradually back off the last two bolts, or nuts, located at opposite ends of the cover or device. Then, pry the cover loose to relieve any spring or other pressure, before removing the last two bolts or nut completely.

5. Always use tools that are in good condition and be sure you understand how to use them before performing any service work.

6. Replace all fasteners with the same part number. Do not use a lesser quality fastener if replacements are necessary.

7. Repairs which require welding should be performed only with the benefit of the appropriate reference information, and by personnel adequately trained and knowledgeable in welding procedures. Determine the type of metal being welded and select correct welding procedure and electrodes, rods or wire to provide a weld metal strength equivalent at least to that of the parent metal. Disconnect the electronic control module (ECM), the electronic programmable transmission control (EPTC II), and the control unit for the engine coolant heater (if equipped) before any welding is done on the machine.

8. Do not damage wiring during removal operations. Reinstall the wiring so it is not damaged nor will it be damaged in operation by contacting sharp corners, or by rubbing against some object or hot surface. Do not connect wiring to a line containing fluid.

9. Be sure all protective devices including guards and shields are properly installed and functioning correctly before starting a repair. If a guard or shield must be removed to perform the repair work, use extra caution. Repair any loose or damaged fluid lines, tubes or hoses because leaks can cause fires.

10. Tighten connections to the correct torque. Make sure that all heat shields, clamps and guards are installed correctly to avoid excessive heat, vibration or rubbing against other parts during operation. Shields that protect against oil spray onto hot exhaust components in event of a line, tube or seal failure must be installed correctly.

11. Do not operate a machine if any rotating part is damaged or contacts any other part during operation. Any high-speed rotating component that has been damaged or altered should be checked for balance before reusing. Make sure all shields are properly installed and functioning correctly before starting the engine or operating the machine.

12. On track-type machines, be careful when servicing or separating tracks. Keep away from the front and rear of the machine. The machine can move unexpectedly when both tracks are disengaged from the drive wheels. Block the machine to prevent it from moving. Also, chips can fly from ripper teeth or from where a pin is being removed or installed.

13. Read and understand the instructions on the container of any sealant or solvent that is used during maintenance or repair activities. Solvent is toxic and flammable: always use in an open area with good air flow, away from sparks, heat, or flames. Wear goggles and gloves. Do not breathe vapors. Avoid contact with skin, eyes, and clothes. If you get dizzy while using solvent, breathe fresh air, and get medical help. If solvent gets on hands, wash them. If solvent gets in eyes, flush the eyes with fresh water and get medical help immediately. Keep a fire extinguisher nearby.

Literature Information

Maintenance Manual

This manual is divided into seven units: Engine, Power Train, Hydraulic System, Machine Systems, Electrical System, Special Operation and Maintenance, and Appendices. Each unit contains individual modules.

Special attention should be given to Appendix D–Electronic Troubleshooting, to be used with the Soldier's Portable On-system Repair Tool (SPORT) and Caterpillar's Electronic Technician (ET) software.

The types of modules within the first six units include: Specifications, Systems Operation, Testing and Adjusting, and Disassembly and Assembly. The Hydraulic System and Electrical System units also contain a Schematic module.

The Specifications, Systems Operation, Testing and Adjusting modules are divided into three sections. The Specifications section contains component-specific information. Nonstandard torques, required sealants, serviceable component specifications, and other information to assist with service and repair are included. All specifications are given in metric units, with the equivalent English units parenthetically noted.

The Systems Operation section of the Specifications, Systems Operation, Testing and Adjusting module includes detailed explanations of how each machine system operates. This section provides theory of operation to assist with machine troubleshooting.

The Testing and Adjusting section of the Specifications, Systems Operation, Testing and Adjusting module includes machine troubleshooting tips and component test procedures.

SPORT with ET is the primary maintenance diagnostic tool used to troubleshoot the DEUCE. The troubleshooting procedures to be used with SPORT and ET are located in Appendix D.

The Disassembly and Assembly module illustrates disassembly and assembly procedures. The procedures are arranged in alphabetical order within the module. This module calls out all nonstandard torque specifications and the weight of components with weights greater than 23 kg (50 lb).

NOTE: Bolt torques which are not specifically identified in the Specifications section or a disassembly or assembly procedure are standard torque values. Standard torque values are given in the Appendix C of the manual. Group numbers related to the disassembly and assembly procedures are given at the beginning of each procedure.

The Schematic module contains general component location information and a complete schematic of the system.

NOTE: The Systems Operation section of the Specifications, Systems Operation, Testing and Adjusting module may contain partial schematics.

The Special Operations and Maintenance unit illustrates procedures and maintenance activities which are beyond those which the operator can perform.

The Appendices unit includes four modules: Maintenance Allocation Chart (MAC); Unit Preventative Maintenance Checks and Services (UPMCS); Standard Torque Specifications; and Electronic Troubleshooting. Military-specific information is included in the Appendices unit. The Standard Torque Specifications module should be used when a torque is not specified in a procedure in the Maintenance Manual.

Related Manuals

The Maintenance Manual should be used in conjunction with the Parts Manual and the Operator's Manual. The Parts Manual lists all serviceable components on the machine by part number. The Parts Manual divides the machine components into sections. Component groups are listed alphabetically within each section.

NOTE: The Parts Manual and the procedures in the Disassembly and Assembly modules do not follow the same structure. It may be necessary to search through different groups in the Parts Manual to find all of the parts which are called out in a particular disassembly or assembly procedure.

NOTE: The Parts Manual refers to parts by their engineering designation, while the Maintenance Manual refers to parts by their common names. Sometimes the engineering designation does not match the common name. For example, the Parts Manual may identify a component as a "Valve Group - Pressure Relief," while the Maintenance Manual may identify the same component as a "pressure relief valve." In most instances, nomenclature differences are minor.

NOTE: There is no difference between the following part numbers, except for format: 123-4567 and 1234567. A dash may be included in part numbers in the Maintenance Manual and Operator's Manual to improve readability. The part numbers in the Parts Manual do not contain dashes.

The Operator's Manual includes safety, operation, transportation, lubrication and maintenance information suitable for the Army operator.

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this publication. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Submit your DA Form 2028 (Recommended Changes to Equipment Technical Publications), through the Internet, on the Army Electronic Product Support (AEPS) website. The Internet address is https://aeps.ria.army.mil. The DA Form 2028 is located under the Public Applications section in the AEPS Public Home Page. Fill out the form and click on SUBMIT. Using this form on the AEPS will enable us to respond quicker to your comments and better manage the DA Form 2028 program. You may also mail, fax or E-mail your letter or DA Form 2028 direct to: AMSTA-LC-LMIT / TECH PUBS, TACOM-RI, 1 Rock Island Arsenal, Rock Island, IL 61299-7630. The email address is: TACOM-TECH-PUBS@ria.army.mil. The fax number is DSN 793-0726 or Commercial (309) 782-0726.

NOTE

This form lists the contents of the complete Maintenance Manual for this product.

NOTE

Special attention should be given to the troubleshooting procedures found in Appendix D when using SPORT with ET.

TM5-2430-200-24

Specifications Systems Operation Testing & Adjusting

Deployable Universal Combat Earthmover (DEUCE)

3100 HEUI DEUCE Engine

Engine PIN: 4CW00222–Up
Machine PIN: 7RR00003–Up

Important Safety Information

Most accidents involving product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “WARNING” as shown below.

The meaning of this safety alert symbol is as follows:

⚠ WARNING

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning, explaining the hazard, can be either written or pictorially presented.

Operations that may cause product damage are identified by NOTICE labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are therefore not all inclusive. If a tool, procedure, work method or operating technique not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and others. You should also ensure that the product will not be damaged or made unsafe by the operation, lubrication, maintenance or repair procedures you choose.

The information, specifications, and illustrations in this publication are on the basis of information available at the time it was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service given to the product. Obtain the complete and most current information before starting any job. Caterpillar dealers have the most current information available. For a list of the most current publication form numbers available, see the Service Manual Contents Microfiche, REG1139F.

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Specifications

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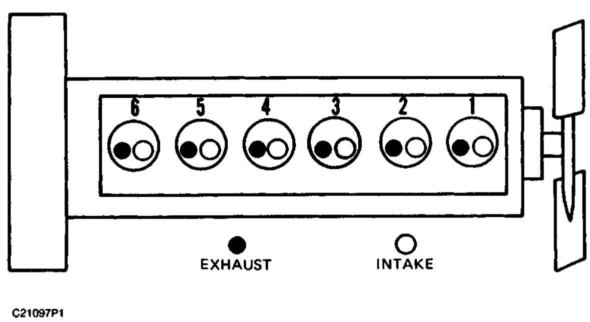
Specifications

Basic Engine

Engine Design

4CW00222-UP



Cylinder and Valve Location.

Bore ....110.025 ± 0.025 mm (4.331 ± 0.0010 in)

Stroke ....127 mm (5.0 in)

Displacement ....7.2 L (439 cu in)

Number of cylinders 6

Cylinder arrangement ....In-line

Valves per cylinder..2

Valve lash setting:

Intake ....0.38 mm (0.015 in)
Exhaust ....0.64 mm (0.25 in)

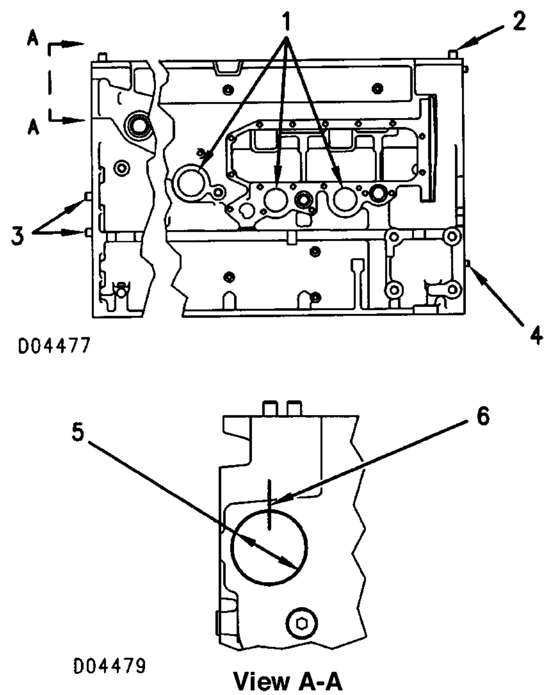
Type of combustion.................................Direct injection

Firing order 1-5-3-6-2-4

Direction of crankshaft rotation (when viewed from flywheel end).......................................Counterclockwise

NOTE: The front end of the engine is opposite the flywheel end. The left and right sides of the engine are as viewed from the flywheel end. The number-one cylinder is the front cylinder.

Cylinder Block



Right Side. View A-A (Rear Face).

(1) Depth plugs are installed (measure from block face to top edge of plug)........................1.25 ± 0.25 mm ....(0.049 ± 0.010 in)

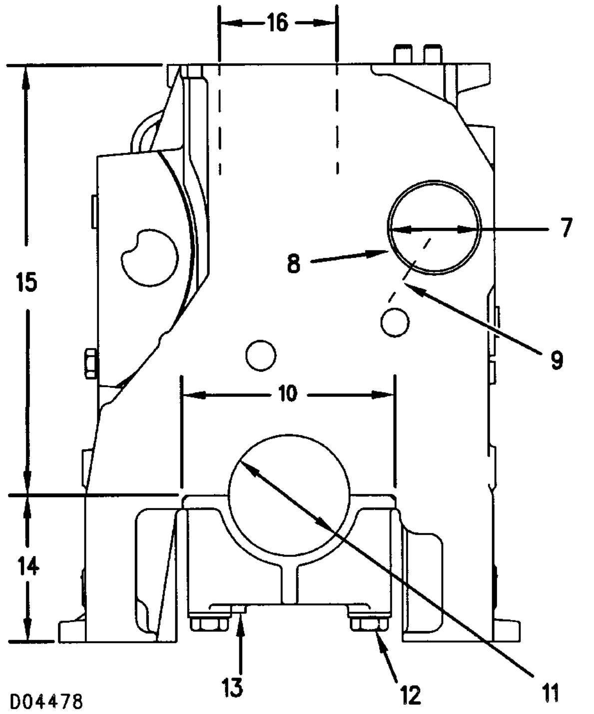
(2) Distance all dowels extend from top face................. ....14 ± 2 mm (0.55 ± 0.08 in)

(3) Distance two large dowels extend from rear face..... ....12.0 ± 0.5 mm (0.47 ± 0.02 in)

(4) Distance all dowels extend from front face.............. ....8.0 ± 0.5 mm (0.31 ± 0.02 in)

(5) Bores in block for all camshaft bearings except front bearing.............................69.000 ± 0.038 mm ....(2.7165 ± 0.0015 in)

(6) Locate bearing oil hole for all camshaft bearings (except front bearing) at top of bore.



Front Face.

(7) Bore in block for front camshaft bearing ....70.000 ± 0.025 mm (2.7559 ± 0.0010 in)

(8) Front camshaft bearing joint location.

(9) Front camshaft bearing oil hole.

NOTE: Install the front camshaft bearing with camshaft bearing oil hole (9) aligned with the oil hole in the block, and camshaft bearing joint (8) positioned as shown.

(10) Width of main bearing cap .....159.995 ± 0.020 mm ....(6.2990 ± 0.0008 in)

Width of cylinder block for main bearing cap........... ....160.000 ± 0.018 mm (6.2992 ± 0.0007 in)

(11) Bore in block for main bearings ....95.000 ± 0.013 mm (3.7402 ± 0.0005 in)

(12) Install main bearing cap bolts as follows:

a. Install bearing caps with the sequence number to the right, 1 through 7 (front to rear).

b. Before assembly, put 2P-2506 Thread Lubricant on threads and washer face.

c. Tighten both bolts of each bearing cap to a torque of........................54 ± 7 N•m (40 ± 5 lb ft)

d. Tighten bolts an additional ....90 ± 5 degrees (one-quarter turn)

(13) Location of bearing cap sequence number.

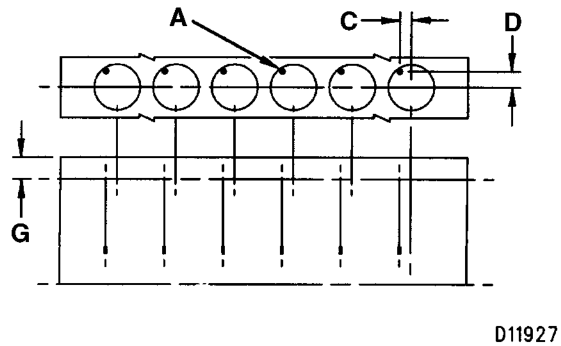
(14) Dimension from centerline of crankshaft bore to pan rail ....110.00 mm (4.331 in)

(15) Dimension from centerline of crankshaft bore to top of block...............................322.00 mm (12.677 in)

(16) Cylinder bore size ....110 mm (4.331 in)

NOTE: Bore size must be checked with a 4C-4377 Cylinder Head Stress Plate (with head gasket).

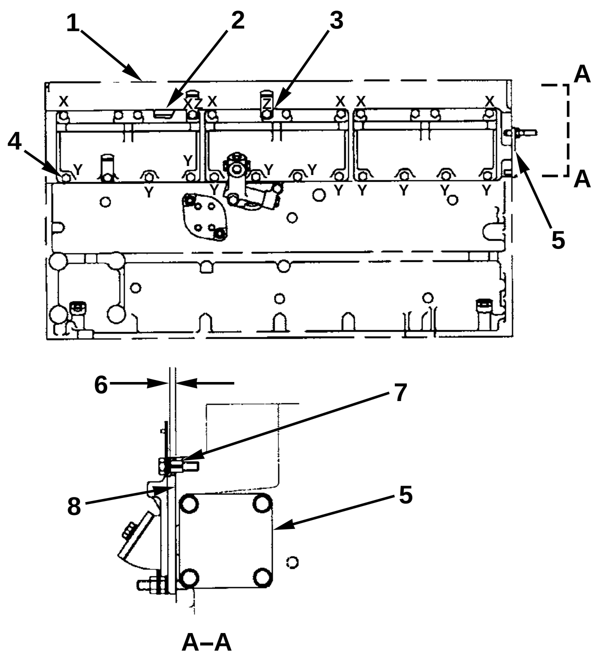
Piston Cooling Jet



Check the piston cooling jets by inserting a 1.90 mm (0.075 in) diameter drill rod into the jet. The rods must pass through a 12.7 mm (0.50 in) diameter circle in location (A). The circle is located at depth (G), 50.0 mm (1.97 in) below the top of the cylinder block.

Dimension (C)..............................25.9 mm (1.02 in)
Dimension (D)..............................33.4 mm (1.31 in)
Dimension (G)..............................50.0 mm (1.97 in)

Cylinder Block Cover Group



(1) Cylinder block.

(2) Gasket.

(3) Length of bolt (locations marked [X and Z]) ....30.0 mm (1.18 in)

(4) Length of bolt (location marked [Y])...20.0 mm (0.79 in)

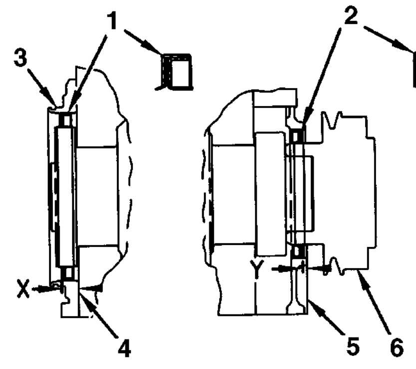
(5) Clean cover face with 138-8440 Solvent. Apply 1U-8846 Gasket Maker to cover. Spread uniformly on face and around the bolt holes. Cover must be installed and tightened within 10 minutes.

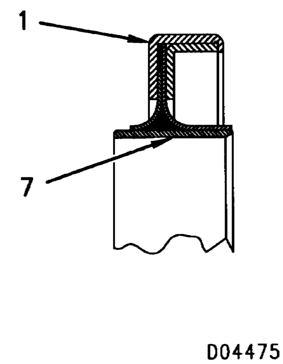
(6) Length wear sleeve (7) extends from face of cylinder block.............5.0 ± 0.5 mm (0.20 ± 0.02 in)

(7) Sleeve (location marked [X]).

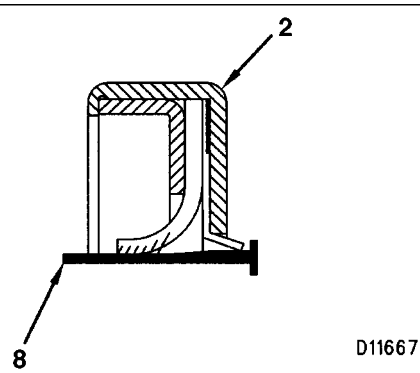
(8) Clean cover face with 138-8440 Solvent. Apply 1U-8846 Gasket Maker to cover. Spread uniformly on face and around bolt holes. Cover must be installed and tightened within 10 minutes.

Crankshaft Seals





Rear Crankshaft Seal Group.



Front Crankshaft Seal Group.

(1) Install rear seal with rear face of seal at dimension (X) from rear block face (4). Dimension (X)..16.0 ± 0.5 mm (0.63 ± 0.02 in)

NOTE: The rear seal runs directly on the crankshaft flange as originally manufactured. The service rear seal group has wear sleeve (7) that is part of the replacement rear seal group.

(2) Install front seal with front face of seal at dimension (Y) from front face of front housing. Dimension (Y) ....2.5 ± 0.5 mm (0.10 ± 0.02 in)

(3) Carrier/flywheel housing.

(4) Rear face of block.

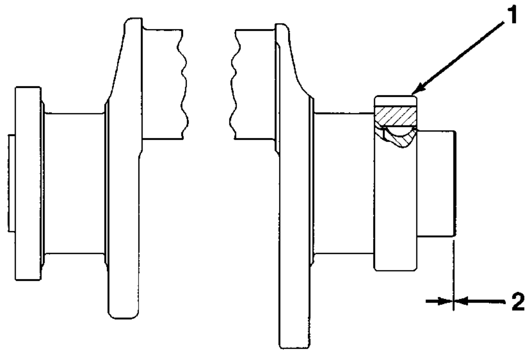
(5) Front housing.

(6) Pulley.

(7) Do not remove wear sleeves from seal group.

(8) Remove shipping sleeve for front seal after installing front seal (2) in housing and immediately before installing pulley (6).

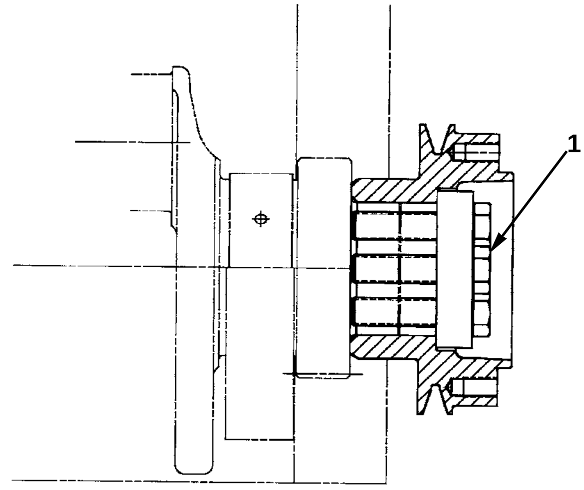
Crankshaft (113-6087)



(1) For installation, heat gear (do not use a torch) to ....316°C (600°F)

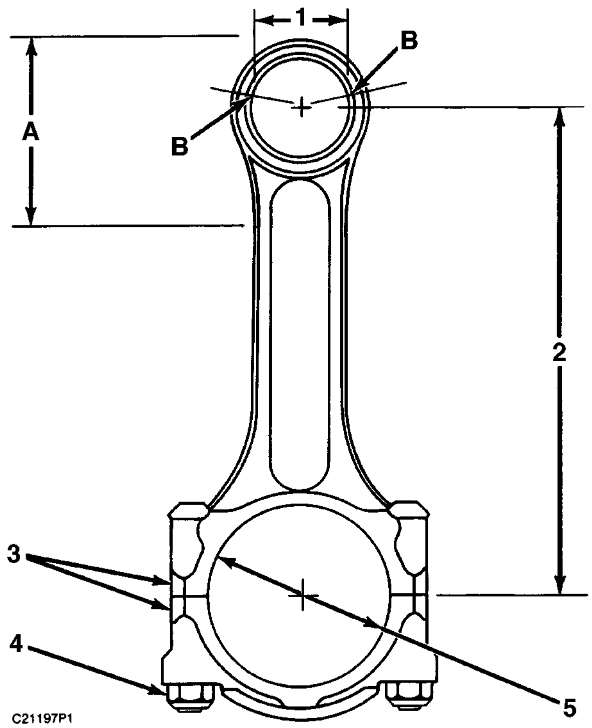
(2) Endplay for crankshaft assembled in engine ....0.07 to 0.32 mm (0.003 to 0.013 in)

Crankshaft Pulley Group



(1) Tighten bolts to a torque of ....190 ± 30 N•m ....(140 ± 22 lb ft)

Connecting Rod



(1) Bore in bearing for piston pin (new)........................ ....40.028 ± 0.008 mm (1.5759 ± 0.0003 in)

To install bearing, rod may be heated at length (A) (do not use a torch) to ....175 to 260°C ....(347 to 500°F)

Length (A)..75 mm (3 in)

Bearing joint must be at either location (B), at an angle above bore centerline of ......12.0 ± 5 degrees

(2) Distance between center of bearings.....200.00 mm ....(7.874 in)

(3) Location for etching cylinder number on rod and cap after assembly. Etch numbers on same side of rod as bearing retainer notch.

(4) Tighten connecting rod bolts as follows:

a. Lubricate bolt threads, seating faces of cap and nut with engine oil before installing nut.

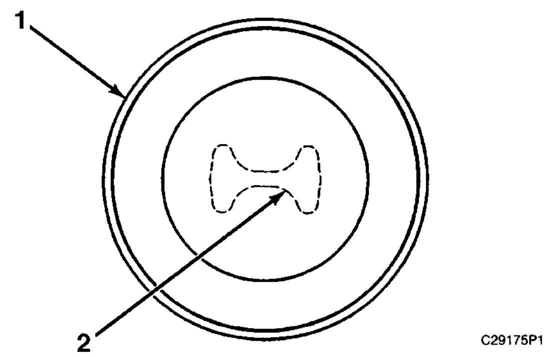
b. Tighten each nut to a torque of........................... ....54 ± 7 N•m (40 ± 5 lb ft)

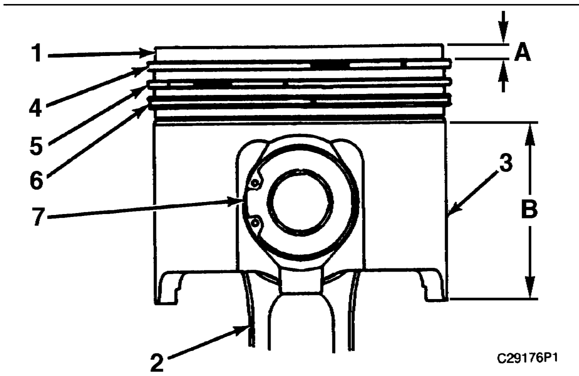
c. Put an alignment mark on cap and nut.

d. Tighten each nut an additional .....60 ± 5 degrees ....(one-sixth turn)

(5) Bore in connecting rod for bearing with bolts tightened to specification (4).....75.000 ± 0.013 mm ....(2.9528 ± 0.0005 in)

Pistons and Rings





(1) Thoroughly lubricate piston crown assembly 360 degrees in zone (A) with clean engine oil just before inserting into block group.

(2) Install connecting rod and piston group with rod forging part number to rear of engine (flywheel end). Thoroughly lubricate piston group with clean engine oil just before inserting into block group.

(3) Thoroughly lubricate piston skirt 360 degrees in zone (B) with clean engine oil just before inserting into block group.

Top and Intermediate Ring

Install piston ring with "UP" side toward top of piston (green strip to right of ring gear).

(4) Top ring marked "UP-1."

Clearance between ends of piston ring (when installed in cylinder with bore size of 110 mm [4.331 in]).....0.525 ± 0.125 mm (0.207 ± 0.0049 in)

Increase in clearance between ends of piston ring for each 0.03 mm (0.001 in) increase in cylinder bore size ....0.09 mm (0.004 in)

Install intermediate ring with side marked "UP-2" toward top of piston (white strip to right of ring end gap).

(5) Intermediate ring marked "UP-2."

Clearance between ends of piston ring (when installed in cylinder with bore size of 110 mm [4.331 in])...0.825 ± 0.125 mm (0.0033 ± 0.0049 in)

Increase in clearance between ends of piston ring for each 0.03 mm (0.001 in) increase in cylinder bore size ....0.09 mm (0.004 in)

Oil Control Ring

(6) Install oil control ring with gap in spring 180 degrees away from gap in ring (light green portion of spring must be visible at ring end gap).

Width of groove in piston for piston ring (new) ....4.041 ± 0.013 mm (0.1591 ± 0.0005 in)

Thickness of piston ring (new) ....3.982 ± 0.008 mm ....(0.1568 ± 0.0003 in)

Clearance between groove and piston ring (new)..... ....0.038 ± 0.080 mm (0.0015 ± 0.0031 in)

Clearance between ends of piston ring (when installed in cylinder with bore size of 110 mm [4.331 in])...........0.45 ± 0.15 mm (0.018 ± 0.006 in)

Increase in clearance between ends of piston ring for each 0.03 mm (0.001 in) increase in cylinder bore size ....0.09 mm (0.004 in)

After rings have been installed, rotate so end gaps are apart ....120 degrees

Piston Pin Bore

(7) Pin bore diameter in piston crown bearing............... ....40.031 ± 0.007 mm (1.5760 ± 0.0003 in)

Pin bore diameter in piston skirt............................... ....40.020 ± 0.008 mm (1.5756 ± 0.0003 in)

Pin diameter ....40.000 ± 0.005 mm ....(1.5748 ± 0.0002 in)

Pin length.........89.95 ± 0.13 mm (3.541 ± 0.005 in)

Thoroughly lubricate pin with clean engine oil before assembling to piston group and connecting rod.

Connecting Rod and Main Bearing Journals

Connecting Rod Bearing Journals

Diameter of Crankshaft Journal (Bearing Surface) for Main Bearings	
Original Size Journal	90.000 ± 0.020 mm (3.5433 ± 0.0008 in)
Undersize Journal 0.25 mm (0.010 in)	89.750 ± 0.020 mm (3.5335 ± 0.0008 in)
Undersize Journal 0.50 mm (0.020 in)	89.500 ± 0.020 mm (3.5236 ± 0.0008 in)

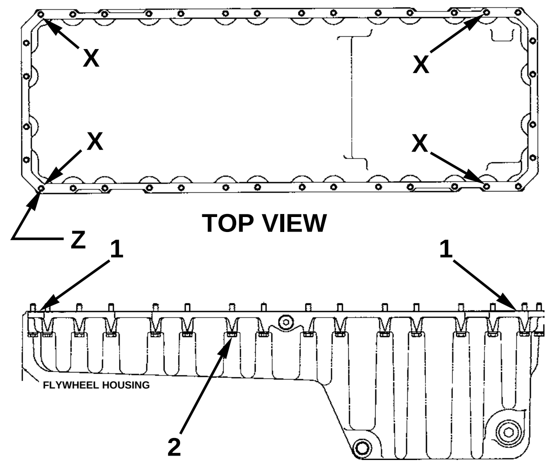
Clearance between bearing and journal (new) ....0.053 to 0.155 mm (0.0021 to 0.0061 in)

Main Bearing Journals

Diameter of Crankshaft Journal (Bearing Surface) for Main Bearings	
Original Size Journal	90.000 ± 0.020 mm (3.5433 ± 0.0008 in)
Undersize Journal 0.25 mm (0.010 in)	89.750 ± 0.020 mm (3.5335 ± 0.0008 in)
Undersize Journal 0.50 mm (0.020 in)	89.500 ± 0.020 mm (3.5236 ± 0.0008 in)

Clearance between bearing and journal (new) ....0.071 to 0.173 mm (0.0029 ± 0.0068 in)

Oil Pan Group



(1) Apply 1U-8846 Gasket Maker in four corners where oil pan, engine block, front housing, and rear housing meet.

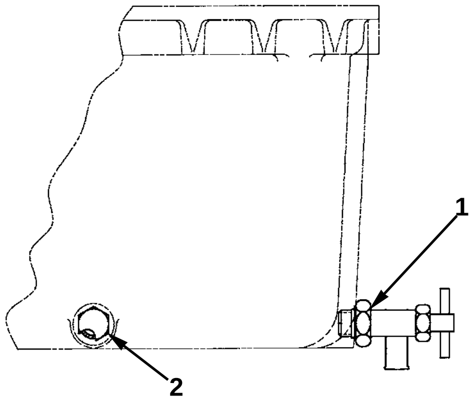
(2) Tighten oil pan bolt as follows:

a. Tighten four bolts (X) to a torque of 31 ± 3 N•m (23 ± 2 lb ft).

b. Starting with bolt (Z), tighten remaining bolts to a torque of 31 ± 3 N•m (23 ± 2 lb ft) in a counterclockwise direction (as viewed from bottom).

c. Starting with bolt (Z), retighten all bolts to a torque of 31 ± 3 N•m (23 ± 2 lb ft), in a counterclockwise direction (as viewed from bottom).

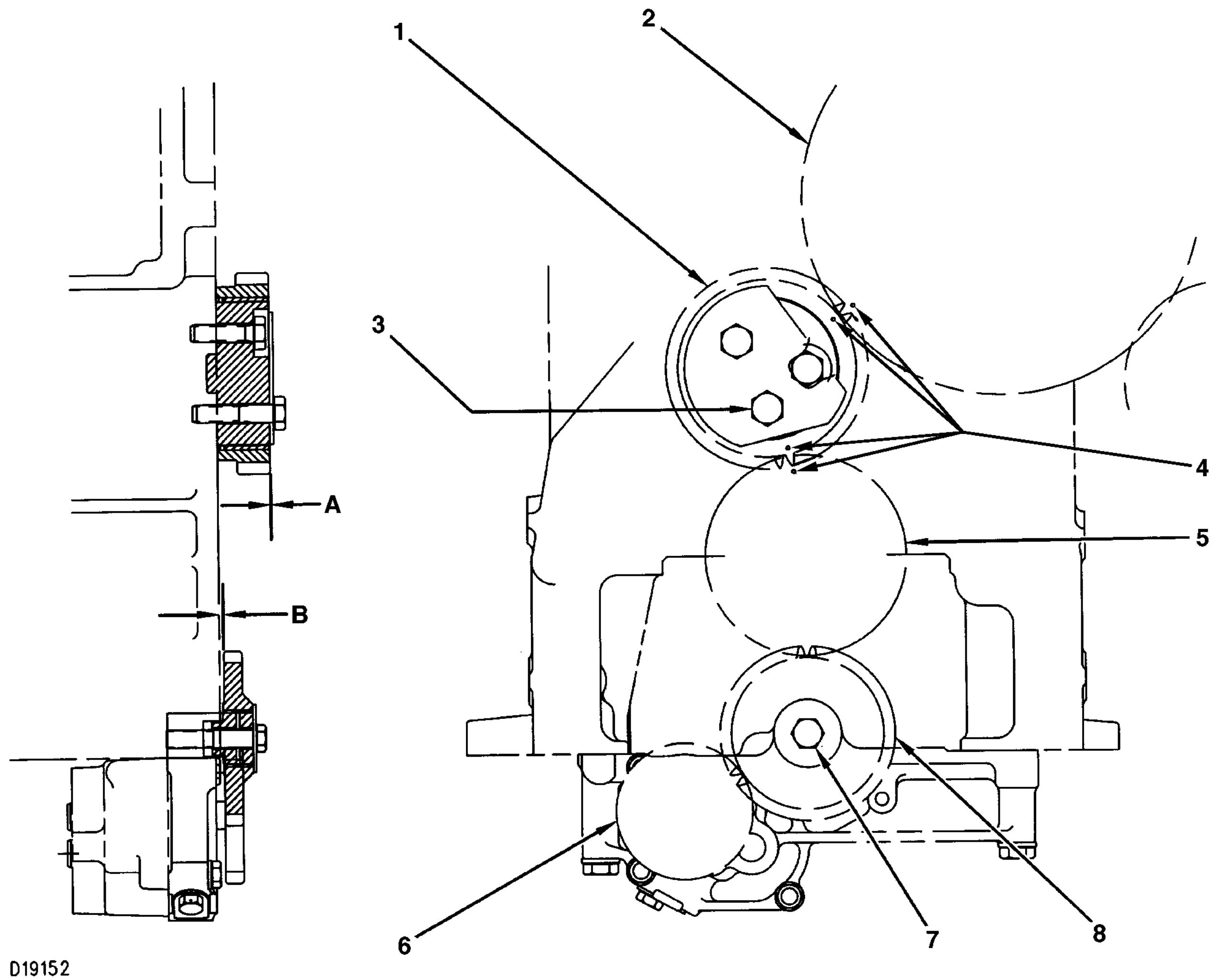
Oil Drain Group



(1) Tighten drain valve to a torque of ....40 ± 5 N•m (29 ± 4 lb ft)

(2) Tighten plug to a torque of....................................... ....40 ± 5 N•m (29 ± 4 lb ft)

Front Gear Group



(1) Camshaft idler gear.

Distance between front face of bearing in gear bore and front face of gear (dimension A) ....0.40 ± 0.25 mm (0.016 ± 0.010 in)

Diameter of cam idler shaft (new)............................. ....80.000 ± 0.013 mm (3.1496 ± 0.0005 in)

(2) Camshaft gear.

(3) Tighten bolts of camshaft idler gear to a torque of... ....70 ± 15 N•m (50 ± 11 lb ft)

(4) Align timing marks on camshaft idler gear (1) with holes on camshaft, and crankshaft gears (2) and (5).

(5) Crankshaft gear.

(6) Oil pump drive gear.

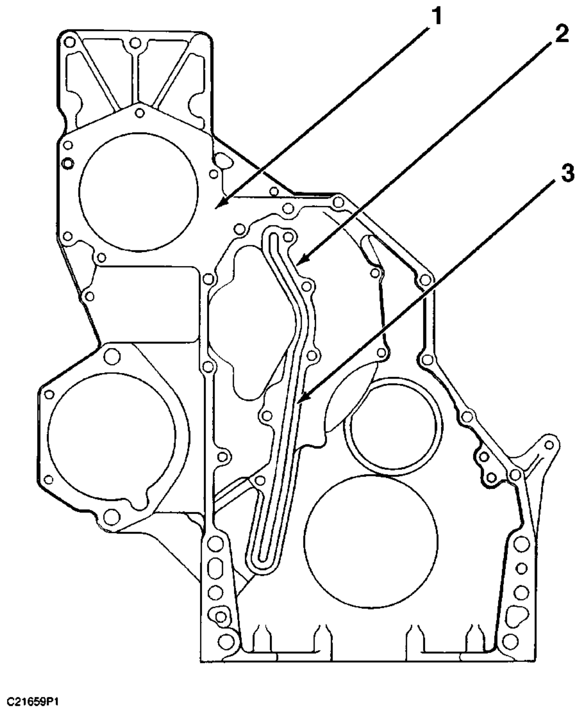
(7) Apply 9S-3263 Thread Lock to threads of oil pump idler gear bolt and tighten to a torque of.................. ....70 ± 15 N•m (50 ± 11 lb ft)

(8) Oil pump idler gear.

Distance between rear face of bearing in gear bore and rear face of gear (dimension B) ....0.75 ± 0.25 mm (0.030 ± 0.010 in)

Diameter of oil pump shaft (new).............................. ....28.644 ± 0.013 mm (1.1277 ± 0.0005 in)

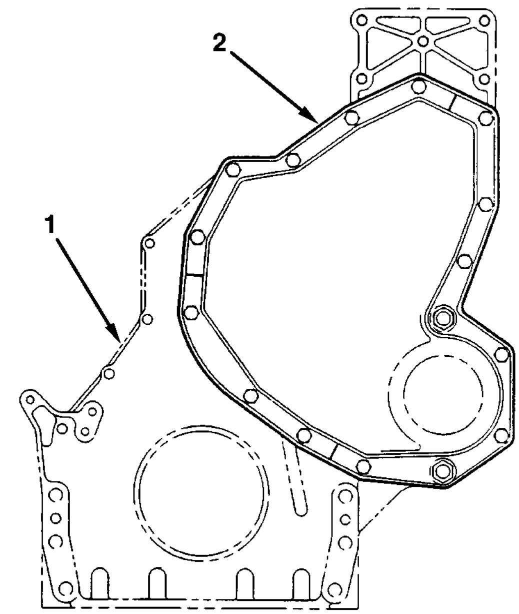
Front Housing



Block Mounting Face.

Before assembling front housing to cylinder block, apply approximately 15 mL (0.5 oz) of 1U-8846 Gasket Maker to entire area of surfaces (1) and (2) where they contact the cylinder block. Do not allow gasket maker to plug oil passage (3). Cover must be assembled and tightened to block within 10 minutes.

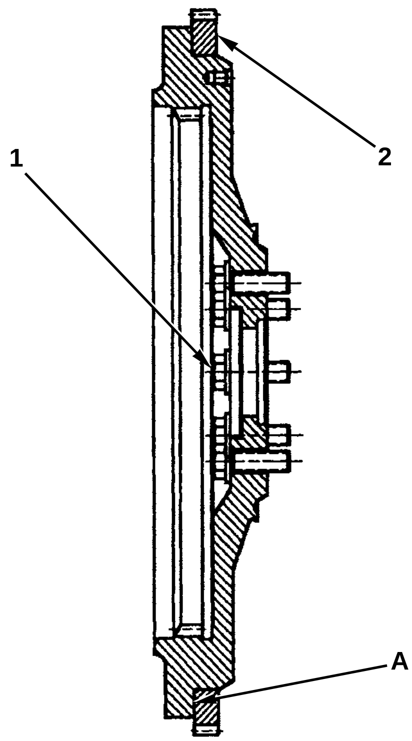
Front Housing Cover



(1) Front housing.

(2) Clean cover face of gasket with solvent. Apply, and spread uniformly, 1U-8846 Gasket Maker to gasket and around bolt holes. Cover must be assembled and tightened within 10 minutes.

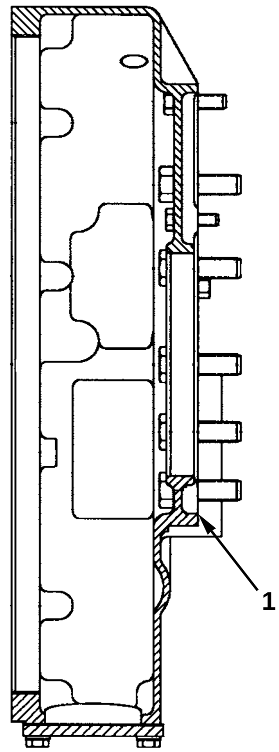
Flywheel



(1) Tighten bolts to a torque of ....120 ± 20 N•m ....(89 ± 15 lb ft)

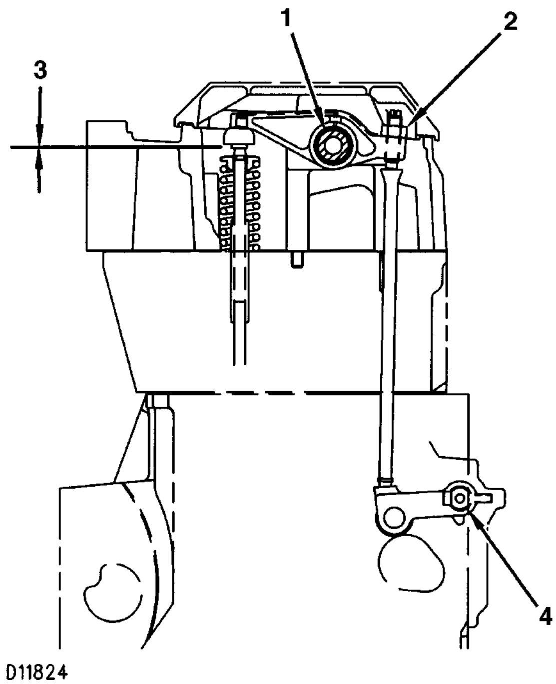
(2) Install ring gear with part number on this side. Ring gear must be assembled against shoulder (A) of flywheel. Maximum temperature of ring gear before installation on flywheel (do not use a torch) ....204°C (400°F)

Flywheel Housing



(1) Apply 1U-8846 Gasket Maker to housing joint face and spread uniformly.

Valve Rocker Arms and Lifters



(1) Bore in rocker arm for shaft (new) ....24.808 ± 0.020 mm (0.9767 ± 0.0008 in)
Diameter of shaft (new).............24.755 ± 0.010 mm ....(0.9746 ± 0.0004 in)

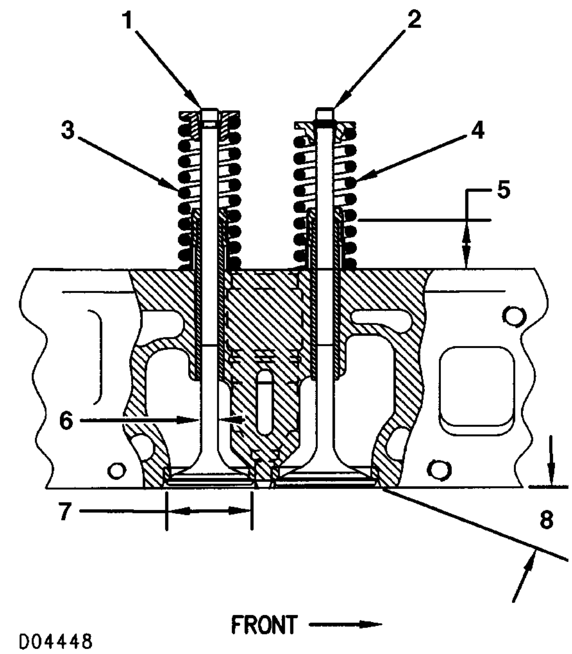
(2) Tighten lock nut to a torque of................................ ....25 ± 7 N•m (18 ± 5 lb ft)

(3) Valve lash:

Intake valves ....0.38 mm (0.015 in)
Exhaust valves ....0.64 mm (0.025 in)

(4) Bore in lifter arm for shaft (new)............................... ....15.670 ± 0.012 mm (0.6169 ± 0.0005 in)
Diameter of shaft (new).............15.620 ± 0.012 mm ....(0.6150 ± 0.0005 in)
Tighten bolts to a torque of ....13 ± 3 N•m ....(10 ± 2 lb ft)
Apply 4C-4030 Compound Thread Lock to threads.

Valves



NOTE: Coat the intake and exhaust valve stems with engine oil prior to installing them in the cylinder head.

NOTE: Coat the intake and exhaust valve tips with 8T-2988 Camshaft Break-In Lubricant (only after the retainer has been assembled).

(1) Exhaust valve.

(2) Intake valve.

(3) 6I-2307 Spring for exhaust valve:

Free length ....81.0 mm (3.19 in)
Assembled length.........................70.8 mm (2.79 in)
Load at assembled length...612 ± 31 N (140 ± 7 lb)
Minimum operating length.................59 mm (2.3 in)
Load at minimum operating length.......................... ....1325 ± 66 N (300 ± 15 lb)

(4) 7C-4273 Spring for intake valve:

Free length ....71.0 mm (2.80 in)
Assembled length ....65.86 mm (2.593 in)
Load at assembled length.....217 ± 22 N (49 ± 5 lb)
Minimum operating length............50.7 mm (2.00 in)
Load at minimum operating length.........858 ± 43 N .... (190 ± 10 lb)

(5) Height to top of valve guides ....23.00 ± 0.50 mm) ....(906 ± 0.020 in)

Install valve guide with 12.065 mm (0.4750 in) diameter on spring side of head.

Assemble with seal seated against top of valve guide.

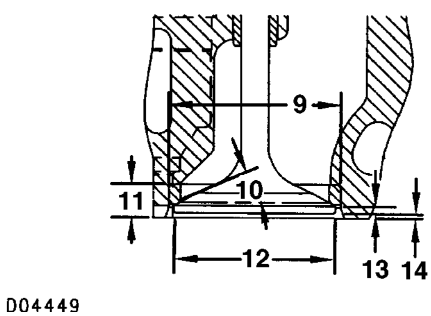
(6) Diameter of valve stems (new)....8.000 ± 0.008 mm ....(0.3150 ± 0.0003 in)
"Use again" minimum diameter of valve stems......... ....7.965 mm (0.3136 in)
Bore in valve guides with guides installed in head.... ....8.072 ± 0.013 mm (0.3178 ± 0.0005 in)
"Use again" maximum bore in valve guides with guides installed in head..........8.080 mm (0.3181 in)

(7) Diameter of valve head:

Intake valve......47.00 ± 0.13 mm (1.850 ± 0.005 in)
Exhaust valve...40.00 ± 0.13 mm (1.575 ± 0.005 in)

(8) Angle of valve faces:

Intake valve ....29 3/4 ± 1/4 degrees
Exhaust valve................................45 ± 1/4 degrees



(9) Diameter of valve seat inserts:

Intake valve ....50.000 ± 0.013 mm ....(1.9685 ± 0.0005 in)
Exhaust valve ....43.000 ± 0.013 mm ....(1.6929 ± 0.0005 in)

Bore in head for valve seat insert:

Insert valve ....49.931 ± 0.013 mm ....(1.9658 ± 0.0005 in)
Exhaust valve ....42.931 ± 0.013 mm ....(1.6902 ± 0.0005 in)
Valve seat insert must be shrunk by lowering temperature before installation in head.

(10) Angle of valve seat inserts:

Intake valve................................30 1/4 ± 1 degrees
Exhaust valve.............................45 1/2 ± 1 degrees

(11) Depth of bore in head for valve seat insert ....10.00 ± 0.13 mm (0.394 ± 0.005 in)

(12) Outside diameter of seating face of valve seat insert:

Intake valve ....44.029 ± 0.085 mm ....(1.733 ± 0.0033 in)
Exhaust valve ....38.077 ± 0.046 mm ....(1.500 ± 0.0018 in)

NOTE: Do not reuse or recondition valve seat inserts if the outside diameter is greater than specified.

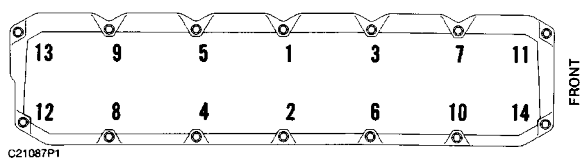
(13) "Use again" thickness of valve lip:

Intake valve ....1.80 mm (0.071 in)
Exhaust valve ....1.50 mm (0.059 in)

(14) Distance from head of valve to cylinder head face (valve closed):

Intake valve:
Maximum permissible.................2.05 mm (0.081 in)
Minimum permissible..................1.13 mm (0.044 in)
Exhaust valve:
Maximum permissible.................2.85 mm (0.112 in)
Minimum permissible..................2.67 mm (0.105 in)

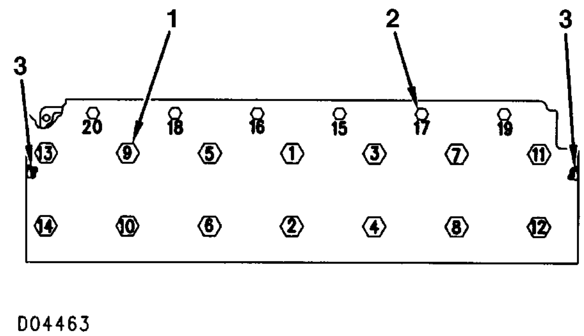
Valve Cover



Valve Cover Bolts, Tightening Sequence.

Tighten valve cover bolts in sequence shown to a torque of ....12 ± 3 N•m (9 ± 2 lb ft)

Cylinder Head



(1) Large bolts (M20).

(2) Small bolts (M10).

Install bolts (1) and (2) as follows:

a. Put engine oil on threads of bolts.

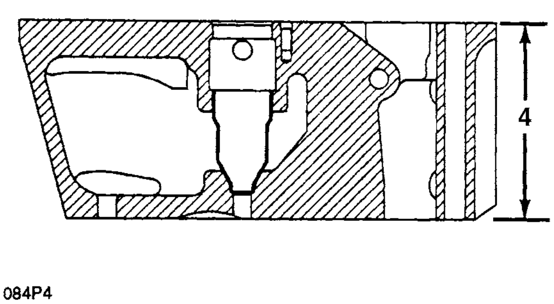
b. Tighten large bolts in sequence shown to a torque of ....150 ± 15 N•m (110 ± 11 lb ft)

c. Tighten large bolts in sequence shown to a torque of................435 ± 20 N•m (320 ± 15 lb ft)

d. Retighten large bolts in sequence shown to a torque of ....435 ± 20 N•m (320 ± 15 lb ft)

e. Tighten small bolts in sequence shown to a torque of........................55 ± 7 N•m (41 ± 5 lb ft)

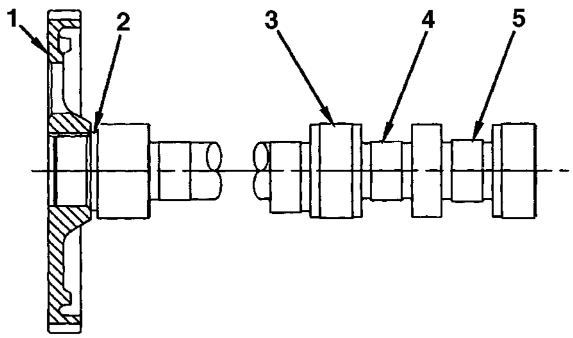
(3) Apply 6V-6640 Gasket Maker and install all plugs to a depth (measured from head face to top edge of plug) of ....1.25 ± 0.25 mm (0.049 ± 0.010 in)



Cylinder Head Cross Section.

(4) Height of cylinder head (new) .....103.00 ± 0.20 mm ....(4.055 ± 0.008 in)

Camshaft Group



(1) Heat gear to install (do not use torch). Do not heat above ....315°C (600°F)

(2) Distance between shoulder of camshaft and gear for thrust washer (new)...................4.83 ± 0.05 mm ....(0.190 ± 0.002 in)
Thickness of thrust washer (new)....4.70 ± 0.03 mm ....(0.185 ± 0.0012 in)
Endplay of camshaft (new)..............0.13 ± 0.08 mm ....(0.005 ± 0.0032 in)
Maximum permissible endplay (worn) ....0.46 mm ....(0.018 in)

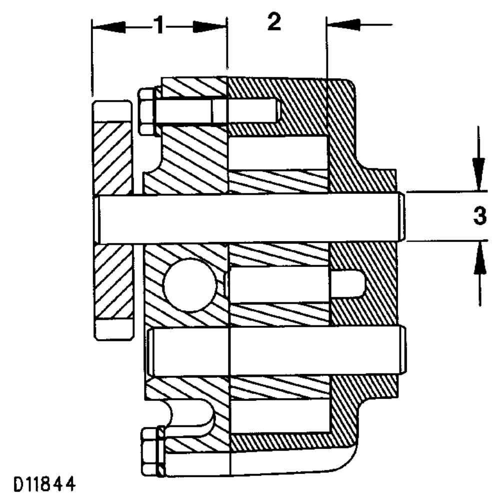
(3) Diameter of camshaft journals (new) ....65.126 ± 0.013 mm (2.5640 ± 0.0005 in)

(4) Intake lobe.

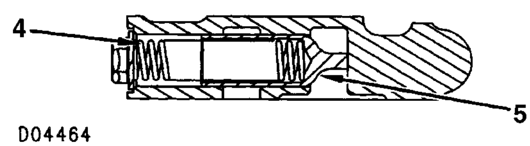
(5) Exhaust lobe.

Lubrication System

Oil Pump



Section View Through Pump Gears.



Section View Through Bypass Valve.

(1) Distance between outside face of gear and joint face of body ....43.00 ± 0.25 mm (1.693 ± 0.010 in)

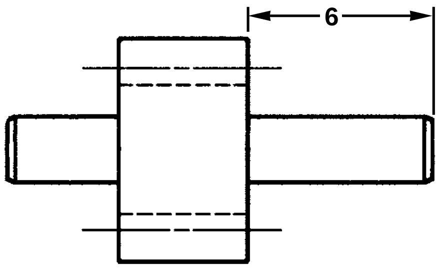
(2) Length of gears ....30.000 ± 0.025 mm ....(1.300 ± 0.001 in)
Depth of bores for gears.............30.13 ± 0.016 mm ....(1.304 ± 0.0006 in)

(3) Diameter of gear shafts ....15.600 ± 0.005 mm ....(0.6142 ± 0.0002 in)
Bores in pump bodies for gear shafts ....15.641 ± 0.008 mm (0.6158 ± 0.0003 in)

(4) 105-1805 Spring for relief valve:

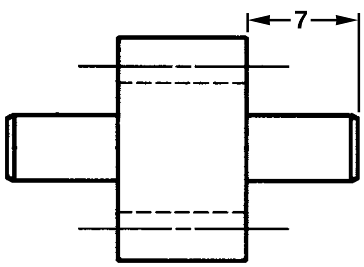
Outside diameter.............................13 mm (0.51 in)
Free length ....64.98 mm (2.558 in)
Assembled length.........................54.5 mm (2.15 in)
Load at assembled length..................51.99 ± 1.9 N ....(12 ± 0.4 lb)

(5) Diameter of relief valve plunger ....
................17.000 ± 0.013 mm (0.6693 ± 0.0005 in)
Bore in pump body for plunger ....
................17.100 ± 0.025 mm (0.4732 ± 0.0010 in)



Drive Gear (A).

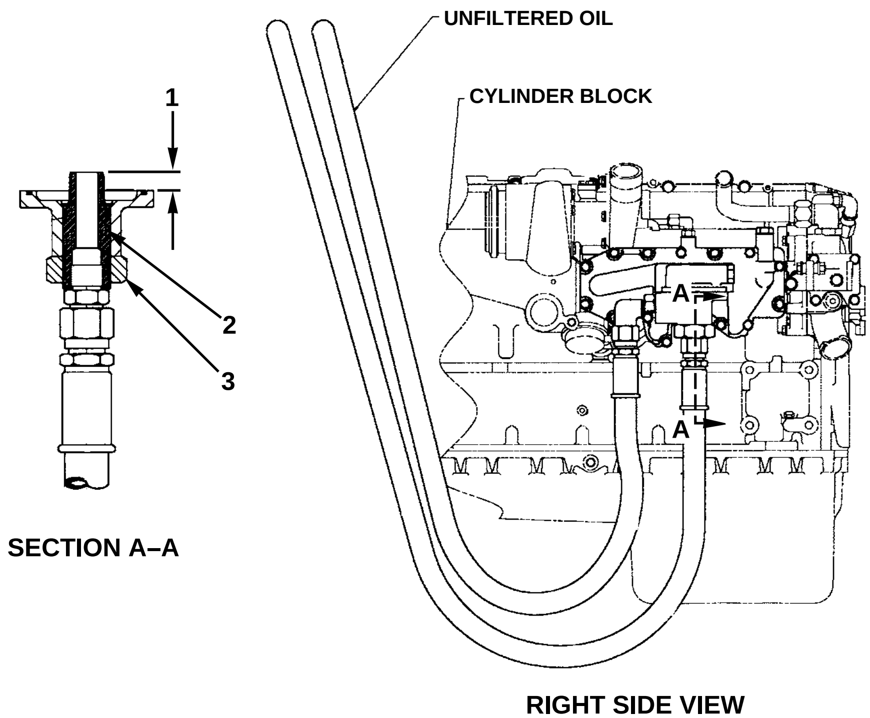
(6) Installation dimension ....43.00 ± 0.25 mm
....(1.693 ± 0.010 in)
Heat gear to install on shaft (do not use torch).
Temperature of gear not to exceed.........................
....316°C (600°F)



Drive Gear (B).

(7) Installation dimension ....26.0 ± 0.3 mm
....(1.02 ± 0.01 in)
Heat gear to install on shaft (do not use torch).
Temperature of gear not to exceed.........................
....316°C (600°F)

Oil Filter Group

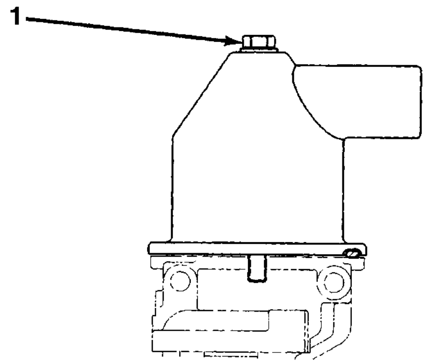


(1) Insert connector to a length of 15.0 ± 1.5 mm (0.59 ± 0.06 in) and apply 154-9731 Thread Compound (Loctite™ 271) to exposed length.

(2) Lubricate seal with clean engine oil prior to assembly.

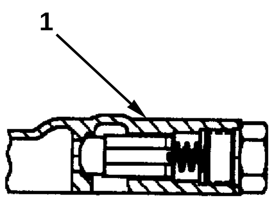
(3) Tighten nut to a torque of ....150 ± 20 N•m
....(110 ± 15 lb ft)

Breather (Crankcase)



(1) Tighten bolt to a torque of....................... 7 ± 2 N•m
.... (62 ± 18 lb in)

Oil Cooler Bypass Valve

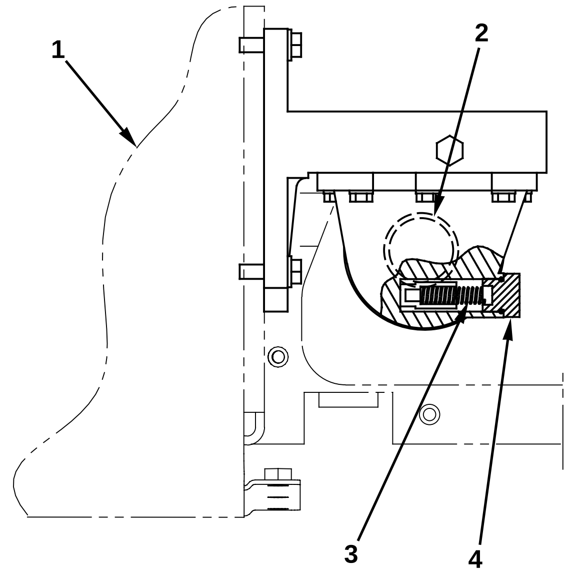


(1) Oil cooler bypass valve to open at......125 ± 30 kPa
....(18 ± 4.5 psi)

9L-9188 Spring for oil cooler bypass valve:

Outside diameter..........................11.2 mm (0.44 in)
Free length...................................57.9 mm (2.28 in)
Assembled length.........................43.2 mm (1.70 in)
Load at assembled length....................15.6 ± 1.3 N
....(3.50 ± 0.30 lb)

Oil Filter Base



(1) Fuel tank.

(2) Tighten filter stud to a torque of ....68 ± 7 N•m
....(50 ± 5 lb ft)

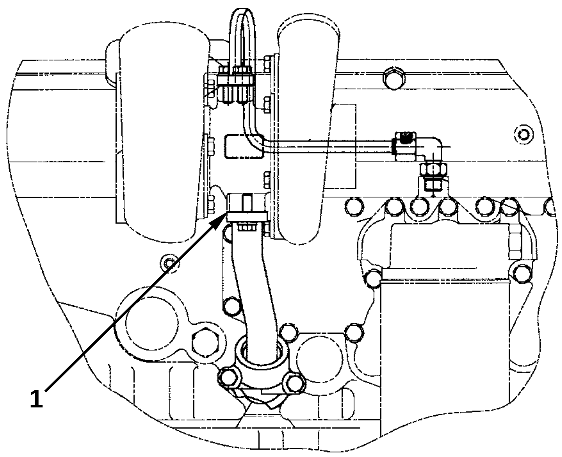
(3) Oil filter bypass valve to open at ....125 ± 30 kPa
....(18 ± 4.5 psi)

9L-9188 Spring for bypass valve:

Outside diameter..........................11.2 mm (0.44 in)
Free length...................................57.9 mm (2.28 in)
Assembled length.........................43.2 mm (1.70 in)
Load at assembled length....................15.6 ± 1.3 N
....(3.50 ± 0.30 lb)

(4) Tighten plug to a torque of ....53 ± 5 N•m
....(39 ± 4 lb ft)

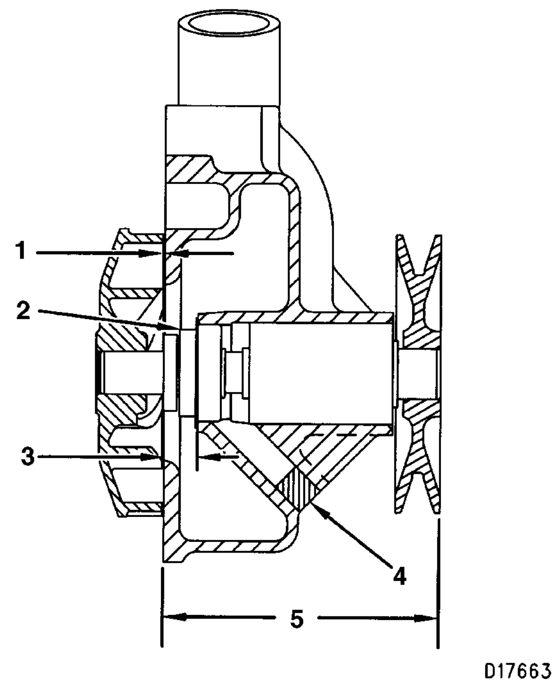
Turbocharger Lines Group



(1) Lubricate seal with engine oil prior to assembly.

Cooling System

Water Pump



Shown With Impeller Cover Removed.

(1) Clearance between impeller and housing ....0.75 ± 0.25 mm (0.030 ± 0.010 in)

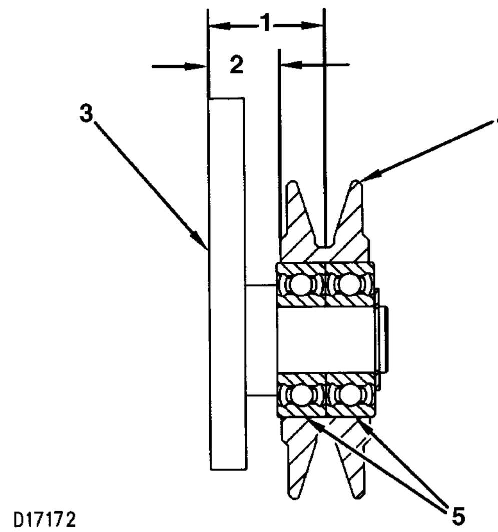
(2) Seal.

(3) Working height of seal..................12.83 ± 0.13 mm ....(0.505 ± 0.005 in)

(4) Filter should not extend beyond surface of housing.

(5) Dimension from front face of pulley to face of housing..................103.8 ± 0.3 mm (4.09 ± 0.01 in)

Water Pump Belt Tightener



Idler Pulley Assembly.

(1) Distance from back of plate assembly (3) to middle of pulley (4) ....26.0 ± 0.3 mm (1.02 ± 0.012 in)

(2) Distance from back of plate assembly (3) to back of pulley (4) ....16.0 ± 0.3 mm (0.63 ± 0.01 in)

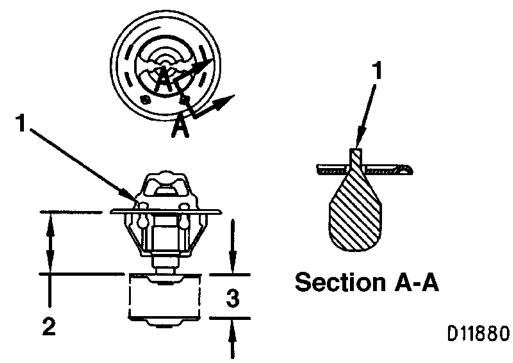
(3) Plate assembly.

(4) Pulley.

(5) Apply 9S-3263 Thread Lock to the pulley bore before assembling.

Use a BT–33–97 (new) or BT–33–95 (old) Burroughs Gauge to tighten V-belts to an initial tension of 534 ± 22 N (120 ± 5 lb). After 30 minutes of operation at rated speed, tighten V-belts to tension of 400 ± 44 N (90 ± 10 lb).

Water Temperature Regulator



Full-open temperature...............................94°C (201°F)

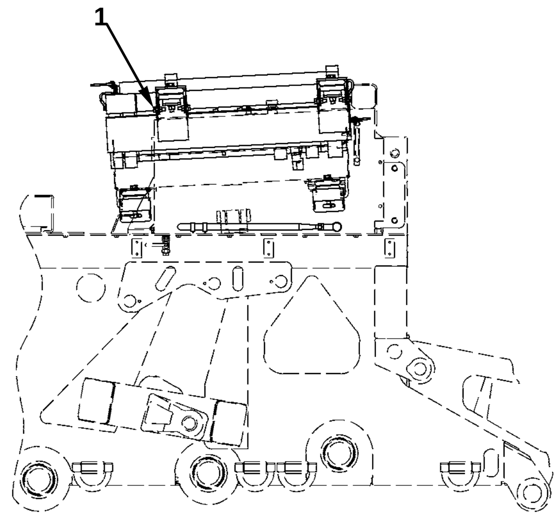
(1) Air vent valve.

(2) Closed dimension...30.5 ± 0.5 mm (1.20 ± 0.02 in)

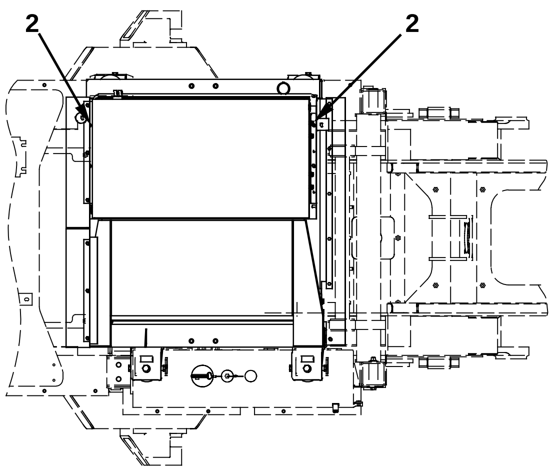
(3) Minimum stroke at full-open temperature ....8.75 mm (0.34 in)

NOTE: Regulator is rated at 83°C (181°F).

Radiator Group



Left Side View.

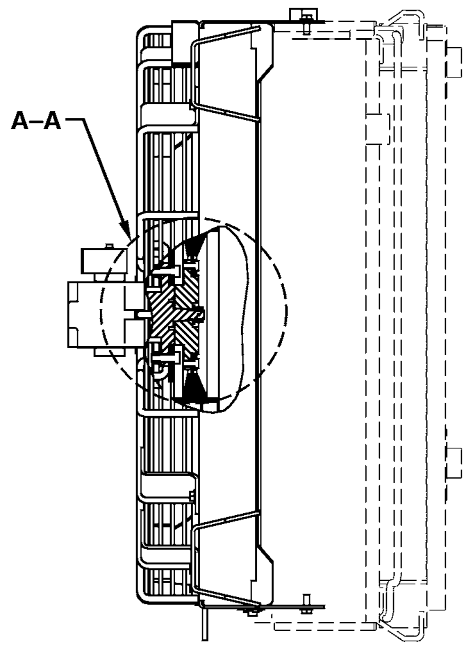


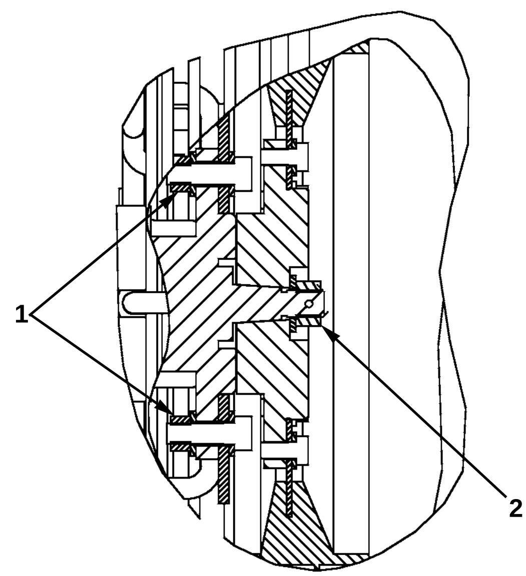
Top View.

(1) Tighten four bolts to a torque of........105 ± 29 N•m ....(77 ± 21 lb ft)

(2) Tighten seven bolts to a torque of ....47 ± 9 N•m ....(35 ± 7 lb ft)

Fan Drive Mounting Group





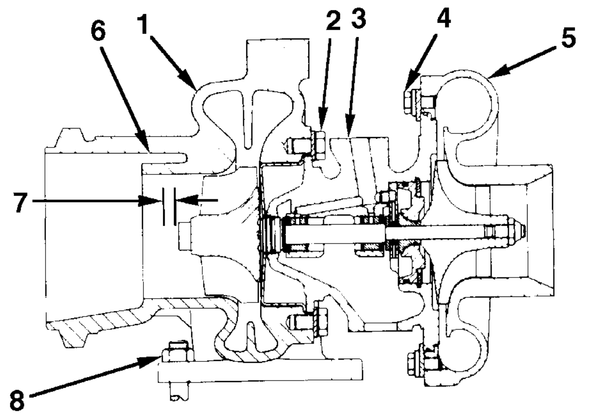
View A–A.

(1) Tighten two nuts to a torque of.........105 ± 20 N•m ....(77 ± 15 lb in)

(2) Tighten (6B-6683) nut to a torque of........................ ....115 ± 20 N•m (85 ± 15 lb ft)

Air Intake and Exhaust System

Turbocharger



(1) Turbine housing.

(2) Apply 5P-3931 Antiseize Lubricant to threads of bolts which hold turbine housing to turbocharger. Tighten to a torque of......................15.8 ± 0.5 N•m ....(140 ± 4 lb in)

(3) Cartridge.

(4) Tighten bolts which hold compressor housing to turbocharger cartridge to a torque of...................... ....7.3 ± 0.5 N•m (65 ± 4 lb in)

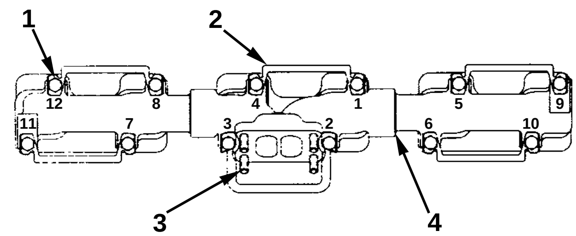
(5) Compressor housing.

(6) Wastegate passage (internal passage in turbine housing).

(7) Endplay for shaft ....0.051 to 0.083 mm ....(0.0020 to 0.0033 in)

(8) Apply 5P-3931 Antiseize Lubricant. Tighten to a torque of........54 ± 5 N•m (40 ± 4 lb ft)

Exhaust Manifold



(1) Apply 5P-3931 Antiseize Lubricant to threads and washer face of bolts and washers, and tighten as follows:

a. Tighten bolts 1 through 12 in sequence to........... ....4 ± 1 N•m (35 ± 9 lb in)

b. Retighten bolts 1 through 12 in sequence to ....45 ± 5 N•m (33 ± 4 lb ft)

(2) Bend lock tabs over flat of bolt heads.

(3) Tighten studs to a torque of..................35 ± 5 N•m ....(26 ± 4 lb ft)

(4) a. Coat inside diameter of female ends of manifold with engine oil.

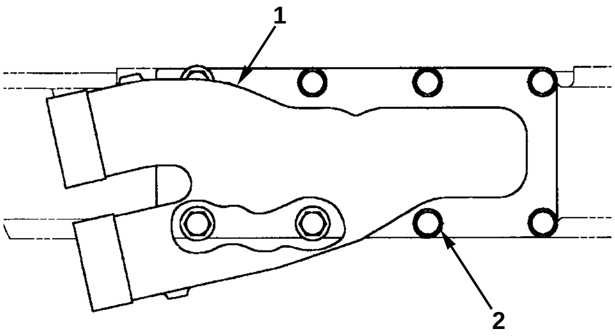
b. Apply thin coat of 2P-2333 Manifold Sealer to outside diameter of male ends of manifold before assembly. Do not apply sealer at tip of male ends.

c. Remove excess sealer from assembled joint.

NOTICE

Perform the procedure in Item (4) while assembling the three-piece exhaust manifold to the cylinder block. If 2P-2333 Manifold Sealer is left on the inside of the exhaust manifold after assembly, the turbocharger could be damaged.

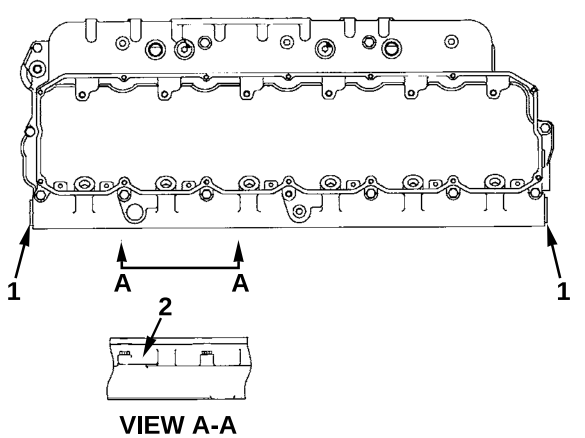
Air Intake Elbow



(1) Clean air intake elbow joint face with solvent, and apply 6V-1541 Quick Cure Primer. Allow primer to air dry (three to five minutes minimum). Apply 1U-8846 Gasket Maker to elbow joint face and spread uniformly. Elbow must be assembled and tightened within 10 minutes.

(2) Tighten bolts to a torque of ....30 ± 7 N•m ....(22 ± 5 lb ft)

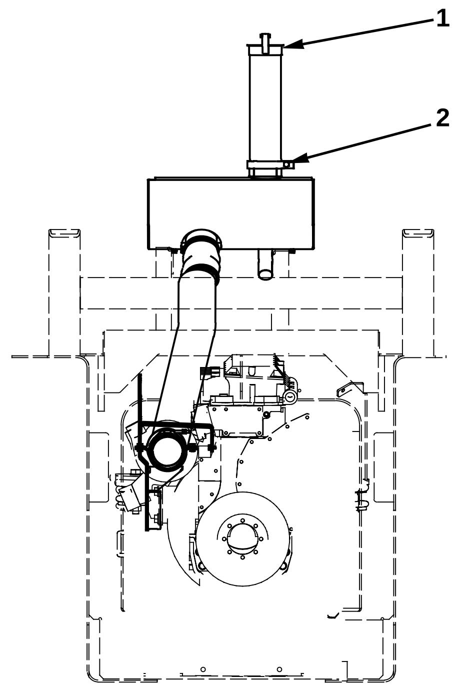
Air Intake Manifold



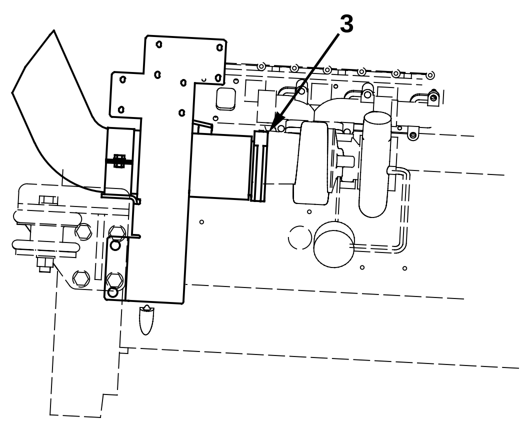
(1) Tighten harness grommet screw to a torque of ....9 ± 0.1 N•m (7 ± 0.1 lb ft)

(2) Apply 4C-4030 Compound Thread Lock to last three threads on end of plug that is opposite O-ring seal.

Muffler Group



View From Front of Machine.



View From Right Side of Machine.

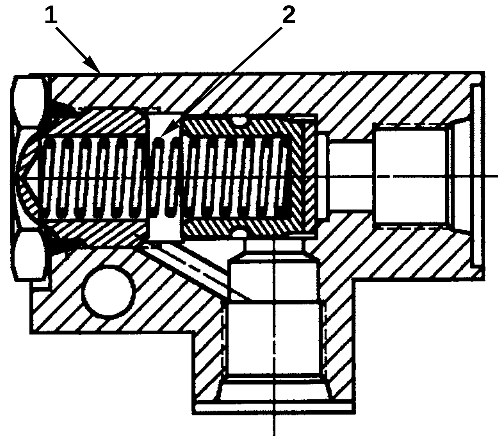
(1) Apply 4C-5598 Antiseize to threads of clamp prior to assembly.

(2) Apply 4C-5598 Antiseize to threads of clamp prior to assembly.

(3) Apply 4C-5598 Antiseize to threads of clamp prior to assembly.

Fuel System

Fuel Filter Bypass Relief Valve



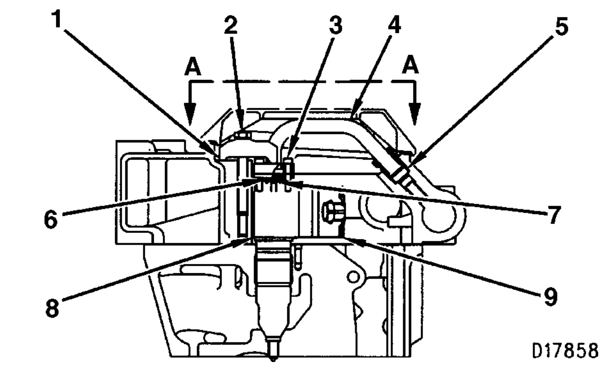
(1) Bypass pressure ....517.5 kPa (75 psi)

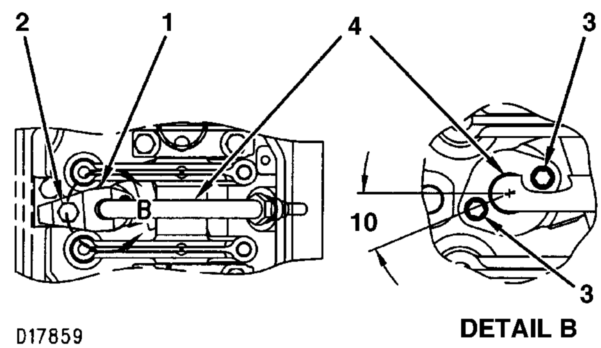
NOTE: This valve is located at the secondary fuel filter.

(2) 141-8287 Spring:

Free length.................................57.61 mm (2.27 in)
Length under test force.............33.96 mm (1.34 in)
Test force.......................85.1 ± 2.9 N (19 ± 0.65 lb)

Hydraulic Oil Lines





View A-A.

(1) Injector hold down clamp.

(2) Tighten bolt to a torque of.....................30 ± 7 N•m
.... (22 ± 5 lb ft)

(3) Tighten bolt to a torque of....................5 ± 0.5 N•m
....(45 ± 4 lb in)

(4) Tighten flare nut of jumper tube assembly to a torque of ....40 ± 5 N•m (30 ± 4 lb ft)

(5) Tighten orifice fitting to a torque of .....0.25 ± 3 N•m
....(18 ± 2 lb ft)

(6) Seat.

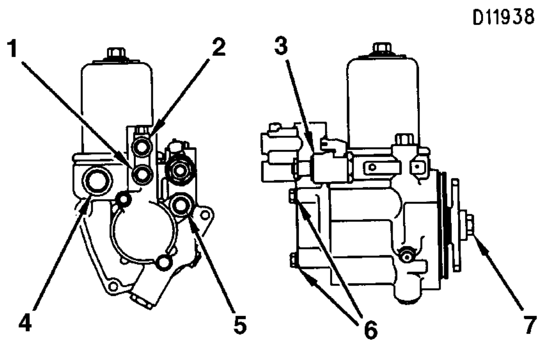
(7) O-ring.

(8) Hydraulic Electronic Unit Injector (HEUI).

(9) Solenoid.

(10) Angle of bolt orientation with jumper tube assembly (4) ....26 ± 3 degrees

Hydraulic Pump Group (Fuel Transfer Pump and High Pressure Oil Pump)



(1) Fuel pump outlet. Final installation into pump, tighten to a torque of.........35 ± 3 N•m (26 ± 2 lb ft)

(2) For fuel pump intake final installation, tighten to a torque of ....35 ± 3 N•m (26 ± 2 lb ft)

(3) Injection actuation pressure control valve.

⚠ WARNING

The removal procedure for the injection actuation pressure control valve requires extreme caution. First, disconnect the electrical connection. Then, remove the injection actuation pressure control valve's solenoid assembly. Finally, remove the injection actuation pressure control valve using a crow's foot wrench with an extension.

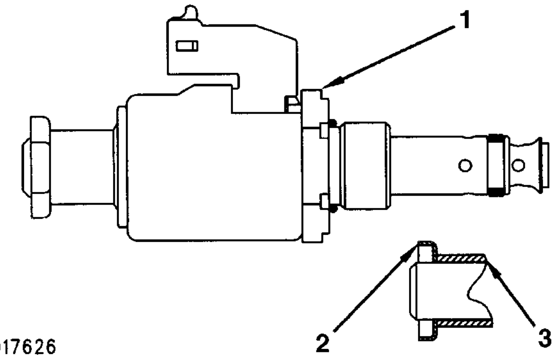
(4) For oil pump intake fitting final installation, tighten to a torque of............................26±3 N•m (19± 2 lb ft)

(5) For oil pump outlet fitting final installation, tighten to a torque of.........................23 ± 2 N•m (17 ± 1 lb ft)

(6) Tighten bolt to a torque of ....25 ± 3 N•m (18 ± 2 lb ft)

(7) Tighten bolt to a torque of ....110 ± 14 N•m (80 ± 10 lb ft)

Injection Actuation Pressure Control Valve



(1) For injection actuation pressure control valve final installation, tighten to a torque of ....50 ± 5 N•m ....(37 ± 4 lb ft)

(2) For final installation of nut, tighten to a torque of...... ....5.5 ± 1.5 N•m (49 ± 13 lb in)

(3) Spacer.

Coil resistance..10.1 Ohms

Fuel Characteristics

Caterpillar Specification for Distillate Fuel	
Specification (Test Procedure)	**Requirement**
Aromatics "ASTM D1319"	35 percent maximum
Ash "ASTM D482"	0.02 percent maximum
Carbon Residue on 10 percent Bottoms ASTM D524"	maximum or 0.35 percent by weight
Cetane Number "ASTM D613"	40 minimum cetane
Cloud Point	This point should be below the lowest expected temperature.
Corrosion (Copper Strip) "ASTM D130"	No. 3 maximum
Distillation "ASTM D86"	10 percent at 282°C (540°F) maximum 90 percent at 360°C (680°F) maximum
Flash Point "ASTM D93"	legal limit
API Gravity "ASTM D287"	30 minimum, 45 maximum
Pour Point "ASTM D97"	6°C (10°F) minimum below ambient temperature
Sulfur "ASTM D3605" or "ASTM D1552"(1)	3 percent maximum(1)
Kinematic Viscosity at 40 °C (104°F) "ASTM D445"(2)	1.4 cST minimum, 20.0 cSt maximum
Water and Sediment "ASTM D1796"	0.1 percent maximum
Water	0.1 percent maximum
Sediment "ASTM D473"	0.05 percent maximum
Gum and Resins "ASTM D381"(3)	10 mg per 100 mL maximum
Fuel Lubricity Scuffing Load Wear Test (SBOCLE) or High Frequency Reciprocating Rig (HFRR)(4)	3100 g minimum 0.45mm maximum at 60°C (140°F) or 0.38 mm maximum at 25°C (77°F)

(1) Caterpillar fuel systems and engine components can operate on high sulfur fuels. However, Fuel sulfur levels effect exhaust particulate emissions. High sulfur fuels increase the potential for internal component corrosion. Fuel sulfur levels above 1.0 percent may significantly shorten the oil change interval. Refer to the TBN and Fuel Sulfur topic in the lubricant's section for additional information.
(2) The viscosity limits are for the fuel as the fuel is delivered to the fuel injection pump. Fuels such as JP-8, JP-5, Jet-A-1, or No. 1 diesel fuel have low viscosity. Maintaining the fuel level above one-half of a tank can minimize wear on fuel system components when the machine is operated in temperatures greater than 38°C (100°F).
(3) Follow the test conditions and procedures for gasoline (motor).
(4) Low sulfur fuel is commonly used. The treatment that is used to create low sulfur fuel often lowers the fuel lubricity. If the fuel lubricity does not meet the minimum requirements, consult your fuel's supplier. Do not treat the fuel without consulting with the fuel supplier. Some additives are not compatible. This can cause problems in the fuel system. See "ASTM D6708" (SBOCLE) and "ASTM D6079" (DFRR).

Lubricity and Low Sulfur Fuel

NOTE: The fuel lubricity is important. You should consider the fuel's lubricity whenever you operate the equipment in arctic weather. Also, you should consider the fuel's lubricity whenever you use fuels that are lower in viscosity. There are many aftermarket additives that are available to treat fuel. If the fuel's lubricity is an issue, consult your fuel supplier for proper recommendations regarding fuel additives.

In the U.S., a 0.05 percent limit on the amount of fuel sulfur in diesel fuel was mandated in January of 1994 for on-highway trucks. The removal of sulfur from diesel fuel helps to reduce particulate emissions from diesel engines. While limits for fuel sulfur have not generally been mandated for off-highway use, some local governments have regulations that include off-highway use. There is frequently no difference in the fuel that is sold for different applications. The same fuel is often used for both on-highway applications and off-highway applications. Other areas of the world are mandating similar limits. Regulations continue to become more stringent. Lower sulfur limits can be expected in the future.

The fluid's lubricity describes the ability of the fluid to reduce the friction between surfaces that are under load. This ability reduces the damage that is caused by friction. Fuel injection systems rely on the lubricating properties of the fuel. Until fuel sulfur limits were mandated, the fuel's lubricity was generally believed to be a function of fuel viscosity.

The process that is most commonly used to remove sulfur from fuel is called hydro-treatment. This process is also the most economical process. Each source of crude oil contains different amounts of sulfur. Crude oils with low sulfur require little hydro-treatment to obtain the 0.05 percent limit. Crude oils with high sulfur require a more severe treatment.

The Hydro-treatment removes the fuel's sulfur as well as other components. The treatment removes nitrogen compounds, polar materials, bicyclic aromatics, polycyclic aromatics, and oxygen compounds. While the removal of sulfur has shown no detrimental effects to the engine, the removal of other compounds have lowered lubricity, the fuel is fuel. As a result of the lowered lubricity, the fuel is less tolerant of contamination by water and dirt. The lower fuel lubricity can be seen as abrasive wear of fuel system components. Fuels that have a low lubricity may not provide adequate lubrication to plungers, to barrels, and to injectors. This problem may be compounded in areas that require winter blends of fuel. The lighter winter fuel blend has the following characteristics: lower viscosity, lower cloud point, and lower pour point.

All low sulfur fuels do not have a low lubricity. The fuel's lubricity may be enhanced with additives. Many fuel suppliers treat the fuel with these additives. Do not use a fuel lubricity additive before you consult the fuel's supplier. Some aftermarket additives may not be compatible with the additives that are already in the fuel. Some additive packages that are supplied by the aftermarket manufacturer may not be compatible with the seals that are used in fuel systems of some diesel engines. Other additive packages that are supplied by aftermarket manufacturers cannot provide proper performance in high temperature conditions. These additives may leave deposits because of the high temperatures that exist in the fuel systems of diesel engines.

Maximum life of the fuel system can be achieved by performing the following tasks: using a reliable fuel supplier, performing proper maintenance of the fuel system, and installing Caterpillar high efficiency fuel filters in the fuel system.

NOTE: Lighter fuels are frequently used in arctic temperatures. Lighter fuels may include the following fuels: Jet A-1, JP-8, JP-5, and kerosene. The fuel lubricity is not a requirement for these fuels. Do not assume that a fuel meets the minimum specification. Contact the fuel supplier for proper recommendations on fuel specifications (lubricity).

Viscosity

The viscosity of the fuel is significant because the fuel serves as a lubricant for fuel system components. Arctic fuels need to have sufficient viscosity. The fuel must lubricate the fuel system at a temperature of 0°C (32°F) or below freezing. If the kinematic viscosity of the fuel is lower than 1.4 cSt as supplied to the fuel injection pump or to the unit injectors, excessive scuffing and seizure can occur. Maintaining the fuel level above one-half of a tank can minimize wear on fuel system components when the machine is operated in temperatures greater than 38°C (100°F).

Cetane Number

The cetane number of the fuel has an effect on the ability of the engine to start. Also, the cetane number has an effect on the interval of time before the engine runs smoothly. Generally, an increase of ten in the cetane number will allow the engine to be started at a lower temperature. The starting temperature can be improved approximately 7 to 8°C (12 to 15°F) for every increase of ten in the cetane number. After the engine reaches the normal operating temperature, a change in the cetane from 40 to 50 will have a minimum effect on engine performance.

Most fuels that have a cetane number above 40 will permit acceptable engine starts in warmer outside temperatures. The engine will start satisfactorily with this fuel when the engine is kept warm. The engine can be kept warm by using either a heated room or a coolant heater.

During average starting conditions, direct injection engines require a minimum cetane number of 40. A higher cetane value may be required for operation in high altitude or for cold weather operation. The minimum fuel cetane number that is required for the precombustion engine is 35.

Modifying the Cetane Number

The cetane number of a fuel can be changed if the fuel is mixed with a fuel that has a different cetane number. Generally, the cetane number of the mixture will be in direct relation to the ratio of the fuels that were mixed. Your fuel supplier can provide the information about the cetane number of a particular fuel.

Additives can also be used to improve the cetane number of a fuel. Additives are evaluated through testing in special engines. However, the fuel characteristics of additives are not identical to a natural product. While both fuels may be rated as having the same cetane number, starting may be different.

Cloud Point

It is important to understand that the cloud point of a fuel is different from the pour point. There is no relationship between cloud point and the pour point. The cloud point is the temperature that allows some of the heavier components in the wax to solidify in the fuel. This wax is not a contaminant in the fuel. The wax is an important element of No. 2 diesel fuel. The wax has a high fuel energy content and the wax has a very high cetane value. Removal of the heavier wax lowers the cloud point of the fuel. Removal of the wax also increases the cost because less fuel can be made from the same amount of crude oil. Basically, a No. 1 diesel fuel is formulated by removing the wax from a No. 2 diesel fuel.

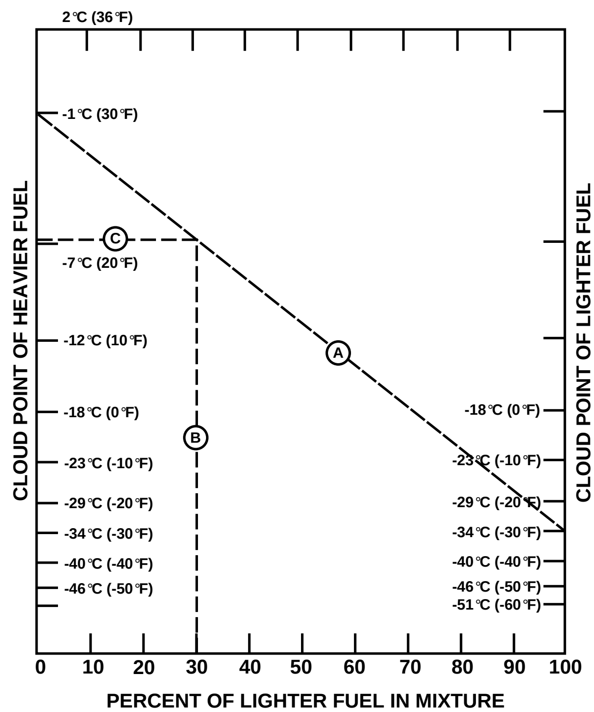
The cloud point of the fuel is important because the cloud point can limit the performance of the fuel filter. The wax can alter the fuel characteristics in cold weather. Solid wax can fill the fuel filters. The solidified wax will stop the flow of fuel. Fuel filters are necessary in order to remove dirt from the fuel. The filters block foreign material, and the filters protect the parts for the fuel injection system. Since fuel must flow through the filters, installing a fuel heater is the most practical way to prevent the problem. A fuel heater will keep the fuel above the cloud point as the fuel flows through the fuel system. The fuel heater will permit the wax to flow through the filters with the fuel.

Modifying the Cloud Point

You can lower the cloud point of a diesel fuel by mixing the diesel fuel with a different fuel that has a lower cloud point. No. 1 diesel fuel or kerosene may be used to lower the cloud point of a diesel fuel. The efficiency of this method is not good, because the ratio of the mixture does not have a direct relation to the improvement in cloud point. The amount of fuel with low cloud point that is required makes the process less preferable to use.

The following illustration contains a table that can be used to find the necessary mixture for two fuels with different cloud points. In order to use the table, you must know the exact fuel cloud point of each fuel. This specification can change from one purchase of fuel to the next purchase of fuel. This specification is normally available from personnel at the source of the fuel supply. When fuels that have a lower cloud point are not available, this method cannot be used.

The manufacturer of the fuel can add cold flow improvers to the fuel. Cold flow improvers modify the wax crystals in the fuels. The cold flow improvers do not change the fuel's cloud point. However, the cold flow improvers keep the wax crystals small enough to pass through standard fuel filters. For mixing precautions, see the topic "Pour Point."



Cloud point of fuel mixtures

Generally, the most practical method that is used to prevent problems that are caused by fuel cloud point at low temperatures is the use of fuel heaters. In most applications, fuel heaters can be used at a lower cost than fuel mixtures.

Pour Point

The fuel's pour point is a temperature below the fuel's cloud point. Fuel stops flowing below the pour point. The pour point is the temperature which limits movement of the fuel with pumps.

To measure the pour point, the fuel temperature is lowered below the cloud point in steps of 3°C (5°F) at a time. The temperature is lowered until the fuel does not flow. The pour point is the last temperature that is shown before the flow stops. At the pour point, the wax has solidified out of the fuel. This makes the fuel more solid than liquid. The pour point of the fuel can be improved. This does not require the removal of important elements. This process is the same process that is used to improve the cloud point of a fuel.

A fuel's pour point should be at least 6°C (10°F) below the lowest ambient temperature that is required for engine start-up and for engine operation. To operate the engine in extremely cold weather, No. 1 fuel or No. 1-D fuel may be necessary because of these fuels' lower pour points.

Modifying the Pour Point

You can lower the fuel's pour point by using additives. You can also lower the pour point by mixing the fuel with a fuel that has a lower pour point. See the topic "Cloud Point" for the procedure. This procedure is not the best procedure to use.

The cloud point fuel mixture illustration (above) can also be used for an estimate of pour points. This is true only if the fuels do not have additives which change the pour point.

In order to calculate the amount of lighter fuel that is required to be blended with the heavier fuel, perform the following steps:

1. Obtain the specification for fuel cloud point of both fuels from your fuel supplier.

2. Locate the cloud point of the heavier fuel on the left side of the table. Mark the point on the table.

3. Locate the cloud point of the lighter fuel on the right side of the table. Mark the point on the table.

4. Draw a line between the two points that were established. Label this line "A."

5. Determine the lowest outside temperature for machine operation. Find this point on the left side of the table. Mark this point. Draw a horizontal line from this point. Stop the line at the intersection of line "A." Label this new line "C."

6. Draw a vertical line from the intersection of lines "A" and "C." Stop the line at the bottom of the table. Label this line "B." The point at the bottom of line "B" reveals the percentage of lighter fuel that is required to modify the pour point.

The above example shows that the blending will require a thirty percent mixture of lighter fuel.

Additives are a good method to use in order to lower the pour point of fuel. These additives are known by the following names: pour depressants, cold flow improvers, and wax modifiers. When the additives are used in a low concentration, the fuel will flow through pumps, lines, and hoses. These additives must be thoroughly mixed into the fuel at temperatures that are above the cloud point. The fuel supplier should be contacted in order to blend the fuel with the additives. The blended fuel can be delivered to your fuel tanks.

Moisture Content

Problems with fuel filters can occur at any time. The cause of the problem can be water in the fuel or moisture in the fuel. At low temperatures, moisture causes special problems. There are three types of moisture in fuel: dissolved moisture (moisture in solution), free and dispersed moisture in the fuel, and free and settled at the bottom of the tank.

Most diesel fuels have some dissolved moisture. Just as the moisture in air, the fuel can only contain a specific maximum amount of moisture at any one temperature. The amount becomes less as the temperature is lowered. For example, a fuel could contain 100 ppm (0.010 percent) of water in solution at 18°C (65°F). This same fuel can possibly hold only 30 ppm (0.003 percent) at 4°C (40°F).

After the fuel has absorbed the maximum possible amount of water, the additional water will be free and dispersed. Free and dispersed moisture is fine droplets of water that is suspended in the fuel. Since the water is heavier than the fuel, the water will slowly become free and settled at the bottom of the tank. In the above example, when the fuel temperature was lowered from 18°C (65°F) to 4°C (40°F), 70 ppm of water became free and dispersed in the fuel.

The small drops of water cause a cloudy appearance in the fuel. If the change in temperature is slow, the small drops of water can settle to the bottom of the tank. When the fuel temperature is lowered rapidly to freezing temperature, the moisture that comes out-of-solution changes to very fine particles of ice instead of small drops of water.

The particles of ice are lighter than the fuel, and the particles of ice will not settle to the bottom of the tank. When this type of moisture is mixed in the fuel, this moisture will fill the fuel filters. The ice crystals will plug the fuel filters in the same way as wax plugs the fuel filters.

If a filter is plugged and fuel flow is stopped, perform the following procedure to determine the cause:

1. Remove the fuel filters.

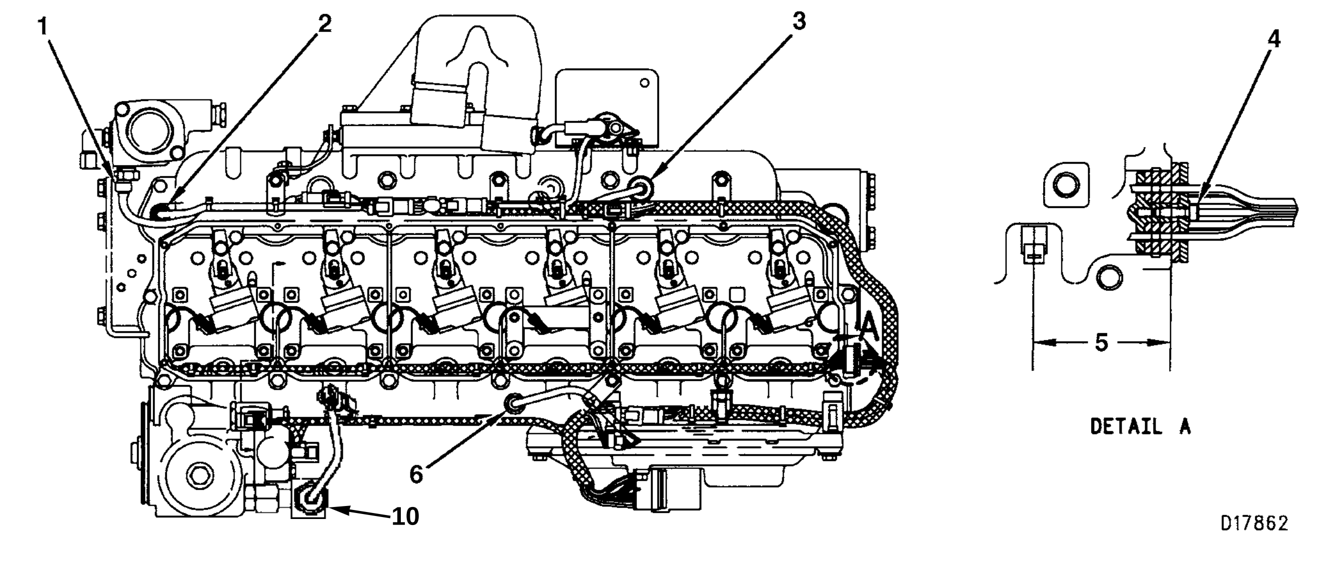
2. Cut the fuel filters open.

3. Inspect the fuel filter before the filter warms. This inspection will show that the filter is filled with particles of either ice or wax.

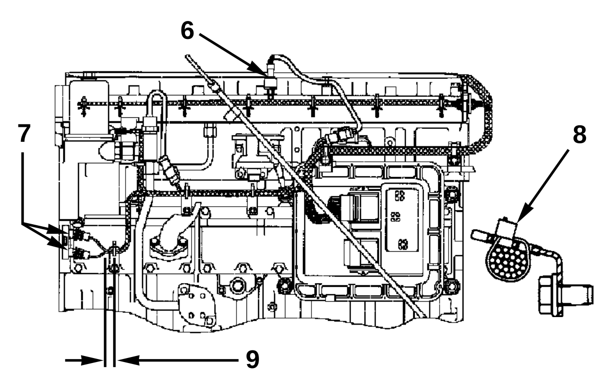
The moisture which is free and settled at the bottom of the tank can become mixed with the fuel. The force of any pumping action will mix the moisture with the fuel whenever fuel is transferred. This moisture then becomes free and dispersed water. This moisture can cause ice in the filters. This moisture can cause other problems with filters at any temperature. Generally, the same force that mixes the water into the fuel will also mix dirt and rust from the bottom of the tank with the water. The result is a dirty mixture of fuel and water which can also fill the filters and stop fuel flow.

Engine Electrical

Electronic Control Group (Wiring and Sensors)



Top View.



Left Side View.

(1) Coolant temperature sensor.

(2) Tighten air intake manifold pressure (boost) sensor to a torque of..................10 ± 2 N•m (90 ± 18 lb in)

(3) Tighten intake air temperature sensor to a torque of ....15 ± 3 N•m (11 ± 2 lb ft)

(4) Tighten bolt (at wire feed through) to a torque of.......................3.0 ± 0.5 N•m (26 ± 4 lb in)

(5) Distance from center of harness clip to harness plug...49.0 mm (1.93 in)

NOTE: The harness assembly must not contact the manifold or rocker stand within this length.

(6) Injection actuation pressure control sensor. Tighten to a torque of ....40 ± 5 N•m (30 ± 4 lb ft)

(7) Speed and timing sensors.

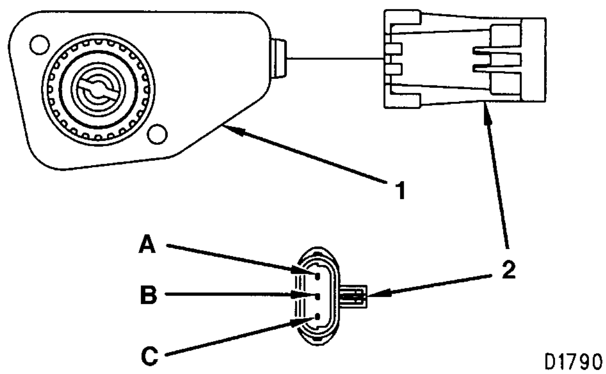
NOTE: Speed and timing sensors are serviced as sets only.

(8) Strap.

(9) Location of harness clip on braid......10.0 ± 2.0 mm ....(0.39 ± 0.08 in)

(10) Tighten engine oil temperature sensor to a torque of.................................20 ± 3 N•m (15.8 ± 2.3 lb ft)

Pedal Mounted Throttle Sensor

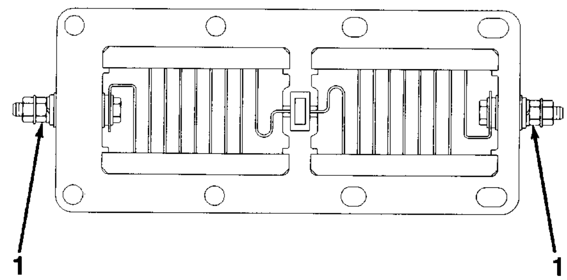


(1) Control assembly.

(2) Plug (with sockets A, B, and C).

Wiring Table		
Pin/Socket	**Circuit No.**	**Color**
A	VS	RD
B	GND	BK
C	SIG	WH

Intake Air Heater

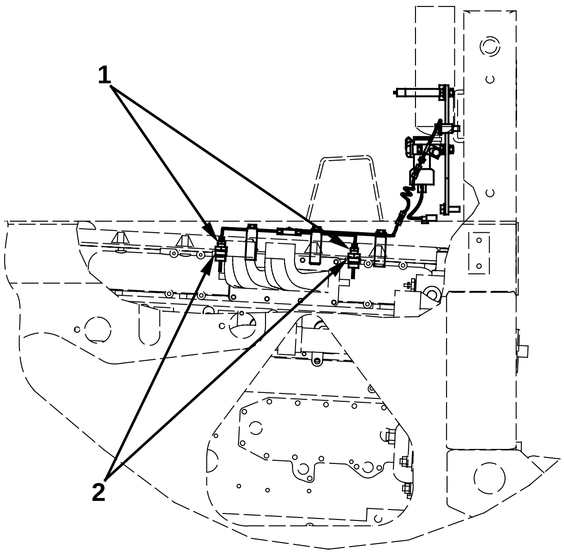


Section View of Heater Assembly.

(1) Tighten nut to a torque of ....13 ± 1 N•m (10 ± 1 lb ft)

NOTE: When assembling the intake air heater to the intake manifold and the air intake elbow, clean the intake air heater joint faces with solvent. Apply 6V-1541 Quick Cure Primer to all joint faces. Allow the primer to air dry for a minimum of three-to-five minutes. Apply 1U-8846 Gasket Maker to the joint face and spread uniformly. The heater must be assembled and tightened within 10 minutes.

Ether Start Aid

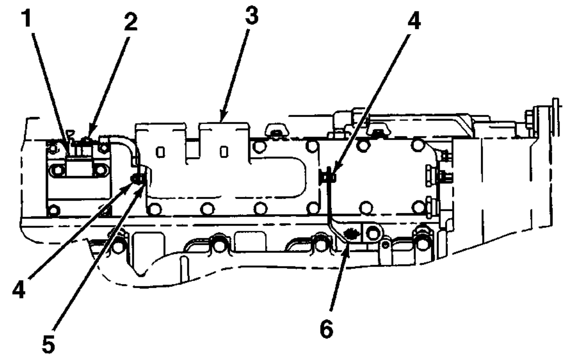


(1) Minimum seating torque of atomizer .... 2.8 N•m (25 lb in)

NOTE: Two marks (180 degrees apart) indicate the spray direction from the orifice. These marks must be pointed to the front and the rear of engine to avoid spraying ether onto the intake air heater element.

(2) Install adapters to a torque of .... 7.8 ± 1 N•m .... (70 ± 9 lb in)

Wiring Group (Intake Air Heater)



(1) Magnetic switch assembly.

(2) Tighten terminal nuts to a torque of .... 4 N•m (35 lb in)

(3) Air intake elbow.

(4) Tighten nut to a torque of .... 7.8 ± 1 N•m (70 ± 9 lb in)

(5) Heater group.

(6) Ground strap (from heater group to engine).

Systems Operation

General Information

The 3100 Hydraulic Electronic Unit Injector (HEUI) Deployable Universal Combat Earthmover (DEUCE) engines are in-line, six-cylinder arrangements, with a firing order of 1, 5, 3, 6, 2, and 4. The engine rotation is counterclockwise, as viewed from the flywheel. The engines are turbocharged and air-to-air aftercooled. The 3100 HEUI engine has a bore size of 110 mm (4.3 in) and a stroke of 127 mm (5.0 in), in a displacement of 7.25 L (442 cu in).

The HEUI system eliminates many of the mechanical components of a pump and line system, providing increased control of timing and fuel-to-air ratio. Timing advance is achieved through precise control of unit injector timing. The HEUI system controls engine rpm by adjusting the duration of fuel injection. A special pulse wheel provides information to the electronic control module (ECM) for detection of cylinder position and engine rpm.

The engine has built-in diagnostics to insure that the electrical components are operating properly. In the event of a system component failure, the operator will be alerted to the condition via the check engine indicator mounted on the instrument panel. An electronic service tool can be used to read the numerical code of the faulty component or condition, or the engine diagnostic switch can be used to flash the code in the check engine indicator. Intermittent faults are logged and stored in memory.

The engine is comprised of five subsystems. The basic engine subsystem contains the block, the cylinder head and other hard parts. The lubrication system distributes engine oil to lubricate, clean and cool the moving parts of the engine. The cooling system distributes coolant to regulate the operating temperature of the engine. The air intake and exhaust system delivers clean air to the engine and removes exhaust. The fuel system delivers fuel to the engine. The engine electrical system controls the injection of fuel into the engine, and monitors the other subsystems for correct operation.

Basic Engine

Cylinder Block and Head

The cylinder block has seven main bearings. Two bolts hold each bearing cap to the block.

Removal of the oil pan allows access to the crankshaft, main bearing caps, piston cooling jets, and the oil pump.

The camshaft compartment is accessible through covers on the left side of the cylinder block. The side covers support the push rod lifters. The camshaft is supported by seven bearings which are pressed into the cylinder block.

The cylinder head is separated from the block by a steel, nonasbestos fiber gasket. Coolant flows out of the block, through the gasket openings, and into the head. This gasket also seals the oil supply and drain passages between the block and the head.

The air intake ports are on the top of the head, and the exhaust ports are located on the right side of the head. There is one intake and one exhaust valve for each cylinder. Replaceable valve guides are pressed into the cylinder head. A push rod and rocker arm system controls the valves.

An electronically controlled unit injector is located between the two valves. The unit injectors are hydraulically actuated. Fuel is injected directly into the cylinders at very high pressure.

Pistons, Rings and Connecting Rods

The engine’s two piece articulated piston consists of an alloy-forged steel crown which is connected to an aluminum skirt by the piston pin. The piston has three rings: one compression ring, an intermediate ring, and one oil ring. All the rings are located above the piston pin bore. The compression ring is of the keystone type, which has a tapered shape. The action of the ring in the piston groove (also tapered) helps prevent the rings from seizing due to carbon deposits. The intermediate ring is rectangular with a sharp lower edge. The oil ring is the standard (conventional) type. Oil returns to the crankcase through holes in the oil ring groove.

Oil from the piston cooling jets sprays the underside of the pistons. This lubricates and cools the pistons and improves piston and ring life.

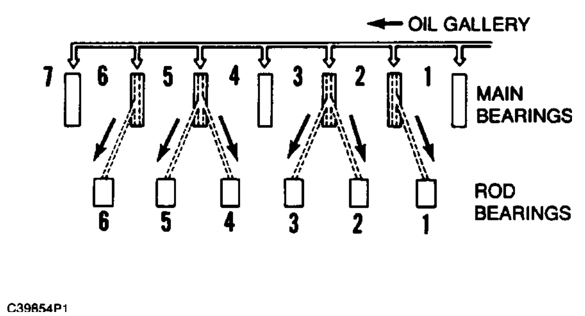
The connecting rod has a taper on the pin bore end. This gives the rod and piston more strength in the areas with the most load. Two bolts hold the rod cap to the rod. This design keeps the rod width to a minimum, so the rod can be removed through the cylinder.

Crankshaft

The crankshaft changes the combustion forces in the cylinder into usable rotating torque which powers the equipment. A vibration damper at the front of the crankshaft reduces twist on the crankshaft, which can damage the engine.

The crankshaft drives a group of gears on the front of the engine. The gear group drives the oil pump, camshaft, and hydraulic oil pump. The front belt pulleys on the crankshaft drive the water pump, alternator and air conditioner compressor.

Hydrodynamic seals are used at both ends of the crankshaft to control oil leakage. The hydrodynamic grooves in the seal lip move lubrication oil into the crankcase as the crankshaft turns. The front seal is located in the front housing. The rear seal is installed in the flywheel housing.

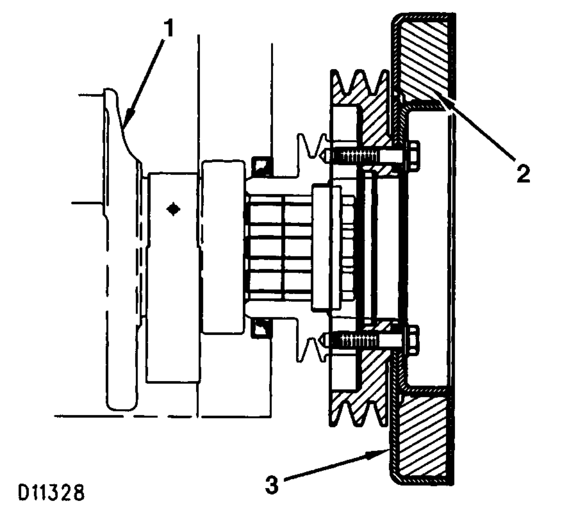


Oil Passages in Crankshaft.

Pressure oil is supplied to all main bearings through drilled holes in the webs of the cylinder block. The oil then flows through drilled holes in the crankshaft to provide oil to the connecting rod bearings. The crankshaft is held in place by seven main bearings. A thrust main bearing next to the rear main bearing controls the endplay of the crankshaft.

Vibration Damper

The force from combustion in the cylinders will cause the crankshaft to twist. This is called torsional vibration. If the vibration is too great, the crankshaft will be damaged. The vibration damper limits the torsional vibrations to an acceptable amount to prevent damage to the crankshaft.



Vibration Damper.
(1) Crankshaft. (2) Weight. (3) Case.

The vibration damper is installed on the front of crankshaft (1). The damper contains weight (2) in case (3). The space between the weight and the case is filled with thick fluid. Movement of the weight in the case limits the torsional vibration.

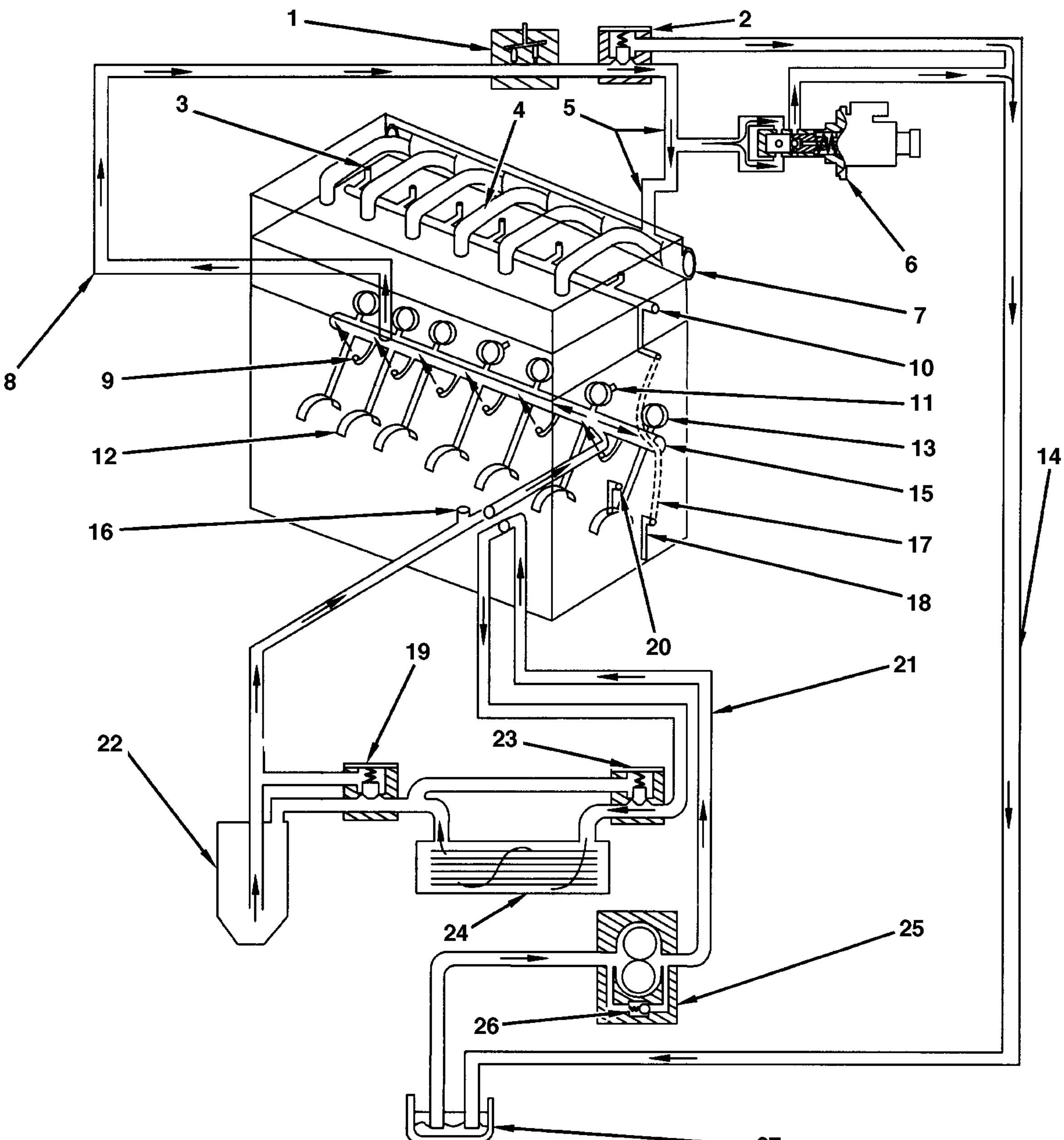
Camshaft

The camshaft is located in the upper left side of the block. The camshaft is driven by gears at the front of the engine. Seven bearings support the camshaft. A thrust plate mounted between the camshaft drive gear and a shoulder of the camshaft controls the endplay of the camshaft.

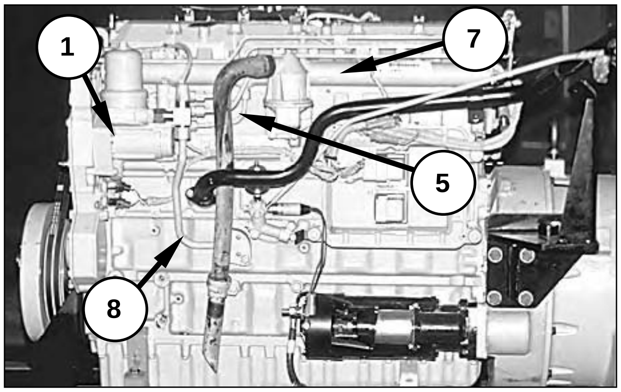
The camshaft is driven by an idler gear which is driven by the crankshaft gear, so the camshaft rotates in the same direction as the crankshaft (counterclockwise as viewed from the flywheel). Timing marks on the crankshaft gear, idler gear, and the camshaft gear assure correct camshaft timing with the crankshaft, for proper valve operation.

As the camshaft turns, each lobe moves a lifter assembly. There are two lifter assemblies for each cylinder. Each lifter assembly moves a push rod and valve (either inlet or exhaust). The camshaft must be in time with the crankshaft. The relation of the camshaft lobes to the crankshaft position cause the valves in each cylinder to operate at the correct time.

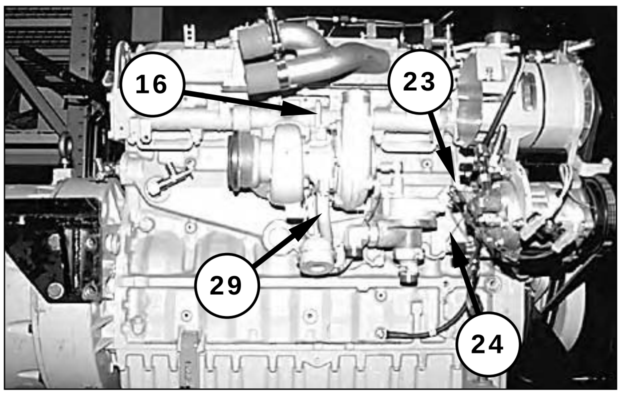
Lubrication System



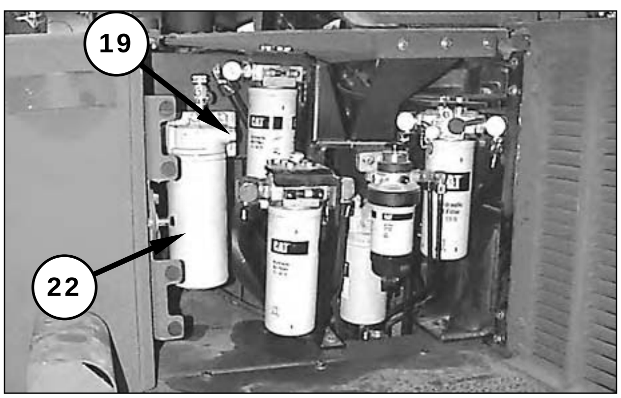
Lubrication System Schematic.
(1) Hydraulic pump. (2) High pressure relief valve. (3) Passage (to rocker arms). (4) Jumper tube. (5) High pressure oil line. (6) Injection actuation pressure control valve. (7) High pressure oil manifold. (8) Hydraulic pump oil supply line. (9) Piston cooling jets. (10) Cylinder head gallery. (11) Passage (to push rod lifters, mounted in side covers). (12) Main bearings. (13) Camshaft bearing. (14) Passage (to oil pan). (15) Main oil gallery. (16) Turbocharger oil supply line. (17) Passage (to front housing). (18) Passage (to oil pump idler gear bearing). (19) Oil filter bypass valve. (20) Passage (to camshaft idler gear bearing). (21) Passage. (22) Oil filter. (23) Oil cooler bypass valve. (24) Oil cooler. (25) Oil pump. (26) Oil pump bypass valve. (27) Oil pan.



Engine, Left Side (Engine Shown Removed from Machine, for Photographic Clarity).
(1) Hydraulic pump. (7) High pressure oil manifold. (5) High pressure oil supply line. (8) Hydraulic pump oil supply line.



Engine, Right Side (Engine Shown Removed from Machine, for Photographic Clarity).
(16) Turbocharger oil supply line. (23) Oil cooler bypass valve. (24) Oil cooler. (29) Turbocharger oil return line.



Oil Filter Compartment, Right Side of Machine.
(19) Oil filter bypass valve. (22) Oil filter.

The oil circuit consists of a low pressure section and a high pressure section. The low pressure circuit typically operates at a pressure of 240 ± 480 kPa (35 to 70 psi). The circuit provides filtered engine oil to hydraulic pump (1) and to the lubricating system of the engine. Oil is drawn from oil pan (27) and supplied through oil cooler (24) and oil filter (22) to both the engine and hydraulic pump (1).

Oil pump (25) is mounted to the bottom of the cylinder block inside oil pan (27). The oil pump pulls oil from the oil pan and pushes the oil through passage (21) to oil cooler (24). Oil then flows through oil filter (22). The filtered oil then enters turbocharger oil supply line (16) and main oil gallery (15).

Main oil gallery (15) distributes oil to main bearings (12), piston cooling jets (9) and camshaft bearing (13). Oil from the main oil gallery also exits the front of the block and enters a groove cast in the front housing.

Oil enters the crankshaft through holes in the bearing surfaces (journals) for main bearings (12). Passages connect the bearing surface (journal) of the main bearings with the bearing surface (journal) of the connecting rod.

Oil from piston cooling jets (9) sprays the bottom of each piston. An oil cooling chamber is formed by the lip that is forged at the top of the piston skirt and the cavity behind the ring grooves in the piston crown. Oil from the cooling jets enters the cooling chamber through a drilled passage in the skirt and returns to oil pan (27) through the clearance gap between the crown and skirt. Four holes which are drilled through the piston oil ring groove and into the interior of the piston drains excess oil from the oil ring.

The front housing passage sends the oil flow in two directions. At the upper end of the passage, oil is directed back into the block and up to cylinder head gallery (10) through passage (3) to the valve rocker arm mechanism. Passage (18) sends oil to the oil pump idler gear bearing.

Oil from the front main bearing enters passage (20) to camshaft idler gear bearing. Oil passages in the crankshaft send oil from all main bearings (12) through the connecting rods to the connecting rod bearings.

Passages send oil from camshaft bearing (13) to an oil passage in the side covers. The oil then enters a hole in the camshaft and flows to passage (11) to lubricate the lifter roller bearings.

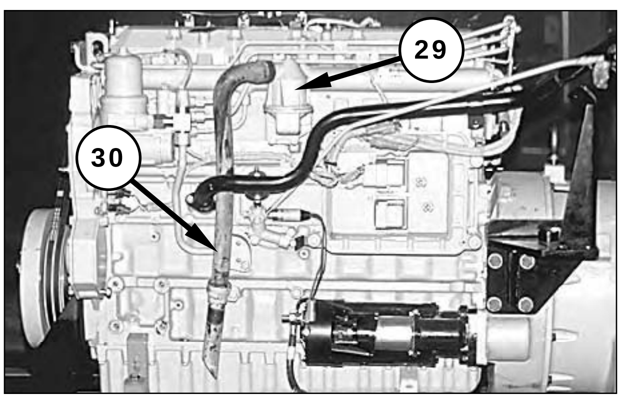
Oil pump bypass valve (26) limits the pressure of the oil coming from oil pump (25). The oil pump can put more oil into the system than is needed. When there is more oil than needed, the oil pressure increases and the oil pump bypass valve opens. This allows the oil that is not needed to go back to the suction side of the oil pump.

When the engine is cold (starting conditions), oil with high viscosity causes a restriction to oil flowing through oil cooler (24) and oil filter (22). In this case, oil cooler bypass valve (23) and oil pump bypass valve (26) open, providing immediate lubrication to all components. Oil pump (25) sends the cold oil through the bypass valves around oil cooler (24) and oil filter (22) to turbocharger oil supply line (16) and main oil gallery (15) in the cylinder block.

Oil cooler bypass valve (23) and oil pump bypass valve (26) will also open when there is a restriction in oil cooler (24) or oil filter (22). This action does not let a restriction in the oil cooler or the oil filter prevent lubrication of the engine.

When the oil pressure differential across oil cooler (24) reaches 155 ± 17 kPa (22 ± 3 psi), oil cooler bypass valve (23) opens, allowing oil to flow around the oil cooler.

When the oil pressure differential across oil filter bypass valve (19) reaches 170 kPa (25 psi), the valve allows the oil flow to go around oil filter (22) and on to lubricate the engine components. When the oil is cold, an oil pressure difference in the bypass valve also causes the valve to open. This bypass valve then provides immediate lubrication to all the engine components when cold oil with high viscosity causes a restriction of the oil flow through the oil filter. The bypass valve will also open when there is a restriction in the oil filter, which allows for lubrication of the engine.



Engine, Front Left Side.
(29) Breather. (30) Hose.

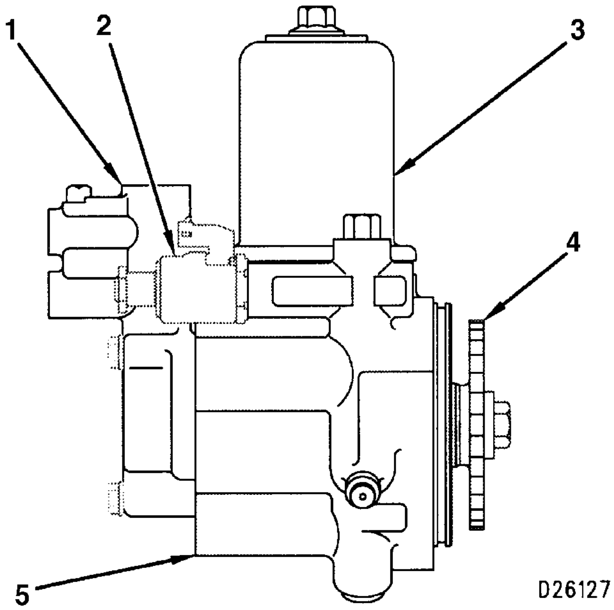
Breather (29) allows blow-by gases from the cylinders to escape from the crankcase. The blow-by gases discharge into the atmosphere through hose (30). This prevents pressure which could cause seals or gaskets to leak from building up in the crankcase.

The high pressure oil circuit provides actuation oil to the unit injectors and operates in a pressure range typically between 4000 and 23 000 kPa (581 and 3338 psi). This high pressure oil flows through lines into high pressure oil manifold (7), located on the left side of the air intake manifold. The manifold stores the oil, at actuation pressure, for unit injector operation. Oil is discharged from the unit injector under the valve cover so that no return lines are required. The oil drains back to the oil pan through passages in the cylinder head.

Hydraulic pump (1) is a gear-driven, axial-piston pump. The pump raises the engine oil pressure level from engine lubrication oil pressure to the actuation pressure level that is required by the unit injectors. Injection actuation pressure control valve (6) electronically controls the output pressure of hydraulic pump (1).

High pressure relief valve (2) regulates high pressure in the system and will allow oil to return to oil pan (27) when the oil pressure reaches or exceeds 28 000 kPa (4060 psi).

Injection Actuation Pressure Control Valve



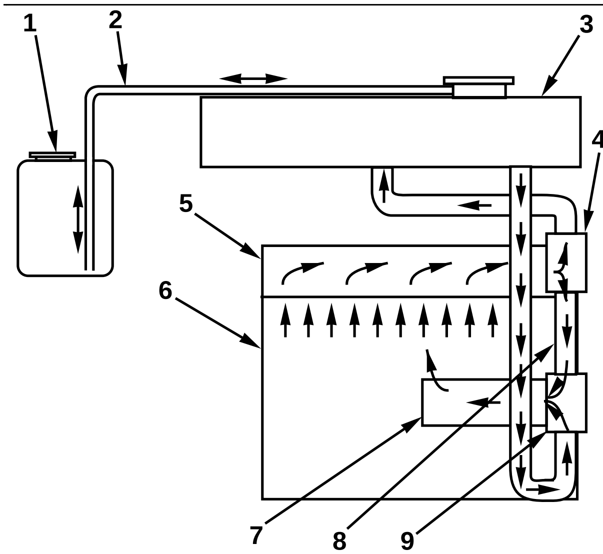
Injection Actuation Pressure Control Valve.
(1) Fuel pump. (2) Injection actuation pressure control valve. (3) Oil accumulator. (4) Gear. (5) High pressure oil pump.

Injection actuation pressure control valve (2) is an electronically operated control valve which controls the hydraulic pump output pressure by bypassing excess flow to the return circuit. A variable-signal current from the ECM to the injection actuation pressure control valve determines pump output pressure. The injection actuation pressure control valve is located on the front, left side of the engine, and is connected to high pressure oil pump (5).

Cooling System

This engine has a pressure-type cooling system. A pressure-type cooling system has two advantages: the cooling system can operate at a higher temperature than the normal boiling (steam) point of water, and the high pressure reduces the chance of cavitation (the sudden creation of low pressure bubbles in liquids by mechanical forces) in the water pump. With a pressure system, air or steam pockets do not develop as easily in the cooling system.

NOTE: In air-to-air aftercooled systems, such as on the DEUCE, a coolant mixture with a minimum of 30 percent ethylene-glycol-based antifreeze must be used for efficient water pump performance. This mixture keeps the cavitation temperature range of the coolant high enough for efficient performance.

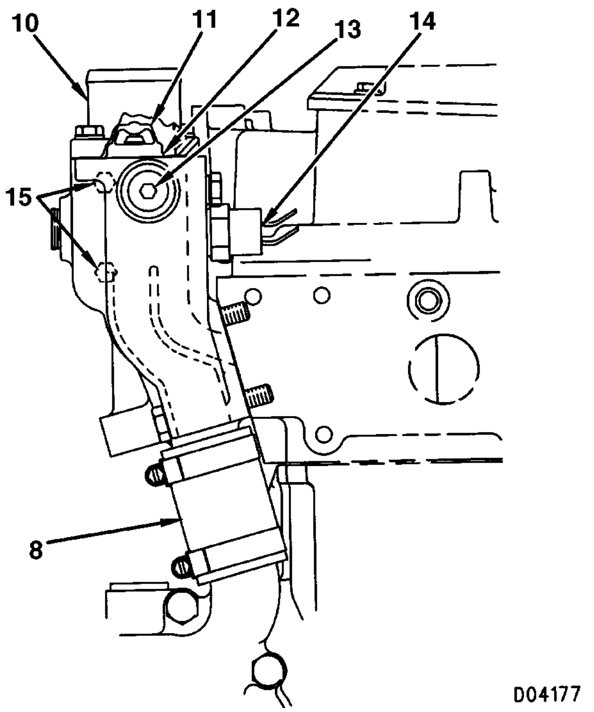


Cooling System Schematic.
(1) Expansion bottle. (2) Shunt line. (3) Radiator. (4) Water temperature regulator housing. (5) Cylinder head. (6) Cylinder block. (7) Oil cooler. (8) Bypass hose. (9) Water pump.

Water pump (9) is located on the right side of the cylinder block. The water pump is belt driven from the crankshaft pulley. Coolant can enter the water pump in two ways: through the bottom inlet of the water pump, or into the top through bypass hose (8).

Coolant from the radiator is pulled into the bottom inlet of the pump by impeller rotation. The coolant exits the back of the pump directly into the oil cooler cavity of the block.

All coolant passes through the core of the oil cooler and enters the internal water manifold of the cylinder block. The manifold distributes the coolant to water jackets around the cylinder walls.



Water Lines Group.
(8) Bypass hose. (10) Outlet (to radiator). (11) Water temperature regulator. (12) Air vent valve (located in flange of water temperature regulator). (13) Plug (water return). (14) Water temperature sensor. (15) Heater supply and return ports (located on back side of housing).

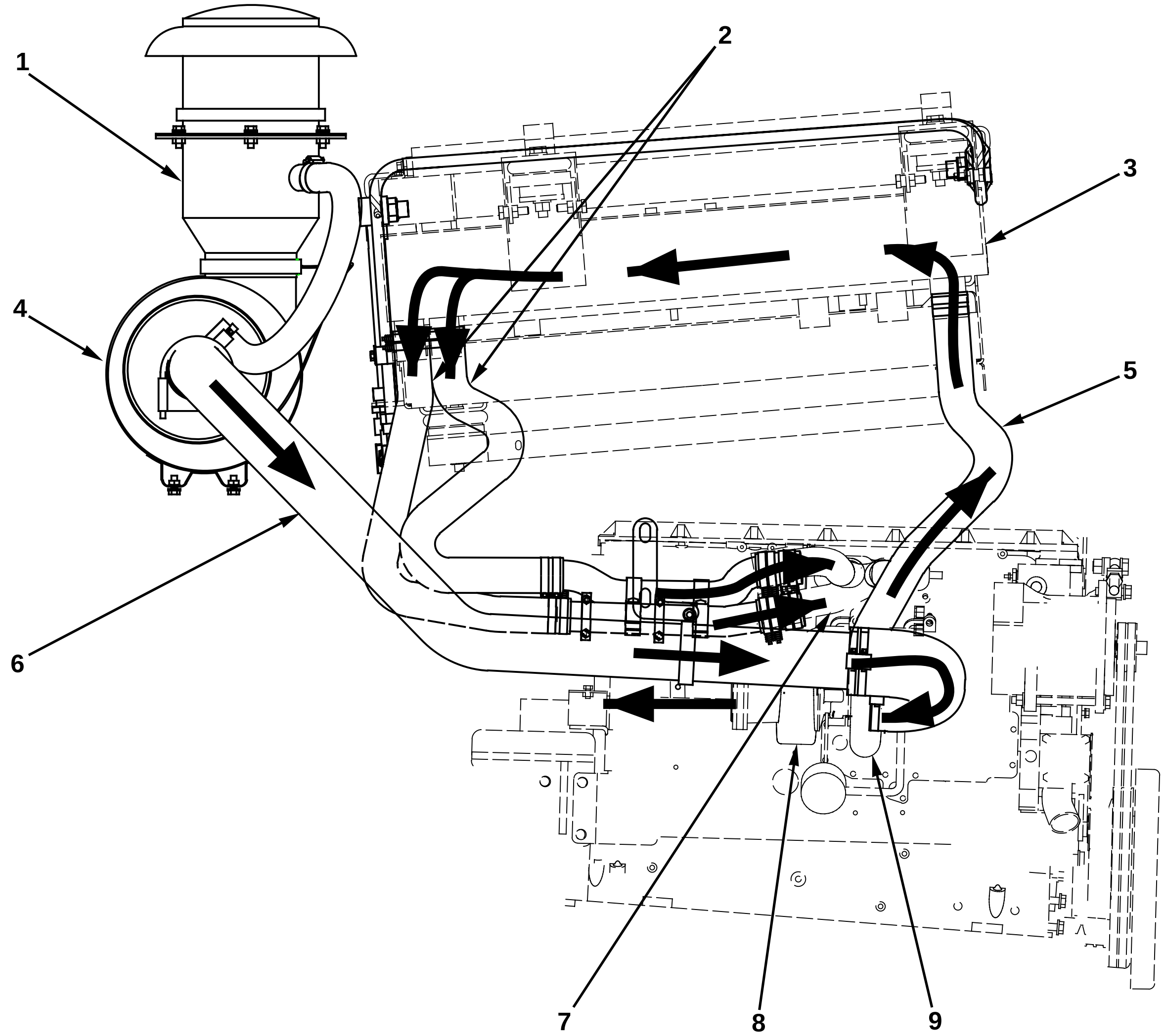
From the cylinder block, the coolant flows into passages in the cylinder head. The passages send the flow around the unit injector sleeves and the intake and exhaust passages. The coolant then enters the water temperature regulator housing at the front, right side of the cylinder head.

Water temperature regulator (11) controls the direction of flow. If the coolant temperature is less than normal, the water temperature regulator is closed. The coolant is directed through bypass hose (8) and into the top inlet of the water pump. When the coolant gets to the correct temperature, the water temperature regulator opens, closing the bypass going to the pump. Most of the coolant goes through outlet (10) to the radiator for cooling. The remaining coolant flows through the bypass hose and into the water pump.

NOTE: Do not operate the machine without water temperature regulator (11). The water temperature regulator is an important part of the cooling system. The water temperature regulator divides coolant flow between the radiator and the bypass, as necessary, to maintain the correct temperature. If the water temperature regulator is not installed in the system, there is no mechanical control, and most of the coolant will take the path of least resistance through the bypass. This will cause the engine to overheat in hot weather. In cold weather, even the small amount of coolant that goes through the radiator is too much, and the engine will not reach normal operating temperatures.

NOTE: Air vent valve (12) will allow the air to escape past the water temperature regulator from the cooling system while the radiator is being filled. During normal operation, the air vent valve will be closed to prevent any coolant from flowing past the water temperature regulator.

Air Intake and Exhaust System

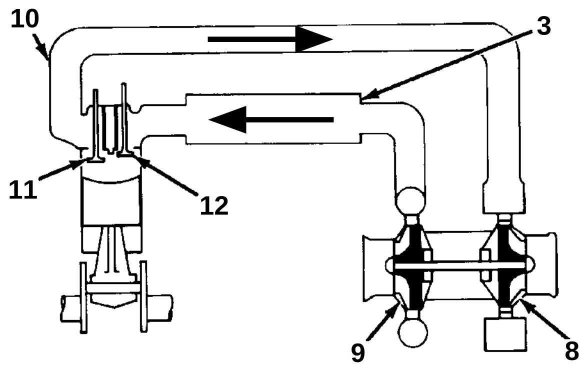


Air Flow Schematic.
(1) Precleaner. (2) Air lines. (3) Air-to-air aftercooler core. (4) Air cleaner. (5) Air line. (6) Air line. (7) Air intake manifold. (8) Turbine side of turbocharger. (9) Compressor side of turbocharger.

The components of the air intake and exhaust system control the quality and amount of air available for combustion. These components are: the precleaner, air cleaner, turbocharger, aftercooler, cylinder head, valves and valve system components, piston and cylinder, and exhaust manifold.

Inlet air is pulled through the air cleaner, compressed and heated by the compressor wheel in the compressor side of turbocharger (9) to about 150°C (300°F), then pushed through air-to-air aftercooler core (3) and moved to air intake manifold (7) at about 54°C (130°F). Cooling the intake air increases combustion efficiency, which helps to lower fuel consumption and increase horsepower output. The core of the air-to-air aftercooler is a separate cooler core which is located above the engine in the radiator group. Ambient temperature air is moved across the aftercooler core by the cooling fan.

From air-to-air aftercooler core (3), the air is forced into the cylinder head to fill the inlet ports. Air flow from the inlet ports into the cylinders is controlled by the intake valves.

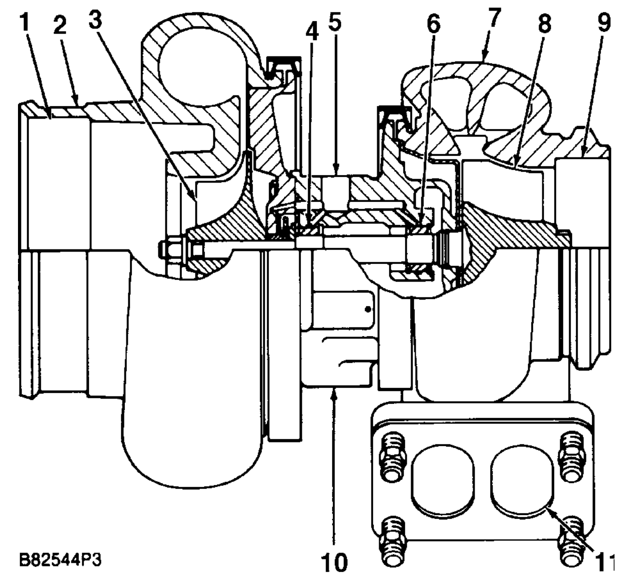


Air Intake and Exhaust System.
(3) Air-to-air aftercooler core. (8) Turbine side of turbocharger. (9) Compressor side of turbocharger. (10) Exhaust manifold. (11) Exhaust valve. (12) Intake valve.

There is one intake and one exhaust valve for each cylinder. The intake valve opens when the piston moves down on the inlet stroke. When the intake valve opens, cooled, compressed air from the intake port is pulled into the cylinder. The intake valve then closes, and the piston begins to move up on the compression stroke. During the compression stroke, the air in the cylinder is compressed. When the piston is near the top of the compression stroke, fuel is injected into the cylinder. The fuel mixes with the air, and combustion begins. The force of combustion pushes the piston down on the power stroke. When the piston moves up again, the exhaust stroke begins. The exhaust valve opens, and the exhaust gases are pushed through the exhaust port into the exhaust manifold. After the piston makes the exhaust stroke, the exhaust valve closes and the cycle (intake, compression, power, exhaust) starts again.

Exhaust gases from exhaust manifold (10) enter the turbine side of turbocharger (8) and cause the turbine wheel to turn. The turbine wheel is connected to the shaft which drives the compressor wheel. Exhaust gases from the turbocharger pass through the exhaust outlet pipe, the muffler, and the exhaust stack.

Turbocharger



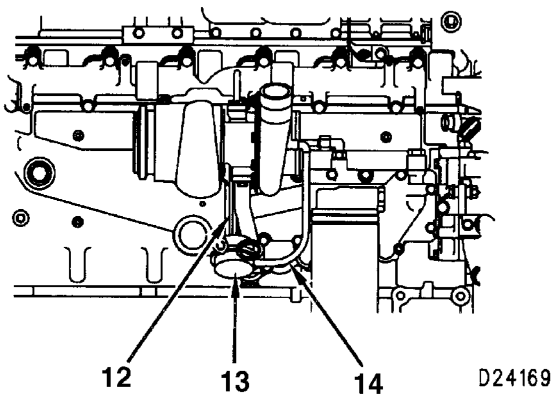
Turbocharger.
(1) Air intake. (2) Compressor housing. (3) Compressor wheel. (4) Bearing. (5) Oil intake port. (6) Bearing. (7) Turbine housing. (8) Turbine wheel. (9) Exhaust outlet. (10) Oil outlet port. (11) Exhaust intake.

The turbocharger is installed on the center section of the exhaust manifold. All of the exhaust gases from the engine go through the turbocharger. The compressor side of the turbocharger is connected to the aftercooler by a hose.

The exhaust gases go into turbine housing (7) through exhaust intake (11) and push the blades of turbine wheel (8). The turbine wheel is connected by a shaft to compressor wheel (3).

Clean air from the air cleaner is pulled through compressor housing air intake (1) by the rotation of compressor wheel (3). The action of the compressor wheel blades causes the intake air to compress. This compression gives the engine more power by increasing the amount of oxygen available for fuel combustion.

When the load on the engine increases, more fuel is injected into the cylinders. This creates more exhaust gases, and will cause the turbine and compressor wheels of the turbocharger to turn faster. As the compressor wheel turns faster, more air is forced into the cylinders. The increased air flow gives the engine more power.



Wastegate Turbocharger.
(12) Actuating lever. (13) Canister. (14) Line (boost pressure).

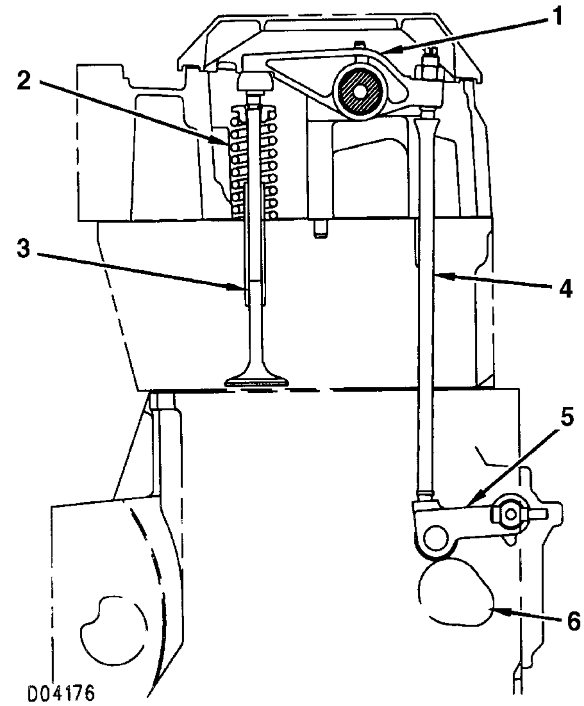
When the engine is operating under low boost conditions, a spring pushes against a diaphragm in canister (13) and moves actuating lever (12), to close the wastegate valve. This allows the turbocharger to operate at maximum performance.

As the boost pressure increases against the diaphragm in canister (13), the wastegate valve opens, and a portion of the exhaust gases is directed through line (14), around the turbine wheel of the turbocharger. This action limits the rpm of the turbocharger.

NOTE: The wastegate turbocharger is preset at the factory and no adjustment can be made.

Bearings (4) and (6) (for the turbocharger) use engine oil, under pressure, for lubrication. The oil comes in through oil intake port (5) and goes through passages in the center section to lubricate the bearings. Oil from the turbocharger goes out through oil outlet port (10) in the bottom of the center section and goes back to the engine lubrication system.

Valve System



Valve System Components.
(1) Valve rocker arm. (2) Valve spring. (3) Valve. (4) Push rod. (5) Lifter. (6) Camshaft lobe.

The valve system components control the flow of intake air and exhaust gases into and out of the cylinders during engine operation.

The crankshaft gear drives the camshaft gear through an idler. The camshaft must be timed to the crankshaft to get the correct relation between piston and valve movement.

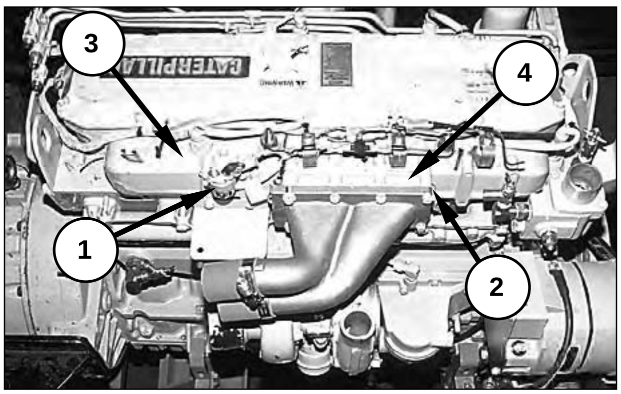
The camshaft has two cam lobes for each cylinder. The lobes operate the intake and exhaust valves. As the camshaft turns, the lobes on the camshaft cause lifters (5) to move push rods (4) up and down. Upward movement of the push rods against valve rocker arms (1) results in a downward movement (opening) of valves (3).

Each cylinder has one intake and one exhaust valve. Valve springs (2) close the valves when the lifters move down.

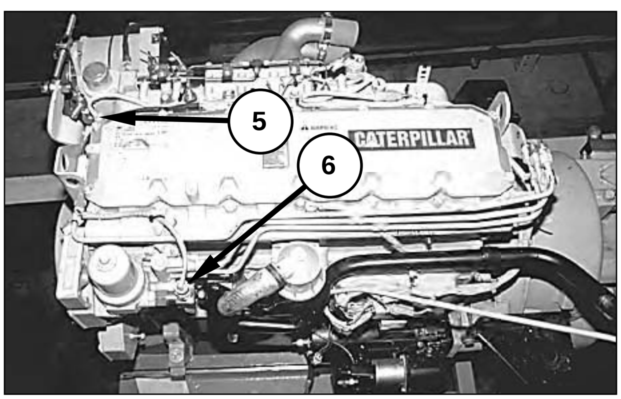
Intake Air Heater

To assist with starting and to prevent white smoke emission at start up, the engine is equipped with an electric heater which is located at the air intake manifold. When the jacket water temperature, engine oil temperature, intake manifold temperature, ignition position, and elapsed time are within set parameters, the ECM turns the heater system on. The system is capable of delivering heat for thirty seconds prior to start up, during cranking, and after the engine has started.

The basic components of the intake air heater system are: intake air heater relay, heater element, coolant temperature sensor, oil temperature sensor, air intake manifold air temperature sensor, ECM, and an indicator.



Location of Components.
(1) Intake air heater relay. (2) Ground strap (from heater group to engine). (3) Air intake manifold. (4) Intake air heater.

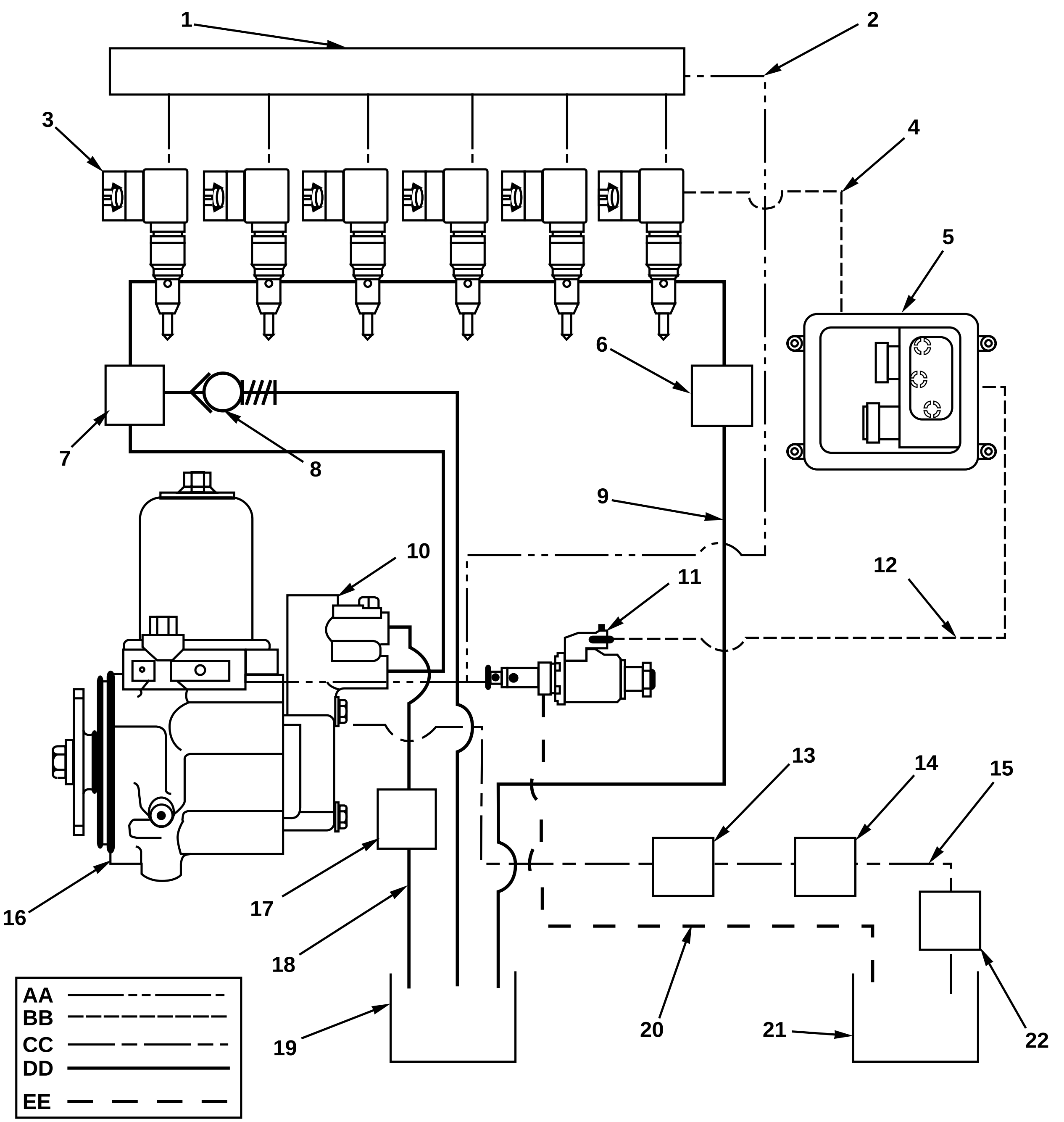


Location of Components.
(5) Coolant temperature sensor. (6) Engine oil temperature sensor.

Intake air heater relay (1) is located on the air intake manifold cover. The relay turns the 24-volt heater ON and OFF in response to signals from the ECM.

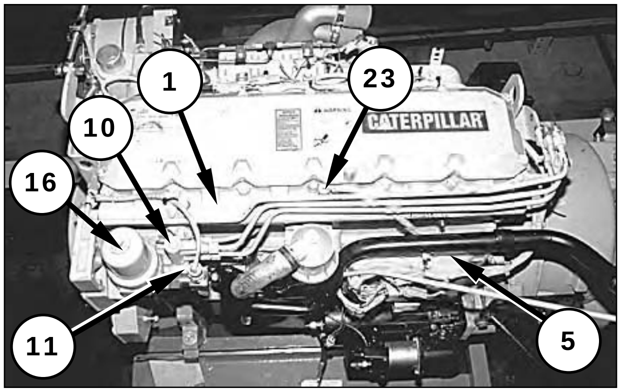
Intake air heater relay (1) is located between air intake manifold (3) and the air intake elbow. The heater element has ground strap (2) that must be connected to the engine.

Fuel System

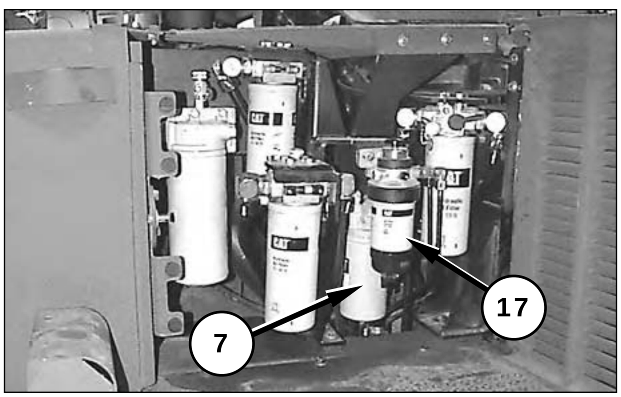


Fuel System Schematic.
(AA) High pressure oil line. (BB) Unit injector wiring harness. (CC) Low pressure oil supply line. (DD) Fuel line. (EE) Low pressure oil return line. (1) High pressure oil manifold. (2) High pressure oil line. (3) Hydraulic Electronic Unit Injectors (HEUI). (4) Unit injector wiring harness. (5) ECM. (6) Fuel pressure regulator. (7) Secondary fuel filter. (8) Filter bypass relief valve. (9) Fuel return line. (10) Fuel transfer pump. (11) Injection actuation pressure control valve. (12) Electrical signal from ECM to injection actuation pressure control valve (controls oil manifold pressure). (13) Secondary oil filter. (14) Engine oil cooler. (15) Low pressure oil supply line. (16) High pressure oil pump. (17) Primary fuel filter and water separator. (18) Fuel line. (19) Fuel tank. (20) Low pressure oil return line. (21) Oil sump. (22) Oil pump (engine lubrication).

The 3100 HEUI DEUCE engine fuel system uses hydraulic electronic unit injectors (3) to inject fuel into the cylinders. The hydraulic electronic unit injectors use high pressure oil, instead of a cam, to pressurize the unit injector.



Fuel System Components (Engine Shown Removed from Machine for Photographic Clarity).
(1) High pressure oil manifold. (5) ECM. (10) Fuel transfer pump. (11) Injection actuation pressure control valve. (16) High pressure oil pump. (23) Injection actuation pressure sensor.

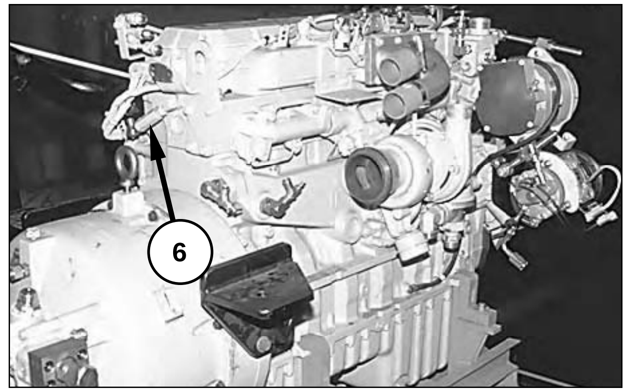


Filter Compartment.
(7) Secondary fuel filter. (17) Primary fuel filter and water separator.

The fuel supply circuit uses fuel transfer pump (10) to draw fuel at low pressure, through primary fuel filter and water separator (17). The transfer pump sends the fuel through secondary fuel filter (7), and then into the cylinder head fuel passages at low pressure. Fuel is delivered at high pressure into the combustion chamber by hydraulic electronic unit injectors (3). The unit injectors are located near the center of the combustion chambers, in the cylinder head between the intake and exhaust valve rocker arms.

Fuel is drawn from fuel tank (19) by fuel transfer pump (10) and is passed through primary fuel filter/water separator (17) and secondary fuel filter (7). The fuel transfer pump (10) incorporates a check valve to permit fuel flow for hand priming, and a pressure regulating valve to protect the system from extreme pressure.

Fuel flowing out of secondary fuel filter (7) flows to the fuel manifold fitting at the front of the engine. Filter bypass relief valve (8) is installed in the circuit to return fuel back to the tank if secondary fuel filter (7) becomes plugged.



Location of Fuel Pressure Regulator.
(6) Fuel pressure regulator.

Fuel flows continuously around each unit injector through an internal passage which runs the length of the cylinder head and exits at the rear of the engine. Fuel exiting the cylinder head passes through fuel pressure regulator (6) and returns to fuel tank (19). Excess fuel (not used for injection) helps to cool the unit injectors and to purge air from the system. Under normal operating conditions, fuel supply pressure is maintained in the range of 400 to 525 kPa (58 to 76 psi) by an orificed pressure regulating valve at the rear of the cylinder head. This valve also contains a check valve and serves as a siphon break. Fuel pressure at low idle should be at a minimum of 365 kPa (53 psi).

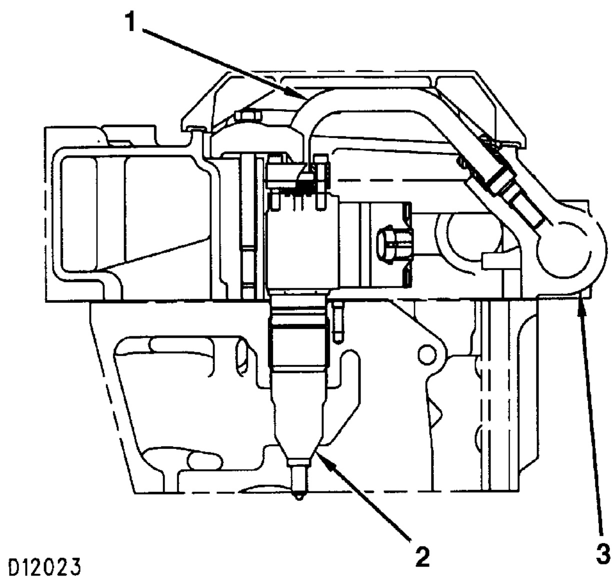
When ECM (5) activates each unit injector, the engine oil in high pressure oil manifold (1) acts on a piston in the upper part of the unit injector. This piston has an area roughly six times the area of the unit injector plunger. Fuel is injected into the cylinder at pressures of 138 000 kPa (20 000 psi) and greater.

ECM (5) is located at the rear, on the left side of the engine. The ECM provides total electronic control of the timing and duration of the fuel injection cycle. The ECM uses engine data gathered by several sensors to make adjustments to the fuel delivery rate, based on the programmed performance map stored in the engine control software.

High pressure oil pump (16) is located at the left front corner of the engine. The high pressure oil pump is a gear driven, axial piston pump. The pump raises the engine oil pressure from normal engine operating oil pressure level to the actuation pressure level required by the unit injectors.

Injection actuation pressure control valve (11) is located in high pressure oil pump (16), at the top left of the engine. Operational maps stored in the ECM's memory identify optimum oil pressure for the best performance.

Unit Injector Hydraulic Oil Supply



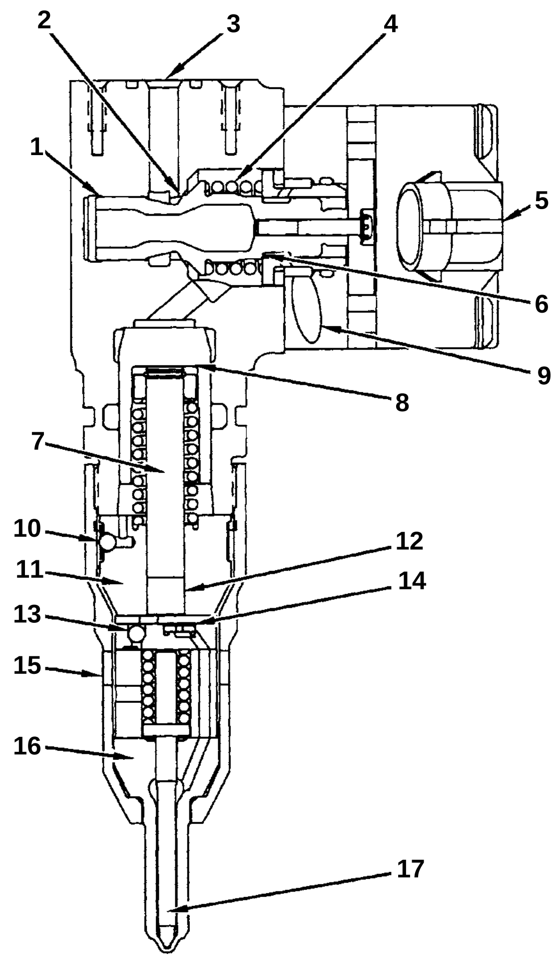
Unit Injector Hydraulic Oil Supply.
(1) Jumper tube. (2) Hydraulic electronic unit injector. (3) High pressure oil manifold.

The high pressure oil pump is a gear driven, axial piston pump. The pump raises the engine oil pressure level from normal engine operating oil pressure level to the actuation pressure level required by the unit injectors. This high pressure oil flows through lines into high pressure oil manifold (3), located near hydraulic electronic unit injector (2). The manifold stores the oil at actuation pressure, ready for unit injector operation. Oil is distributed equally and continually to the top of all unit injectors through each jumper tube (1), under the valve cover. After pressurizing a unit injector, the oil is discharged from the unit injectors onto the cylinder head. From there, the oil drains back to the oil pan. No oil return lines are required.

The hydraulic electronic unit injector uses a high pressure hydraulic system. The oil for this system is drawn from the engine lubrication system on the left side of the block and raised to high pressure by a gear-driven pump. The pressure is regulated by the ECM to the optimum pressure for a given set of conditions, as determined by operational maps stored in memory. The pressure available ranges from approximately 4 to 23 MPa (581 to 3335 psi). This is a closed-loop system; the ECM senses hydraulic pressure from the injection actuation pressure sensor on the high pressure oil manifold, and regulates pressure via a signal from the ECM to the injection actuation control valve mounted on the high pressure hydraulic pump.

High pressure oil is routed from the pump output through a steel tube to the oil manifold on the air intake manifold. Oil is allowed to dump inside the air intake manifold base and return to the oil sump. There are no return oil lines.

Hydraulic Electronic Unit Injector (HEUI)



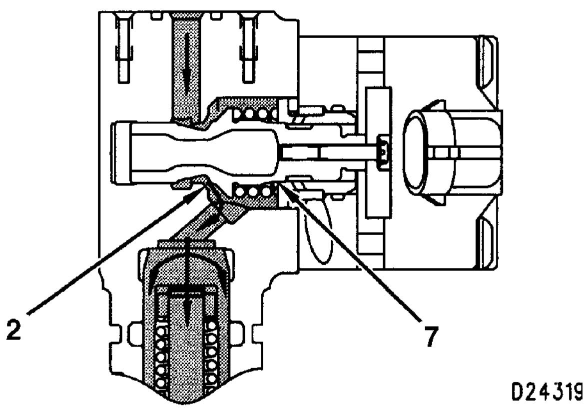
Hydraulic Electronic Unit Injector.
(1) Poppet valve. (2) Lower seat (poppet valve). (3) Entry port (high pressure oil). (4) Solenoid return spring. (5) Solenoid. (6) Upper seat (poppet valve). (7) Plunger. (8) Intensifier piston. (9) Poppet cavity (oil). (10) Check ball (spring loaded). (11) Barrel. (12) Piston cavity (fuel). (13) Check ball (fuel intake). (14) Reverse flow check. (15) Fill ports. (16) Nozzle assembly. (17) Nozzle valve.

The injection pump, fuel lines, and nozzles used in traditional engines have been replaced with a hydraulic electronic unit injector for each cylinder. Solenoid (5), on each unit injector, controls the amount of fuel delivered by that unit injector. An ECM sends a signal to each unit injector's solenoid, causing the solenoid to energize and inject fuel into the cylinder.

Low pressure fuel from the fuel supply manifold enters the hydraulic electronic unit injector at fill ports (15) through drilled passages in the cylinder head. Fuel can be injected at any time depending on the injection timing requirements programmed into the ECM.

A 110 volt DC electrical pulse from the fuel injection control circuits (in the ECM) energizes solenoid (5) in the unit injector. The duration of this pulse determines the length of time that fuel flows through nozzle valve (17). The hydraulic oil pressure on intensifier piston (8) determines injection pressure. The duration is determined from inputs to the ECM.

When the engine is in an “at rest” condition, solenoid (5) is not energized, and poppet valve (1) is held on lower seat (2) by solenoid return spring (4). In this “at rest” condition, high pressure inlet oil is blocked, and poppet cavity (9) is opened to the drain. Intensifier piston (8) and plunger (7) are at the top of their bore, and piston cavity (12) is full.



Unit Injector Oil Flow.
(2) Lower seat (poppet valve). (6) Upper seat (poppet valve).

When a pulse energizes solenoid (5), poppet valve (1) moves off lower seat (2) and onto upper seat (6). The path to poppet cavity (9) is closed. High pressure oil enters the unit injector through entry port (3) and acts on the top of intensifier piston (8). Pressure builds, pushing plunger (7) down. The downward movement of the plunger pressurizes the fuel in piston cavity (12), causing nozzle valve (17) to open. The downward stroke of the piston during injection creates a positive pressure which moves the intensifier piston and the plunger downward, and pressure increases on the fuel in the cavity of barrel (11), below the plunger. Fuel flows past reverse flow check (14) down the fuel passage, and pressurizes the nozzle. When valve opening pressure is reached, the nozzle valve opens and injection begins.

Intensifier piston (8) continues to move downward until solenoid (5) is de-energized. The de-energized solenoid permits poppet valve (1), intensifier piston (8), and plunger (7) to return to their “at rest” condition. As the plunger returns, fuel is drawn into piston cavity (12) through fill ports (15), and across check ball (13). The unit injector is now ready to repeat the cycle.

Nozzle assembly (16) is conventionally designed, with the exception of check ball (13) and reverse flow check (14). The check ball unseats and seals during the downward stroke of plunger (7), to allow piston cavity (12) to refill. The reverse flow check is a one-way check plate which allows fuel to enter the nozzle assembly, but closes to prevent reverse flow at the end of injection. The reverse flow check traps fuel pressure in the nozzle to prevent combustion gas from entering the nozzle if there is leakage at the nozzle valve seat.

Engine Electrical System

Glossary of 3100 HEUI DEUCE Engine Electronic Control Terms

Air-to-Air Aftercooler

The air-to-air aftercooler cools inlet air downstream of the turbocharger. The air is passed through an aftercooler (heat exchanger) which is mounted in front of the radiator, before going to the air intake manifold.

American Wire Gauge

This is a measure of the diameter (and therefore, the current carrying ability) of electrical wire. The smaller the number, the larger the wire.

Auxiliary Engine Speed Control

Operated with the auxiliary engine speed control switch, this mode permits a constant engine rpm to be set when the vehicle is not moving (like a manual throttle control cable).

Before Top Center

This term refers to the 180 degrees of crankshaft rotation before the piston reaches top center (normal direction of rotation).

Boost Pressure Sensor

This sensor measures the air intake manifold air pressure and sends a signal to the ECM.

Bypass Circuit

This circuit, usually temporary, substitutes for an existing circuit, typically for test purposes.

Calibration

Used here for timing, calibration is an electronic adjustment of a sensor signal.

Coolant Temperature Sensor

This sensor detects the engine coolant temperature for cold mode operation.

Code

See “Diagnostic Flash Code.”

Data Link

The data link is the communication medium used for programming and troubleshooting with Caterpillar electronic service tools.

Desired RPM

The desired rpm is an input to the electronic governor within the ECM. The electronic governor uses inputs from the throttle position sensor and the engine speed sensor to determine the desired rpm.

Diagnostic Flash Code

The diagnostic flash code indicates a problem or event in the engine’s electrical system.

Diagnostic Lamp

Sometimes referred to as the “check engine indicator,” the diagnostic indicator is used to warn the operator of the presence of an active diagnostic flash code.

Direct Current

Direct current flows consistently in one direction only.

Duty Cycle

Generically, duty cycle refers to the time ON versus the time OFF of any signal, device, or engine.

Electronic Control Module (ECM)

This engine control computer provides power for the engine electronics, monitors the engine inputs and acts as a governor to control the engine rpm.

Electronic Engine Control

This complete electronic system monitors and controls the engine operation under all conditions.

Electronic Service Tool

This Caterpillar electronic service tool is used to diagnose and program a variety of electronic controls.

Engine Speed and Timing Sensor

This sensor provides electrical signals to the ECM, which the ECM interprets as crankshaft position and engine speed.

Estimated Dynamic Timing

Estimated dynamic timing is the ECM’s estimate of the actual injection timing.

Failure Mode Identifier

This identifier specifies what type of failure a component has endured (adopted from SAE standard practice J1587 diagnostics).

Flash Memory

See "Personality Module."

Fuel Ratio Control

Fuel ratio control fuel position is a limit which is based on control of the fuel/air ratio, and is used for emission control purposes. The ECM senses a higher boost pressure (more air into the cylinder) and allows more fuel into the cylinder.

Fuel Position

The fuel position signal within the ECM comes from the electronic governor. The signal is based on the desired rpm, the fuel ratio control fuel position, and the rated fuel position. Refer to "Electronic Control Signal Flow Chart," in this module.

Harness

This wiring bundle connects all components of the electrical engine systems.

Hertz (Hz)

This is a measure of frequency in cycles per second.

High Pressure Oil Manifold

This is an oil gallery which is added to the air intake manifold to supply the unit injectors with high pressure oil.

High Pressure Oil Pump

This pump is a gear-driven, axial-piston pump used to raise the engine oil pressure level from typical engine operating oil pressure level to the actuation pressure level required by the unit injectors.

Hydraulic Electronic Unit Injector (HEUI) System

This fuel system uses hydraulically actuated, electronically controlled unit injectors which combine the pumping, electronic fuel metering and injecting elements in a single unit.

Injection Actuation Pressure Control Valve

This valve is used by the ECM to maintain proper oil pressure in the high pressure oil manifold.

Injection Actuation Pressure Sensor

This sensor measures hydraulic oil pressure and sends a signal to the ECM.

Intake Air Temperature Sensor

This sensor measures the intake air temperatures and provides a signal to the ECM.

Jumper Tube

These tube assemblies are used to connect the high pressure oil manifold to each hydraulic electronic unit injector.

Open Circuit

In this condition, an electrical wire or connection is broken, so the signal or supply voltage can no longer reach its intended destination.

Parameter

A parameter is a programmable value which affects the characteristics or behavior of the engine and/or vehicle.

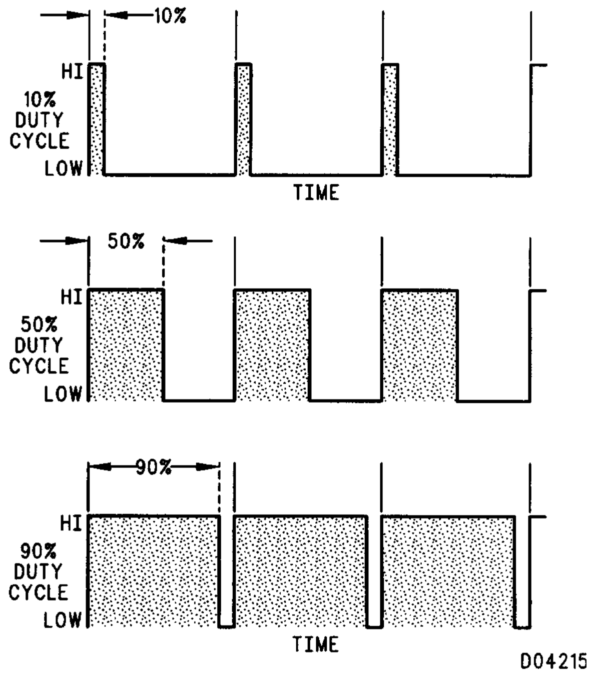
Parameter Identifier

This two or three digit code is assigned to each component to identify data via a data link to the ECM.

Personality Module

The personality module in the ECM contains all the instructions (software) for the ECM and performance maps for a specific horsepower family. Software updates and rerates are accomplished by electronically "flashing" in new data using an electronic service tool.

Pulse Width Modulation



Example of Pulse Width Modulation Signals.

This signal consists of variable width pulses at fixed intervals, whose "time on" versus "time off" can vary (also referred to as "duty cycle"). The signal is generated by the throttle position sensor.

Rated Fuel Position

This indicates the maximum allowable fuel position (longest injection pulse). Rated fuel position will produce rated power for this engine configuration.

Reference Voltage

This is regulated voltage which the ECM supplies to a sensor. The sensor uses the reference voltage to generate signal voltage.

Sensor

This device is used to detect changes in pressure, temperature, or mechanical movement, and to convert them into electrical signals.

Service Program Module

This software program, on a factory programmable computer chip, is designed to adapt to Electronic Technician for a particular application (such as truck, marine or industrial).

Short Circuit

In this condition, an electrical circuit is unintentionally connected to an undesirable point. For example, a wire which rubs against a vehicle frame until electrical contact is made creates a short circuit.

Signal

A signal is voltage or waveform which is used to transmit information, typically from a sensor to the ECM.

Speed "Burp"

A sudden, brief change in engine speed is called a speed "burp."

Subsystem

As used here, the subsystem is a part of the engine system that relates to a particular function, for example: vehicle speed subsystem.

Supply Voltage

Supply voltage is supplied to a component to provide electrical power for its operation. The voltage may be generated by the ECM, or may be vehicle battery voltage supplied by the vehicle wiring.

"T" Harness

This test harness is designed to permit normal circuit operation while measuring voltages. The harness is typically inserted between two ends of a connector.

Throttle Position

The ECM's interpretation of the signal from the throttle position sensor is called the "throttle position."

Throttle Position Sensor

This electronic sensor, which is connected to the accelerator pedal, sends a pulse width modulated signal to the ECM.

Transducer

The transducer converts a mechanical signal into an electrical signal.

Vehicle Speed Sensor

This electromagnetic pickup measures vehicle speed from the rotation of the gear teeth in the vehicle's drive train.

Electronic Control System

The electronic control system is integrally designed with the engine's fuel, air intake, and exhaust systems to electronically control fuel delivery and injection timing. The electronic control system provides increased control of timing and fuel/air ratio control, in comparison to conventional mechanical engines. Injection timing is achieved by precise control of unit injector firing time, and engine rpm is controlled by adjusting the injection duration. The ECM energizes the fuel injection pump solenoids to start the injection of fuel, and de-energizes the fuel injection pump solenoids to complete or stop the injection of fuel. Refer to "Systems Operation, Fuel System, Hydraulic Electronic Unit Injector (HEUI)," for a complete explanation of the fuel injection process.

The engine uses three types of electronic components: input, control and output.

An input component is one that sends an electrical signal to the system's ECM. The signal sent varies in either voltage, frequency, or pulse width, in response to a change in some specific system of the vehicle (examples are: speed and timing sensor, coolant temperature sensor, etc.). The ECM reads the input sensor signal for information about the condition, environment, or operation of the vehicle.

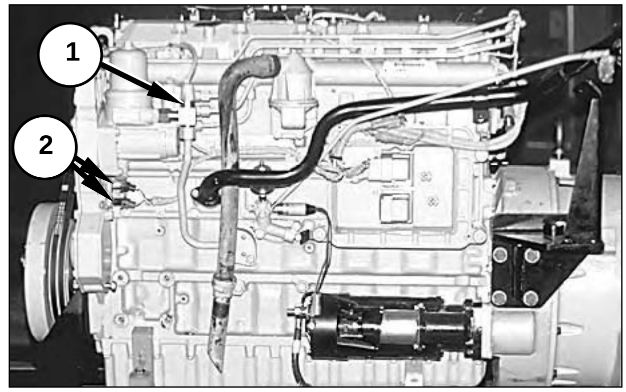
A system control component receives the input signals. Electronic circuits inside the control evaluate the signals and supply electrical energy to the output components of the system in response to predetermined input signal values.

An output component is one that is operated by a control module. An output component receives electrical energy from the control group and uses that energy to do one of two things: perform work (such as a moving solenoid plunger will do), and thereby take an active part in regulating or operating the vehicle, or give information or a warning (such as an indicator or an alarm will do).

These components provide the ability to electronically control the engine operation to improve performance, minimize fuel consumption, and reduce emissions levels.

Electronic Control System Components

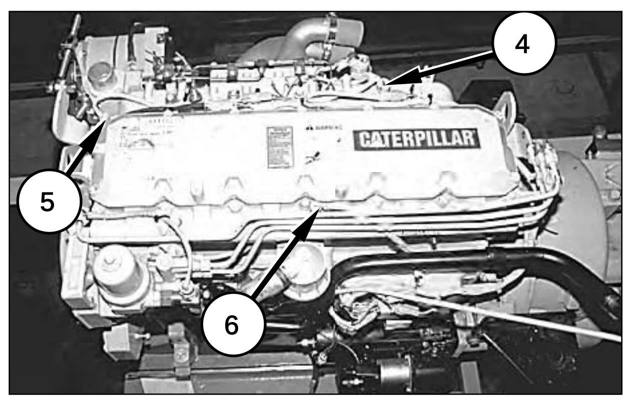
Input Components



Left Side View of Engine (Engine Removed from Machine for Photographic Clarity).
(1) Engine oil temperature sensor. (2) Speed and timing sensor.

Engine oil temperature sensor (1) measures the temperature of the engine oil. The ECM uses the engine oil temperature signal to determine the operation of the intake air heater and the ether injection system.

Speed and timing sensor (2) measures the engine speed and the rotation angle of the crankshaft. The ECM uses the engine's speed signal to operate the tachometer. The ECM uses the engine speed signal and the crankshaft rotation angle signal to control the fuel injection system.

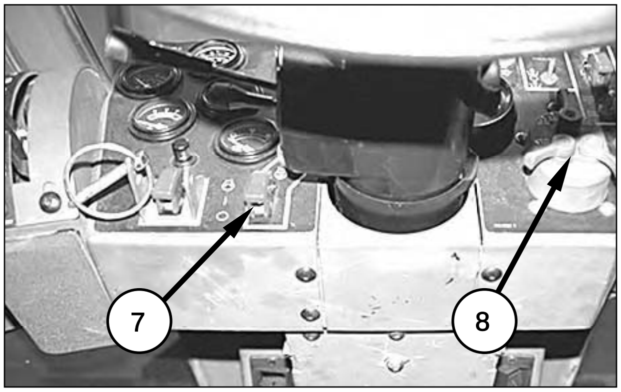


Top View of Engine (Engine Removed from Machine for Photographic Clarity).
(4) Intake air temperature sensor. (5) Boost pressure sensor. (6) Injection actuation pressure sensor.

Intake air temperature sensor (4) measures the temperature of the air in the intake manifold. The ECM uses the air intake manifold temperature signal to control the fuel injection system.

Boost pressure sensor (5) measures the pressure in the air intake manifold. The ECM uses the air intake manifold pressure signal to control the fuel injection system.

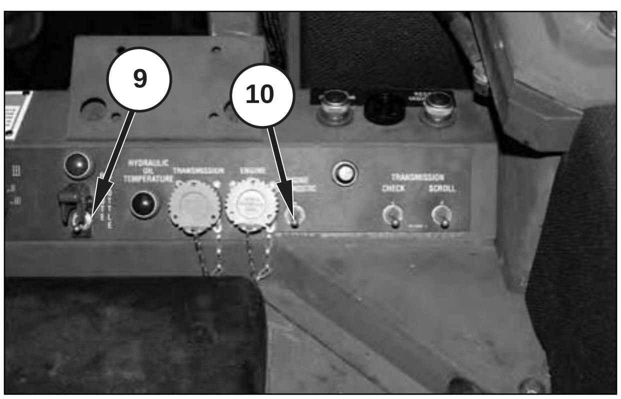
Injection actuation pressure sensor (6) measures the oil pressure in the high pressure manifold. The ECM uses the injection actuation pressure sensor signal to control the fuel injection system.



Instrument Panel.
(7) Ether start-aid switch. (8) Blackout switch.

Ether start-aid switch (7) controls the manual injection of ether into the engine for use in cold weather starting. The ECM receives the signal from the switch and, depending on the starting criteria, will instruct the ether injection solenoid to operate, and turns on the start-aid indicator.

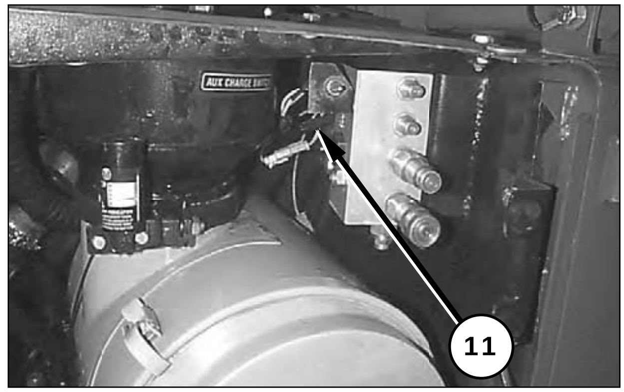
Blackout switch (8) controls the lighting system. The ECM receives the signal from the blackout switch to disable the noncritical warning indicators on the instrument panel and the control console.



Control Console.
(9) Engine speed control switch. (10) Engine diagnostic switch.

Engine speed control switch (9) controls the engine speed when the remote hydraulic tools are operating. The engine ECM receives the signal from the engine speed control switch and sets the engine speed to the correct level.

Engine diagnostic switch (10) controls the engine diagnostic system. The ECM receives the signal from the engine diagnostic switch to enable DIAGNOSTIC mode and indicate any error codes on the check engine indicator.



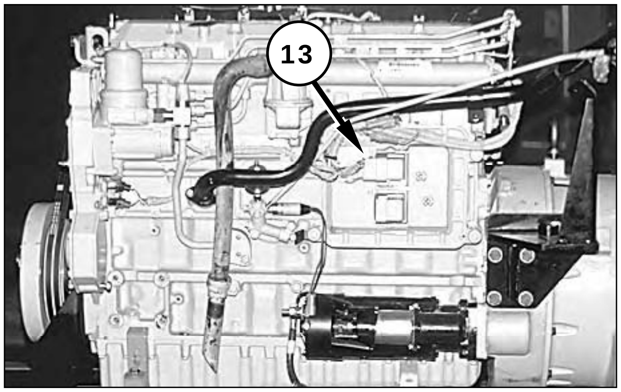
Air cleaner compartment.
(11) Crank-without-inject plug.

Crank-without-inject plug (11) controls the crank-without-inject system. The ECM receives the signal from the crank-without-inject plug and initiates CRANK-WITHOUT-INJECT mode, and turns on the crank-without-inject indicator.

Cab Floor.
(12) Throttle position sensor.

Throttle position sensor (12) allows the operator to determine the desired engine speed. The ECM uses the accelerator position sensor signal to determine the desired engine speed.

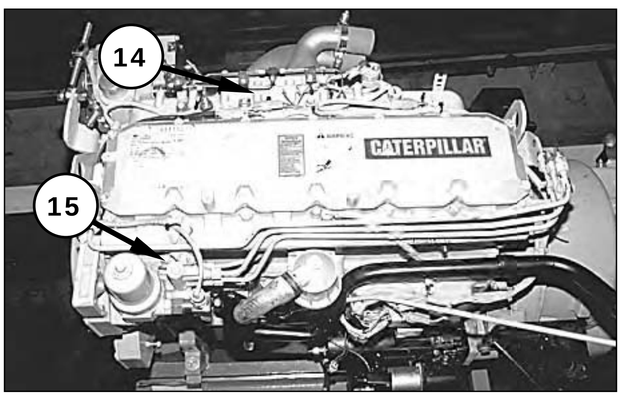
Control Components



Left Side of Engine (Engine Shown Removed from Machine for Photographic Clarity).
(13) ECM.

ECM (13) is the only control component in the electrical system on the engine. The ECM receives the signals from the input components and directs the operation of the output components in the engine's electrical system.

Output Components



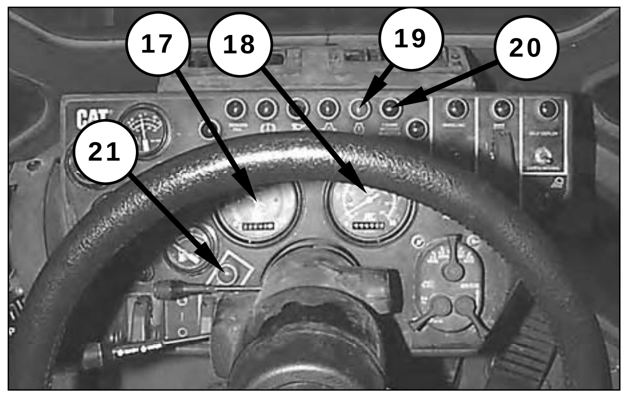
Top of Engine (Engine Shown Removed from Machine for Photographic Clarity).
(14) Air intake heater. (15) Injection actuation pressure control valve.

Air intake heater (14) heats the air which is flowing into the intake manifold. The ECM turns the air intake heater on when the criteria for heating the intake air are met.

Injection actuation pressure control valve (15) controls the pressure in the high pressure oil manifold, which is used to run the hydraulic electronic unit injectors. The ECM controls the injection actuation pressure control valve to maintain a predetermined pressure in the high pressure oil manifold.

Engine Compartment.
(16) Ether injection solenoid.

Ether injection solenoid (16) injects ether into the intake manifold, to assist in starting the engine in cold weather. The ECM actuates the solenoid when the starting conditions are correct and the manual start-aid switch is pressed.

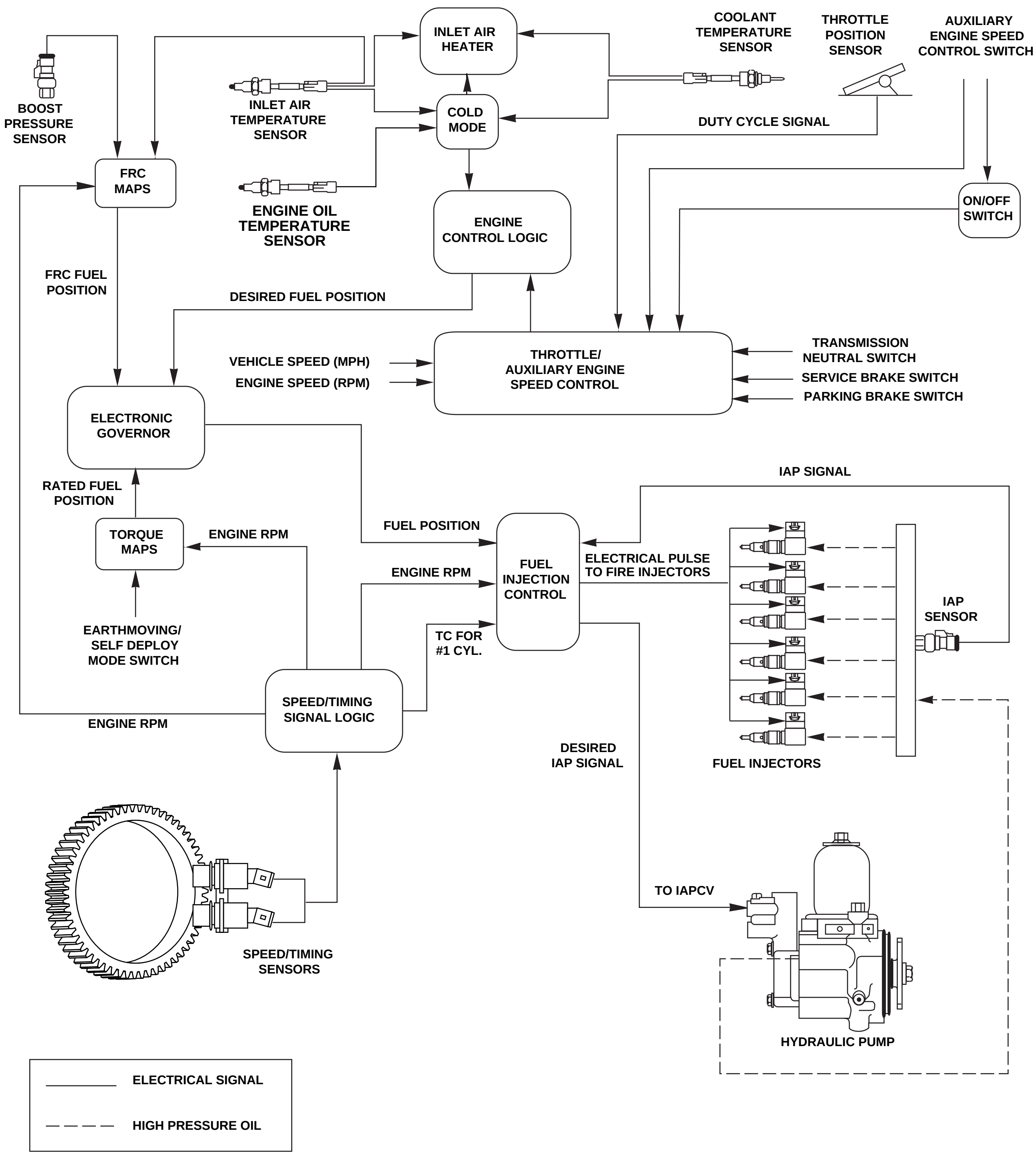


Instrument Panel.
(17) Tachometer. (18) Speedometer. (19) Check engine indicator. (20) Crank-without-inject indicator. (21) Start-aid indicator.

Start-aid indicator (21), crank-without-inject indicator (20), check engine indicator (19), tachometer (17) and speedometer (18) are all outputs of the ECM. The ECM turns the indicators on when their respective functions are active (if the blackout light switch is in the SERVICE DRIVE or STOP LIGHT position). The ECM sends an engine speed output signal to the tachometer and a vehicle ground speed output signal to the speedometer.

NOTE: The ECM receives the vehicle ground speed signal from the Electronic Programmable Transmission Control II (EPTC II) and uses the signal to drive the speedometer.

Electronic Control System Operation



3100 HEUI Electronic Control System.

Electronic Controls

The 3100 HEUI DEUCE Engine’s electronic control system consists of two main components: the ECM and the personality module. The ECM is the computer, and the personality module is the software for the computer. The personality module also stores the operating data that define horsepower, torque curves, rpm, etc. The two work together to control the engine.

NOTE: Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* “Systems Operation, ECM Circuit,” for more information about the ECM.

The throttle position sensor in the cab is used by the operator to accelerate the engine. The signal from this sensor is pulse width modulated and is directed first to the throttle and auxiliary engine speed control circuit. If the auxiliary engine speed control is being operated, the circuit prevents the operator in the cab from overriding the auxiliary engine speed control signal. This protects the remote hydraulic tools from excessive oil flow. The throttle signal then goes through the throttle and auxiliary engine speed control logic and control circuits, where the signal is compared with vehicle speed and engine rpm.

The signal then goes into the engine control logic circuits. Input from the coolant temperature sensor, engine oil temperature sensor, and intake air temperature sensor are sampled. If appropriate, the ECM will place the engine in cold mode operation. The output signal is desired rpm, which is then routed to the electronic governor circuits.

Fuel Injection

Input from the intake air temperature sensor, the boost pressure sensor, and engine rpm are compared with the fuel ratio control maps. The output of this circuit is the fuel ratio control fuel position, which limits fueling during acceleration until the boost pressure rises. This prevents overfueling and black smoke. The fuel ratio control limit of fuel position is normally higher than the desired fuel position and does not affect engine performance if sufficient boost pressure and airflow is attained.

The software in the personality module contains torque maps, which establish the maximum fuel rates and therefore the power levels at all operating speeds, and set the rated fuel position. The torque maps are established by engine rating software which has been “flashed” into the personality module. The personality module is permanently wired in place as a part of the ECM and cannot be physically removed and replaced. Updated software and rerates must be “flashed” via an electronic service tool. Engine rpm and the SELF-DEPLOY/EARTHMOVING mode switch provide input signals to the torque maps.

The electronic governor accepts the signals from torque maps, fuel ratio control fuel position, and desired rpm, and sends the fuel position signal to the fuel injection control circuits. Other input to fuel injection control include the top center position on the number-one cylinder, and engine rpm, both of which come from the speed and timing signal logic circuit.

The top center position for the number-one cylinder is established by signals from the dual speed and timing sensors. These are passive sensors mounted on the upper left side of the engine. The sensors pick up the magnetic impulses from a series of 25 teeth on the back of the camshaft gear. Twenty-four of these teeth are evenly spaced, 15 degrees apart, while the 25th is placed 22 1⁄2 degrees after the top center position for the number-one cylinder. This allows the ECM to establish the position of the number-one cylinder, and fire each unit injector at the correct time and in firing order. The speed and timing sensors are redundant, which permits the operator to continue without down time if one of the sensors fails. If one of the sensors fails, the check engine indicator will turn on, and the sensors should be replaced as soon as possible. The sensors must be replaced as a set because they are not electrically identical.

One output of the fuel injection control circuits is a shaped pulse of 110 volts DC which energizes the unit injector solenoid. The length of the electrical pulse determines how long fuel will flow into the cylinders.

The other output of the fuel injection control circuit is the signal which controls the injection actuation pressure control valve. The injection actuation pressure control valve controls the hydraulic pressure of the oil which is used to actuate the unit injectors.

Testing and Adjusting

Troubleshooting

WARNING

Some of the tests that follow must be done with the machine in operation. A trained machine operator will be needed. Whenever the engine is in operation, the machine operator must be in the cab with the parking and service brakes APPLIED, unless told differently.

Sudden movement of the machine can cause injury to persons on or near the machine. To prevent possible injury, do the procedure that follows before troubleshooting the engine.

With the engine running, this machine will spot turn when the steering wheel is turned, even if the transmission is in NEUTRAL.

To avoid personal injury due to unexpected movement, engage the parking brake and make sure the area is free of personnel before starting the engine.

1. Move the machine to a smooth, horizontal location. Move away from other working machines and personnel. Put the transmission shift lever into the NEUTRAL position. Engage the parking brake. Stop the engine.

2. Permit only two people in the cab (one operator and one service person). Keep all other personnel either away from the machine or in view of the operator. The machine operator must only operate the machine, as directed by the service person. The service person will look at all lights (light emitting diodes [LEDs]) or gauges.

3. The transmission must be in the NEUTRAL position.

The "General Troubleshooting Problems" list, on the following page, is a list of possible problems. To repair a problem, refer to the problems, causes and corrections listed on the pages that follow. If an electronic service tool is available, refer to *Electronic Troubleshooting, Deployable Universal Combat Earthmover (DEUCE), Appendix D: 3100 HEUI DEUCE Engine* for troubleshooting procedures.

This list of problems, causes and corrections will give an indication of where a possible problem can be, and what repairs are needed. Normally, more repair work is needed beyond the recommendations in the list.

Remember that a problem is not normally caused by one part only, but by the relation of one part to another. This list is only a guide and cannot give all possible problems and corrections. Service personnel must find the problem and its cause, and then make the necessary repairs.

Using the engine diagnostic flash codes for troubleshooting will simplify the process. The diagnostic flash codes will lead to a mechanical or electrical problem more efficiently. Always use the engine diagnostic switch to check and resolve any active electrical system faults before proceeding with the general troubleshooting procedures.

Diagnostic Flash Codes

For diagnostic flash codes and their descriptions, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* "Testing and Adjusting, Troubleshooting, Engine Diagnostic Flash Codes," and/or *Electronic Troubleshooting, Deployable Universal Combat Earthmover (DEUCE), Appendix D: 3100 HEUI DEUCE Engine.*

Active Diagnostic Flash Codes

Diagnostic flash codes are used by the 3100 HEUI DEUCE Engine System to warn the vehicle operator of a problem and indicate to the service technician the nature of the problem. Some codes are used only to record an event and do not indicate problems that need repair.

An active diagnostic flash code represents a problem that should be investigated and corrected as soon as possible. Repairing the cause of an active code will clear the code.

When an active diagnostic flash code is generated, the check engine indicator will turn ON and blink every five seconds. If the condition which generated the fault occurs only for a brief moment, the indicator will go OFF after five seconds, and the code will be logged.

Active diagnostic flash codes can be reviewed with the check engine indicator and engine diagnostic switch, located in the cab. The check engine indicator flashes the codes corresponding to any active faults. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Troubleshooting, Engine Diagnostic Codes."

Logged Diagnostic Flash Codes and Events

NOTE: Computer-based diagnostic and repair tools can read logged diagnostic flash codes and provide more detailed diagnostic and repair instructions.

When the ECM generates a diagnostic flash code, the code will be active and may be logged in permanent memory within the ECM. The ECM has an internal diagnostic clock and will record the engine operating hour each time a code is logged. Logged codes can be valuable indicators for troubleshooting intermittent problems, and can be retrieved (or erased) using an electronic service tool. For troubleshooting procedures to use with an electronic service tool, refer to *Electronic Troubleshooting, Deployable Universal Combat Earthmover (DEUCE), Appendix D: 3100 HEUI DEUCE Engine.*

Diagnostic flash codes which are logged repeatedly may indicate a problem that needs special investigation. Codes which are logged only a few times, and do not result in operator complaints, may not need attention until a scheduled maintenance interval.

NOTE: The most likely cause of an intermittent problem is a faulty connection or damaged wiring. The next most likely cause is component failure (sensor or switch, for example). The least likely cause is a failure within the ECM itself.

Troubleshooting Problem List (For Troubleshooting Without an Electronic Service Tool)

Troubleshooting Problems

Problem 1: Engine Crankshaft Will Not Turn When Engine Start Switch Is in START

Probable Cause(s):

- Electrical system problem
- Problem with accessory equipment
- Internal problem prevents engine crankshaft from turning

1. Electrical system problem:

a. Raise the radiator. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE)*, “Radiator Tilt.”

b. If 24 to 28 volts are not present at the battery terminal of the starter solenoid, with the engine start switch in the START position, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* “Troubleshooting, Problem List, Engine Cranks Slowly.”

c. If 24 to 28 volts are not present at the starter terminal of the starter solenoid, with the start switch in the START position, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* “Troubleshooting, Problem List, Engine Cranks Slowly.”

d. If 24 to 28 volts are present at the starter and battery terminal of the starter solenoid, remove the starter and operate the start switch to see if it rotates. If the starter does not rotate, replace it. If the starter rotates, go to Step 2.

2. Problem with accessory equipment:

a. Place the machine in CRANK-WITHOUT-INJECT mode. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* “Systems Operation, ECM Circuit, Component Location.”

b. Remove the steering pump drive shaft. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* “Drive Shaft, Steering.” If the engine turns over when the start switch is used, repair or replace the steering pump.

c. Remove the main drive shaft. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* “Drive Shaft, Main.” If the engine turns over when the start switch is used, repair or replace the transmission.

d. Remove the implement hydraulic pump. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Hydraulic System,* “Implement Pump.” If the engine turns over when the start switch is used, repair or replace the implement hydraulic pump.

e. Remove the cooling fan hydraulic pump. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Hydraulic System,* “Fan Pump.” If the engine turns over when the start switch is used, repair or replace the cooling fan hydraulic pump.

f. Remove the transmission lubrication pump. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* “Power Train Lubrication Pump.” If the engine turns over when the start switch is used, repair or replace the transmission lubrication pump.

3. Internal problem prevents engine crankshaft from turning:

a. Remove the unit injectors. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Unit Fuel Injection Pump Group.” Check for fluid in the cylinders while turning the crankshaft (turn the crankshaft by hand, or use CRANK-WITHOUT-INJECT mode). If there is no fluid in any of the cylinders, proceed to Step b.

b. Remove and disassemble the engine. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine.* Look for possible internal failures such as: bearing seizure, piston seizure, and valves making contact with the pistons.

Problem 2: Engine Hard to, or Will Not Start (Engine Crankshaft Turns Too Slowly)

Probable Cause(s):

- Electrical system problem
- Oil too thick
- Problem with accessory equipment
- Internal problem prevents engine crankshaft from turning freely

1. Electrical system problem:

a. Raise the radiator. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE)*, “Radiator Tilt.”

b. If 24 to 28 volts are not present at the battery terminal of the starter solenoid, with the engine start switch in the START position, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* “Troubleshooting, Problem List, Engine Cranks Slowly.”

c. If 24 to 28 volts are not present at the starter terminal of the starter solenoid, with the engine start switch in the START position, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* “Troubleshooting, Problem List, Engine Cranks Slowly.”

d. If 24 to 28 volts are present at the starter and battery terminal of the starter solenoid, remove the starter and operate the start switch to see if it rotates. If the starter does not rotate, replace it. If the starter rotates, go to Step 2.

2. Oil too thick:

a. Use the recommended lubrication viscosities, refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Lubrication Viscosities and Refill Capacities." If the oil is changed, replace it with the oil viscosity recommended, and replace the oil filters. Use the procedure in *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Special Operational Preparations, Preparation for Arctic Operation" to ensure that all of the thick oil is drained from the system.

b. Determine if maintenance intervals are correct for the service application and if they are being followed. If they are, and the oil quality has deteriorated, an oil sample (Scheduled oil Sampling [S•O•S] or Army Oil Analysis Program [AOAP]) should be analyzed.

3. Problem with accessory equipment:

a. Set the machine to crank-without-inject. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* "Systems Operation, ECM Circuit, Component Location."

b. Remove the steering pump drive shaft. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Drive Shaft, Steering." If the engine turns over when the start switch is used, repair or replace the steering pump.

c. Remove the main drive shaft. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Drive Shaft, Main." If the engine turns over when the start switch is used, repair or replace the transmission.

d. Remove the implement hydraulic pump. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Hydraulic System,* "Implement Pump." If the engine turns over when the start switch is used, repair or replace the implement hydraulic pump.

e. Remove the cooling fan hydraulic pump. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Hydraulic System,* "Fan Pump." If the engine turns over when the start switch is used, repair or replace the cooling fan hydraulic pump.

f. Remove the transmission lubrication pump. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Power Train Lubrication Pump." If the engine turns over when the start switch is used, repair or replace the lubrication pump.

4. Internal problem prevents engine crankshaft from turning freely:

Remove and disassemble the engine. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine.* Look for possible internal failures such as: bearing seizure, piston seizure, and valves making contact with the pistons.

Problem 3: Engine Cranks but Will Not Start (Engine Crankshaft Turns Freely, Exhaust Smoke Cannot be Seen While Starting

Probable Cause(s):

- Crank-without-inject mode is functioning
- Fuel or engine oil supply low
- No power to ECM
- Software problem
- No speed and timing signal
- Low fuel pressure
- Air in fuel
- Incorrect injection actuation pressure
- Slow cranking

1. Crank-without-inject mode is functioning.

a. If the crank-without-inject indicator is on, disable the crank-without-inject system. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* "Systems Operation, ECM Circuit, Component Location."

b. Check the crank-without-inject indicator while the engine start switch is in the START position, and the blackout light switch is in the SERVICE DRIVE position. The indicator should be on. If the indicator is not on, replace the bulb and make sure the crank-without-inject system is OFF.

2. Fuel or engine oil supply low:

a. Check for an acceptable quantity and quality of fuel to operate the engine.

b. Ensure that the engine oil level is at the desired level. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Every 10 Service Hours or Daily." The engine oil feeds the high pressure hydraulic pump which drives the unit injectors.

3. No power to ECM:

Check the ECM power, ground circuits and connections. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* "Troubleshooting, Engine Diagnostic Flash Codes, Connector Checks."

4. Software problem:

a. Use the engine diagnostic switch to check for a diagnostic flash code of 59, "Incorrect Engine Software." If the code is present, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* "Troubleshooting, Engine Diagnostic Flash Codes."

b. An ECM with an unprogrammed personality module has been installed on the machine. Check the ECM part number.

5. No speed and timing signal:

The cranking speed is typically 100 to 150 rpm with a cold engine. A cranking speed of 100 rpm or greater should create enough hydraulic oil pressure to operate the unit injectors. If the cranking speed is below 100 rpm, refer to Problem 2: "Engine Hard to, or Will Not Start" in this section. If the cranking speed is above 100 rpm, use the engine diagnostic switch to check for a diagnostic flash code of 34, "Engine Rpm Signal Fault." If the code is present, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* "Troubleshooting, Engine Diagnostic Flash Codes."

6. Low fuel pressure:

a. Check the engine fuel pressure while cranking. At 200 rpm, pressure should read approximately 275 to 350 kPa (40 to 50 psi). Refer to "Testing and Adjusting, Fuel System, Fuel Pressure" in this module.

b. If the fuel pressure is zero, remove the fuel transfer pump and see if the cam timing gear is turning. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Fuel Transfer Pump."

c. If the fuel pressure is low, then check the fuel filters and fuel lines for restrictions. Check the fuel transfer pump, valves and bypass valves.

d. If the fuel system has been repaired, verify that the orificed check valve is mounted correctly on the fuel return line, and is working. Ensure that the correct orifice has been installed.

7. Air in fuel:

a. Check for air in the fuel by installing a 2P-8278 Fuel Flow Tube on the return line. If access to the rear of the engine is restricted, install the sight glass on the return line, at the tank.

b. Check the fuel transfer pump fittings and joints for air leaks. Check the unit injectors and sleeves for combustion gas leaks.

c. Remove each unit injector and use a magnifying glass to inspect the base of the sleeve. The unit injector may also show evidence of leaking combustion gas. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Unit Fuel Injection Pump Group."

8. Incorrect injection actuation pressure:

a. Check the dipstick for normal oil level. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Every 10 Service Hours or Daily."

b. Use the engine diagnostic switch to check for diagnostic flash code 39, "Injection Actuation Pressure System Fault." If the code is present, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* "Troubleshooting, Engine Diagnostic Flash Codes."

c. After opening or working on the high pressure hydraulic oil system, there may be air remaining in the system. To purge the air, crank the engine for 30 seconds at a time, at least five times. Allow the starter to cool off for two minutes between each cranking period.

d. Check to see that oil is reaching the hydraulic pump inlet. Slightly loosen the oil supply line from the engine oil gallery on the left side of the engine block to see if oil leaks out.

e. Check the engine oil pressure with a gauge installed in the oil gallery on the left side of the engine block. There should be about 28 to 55 kPa (4 to 8 psi) while cranking. If no oil pressure registers, check for any dilution of the oil (dilution will lower oil pressure), and check the engine oil pump.

9. Slow cranking:

The cranking speed should be at a minimum of 100 rpm for engine starting. Refer to Problem 2: "Engine Hard to, or Will Not Start."

Problem 4: Engine Cranks but Will Not Start (Engine Crankshaft Turns Freely, Exhaust Smoke Can be Seen While Starting)

Probable Cause(s):

- Cold outside temperature
- Low fuel pressure
- Air in fuel
- Loss of compression
- Water in fuel
- Defective or worn unit injectors

1. Cold outside temperature:

NOTE: The presence of white smoke while cranking, for a very brief period after starting the engine and while operating in cold temperatures, is normal.

a. Use the engine diagnostic switch to check for active diagnostic flash codes. If codes 49, "Intake Air Heater Fault," 38, "Intake Manifold Temperature Sensor Fault," or 89, "Start Aid Lamp Fault," are present, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* "Troubleshooting, Engine Diagnostic Flash Codes."

b. Check the fuel grade and quality. If the cloud point is too high, waxing may occur, which results in plugged fuel filters and lines.

2. Low fuel pressure:

a. Check the engine fuel pressure while cranking. At 200 rpm, the pressure should read approximately 275 to 350 kPa (40 to 50 psi). Refer to "Testing and Adjusting, Fuel System, Fuel Pressure" in this module.

b. If the fuel pressure is zero, remove the fuel transfer pump and see if the cam timing gear is turning. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Fuel Transfer Pump."

c. If the fuel pressure is low, check the fuel filters and fuel lines for restrictions. Check the fuel transfer pump, valves and bypass valves.

d. If the fuel system has been repaired, verify that the orificed check valve is mounted correctly on the fuel return line and is working, and that the correct orifice has been installed.

3. Air in fuel:

a. Check for air in the fuel by installing a 2P-8278 Fuel Flow Tube on the return line. If access to the rear of the engine is restricted, install the sight glass on the return line, at the tank.

b. Check the fuel transfer pump fittings and joints for air leaks. Check the unit injectors and sleeves for combustion gas leaks.

c. Remove each unit injector and use a magnifying glass to inspect the base of the sleeve. The unit injector may also show evidence of leaking combustion gas. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Unit Fuel Injection Pump Group."

4. Loss of compression:

a. Check the intake and exhaust valve clearances and make adjustments. Refer to "Testing and Adjusting, Air Intake and Exhaust System, Valve Lash," in this module.

b. Blown head gasket. Repair or replace as necessary. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Cylinder Head Assembly."

c. Piston failure. Repair or replace as necessary. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Piston and Connecting Rod Assemblies."

5. Water in fuel:

a. Check the fuel and water separator. Drain any water from the separator. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Every 10 Service Hours or Daily, Water Separator."

b. Check the fuel tank for water. If a large amount of water is found, completely drain the fuel tank and fuel lines. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* Maintenance Section, Every 1000 Service Hours or When Required, Fuel Tank." Replace the fuel filters. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Every 250 Hours of Service or 3 Months, Fuel System," and "Maintenance Section, Every 500 Service Hours or 6 Months, Fuel System." Refill the fuel tank with good fuel, of the correct grade.

6. Defective or worn unit injectors:

If poor quality fuel has been used, the internal components of the injector could be worn excessively. Excessive wear can cause the injector not to inject fuel. For fuel recommendations, refer to "Specifications, Fuel System, Fuel Characteristics," in this module. Replace the injectors. For the replacement procedure, refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Unit Fuel Injection Pump Group."

Problem 5: Engine Misfiring or Running Rough

Probable Cause(s):

- Cold outside temperature
- Air in fuel
- Injector problem
- Incorrect injection actuation pressure
- Water in fuel
- Low fuel pressure
- Throttle position sensor/PTO problem
- Loss of compression

1. Cold outside temperature:

NOTE: The presence of white smoke while cranking, and for a very brief period after starting the engine is normal.

a. If the engine continues to run rough after reaching operating temperatures, use the engine diagnostic switch to check for active diagnostic flash codes. If codes 49, "Intake Air Heater Fault," 38, "Intake Manifold Temperature Sensor Fault," or 89, "Start Aid Lamp Fault" are present, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* "Troubleshooting, Engine Diagnostic Flash Codes."

b. Check the fuel grade and quality. If the cloud point is too high, waxing may occur, which results in fuel filters and lines.

2. Air in fuel:

a. Check for air in the fuel by installing a 2P-8278 Fuel Flow Tube on the return line. If access to the rear of the engine is restricted, install the sight glass on the return line, at the tank.

b. Check the fuel transfer pump fittings and joints for air leaks. Check the unit injectors and sleeves for combustion gas leaks.

c. Remove each unit injector and use a magnifying glass to inspect the base of the sleeve. The unit injector may also show evidence of leaking combustion gas. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Unit Fuel Injection Pump Group."

3. Injector problem:

a. An injector may fail to operate properly, causing a misfire in that cylinder. Some possible causes are: debris in the oil supply, incorrect removal of an injector, mechanical pressure on the adapter section, mechanical pressure on the solenoid, or the solenoid coil may develop a shorted or open circuit.

NOTE: There is no bench test ("pop test") available for field testing hydraulic electronic unit injectors. The only test for hydraulic electronic unit injectors is on the engine.

b. Use the engine diagnostic switch to check for active diagnostic flash codes. If codes are present, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* "Troubleshooting, Engine Diagnostic Flash Codes."

4. Incorrect injection actuation pressure:

a. Check the dipstick to be sure the oil level is normal. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Every 10 Service Hours or Daily."

b. Use the engine diagnostic switch to check for active diagnostic flash codes while cranking the engine. If diagnostic flash code 39, "Injection Actuation Pressure System Fault" is present, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* "Troubleshooting, Engine Diagnostic Flash Codes."

c. After opening or working on the high pressure hydraulic oil system, there may be air remaining in the system. To purge the air, crank the engine for 30 seconds at a time, at least five times. Allow the starter to cool off for two minutes between each cranking period.

d. Check to see that oil is reaching the hydraulic pump inlet. Slightly loosen the oil supply line from the engine oil gallery on the left side of the engine block to see if oil leaks out.

e. Check the engine oil pressure with a gauge installed in the oil gallery on the left side of the engine block. The oil pressure should be about 28 to 55 kPa (4 to 8 psi) during cranking. If no oil pressure registers, check for any dilution of the oil (dilution will lower oil pressure), check the engine oil pump, and the pickup.

5. Water in fuel:

a. Check the fuel and water separator. Drain any water from the separator. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Every 10 Service Hours or Daily, Water Separator."

b. Check the fuel tank for water. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* Maintenance Section, Every 1000 Service Hours or When Required, Fuel Tank." Replace the fuel filters. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Every 250 Hours of Service or 3 Months, Fuel System," and "Maintenance Section, Every 500 Service Hours or 6 Months, Fuel System." Refill the fuel tank with good fuel of the correct grade.

6. Low fuel pressure:

a. Check the fuel pressure with a gauge. Refer to "Testing and Adjusting, Fuel System, Fuel Pressure" in this module. The fuel pressure at low idle should read about 400 to 435 kPa (58 to 63 psi). During normal operating conditions, under load, the fuel pressure should read between 400 to 525 kPa (58 to 76 psi), as measured at the inlet to the secondary fuel filter. The fuel pressure to the cylinder head fuel gallery should be as above, less the pressure differential across the secondary fuel filter. A pressure drop across the secondary fuel filter is typically at least 35 kPa (5 psi) with a new filter. As the filter accumulates deposits, the pressure differential will increase.

b. If fuel pressure at the unit injectors drops to approximately 69 kPa (10 psi), misfires may occur. This would typically be a "rolling misfire" which affects all cylinders at random, rather than a consistent misfire on a given cylinder.

c. Check the fuel filters and fuel lines for restrictions or plugging. Check for failures of the fuel transfer pump or unit injector sleeves. Check to see if the orifice check valve is loose, missing from the fuel return line, or if the wrong orifice was installed. If sleeve or O-ring damage is found, replace damaged parts with new parts, as necessary.

7. Throttle position sensor/PTO problem:

NOTE: Momentary loss of the throttle position or auxiliary engine speed control signal may cause a "speed burp" or brief drop in engine rpm. This intermittent signal loss may be perceived as an unstable engine problem.

Use the engine diagnostic switch to check for active diagnostic flash codes. If codes exist, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* "Troubleshooting, Engine Diagnostic Flash Codes."

NOTE: The status of the throttle position, vehicle speed, and brake switches can be viewed in the display status screens on the electronic service tool.

8. Loss of compression:

a. Check the intake and exhaust valve clearances and make adjustments. Refer to "Testing and Adjusting, Air Intake and Exhaust System, Valve Lash," in this module.

b. Blown head gasket. Repair or replace as necessary. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Cylinder Head Assembly."

c. Piston failure. Repair or replace as necessary. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Piston and Connecting Rod Assemblies.”

Problem 6: Engine Stall at Low RPM

Probable Cause(s):

- Fuel pressure is low
- Air in fuel
- Incorrect fuel grade
- Combustion gas, or water, in fuel
- Defect in unit injector(s)
- Loss of pressure in high pressure hydraulic oil system
- Engine accessories

1. Fuel pressure is low:

a. Check the engine fuel pressure during cranking. Refer to “Testing and Adjusting, Fuel System, Fuel Pressure” in this module. At 200 rpm, pressure should read about 275 to 350 kPa (40 to 50 psi), as measured at the inlet to the secondary fuel filter.

b. If the fuel pressure is zero, remove the fuel transfer pump and see if the cam timing gear is turning. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Fuel Transfer Pump.”

c. If the fuel pressure is low, check fuel filters and fuel lines for restrictions. Check the fuel transfer pump, valves and bypass valves.

d. If the fuel system has been repaired, verify that the orificed check valve is correctly mounted on the fuel return line and is working, and that the correct orifice has been installed.

2. Air in fuel:

a. Check for air in the fuel by installing a 2P-8278 Fuel Flow Tube on the return line. If access to the rear of the engine is restricted, install the sight glass on the return line at the tank.

b. Check the fuel transfer pump fittings and joints for air leaks. Check the unit injectors and sleeves for combustion gas leaks.

c. Remove each unit injector and use a magnifying glass to inspect the base of the sleeve. The unit injector may also show evidence of leaking combustion gas. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Unit Fuel Injection Pump Group.”

3. Incorrect fuel grade:

Check the fuel grade. In temperatures below 0°C (32°F), make sure that winter grade fuel is being used. Check for waxing.

4. Combustion gas, or water, in fuel:

a. Check the fuel and water separator. Drain any water from the separator. Refer to *Operator’s Manual, Deployable Universal Combat Earthmover (DEUCE),* “Maintenance Section, Every 10 Service Hours or Daily, Water Separator.”

b. Check the fuel tank for water. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* Maintenance Section, Every 1000 Service Hours or When Required, Fuel Tank.” Replace the fuel filters. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* “Maintenance Section, Every 250 Hours of Service or 3 Months, Fuel System,” and “Maintenance Section, Every 500 Service Hours or 6 Months, Fuel System.” Refill the fuel tank with good fuel of the correct grade.

c. Remove the fuel injectors and look for evidence of pitting, or holes in the fuel injector sleeves. Repair or replace damaged parts as necessary. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Unit Fuel Injection Pump Group.”

5. Defect in unit injector(s):

a. An injector may fail to operate properly, causing low power. Some possible causes are: debris in the oil supply, incorrect removal of an injector, mechanical pressure on the adapter section, mechanical pressure on the solenoid, or the solenoid coil may develop a shorted or open circuit.

NOTE: There is no bench test (“pop test”) available for field testing hydraulic electronic unit injectors. The only test for injectors is on the engine.

b. Use the engine diagnostic switch to check for active diagnostic flash codes. If codes are present, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* “Troubleshooting, Engine Diagnostic Flash Codes.”

c. If poor quality fuel has been used, the internal components of the injector could be worn excessively. Excessive wear can cause the injector not to inject fuel. For fuel recommendations, refer to “Specifications, Fuel System, Fuel Characteristics,” in this module. Replace the injectors. For the replacement procedure, refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Unit Fuel Injection Pump Group.”

6. Loss of pressure in high pressure hydraulic oil system:

a. Check the dipstick to be sure the oil level is normal. Refer to *Operator’s Manual, Deployable Universal Combat Earthmover (DEUCE),* “Maintenance Section, Every 10 Service Hours or Daily.”

b. Use the engine diagnostic switch to check for active diagnostic flash codes during engine cranking. If diagnostic flash code 19, “Injection Actuation Pressure System Fault” is present, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* “Troubleshooting, Engine Diagnostic Flash Codes.”

c. After the high pressure hydraulic oil system is opened or worked on, there may be air remaining in the system. To purge the air, crank the engine for 30 seconds at a time, at least five times. Allow the starter to cool off for two minutes between each cranking period.

d. Check to see that oil is reaching the hydraulic pump inlet. Slightly loosen the oil supply line from the engine oil gallery on the left side of the engine block to see if oil leaks out.

e. Check the engine oil pressure with a gauge installed in the oil gallery on the left side of the engine block. The oil pressure should be about 28 to 55 kPa (4 to 8 psi) during cranking. If no oil pressure registers, check for dilution of the oil (dilution will lower oil pressure), engine oil pump, and pickup.

7. Engine accessories:

a. Remove the steering pump drive shaft. If the problem goes away, repair or replace the steering pump. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* “Drive Shaft, Steering.” If the engine turns over when the start switch is used, repair or replace the steering pump.

b. Remove the main drive shaft. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* “Drive Shaft, Main.” If the problem goes away, repair or replace the transmission.

c. Remove the implement hydraulic pump. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Hydraulic System,* “Implement Pump.” If the problem goes away, repair or replace the implement hydraulic pump.

d. Remove the cooling fan hydraulic pump. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Hydraulic System,* “Fan Pump.” If the problem goes away, repair or replace the cooling fan hydraulic pump.

e. Remove the transmission lubrication pump. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* “Power Train Lubrication Pump.” If the problem goes away, repair or replace the transmission lubrication pump.

Problem 7: Low Power

Probable Cause(s):

- Dirty fuel filters
- Oil level too high
- Water in fuel
- Low quality fuel
- Defect in boost sensor
- Defect in coolant temperature sensor
- Defect in throttle position sensor
- Defect in injection actuation pressure system
- Air or combustion gas in fuel
- Low fuel pressure
- Turbocharger has carbon deposits, or another cause of friction

- Restrictions and/or leaks in air intake system
- Plugged or damaged muffler
- Defect in unit injector(s)
- Valve adjustment incorrect
- Excessive load by nonengine component

1. Dirty fuel filters:

Replace the fuel filters. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Every 250 Hours of Service or 3 Months, Fuel System," and "Maintenance Section, Every 500 Service Hours or 6 Months, Fuel System."

2. Oil level too high:

Remove the dipstick and check the oil level. If the level is too high, drain the oil to bring the oil to the desired level. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Every 10 Service Hours or Daily" and *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Every 250 Service Hours or 3 Months, Engine Oil and Filter."

NOTE: An oil sample (S•O•S or AOAP) should be performed to find out if the oil level is increasing due to a fuel leak or other engine problem.

3. Water in fuel:

a. Check the fuel and water separator. Drain any water from the separator. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Every 10 Service Hours or Daily, Water Separator."

b. Check the fuel tank for water. If a large amount of water is found, completely drain the fuel tank and fuel lines. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* Maintenance Section, Every 1000 Service Hours or When Required, Fuel Tank." Replace the fuel filters. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Every 250 Hours of Service or 3 Months, Fuel System," and "Maintenance Section, Every 500 Service Hours or 6 Months, Fuel System." Refill the fuel tank with good fuel of the correct grade.

4. Low quality fuel:

Remove the fuel from the fuel tank. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* Maintenance Section, Every 1000 Service Hours or When Required, Fuel Tank." Install a new fuel filter. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Every 250 Hours of Service or 3 Months, Fuel System," and "Maintenance Section, Every 500 Service Hours or 6 Months, Fuel System." Put a good grade of clean fuel in the fuel tank. The API rating of fuel can be easily checked with the 1P-7408 Thermo-Hydrometer.

5. Defect in boost sensor:

Use the engine diagnostic switch to check for active diagnostic flash codes. If codes are present, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* "Troubleshooting, Engine Diagnostic Flash Codes."

6. Defect in coolant temperature sensor:

Use the engine diagnostic switch to check for active diagnostic flash codes. If codes are present, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* "Troubleshooting, Engine Diagnostic Flash Codes."

7. Defect in throttle position sensor:

Use the engine diagnostic switch to check for active diagnostic flash codes. If codes are present, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* "Troubleshooting, Engine Diagnostic Flash Codes."

8. Defect in injection actuation pressure system:

a. Check the dipstick to be sure the oil level is normal. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Every 10 Service Hours or Daily"

b. Use the engine diagnostic switch to check for active diagnostic flash codes during engine cranking. If diagnostic flash code 19, "Injection Actuation Pressure System Fault" is present, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* "Troubleshooting, Engine Diagnostic Flash Codes."

c. After the high pressure hydraulic oil system is opened or worked on, there may be air remaining in the system. To purge the air, crank the engine for 30 seconds at a time, at least five times. Allow the starter to cool off for two minutes between each cranking period.

d. Check to see that oil is reaching the hydraulic pump inlet. Slightly loosen the oil supply line from the engine oil gallery on the left side of the engine block to see if oil leaks out.

e. Check the engine oil pressure with a gauge installed in the oil gallery on the left side of the engine block. The oil pressure should be about 28 to 55 kPa (4 to 8 psi) during cranking. If no oil pressure registers, check for any dilution of the oil (dilution will lower oil pressure), check the engine oil pump and pickup.

9. Air or combustion gas in fuel:

a. Check for air in fuel by installing a 2P-8278 Fuel Flow Tube on the return line. If access to the rear of the engine is restricted, install the sight glass on the return line at the tank.

b. Check the fuel transfer pump fittings and joints for air leaks. Check the unit injectors and sleeves for combustion gas leaks.

c. Remove each unit injector and use a magnifying glass to inspect the base of the sleeve. The unit injector may also show evidence of leaking combustion gas. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Unit Fuel Injection Pump Group."

10. Low fuel pressure:

a. Check the fuel pressure with a gauge. Refer to "Testing and Adjusting, Fuel System, Fuel Pressure" in this module. The fuel pressure at low idle should read about 400 to 435 kPa (58 to 63 psi). During normal operating conditions under load, the fuel pressure should read between 400 to 525 kPa (58 to 76 psi) as measured at the inlet to the secondary fuel filter. The fuel pressure to the cylinder head fuel gallery should be as above, less the pressure differential across the secondary fuel filter. A pressure drop across the secondary fuel filter is typically at least 35 kPa (5 psi) with a new filter. As the filter accumulates deposits, the pressure differential will increase.

b. If fuel pressure at the unit injectors drops to approximately 69 kPa (10 psi), misfires may occur. This would typically be a "rolling misfire" which affects all cylinders at random, rather than a consistent misfire on a given cylinder.

c. Check the fuel lines for restrictions or plugging. Check for fuel transfer pump or unit injector sleeve failure. Check to see if the orifice check valve is loose, missing from the fuel return line, or if the wrong orifice was installed. If fuel injector sleeve or O-ring damage is found, replace damaged parts with new parts.

11. Turbocharger has carbon deposits or another cause of friction:

Remove the turbocharger and inspect the impeller and turbine for damage. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Turbocharger." Repair or replace the turbocharger, if necessary.

12. Restrictions and/or leaks in air intake system:

a. Look for restrictions in the air cleaner.

b. Check the pressure in the air intake manifold. Refer to "Testing and Adjusting, Air Intake and Exhaust System, Measurement of Boost Pressure in Intake Manifold" in this module. Look for restrictions at the air cleaner. Correct any leaks.

c. Check for leaks.

d. To test the air-to-air aftercooler, check the temperature of the inlet and outlet air from the air cooler. Remove any external or internal restrictions.

13. Plugged or damaged muffler:

Measure the exhaust manifold pressure. Refer to "Testing and Adjusting, Air Intake and Exhaust System, Restriction of Air Intake and Exhaust" in this module. Repair or replace the muffler, if necessary.

14. Defect in unit injector(s):

a. An injector may fail to operate properly, causing low power. Some possible causes are: debris in the oil supply, incorrect removal of an injector, mechanical pressure on the adapter section, mechanical pressure on the solenoid, or the solenoid coil may develop a shorted or open circuit.

NOTE: There is no bench test ("pop test") available for field testing hydraulic electronic unit injectors. The only test for injectors is on the engine.

b. Use the engine diagnostic switch to check for active diagnostic flash codes. If codes are present, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* "Troubleshooting, Engine Diagnostic Flash Codes."

c. If poor quality fuel has been used, the internal components of the injector could be worn excessively. Excessive wear can cause the injector not to inject fuel. For fuel recommendations, refer to "Specifications, Fuel System, Fuel Characteristics," in this module. Replace the injectors. For the replacement procedure, refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Unit Fuel Injection Pump Group."

15. Valve adjustment incorrect:

Check the intake and exhaust valve clearances and make adjustments. Refer to "Testing and Adjusting, Air Intake and Exhaust System, Valve Lash," in this module.

16. Excessive load by nonengine component:

a. Check the steering hydraulic system for correct operation. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage, Steering, and Brakes,* "Testing and Adjusting, Steering System Procedures."

b. Check the transmission and torque converter for correct operation. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Transmission and Torque Converter,* "Testing and Adjusting, Transmission Hydraulic System" and "Torque Converter Hydraulic System."

c. Check the undercarriage and brake system for correct operation. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage, Steering, and Brakes,* "Testing and Adjusting, Suspension System Procedures" and "Brake System Procedures."

d. Check the implement and fan hydraulic system for correct operation. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Implement and Fan Hydraulic System,* "Testing and Adjusting."

Problem 8: Too Much Vibration

Probable Cause(s):

- Vibration damper loose
- Vibration damper defective
- Engine supports are loose, incorrect or defective
- Driven equipment is not in alignment, or is out of balance
- Engine misfiring or running rough

1. Vibration damper loose:

Check the vibration damper for any loose or missing fasteners. Tighten all bolts. If the vibration damper bolt holes are damaged or worn, replace the vibration damper. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Vibration Damper, Crankshaft Pulley and Crankshaft Front Seal."

2. Vibration damper defective:

Inspect the vibration damper for leaks or damage to the case, such as dents or bending. Replace a leaking or damaged vibration damper. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Vibration Damper, Crankshaft Pulley and Crankshaft Front Seal."

3. Engine supports are loose, incorrect or defective:

a. Tighten all mounting bolts.

b. Inspect the front and rear engine mounts for cracks or other signs of damage. Replace all of the mounts if there is any damage. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Engine Support, Front" and "Engine Support, Rear."

4. Driven equipment is not in alignment, or is out of balance:

a. Disconnect the steering pump drive shaft from the engine. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Drive Shaft, Steering." Operate the engine. If the vibration is gone, replace the steering pump drive shaft.

b. Disconnect the main drive shaft from the engine. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Drive Shaft, Main." Operate the engine. If the vibration is gone, replace the main drive shaft. If the vibration is not gone, investigate the transmission for the source of the vibration.

c. Remove the implement hydraulic pump. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Hydraulic System,* "Implement Pump." If the problem goes away, repair or replace the implement hydraulic pump.

d. Remove the cooling fan hydraulic pump. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Hydraulic System,* "Fan Pump." If the problem goes away, repair or replace the cooling fan hydraulic pump.

e. Remove the transmission lubrication pump. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Power Train Lubrication Pump." If the problem goes away, repair or replace the transmission lubrication pump.

5. Engine misfiring or running rough:

Refer to Problem 5: "Engine Misfiring or Running Rough."

Problem 9: Loud Combustion Noise (Sound)

Probable Cause(s):

- Low quality fuel
- Defect in unit injector(s)
- Excessive injection actuation pressure
- Cold mode operation
- Engine timing incorrect
- Mechanical problem

1. Low quality fuel:

Test the engine using new fuel, refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE)* "Maintenance Section, Fuel Specifications." Remove the fuel from the fuel tank. Install a new fuel filter. Put a good grade of clean fuel in the fuel tank. The API rating of fuel can be easily checked with the 1P-7408 Thermo-Hydrometer.

2. Defect in unit injector(s):

a. An injector may fail to operate properly, causing low power. Some possible causes are: debris in the oil supply, incorrect removal of an injector, mechanical pressure on the adapter section, mechanical pressure on the solenoid, or the solenoid coil may have developed a shorted or open circuit.

NOTE: There is no bench test ("pop test") available for field testing hydraulic electronic unit injectors. The only test for injectors is on the engine.

b. Use the engine diagnostic switch to check for active diagnostic flash codes. If codes are present, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* "Troubleshooting, Engine Diagnostic Flash Codes."

3. Excessive injection actuation pressure:

Use the engine diagnostic switch to check for active diagnostic flash codes while cranking the engine. If diagnostic flash code 17, "Injection Actuation Pressure System Fault" is present, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* "Troubleshooting, Engine Diagnostic Flash Codes."

4. Cold mode operation:

Check the start-aid indicator. If the start-aid indicator is on, the engine is in cold mode and has not warmed up fully.

5. Engine timing incorrect:

a. Use the engine diagnostic switch to check for active diagnostic flash codes while cranking the engine. If diagnostic flash code 42, "Timing Sensor Calibration Fault" is present, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* "Troubleshooting, Engine Diagnostic Flash Codes."

b. If the engine has been repaired and the cam gear was involved, then the gear may be installed incorrectly. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Engine,* "Camshaft," for the correct procedure to install the camshaft gear.

NOTE: The cam gear is keyed to the camshaft. If the gear is installed correctly, timing is not the likely cause of the knocking.

6. Mechanical problem:

a. Check the intake and exhaust valve clearances and make adjustments. Refer to “Testing and Adjusting, Air Intake and Exhaust System, Valve Lash” in this module.

b. Disassemble the engine and investigate the problem. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine.* The problem may be a sticking valve or another internal problem.

Problem 10: Valve Train Noise

Probable Cause(s):

- Not enough lubrication
- Too much valve lash
- Damage to valve springs, locks, push rod, or broken or worn valve lifter
- Damage to valves
- Damage to camshaft

1. Not enough lubrication:

Check the lubrication in the valve compartment. There must be a strong flow of oil at high engine rpm, but only a small flow of oil at low rpm.

2. Too much valve lash:

Check the valve lash and make adjustments, if necessary. Refer to “Testing and Adjusting, Air Intake and Exhaust System, Valve Lash” in this module.

3. Damage to valve springs, locks, push rod, or broken or worn valve lifter:

Remove and inspect components for damage. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Valve Guides, Valve Seat Inserts,” and “Valves.” Install new parts where necessary. Broken locks can cause the valve to fall into the cylinder.

4. Damage to valves:

Replace any damaged valves. *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Valves.”

5. Damage to camshaft:

Remove the camshaft and inspect the components for damage. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Camshaft.” Replace any parts with damage. Clean the engine thoroughly.

Problem 11: Oil in Cooling System

Probable Cause(s):

- Defect in core of engine oil cooler
- Failure of cylinder head gasket

1. Defect in core of engine oil cooler:

Inspect the cooler and replace or repair a defective oil cooler. Flush the cooling system to remove oil. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* “Maintenance Section, Every 2000 Service Hours or 2 Years, Cooling System.”

2. Failure of cylinder head gasket:

a. With a cool engine, remove the radiator cap.

b. With the engine running, look for air bubbles in the coolant. Bubbles in the coolant are a sign of probable leakage at the head gasket.

c. Remove the cylinder head from the engine. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Cylinder Head Assembly.” Check the cylinder head, cylinder walls and head gasket surface of the cylinder block for cracks. Replace damaged components as necessary.

NOTE: Always replace the head gasket after the head has been removed for any reason.

Problem 12: Mechanical Noise (Knock) in Engine

Probable Cause(s):

- Failure of connecting rod bearings
- Damaged gears
- Damaged crankshaft

1. Failure of connecting rod bearings:

Remove and disassemble the engine. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine.* Inspect the connecting rod bearings and the bearing surfaces (journals) on the crankshaft. Install new parts where necessary.

2. Damaged gears:

a. Remove the engine. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Engine Assembly and Torque Converter."

b. Remove the front housing and camshaft idler gear. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Front Housing and Camshaft Idler Gear Assembly."

c. Install new parts where necessary.

3. Damaged crankshaft:

Replace the crankshaft. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Crankshaft."

Problem 13: Fuel Consumption Higher Than Usual

Probable Cause(s):

- Low quality fuel
- Improper speed and timing calibration
- Defect in unit injector(s)
- Air intake restriction
- Exhaust restriction
- Fuel supply system leaks
- Fuel leak in cylinder head
- Turbocharger has carbon deposits, or another cause of friction
- Fuel and combustion noise (knocking)

1. Low quality fuel:

Remove the fuel from the fuel tank. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Every 1000 Service Hours or When Required, Fuel Tank." Install a new fuel filter. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Every 250 Hours of Service or 3 Months, Fuel System," and "Maintenance Section, Every 500 Service Hours or 6 Months, Fuel System." Put a good grade of clean fuel in the fuel tank. The API rating of fuel can be easily checked with the 1P-7408 Thermo-Hydrometer.

2. Improper speed and timing calibration:

Use the engine diagnostic switch to check for active diagnostic flash codes while cranking the engine. If either diagnostic flash code 34, "Engine Rpm Signal Fault," or diagnostic flash code 42, "Timing Sensor Calibration Fault," is present, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* "Troubleshooting, Engine Diagnostic Flash Codes."

3. Defect in unit injector(s):

a. An injector may fail to operate properly, causing low power. Some possible causes are: debris in the oil supply, incorrect removal of an injector, mechanical pressure on the adapter section, mechanical pressure on the solenoid, or the solenoid coil may develop a shorted or open circuit.

NOTE: There is no bench test ("pop test") available for field testing hydraulic electronic unit injectors. The only test for injectors is on the engine.

b. Use the engine diagnostic switch to check for active diagnostic flash codes. If codes are present, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* "Troubleshooting, Engine Diagnostic Flash Codes."

c. If poor quality fuel has been used, the internal components of the injector could be worn excessively. Excessive wear can cause the injector not to inject fuel. For fuel recommendations, refer to "Specifications, Fuel System, Fuel Characteristics," in this module. Replace the injectors. For the replacement procedure, refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Unit Fuel Injection Pump Group."

4. Air intake restriction:

a. Inspect for plugged engine air intake filters. If necessary, clean or replace the filters. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, When Required, Engine Air Intake System."

b. Measure the restriction in the air intake system. Refer to "Testing and Adjusting, Air Intake and Exhaust System, Measurement of Boost Pressure in Air Intake Manifold" in this module. If the pressure is too high (greater than 6. 22 kPa [25 in] of water), inspect the air intake system for a restriction.

5. Exhaust restriction:

a. Measure the exhaust system back pressure. Refer to “Testing and Adjusting, Air Intake and Exhaust System, Restriction of Air Intake and Exhaust” in this module. The back pressure must not be more than 10 kPa (40 in).

b. If the back pressure is too high, inspect the exhaust system for restrictions.

c. Replace the muffler. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Muffler Group.”

6. Fuel supply system leaks:

Check the fuel system for any external leaks. Check all lines, hoses, and fittings for leaks, and tighten or replace as necessary.

7. Fuel leak in cylinder head:

a. Remove the fuel supply line at the front of the cylinder head, and pressurize the cylinder head (the return line to the fuel tank will have to be blocked).

b. Remove the valve cover. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Valve Cover.” Check for a defective O-ring seal on the top of each unit injector. Look for fuel leaking from the unit injectors where they seal with the cylinder head. If fuel is leaking from the unit injector, remove the unit injector and replace the upper O-ring seal. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Unit Fuel Injection Pump Group.”

c. Take an oil sample (S•O•S or AOAP) to check for fuel dilution. Change the oil and oil filter, if necessary. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* “Maintenance Section, Every 250 Hours or 3 Months, Engine Oil and Filter.”

d. Check for porosity around the oil drain back holes. If porosity is found, replace the cylinder head. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Cylinder Head Assembly.”

e. Check the coolant for evidence of fuel. If fuel is found in the coolant, check the unit injector sleeves in the cylinder head for cracks or erosion. If defects are found, remove the sleeves and install new sleeves. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Fuel Injector Sleeves.”

8. Turbocharger has carbon deposits, or another cause of friction:

Remove the intake and exhaust lines and inspect the turbocharger impeller and turbine for damage. Repair or replace the turbocharger, if necessary. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Turbocharger.”

9. Fuel and combustion noise (knock):

Refer to Problem 5: “Engine Misfiring or Running Rough.” Also, refer to Problem 9: “Loud Combustion Noise (Sound).”

Problem 14: Oil at the Exhaust

Probable Cause(s):

- Failed turbocharger seals
- Worn or failed valve guide seals
- Worn valve guides
- Broken or worn piston rings
- Scored or worn cylinder walls

1. Failed turbocharger seals:

Check the intake manifold and exhaust piping for oil. If oil is present, replace the turbocharger. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Turbocharger.”

2. Worn or failed valve guide seals:

Inspect the seals and replace as necessary. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Valve Guides.”

3. Worn valve guides:

If the valve guides are worn beyond specification, repair or replace the cylinder head. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Cylinder Head Assembly.”

4. Broken or worn piston rings:

Check the amount of blow-by. Refer to "Testing and Adjusting, Air Intake and Exhaust, Engine Blow-by (Air Flow)" in this module. Damaged pistons or rings can cause too much pressure in the crankcase. This condition will create excessive fumes (blow-by) in the crankcase breather.

5. Scored or worn cylinder walls:

Inspect the cylinder walls for problems, and hone, or bore and sleeve, as necessary.

Problem 15: Coolant in Lubrication Oil

Probable Cause(s):

- Failure of the oil cooler core
- Failure of cylinder head gasket
- Failure of seal between cylinder head and sleeve in unit injector bore
- Crack or defect in cylinder head
- Crack or defect in cylinder block

1. Failure of the oil cooler core:

Install a new core for the defective oil cooler. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Oil Cooler." Drain the crankcase and refill with clean lubricant. Install a new oil filter. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Every 250 Hours or 3 Months, Engine Oil and Filter."

2. Failure of cylinder head gasket:

a. With a cool engine, remove the radiator cap.

b. With the engine running, look for air bubbles in the coolant. Bubbles in the coolant are a sign of probable leakage at the head gasket.

c. Remove the cylinder head from the engine. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Cylinder Head Assembly." Check the cylinder head, cylinder walls and the head gasket surface of the cylinder block for cracks. Replace any damaged components as necessary.

NOTE: Always replace the head gasket when the head has been removed for any reason.

3. Failure of seal between cylinder head and sleeve in unit injector bore:

Replace the sleeve. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Fuel Injector Sleeves."

4. Crack or defect in cylinder head:

Install a new cylinder head. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Cylinder Head Assembly."

5. Crack or defect in cylinder block:

Install a new cylinder block. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine.*

Problem 16: Excessive Black Smoke

Probable Cause(s):

- Air intake restriction
- Exhaust system restriction
- Low quality fuel
- Low injection actuation pressure
- Defect in boost sensor
- Valve adjustment is not correct, or valve leaks
- Defective unit injectors
- Turbocharger has carbon deposits, or other cause of friction

1. Air intake restriction:

a. Inspect for a plugged engine air intake filter. If necessary, clean or replace the filter. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, When Required, Engine Air Intake System."

b. Measure the restriction in the air intake system, refer to "Testing and Adjusting, Air Intake and Exhaust System, Measurement of Boost Pressure in Air Intake Manifold." If the pressure is too high (greater than 6.22 kPa [25 in] of water), inspect the air intake system for a restriction.

2. Exhaust system restriction:

a. Measure the exhaust system back pressure. Refer to “Testing and Adjusting, Air Intake and Exhaust System, Restriction of Air Intake and Exhaust” in this module. The back pressure must not be more than 10.0 kPa (40 in) of water.

b. If the back pressure is too high, inspect the exhaust system for restrictions.

c. Replace the muffler. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Muffler Group.”

3. Low quality fuel:

Remove the fuel from the fuel tank. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* Maintenance Section, Every 1000 Service Hours or When Required, Fuel Tank.” Install a new fuel filter. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* “Maintenance Section, Every 250 Hours of Service or 3 Months, Fuel System,” and “Maintenance Section, Every 500 Service Hours or 6 Months, Fuel System.” Put a good grade of clean fuel in the fuel tank. The API rating of fuel can be easily checked with the 1P-7408 Thermo-Hydrometer.

4. Low injection actuation pressure:

Use the engine diagnostic switch to check for active diagnostic flash codes during engine cranking. If diagnostic flash code 17, “Injection Actuation Pressure System Fault” is present, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* “Troubleshooting, Engine Diagnostic Flash Codes.”

5. Defect in boost sensor:

Use the engine diagnostic switch to check for active diagnostic flash codes. If codes are present, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* “Troubleshooting, Engine Diagnostic Flash Codes.”

6. Valve adjustment is not correct, or valve leaks:

Check and adjust the valve lash. Refer to “Testing and Adjusting, Air Intake and Exhaust System, Valve Lash” in this module.

7. Defective unit injectors:

a. An injector may fail to operate properly, causing low power. Some possible causes are: debris in the oil supply, incorrect removal of an injector, mechanical pressure on the adapter section, mechanical pressure on the solenoid, or the solenoid coil may have developed a shorted or open circuit.

NOTE: There is no bench test (“pop test”) available for field testing hydraulic electronic unit injectors. The only test for injectors is on the engine.

b. Use the engine diagnostic switch to check for active diagnostic flash codes. If codes are present, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* “Troubleshooting, Engine Diagnostic Flash Codes.”

c. If poor quality fuel has been used, the internal components of the injector could be worn excessively. Excessive wear can cause the injector not to inject fuel. For fuel recommendations, refer to “Specifications, Fuel System, Fuel Characteristics,” in this module. Replace the injectors. For the replacement procedure, refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Unit Fuel Injection Pump Group.”

8. Turbocharger has carbon deposits, or other cause of friction:

Remove the intake and exhaust lines and inspect the turbocharger impeller and turbine for damage. Repair or replace the turbocharger if necessary. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Turbocharger.”

Problem 17: Excessive White Smoke

Probable Cause(s):

- Cold outside temperature
- Long idle periods
- Low quality fuel
- Water in fuel system
- Fuel pressure is low
- Intake air heater not operating properly
- Valve lash incorrect
- Misfiring cylinder(s)

- Intake and exhaust valves or piston rings leak compression
- Defective unit injector(s)
- Defect in air intake manifold air temperature sensor
- Defect in coolant temperature sensor

1. Cold outside temperature:

When the air outside is cold, the cylinder temperature is cooler. Not all the fuel will burn in the cylinders. The fuel which does not burn comes out the exhaust as white smoke. White smoke is normal in cold temperatures until the engine operates long enough to become warm. There will be less white smoke if number-one diesel fuel is used.

2. Long idle periods:

When an engine runs at idle speed for a long period of time, the cylinders cool and all of the fuel does not burn. Do not idle an engine for a long period of time. When the machine is not in use, stop the engine.

3. Low quality fuel:

Remove the fuel from the fuel tank. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* Maintenance Section, Every 1000 Service Hours or When Required, Fuel Tank." Install a new fuel filter. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Every 250 Hours of Service or 3 Months, Fuel System," and "Maintenance Section, Every 500 Service Hours or 6 Months, Fuel System." The API rating of fuel can be easily checked with the 1P-7408 Thermo-Hydrometer.

4. Water in fuel system:

a. Check the fuel and water separator. Drain any water from the separator. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Every 10 Service Hours or Daily, Water Separator."

b. Check the fuel tank for water. If a large amount of water is found, completely drain the fuel tank and fuel lines. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* Maintenance Section, Every 1000 Service Hours or When Required, Fuel Tank." Replace the fuel filters. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Every 250 Hours of Service or 3 Months, Fuel System," and "Maintenance Section, Every 500 Service Hours or 6 Months, Fuel System." Refill the fuel tank with good fuel of the correct grade.

5. Fuel pressure is low:

a. Check the fuel pressure with a gauge. Refer to "Testing and Adjusting, Fuel System, Fuel Pressure" in this module. The fuel pressure at low idle should read between 400 to 435 kPa (58 to 63 psi). During normal operating conditions under load, the fuel pressure should read between 400 and 525 kPa (58 to 76 psi) as measured at the inlet to the secondary fuel filter. The fuel pressure to the cylinder head fuel gallery should be as above, less the pressure differential across the secondary fuel filter. A pressure drop of at least 35 kPa (5 psi) across the secondary fuel filter is typical with a new filter. As the filter accumulates deposits, the pressure differential will increase.

b. If the fuel pressure at the unit injectors drops to approximately 69 kPa (10 psi), misfires may occur. This would typically be a "rolling misfire" which affects all cylinders at random, rather than a consistent misfire on a given cylinder.

c. Check the fuel lines for restrictions or plugging. Check for a fuel transfer pump or unit injector sleeve failure. Check to see if the orifice check valve is loose, missing from the fuel return line, or if the wrong orifice was installed. If sleeve or O-ring damage is found, replace with new parts as necessary.

6. Intake air heater not operating properly:

Use the engine diagnostic switch to check for active diagnostic flash codes during engine cranking. If diagnostic flash code 49, "Intake Air Heater Fault" is present, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* "Troubleshooting, Engine Diagnostic Flash Codes."

7. Valve lash incorrect:

Adjust the valve lash. Refer to “Testing and Adjusting, Air Intake and Exhaust System, Valve Lash” in this module.

8. Misfiring cylinder(s):

Refer to Problem 5: “Engine Misfiring or Running Rough.”

9. Intake and exhaust valves or piston rings leak compression:

a. Check the intake and exhaust valve clearances and make adjustments. Refer to “Testing and Adjusting, Air Intake and Exhaust System, Valve Lash,” in this module. Replace damaged valves, as necessary. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Valves.”

b. Check the amount of blow-by. Refer to “Testing and Adjusting, Air Intake and Exhaust System, Engine Blow-by (Air Flow)” in this module. Damaged pistons or rings can cause too much pressure in the crankcase. This condition will create excessive fumes (blow-by) in the crankcase breather.

10. Defective unit injector(s):

a. An injector may fail to operate properly, causing low power. Some possible causes are: debris in the oil supply, incorrect removal of an injector, mechanical pressure on the adapter section, mechanical pressure on the solenoid, or the solenoid coil may have developed a shorted or open circuit.

NOTE: There is no bench test (“pop test”), available for field testing hydraulic electronic unit injectors. The only test for injectors is on the engine.

b. Use the engine diagnostic switch to check for active diagnostic flash codes. If codes are present, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* “Troubleshooting, Engine Diagnostic Flash Codes.”

c. If poor quality fuel has been used, the internal components of the injector could be worn excessively. Excessive wear can cause the injector not to inject fuel. For fuel recommendations, refer to “Specifications, Fuel System, Fuel Characteristics,” in this module. Replace the injectors. For the replacement procedure, refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Unit Fuel Injection Pump Group.”

11. Defect in air intake manifold air temperature sensor:

Use the engine diagnostic switch to check for active diagnostic flash codes during engine cranking. If diagnostic flash code 38, “Intake Manifold Temperature Sensor Fault” is present, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* “Troubleshooting, Engine Diagnostic Flash Codes.”

12. Defect in coolant temperature sensor:

Use the engine diagnostic switch to check for active diagnostic flash codes during engine cranking. If diagnostic flash code 27, “Coolant Temperature Sensor Fault” is present, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* “Troubleshooting, Engine Diagnostic Flash Codes.”

Problem 18: Excessive Blue Smoke

Probable Cause(s):

- Oil level in engine too high
- Failure of turbocharger oil seal
- Worn or broken valve guides
- Worn piston rings and/or cylinder wall(s)
- Wear or damage to pistons

1. Oil level in engine too high:

Remove the dipstick and check the oil level. If the level is too high, drain the oil to bring the oil to the desired level. Refer to *Operator’s Manual, Deployable Universal Combat Earthmover (DEUCE),* “Maintenance Section, Every 10 Service Hours or Daily” and *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* “Maintenance Section, Every 250 Service Hours or 3 Months, Engine Oil and FIlter.”

NOTE: An oil sample (S•O•S or AOAP) should be run to find out if the oil level is increasing due to a fuel leak or other engine problem.

2. Failure of turbocharger oil seal:

Check the air intake manifold and exhaust piping for oil, and repair the turbocharger if necessary.

3. Worn or broken valve guides:

If the valve guides are worn beyond specification, repair or replace the cylinder head. Refer to Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine, “Valve Guides” and “Cylinder Head Assembly.”

4. Worn piston rings and/or cylinder wall(s):

Check the amount of blow-by. Refer to “Testing and Adjusting, Air Intake and Exhaust System, Engine Blow-by (Air Flow)” in this module. Damaged pistons or rings can cause too much pressure in the crankcase. This condition will create excessive fumes (blow-by) in the crankcase breather.

NOTE: High wear at low hours is normally caused by dirt which enters the engine with the inlet air.

5. Wear or damage to pistons:

Check the piston ring to groove clearance. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Piston and Connecting Rod Assemblies,” and to “Specifications, Basic Engine, Pistons and Rings” in this module. Pistons which have worn grooves, and pistons with damage or defects can cause blue smoke and excessive oil consumption. Ensure that the oil return holes under the oil ring are open. Replace the pistons as necessary.

Problem 19: Engine Has Low Oil Pressure

Probable Cause(s):

- Insufficient oil
- Defect in oil pressure gauge or sending unit
- Dirty oil filter or oil cooler
- Diesel fuel in lubrication oil
- Oil pump defective
- Oil pump suction pipe defective
- Oil pressure relief valves do not close
- O-ring defective
- Too much clearance between rocker arm shaft and rocker arms
- Too much clearance between camshaft and camshaft bearings
- Too much clearance between crankshaft and crankshaft bearings

1. Insufficient oil:

Check the oil dipstick for the correct level. Refer to *Operator’s Manual, Deployable Universal Combat Earthmover (DEUCE),* “Maintenance Section, Every 10 Service Hours or Daily.”

2. Defect in oil pressure gauge or sending unit:

a. Check the engine oil pressure using an external gauge. Refer to “Testing and Adjusting, Lubrication System, Measuring Engine Oil Pressure” in this manual.

b. Compare the oil pressure reading to the value on the gauge on the instrument panel.

c. If the values do not match, replace the sending unit. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* “System Operation, Operating Pressure and Temperature Circuit.”

d. Recheck the oil pressure. If the values still do not match, replace the gauge in the instrument panel. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* “Instrument Wiring Group.”

3. Dirty oil filter or oil cooler:

a. Change the oil and oil filter. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* “Maintenance Section, Every 250 Service Hours or 3 Months, Engine Oil and FIlter.”

b. Verify that maintenance was done at the correct intervals.

c. If the problem persists, check the operation of the filter bypass valve.

d. Clean or install a new oil cooler core. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Oil Cooler.”

4. Diesel fuel in lubrication oil:

Refer to Problem 23: “Fuel in Lubrication Oil.”

5. Oil pump defective:

Repair or replace the oil pump. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Oil Pump.”

6. Oil pump suction pipe defective:

Replace the oil pump suction pipe. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Oil Pump."

7. Oil pressure relief valves do not close:

a. Clean the valve and housing. Install new parts as necessary. Refer to "Specifications, Lubrication System, Oil Pump" in this module.

b. Check the bypass valves in the oil cooler and oil filter base. Refer to "Specifications, Lubrication System, Oil Cooler Bypass Valve" and "Oil Filter Base" in this module.

8. O-ring defective:

Check the O-ring in the oil line from the oil pump to the engine.

9. Too much clearance between rocker arm shaft and rocker arms:

Check lubrication in the valve compartments. Install new parts as necessary.

10. Too much clearance between camshaft and camshaft bearings:

Install a new camshaft and camshaft bearings, if necessary. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Camshaft" and "Camshaft Bearings."

11. Too much clearance between crankshaft and crankshaft bearings:

Repair or replace the crankshaft and/or bearings. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Crankshaft" and "Crankshaft Main Bearings."

Problem 20: Engine Lubrication Oil Consumption Higher Than Normal

Probable Cause(s):

- Too much lubrication oil in engine
- Oil leaks
- Oil temperature is too high
- Worn valve guide seals
- Worn pistons, rings or cylinder walls
- Failure of seal rings in turbocharger
- Worn valve guides

1. Too much lubrication oil in engine:

Remove the dipstick and check the oil level. If the level is too high, drain the oil to the desired level. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Every 10 Service Hours or Daily" and *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Every 250 Service Hours or 3 Months, Engine Oil and Filter."

NOTE: An oil sample (S•O•S or AOAP) should be run to find out if the oil level is increasing due to a fuel leak or other engine problem.

2. Oil leaks:

a. Inspect the outside of the engine for oil leaks. Make repairs as needed.

b. Check for a dirty crankcase breather. Clean or replace the breather if necessary. Refer to "Specifications, Lubrication System, Breather (Crankcase)" and "Systems Operation, Lubrication System" in this module.

NOTE: Use the engine diagnostic switch to check for active diagnostic flash codes.

3. Oil temperature is too high:

a. Check the oil cooler bypass valve and replace the valve if it is stuck in the open (unseated) position. Refer to "Specifications, Lubrication System, Oil Cooler Bypass Valve" and "Systems Operation, Lubrication System" in this module.

b. Check the oil cooler for plugging. Clean or replace the oil cooler if necessary. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Oil Cooler."

4. Worn valve guide seals:

If the valve guides are worn beyond specification, repair or replace the cylinder head. Refer to Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine, "Valve Guides" and "Cylinder Head Assembly."

5. Worn pistons, rings or cylinder walls:

Check the amount of blow-by. Refer to “Testing and Adjusting, Air Intake and Exhaust System, Engine Blow-by (Air Flow)” in this module. Damaged pistons or rings can cause too much pressure in the crankcase. This condition will create excessive fumes (blow-by) in the crankcase breather.

6. Failure of seal rings in turbocharger:

Check the inlet piping, air-to-air aftercooler and intake manifold for oil. Repair or replace the turbocharger if necessary. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Turbocharger.”

7. Worn valve guides:

Replace the valve guides. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* Valve Guides.”

Problem 21: Coolant Temperature Too High

Probable Cause(s):

- Low coolant level
- Radiator cap
- Loose belt(s)
- Incorrect mixture
- Air in cooling system
- Cooling fan malfunction
- Sending unit
- Defective temperature gauge
- Radiator
- Defective coolant hose(s)
- Air intake restriction
- Exhaust restriction
- Water temperature regulator failure
- Defective water pump
- Aftercooler
- Excessive outside air temperature
- Engine used in lug condition for extended periods

1. Low coolant level:

a. Check the coolant level. Refer to *Operator’s Manual, Deployable Universal Combat Earthmover (DEUCE),* Maintenance Section, Every 10 Service Hours or Daily, Radiator.”

b. If the coolant level in the overflow bottle is low, refill the bottle to the correct level.

c. If there is very little, or no coolant in the overflow bottle, check the coolant level in the radiator by removing the pressure cap. With the engine cool, ensure that coolant can be seen at the low end of the fill neck on the radiator top tank.

2. Radiator cap:

a. With a cool engine, remove the radiator cap and visually inspect the cap for damage. Replace the cap if the seal is cut or damaged.

b. Test the pressure setting of the cap. Refer to “Testing and Adjusting, Cooling System, Pressure Cap Test” in this module. Replace the cap if the pressure setting is out of specification.

3. Loose belt(s):

Check the tension on the water pump belt. Refer to “Specifications, Cooling System, Water Pump Belt Tightener” in this module. Adjust the belt tension if necessary.

4. Incorrect mixture:

Check the mixture of antifreeze and water. The mixture should be approximately 50 percent water and 50 percent antifreeze with a 3-to-6 percent coolant conditioner. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* “Maintenance Section, Every 500 Service Hours or 6 Months, Cooling System.” If the system is not correct, drain the system as needed and put the correct mixture of water, antifreeze, and coolant conditioner in the cooling system.

5. Air in cooling system:

a. Check the cooling system for leaks.

b. If no external leaks are discovered but the system will not hold pressure, there may be a leak in the fuel injector sleeves, head gasket or cylinder head. Repair or replace the cylinder head. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Cylinder Head Assembly.”

6. Cooling fan malfunction:

Check the speed of the cooling fan. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Implement and Fan Hydraulic System,* "Testing and Adjusting, Instrument Tests, Cooling Fan System." Repair the cooling fan hydraulic system if necessary.

7. Sending unit:

Use the engine diagnostic switch to check for active diagnostic flash codes during engine cranking. If diagnostic flash code 27, "Coolant Temperature Sensor Fault" is present, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* "Troubleshooting, Engine Diagnostic Flash Codes."

8. Defective temperature gauge:

Check the coolant temperature with an accurate gauge. Refer to "Testing and Adjusting, Cooling System, Water Temperature Gauge Test" in this module. Replace the temperature gauge in the instrument panel if the reading is incorrect. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* "Instrument Wiring Group."

9. Radiator:

a. Clean the radiator cooling fins. Ensure that there is no debris plugging the cooling fins. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* Maintenance Section, When Required, Radiator."

b. Flush the cooling system to remove any restrictions which may be blocking the radiator core. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Every 2000 Service Hours or 2 Years, Cooling System."

10. Defective coolant hose(s):

a. Inspect the cooling system hoses for cracks, leaks or other damage. Replace any defective hoses.

b. Squeeze the hoses along their length to look for soft or weak hoses. A soft or weak hose can collapse during operation and cause a loss of coolant flow. Replace any soft or weak hoses.

11. Air intake restriction:

a. Inspect the engine air intake filters for plugs. If necessary, clean or replace the filters. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, When Required, Engine Air Intake System."

b. Measure the restriction in the air intake system, refer to "Testing and Adjusting, Air Intake and Exhaust System, Measurement of Boost Pressure in Air Intake Manifold" in this module. If the pressure is too high (greater than 6.22 kPa [25 in] of water), inspect the air intake system for a restriction.

12. Exhaust restriction:

a. Measure the back pressure in the exhaust system. Refer to "Testing and Adjusting, Air Intake and Exhaust System, Restriction of Air Intake and Exhaust" in this module. The back pressure must not be more than 10.0 kPa (40 in) of water.

b. If the back pressure is too high, inspect the exhaust system for restrictions.

c. Replace the muffler. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Muffler Group."

13. Water temperature regulator failure:

Test the water temperature regulator for correct operation, and replace the regulator if defects are found. Refer to "Testing and Adjusting, Cooling System, Water Temperature Regulator Test" in this module.

14. Defective water pump:

a. Perform a water pump pressure check. Refer to "Testing and Adjusting, Cooling System, Water Pump Pressure Check" in this module. Repair or replace the water pump if defects are found. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Water Pump."

b. Remove the water pump and inspect the pump for damage. Repair or replace the water pump if defects are found. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Water Pump."

15. Aftercooler:

Check for debris or deposits which would prevent the free flow of air through the aftercooler.

16. Excessive outside air temperature:

When outside air temperatures are too high (greater than 49°C [120°F]), there is not enough temperature difference between the outside air and coolant temperatures.

17. Engine used in a lug condition for extended periods:

"Lugging" can occur when there is too much load applied to the engine or the engine is run at a lower rpm. This low rpm causes a reduction in air flow through the radiator, and a reduction in the flow of coolant through the system. This combination of less air and less coolant flow during a high input of fuel will cause excessive heating. Alternate periods of high load with periods of light load to reduce engine overheating.

Problem 22: Coolant Temperature Too Low

Probable Cause(s):

- Long idle periods
- Very light loads
- Water temperature regulator
- Air vent valve
- Cooling fan

1. Long idle periods:

When the engine is running with no load, only a small quantity of fuel is burned, and engine heat is removed too fast.

2. Very light load:

Under very light loads, the heat input from the engine is low, resulting in below-normal heating. A slight restriction of air flow through the radiator will help correct this problem.

3. Water temperature regulator:

Test the water temperature regulator for correct operation. Refer to "Testing and Adjusting, Cooling System, Water Temperature Regulator Test" in this module. Replace the water temperature regulator if defects are found.

4. Air vent valve:

An air vent valve located in the water temperature regulator, which is stuck open, can cause below-normal coolant temperatures when the engine has a light load.

5. Cooling fan:

Check the speed of the cooling fan. Repair the cooling fan hydraulic system if necessary. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Implement and Fan Hydraulic System,* "Testing and Adjusting, Instrument Tests, Cooling Fan System."

Problem 23: Fuel in Lubrication Oil

Probable Cause(s):

- Defective upper seal on unit injector
- Porosity in cylinder head
- Defective seal in fuel transfer pump

1. Defective upper seal on unit injector:

Remove the fuel supply line at the front of the cylinder head. Plug the fuel return line. Pressurize the cylinder head and look for fuel leaking from the unit injectors where they seal with the cylinder head. If fuel is leaking from a unit injector, remove the unit injector and replace the upper O-ring seal. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Unit Fuel Injection Pump Group."

2. Porosity in cylinder head:

Remove the fuel supply line at the front of the cylinder head. Plug the fuel return line. Pressurize the cylinder head and look for porosity around the oil drain back holes. If porosity is found, replace the cylinder head. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Cylinder Head Assembly."

3. Defective seal in fuel transfer pump:

Remove the fuel transfer pump and check for a defective O-ring seal between the fuel transfer pump and the hydraulic pump. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Fuel Transfer Pump." Replace the O-ring if necessary.

Problem 24: Fuel in Coolant

Probable Cause(s):

- Defect in unit injector sleeve

1. Defect in unit injector sleeve:

Remove the unit injectors and inspect the sleeves in the cylinder head unit injector bores. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Fuel Injector Sleeves." Look for signs of cavitation erosion or cracks. Cavitation on the inside may be due to air bubbles in the fuel. Air bubbles may be caused by a leak on the suction side of the fuel transfer pump, or combustion leakage. Check for pathways or cracks at the unit injector-to-sleeve interference fit near the unit injector nozzle. If cavitation erosion is found on the outside of the sleeve, after the sleeve is removed from the cylinder head, the erosion may be due to an incorrect level of coolant conditioner. If any problems are seen, remove the sleeve(s) and replace with them new parts.

Problem 25: Loss of Coolant

Probable Cause(s):

- Leaks in hoses or connections
- Leaks in radiator and/or expansion tank
- Leaks in cab or engine coolant heaters
- Leaks in water pump
- Cylinder head gasket leakage
- Defective radiator cap
- Engine runs too hot
- Cylinder head gasket leakage, or crack(s) in cylinder head or cylinder block
- Erosion or crack(s) in unit injector sleeves

1. Leaks in hoses or connections:

Check all hoses and connections for visual signs of leakage. Repair or replace the hoses as necessary.

2. Leaks in radiator and/or expansion tank:

a. Test the cooling system for leaks. Refer to "Testing and Adjusting, Cooling System, Radiator and Cooling System Leak Test" in this module.

b. If no external leaks are discovered, but the system will not hold pressure, there may be a leak in the fuel injector sleeves, head gasket or cylinder head. Repair or replace the cylinder head. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Cylinder Head Assembly."

3. Leaks in cab or engine coolant heaters:

a. Test the cooling system for leaks. Refer to "Testing and Adjusting, Cooling System, Radiator and Cooling System Leak Test" in this module.

b. If no external leaks are discovered, but the system will not hold pressure, there may be a leak in the fuel injector sleeves, head gasket or cylinder head. Repair or replace the cylinder head. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Cylinder Head Assembly."

4. Leaks in water pump:

Check the water pump for leaks before starting the engine. Start the engine and look for leaks. If there are leaks at the water pump, repair or install a new water pump. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Water Pump."

5. Cylinder head gasket leakage:

Look for leaks along the surface of the cylinder head gasket. If there are leaks, install a new head gasket. Tighten the bolts which hold the cylinder head. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Cylinder Head."

6. Defective radiator cap:

a. Remove the radiator cap and visually inspect the cap for damage. Replace the cap if the seal is cut or damaged.

b. Test the pressure setting of the cap. Refer to "Testing and Adjusting, Cooling System, Pressure Cap Test" in this module. Replace the cap if the pressure setting is out of specification.

7. Engine runs too hot:

If the coolant temperature is too high, pressure will be high enough to move the cap off the sealing surface in the radiator and cause coolant loss through the overflow tube. See Problem 21: "Coolant Temperature Too High."

8. Cylinder head gasket leakage, or crack(s) in cylinder head or cylinder block:

a. With a cool engine, remove the radiator cap. With the engine running, look for air bubbles in the coolant. Bubbles in the coolant are a sign of probable leakage at the head gasket.

b. Remove the cylinder head from the engine. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Cylinder Head Assembly.” Check the cylinder head, cylinder walls and head gasket surface of the cylinder block for cracks.

NOTE: When installing the head, use a new head gasket.

9. Erosion or crack(s) in unit injector sleeves:

Remove the unit injectors, and inspect the sleeves in the cylinder head unit injector bores. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Unit Fuel Injection Pump Group.” Look for signs of cavitation erosion or cracks. Cavitation on the inside may be due to air bubbles in the fuel. Air bubbles may be caused by a leak on the suction side of the fuel transfer pump, or combustion leakage. Check for pathways or cracks at the unit injector-to-sleeve interference fit near the unit injector nozzle. If cavitation erosion is found on the outside of the sleeve, after the sleeve is removed from the cylinder head, the erosion may be due to an incorrect level of coolant conditioner. If any problems are seen, remove the sleeve(s) and replace with new parts.

Problem 26: Soot in Air Intake Manifold

Probable Cause(s):

• Engine design

• Defective valve or seat

1. Engine design:

On diesel engines, a small amount of soot is normal. This is due to the design characteristics of the engine. Valve overlap allows the intake to open slightly before the exhaust stroke has been completed, which will allow some soot to be pushed into the air intake manifold.

2. Defective valve or seat:

A defective valve or seat allows a large quantity of soot to be pushed into the air intake manifold.

Electronic Control System

No mechanical adjustments can be made to the electronic control system components. The test procedures for the electronic control system are listed according to relevant diagnostic flash codes in *Specifications Systems Operation Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* “Troubleshooting With Diagnostic Flash Codes,” and/or in *Electronic Troubleshooting, Deployable Universal Combat Earthmover (DEUCE), Appendix D: 3100 HEUI DEUCE Engine.*

The only electronic system calibration which must be performed is the engine speed and timing calibration. The engine speed and timing calibration procedure must be performed after the ECM is replaced. The engine can be operated for a limited period (up to 30 days) before the engine speed and timing calibration procedure must be performed. The ECM will use default timing data, resulting in reduced engine performance. The check engine indicator will be on, and a diagnostic flash code of 42, “Timing Sensor Calibration Fault” will be present until the procedure is performed.

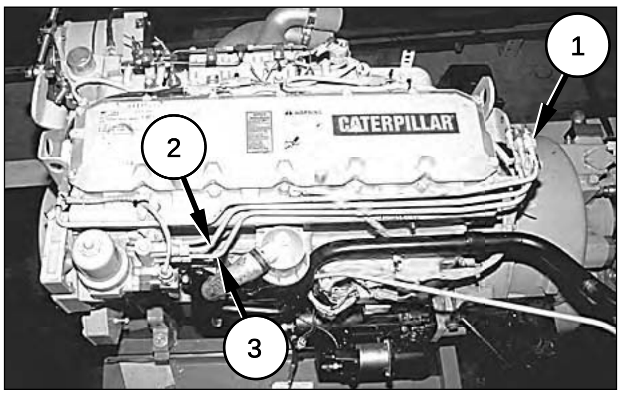
NOTE: The engine speed and timing calibration procedure can only be performed with an electronic service tool. The engine and speed timing calibration should be performed immediately after the ECM has been replaced. For the calibration procedure, refer to *Electronic Troubleshooting, Deployable Universal Combat Earthmover (DEUCE), Appendix D: 3100 HEUI DEUCE Engine.*

Fuel System

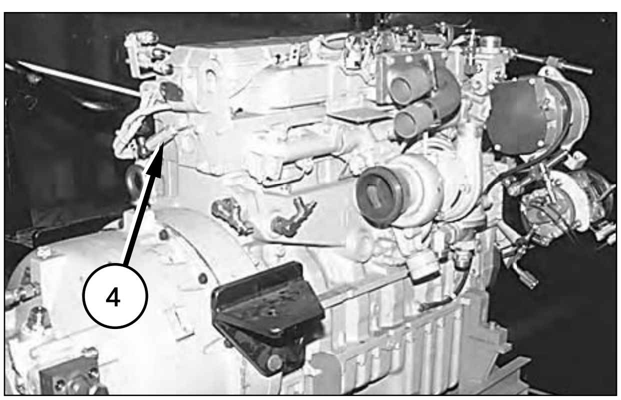
Fuel Pressure

Tools Needed		
1U-5470	Engine Pressure Group	1
3J-1907	O-Ring Seal	2
3Y-2888	Connector ($^{9}/_{16}$–18 to $^{1}/_{8}$–27 NPTF)	1
6V-3965	Adapter	1
6V-8397	O-Ring Seal	1
8T-8902	T-Fitting	1

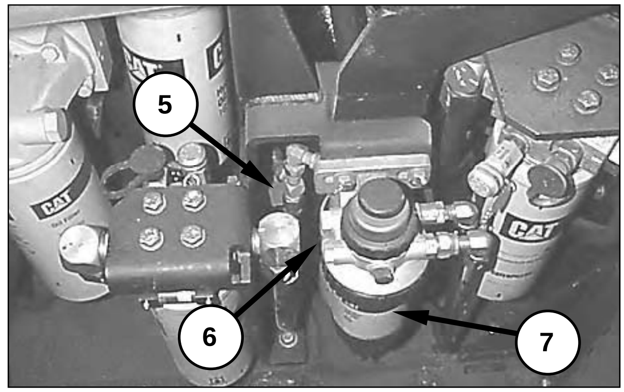
NOTE: This procedure requires that the machine be operated. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE)* for information about machine operation.

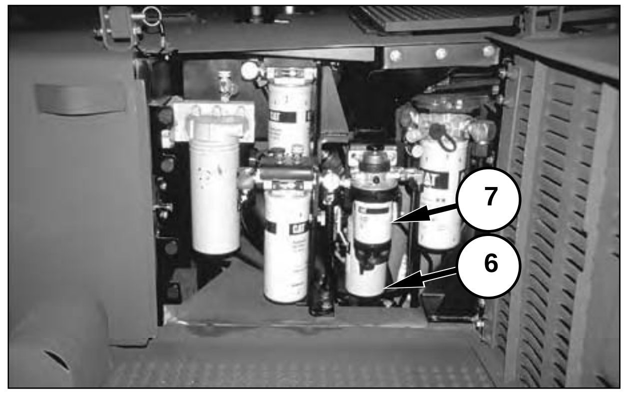


Fuel Lines (Engine Shown Removed from Machine for Photographic Clarity).
(1) Tube assembly from secondary fuel filter outlet to cylinder head inlet. (2) Fuel and water separator outlet to fuel transfer pump inlet tube assembly. (3) Fuel transfer pump outlet to secondary fuel filter inlet fitting.



Fuel Lines (Engine Shown Removed from Machine for Photographic Clarity).
(4) Regulating orifice and check valve (return to fuel tank).





Filter Compartment.
(5) Secondary fuel filter bypass relief valve. (6) Secondary fuel filter. (7) Primary fuel filter/water separator.

1. Install a T-fitting, a pressure tap, and a pressure gauge to tube assembly (1) between the tube assembly and the hose coming from the secondary fuel filter.

2. Start the engine.

3. The fuel pressure on the gauge should fall into the ranges indicated in the chart.

Expected Fuel Pressure Values (With New Fuel Filter)	
Condition	**Pressure kPa (psi)**
Low Idle, No Load	400 to 435 (58 to 63)
Machine Operating Under Load	400 to 525 (58 to 76)
Minimum Acceptable	69 (10)

4. If the pressure is low, check for:

   • Plugged secondary fuel filter (6).

   • Plugged primary fuel filter and water separator (7).

   • Failed secondary fuel filter bypass relief valve (5).

   • Restriction in line from fuel tank to primary fuel filter and water separator.

- Restriction in line from primary fuel filter and water separator to fuel transfer pump.
- Damage to fuel transfer pump.
- Damage or incorrect installation of regulating orifice and check valve (4).
- Worn or damaged fuel transfer pump.

5. If the fuel pressure is within specification, remove all tooling and check for leaks.

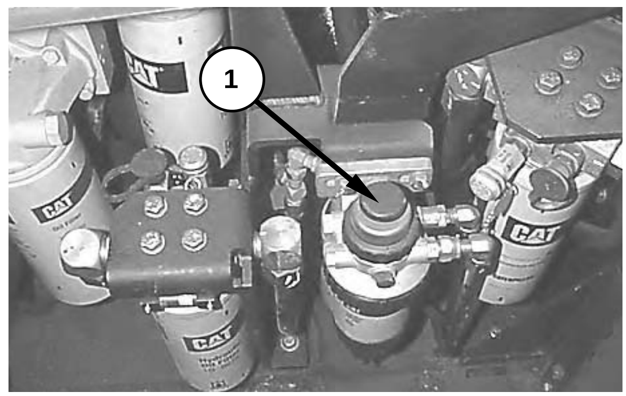
Fuel Priming Procedure

If the fuel system has run dry, fill the fuel tank and perform this procedure to remove air bubbles from the system.

NOTICE

Do not loosen fuel lines at the fuel manifold. The fittings may be damaged and/or a loss of priming pressure may occur when the fuel lines are loosened.

NOTE: This procedure requires that the machine be operated. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE)* for information about machine operation.



Fuel Filter Compartment, Right Side of Machine.
(1) Priming pump plunger.

1. Operate priming pump plunger (1) to fill the final filter with fuel. Continue pumping until resistance is felt.

NOTE: Twenty-five to 30 pump strokes may be required to fill the filter, and up to 75 pump strokes may be required to fill the fuel manifold.

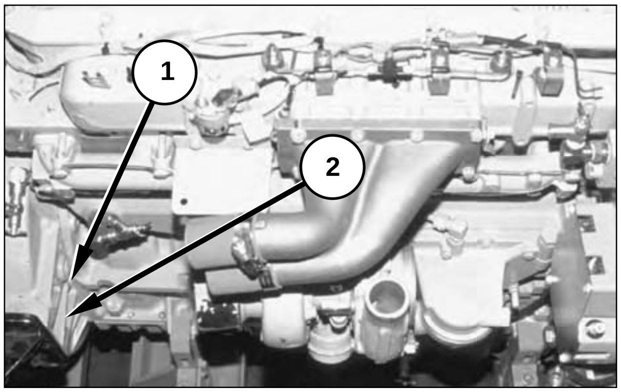
2. After the fuel system has been pressurized, crank the engine using the engine starting procedure. Continue to operate priming pump plunger (1) while the engine is cranking.

NOTE: If the engine starts but runs roughly, misfires or smokes, further priming may be necessary to help purge the fuel lines of air. Continue to run the engine at low idle until the engine runs smoothly.

Finding Top Center Position for Number-One Piston

Tools Needed	
8T-0292	Bolt (Part of 1U6675 Unit Injector Spring Compressor use in 2232254/1U6680 Tool Group)

1. Remove the valve cover. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Remove and Install Valve Cover.”



Bolt Location (Engine Shown Removed From Machine, for Photographic Clarity).
(1) Plug. (2) Flywheel housing.

2. Remove plug (1) from the timing hole on the right front of flywheel housing (2).

3. Put an 8T-0292 Bolt in the timing hole. Turn the engine flywheel counterclockwise (as viewed from the rear of the engine) until the 8T-0292 Bolt aligns with the threaded hole in the flywheel.

NOTE: If the flywheel is turned beyond the point where the 8T-0292 Bolt aligns with the threaded hole, the flywheel must be turned clockwise approximately 30 degrees, and then turned counterclockwise until the 8T-0292 Bolt engages with the threaded hole. This procedure is necessary to remove the backlash from the gears when the number-one piston is put on top center.

4. The intake and exhaust valves for the number-one cylinder are fully closed if the number-one piston is on the compression stroke and the valve rocker arms can be moved by hand. If the valve rocker arms cannot be moved and the valves are slightly open, the number-one piston is on the exhaust stroke. Make reference to charts in, “Testing and Adjusting, Air Intake and Exhaust System, Valve Lash,” entitled “Crankshaft Position for Valve Lash Setting,” to find the correct cylinder(s) to check or adjust the stroke position of the crankshaft when the top center bolt has been installed in the flywheel.

NOTE: When the actual stroke position is identified and the other stroke position is needed, the 8T-0292 Bolt must be removed from the flywheel, the flywheel must be turned counterclockwise 360 degrees, and the 8T-0292 Bolt must then be reinstalled.

NOTE: The timing hole is only used for the valve lash setting and to time the engine electronically with the 7X-1200 Timing Adapter Group.

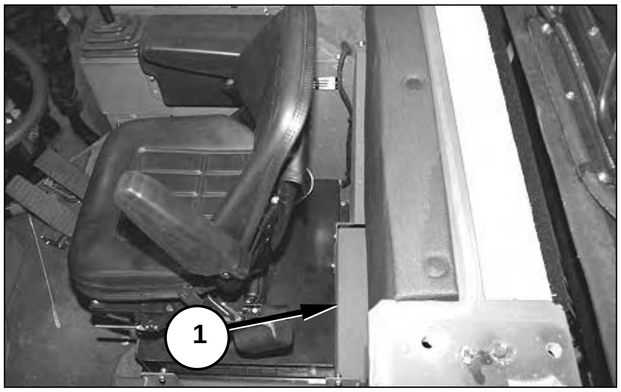
NOTICE

The 8T-0292 Bolt must be removed before the engine is started.

NOTE: Install the valve cover before the machine is returned to operation.

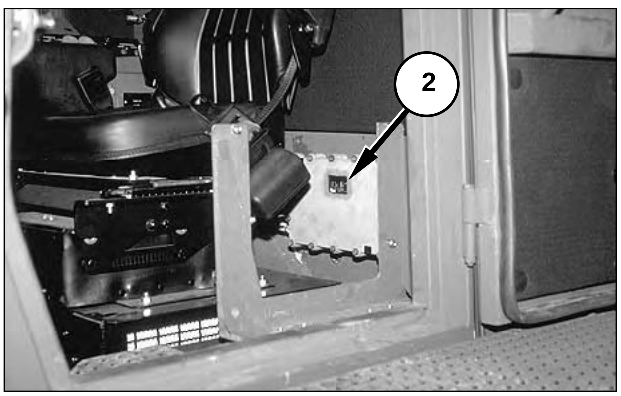
Engine Speed Measurement

NOTE: This procedure requires that the machine be operated. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE)* for information about machine operation.

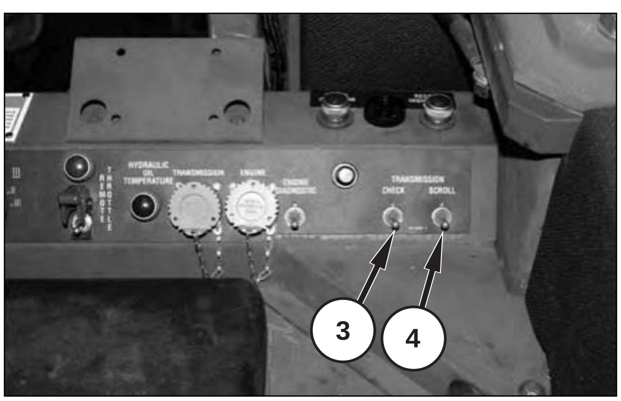


Inside Cab, Behind Operator's Seat.
(1) EPTC II cover.

1. Remove one bolt and washer from each corner of EPTC II cover (1), and remove the EPTC II cover.



Inside Cab, Behind Operator's Seat.
(2) EPTC II display.



Right Console.
(3) Check switch. (4) Scroll switch.

2. Move the engine start switch to the ON position, and then simultaneously hold check switch (3) and scroll switch (4) in the ON positions. Release the switches when "–5–" is shown on EPTC II display (2).

3. Start and operate the engine at low idle.

4. Record the number shown on EPTC II display (2). Multiply the number by 10 to determine the engine speed. Low idle speed should be 850 ± 50 rpm.

5. Increase the engine speed to high idle.

6. Record the number shown on EPTC II display (2). Multiply the number by 10 to determine the engine speed. High idle speed should be 2590 ± 50 rpm.

7. Replace EPTC II cover (1).

Air Intake and Exhaust System

Restriction of Air Intake and Exhaust

There will be a reduction of horsepower and engine efficiency if there is a restriction in the air intake or exhaust system.

Air flow through the air cleaner must not have a restriction (a negative pressure difference between atmospheric air and air that has gone through the air cleaner) of more than 6.22 kPa (25 in) of water.

Back pressure from the exhaust (a pressure difference between exhaust at the outlet elbow and atmospheric air) must not be more than 10.0 kPa
(40 in) of water.

Measurement of Boost Pressure in Air Intake Manifold

Tools Needed		
1U-5470	Engine Pressure Group	1
8J-7844	Adapter ($\frac{3}{4}$-16 to $\frac{1}{4}$ /NPTF)	1
3K-0360	O-ring Seal	1
4M-5317	Reducing Bushing ($\frac{1}{4}$ NPTF to $\frac{1}{8}$ NPTF)	1

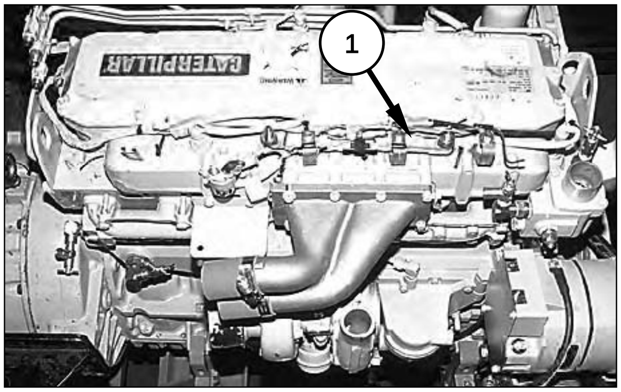
The engine efficiency can be checked by comparing the pressure in the air intake manifold to the specifications below. This test is used when the engine horsepower decreases, yet there is no real sign of a problem with the engine. Perform this test under these conditions:

- 737 mm (29 in) of mercury barometric pressure (dry).
- 29°C (85°F) outside air temperature.
- 35 API rated fuel.

Any deviation from these conditions can change the pressure in the air intake manifold. Outside air that has a higher temperature and lower barometric pressure than listed above will cause a lower horsepower and a lower air intake manifold pressure measurement than the specification. Outside air that has a lower temperature and a higher barometric pressure will cause higher horsepower and a higher air intake manifold pressure measurement.

A difference in the fuel API rating will also change the horsepower and the pressure in the air intake manifold. If the fuel is rated above 35 API, pressure in the air intake manifold can be less than the specification. If the fuel is rated below 35 API, the pressure in the air intake manifold can be more than the specification. The API rating of fuel can be checked with the 1P-7408 Thermo-Hydrometer. Be sure that the air intake or exhaust does not have a restriction before the air intake manifold pressure is measured.

NOTE: This procedure requires that the machine be operated. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE)* for information about machine operation.



Pressure Test Location.
(1) Air intake manifold plug.

1. Park the machine in an open location, away from people and structures.

2. Block the machine to prevent inadvertent movement.

3. Raise the radiator. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE)*, "Operation Section, Maintenance Features."

4. Remove air intake manifold plug (1).

5. Install the air pressure gauge to the hole where the plug was removed.

6. Prepare the machine so that engine speed can be measured. Refer to "Testing and Adjusting, Fuel System, Engine Speed Measurement," in this module.

7. Start the engine and bring the fluids to normal operating temperature.

WARNING

The machine may accidentally move during this procedure. Do not allow other personnel in the area during the test. Perform this test in an open area away from other people and structures.

8. Record the air temperature.

9. Put the machine into EARTHMOVING mode.

10. Fully apply the service brake.

11. Put the transmission control lever into SECOND REVERSE.

12. Fully apply the accelerator pedal.

13. Record the engine speed and the boost pressure value, and then release the accelerator pedal.

NOTICE

Do not stall the torque converter for more than two minutes at a time. Continuously monitor the instrument panel and stop operation if overheating occurs in any system. If any overheating occurs, allow the systems to cool before repeating the test.

14. Boost pressure should be 163 ± 24 kPa (48 ± 7.2 in Hg).

15. Allow the machine to idle for five minutes, to allow the turbocharger to cool down.

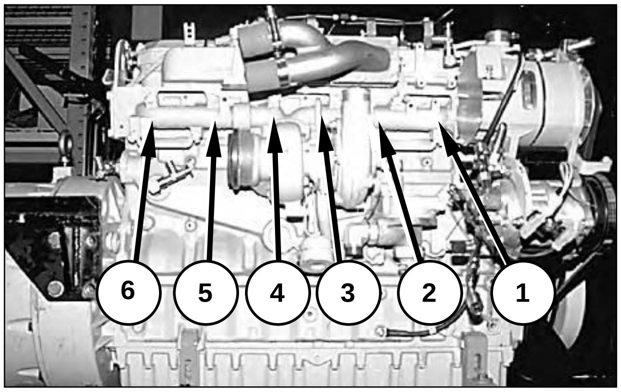
16. Turn off the engine.

17. Remove all tooling and lower the radiator.

Exhaust Temperature

Tools Needed		
1U-8885	Infrared Thermometer	1

NOTE: This procedure requires that the machine be operated. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE)* for information about machine operation.



Right Side View of Engine (Engine Shown Removed from Machine for Photographic Clarity).
(1) Cylinder number-one. (2) Cylinder number-two. (3) Cylinder number-three. (4) Cylinder number-four. (5) Cylinder number-five. (6) Cylinder number-six.

1. Tilt the radiator and the cab. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE)*, "Operation Section, Maintenance Features."

2. Start the engine, and use the 1U-8865 Infrared Thermometer to check the exhaust temperature at the exhaust ports of cylinders (1 through 6). The temperature differences between exhaust ports should not vary by more than 25 to 55°C (50 to 100°F).

NOTE: The temperature of an exhaust manifold port, when the engine runs at low idle speed, can indicate a malfunction in a unit injector. Low temperature at an exhaust manifold port indicates that there is no fuel reaching to the cylinder. This could be caused by an inoperative unit injector pump. Exceedingly high temperatures at an exhaust manifold can be an indication of too much fuel to the cylinder, caused by a malfunctioning unit injector pump.

3. Stop the engine, and lower the radiator and cab.

Air-to-Air Aftercooler System

Visual Inspection

Inspect all air lines, hoses and gasket connections. Make sure that hose clamps are tightened to the correct torque. Check welded joints for cracks, and make sure all brackets are in good condition and tightened in position. Use compressed air to clean any cooler core blockage caused by debris or dust. Inspect the cooler core fins for damage, debris or corrosion. Use a stainless steel brush with soap and water to remove corrosion.

WARNING

Air under pressure can cause personal injury.

When using pressure air for cleaning, wear a protective face shield, protective clothing and protective shoes.

The maximum air pressure must be below 205 kPa (30 psi) for cleaning purposes.

NOTE: When air-to-air aftercooler system parts are repaired and/or replaced, a leak test is recommended.

Air System Restriction

Pressure measurements should be taken at the turbocharger outlet and at the air intake manifold. When the total pressure drop of the charged air system at maximum air flow exceeds 13.5 kPa (4 in Hg), the air lines and cooler core must be inspected for internal restrictions and cleaned, repaired or replaced.

Turbocharger Failure

If a turbocharger failure occurs, remove the air-to-air cooler core and flush the cooler internally with a solvent which removes oil and other foreign substances. Shake the cooler to eliminate any trapped debris. Wash the cooler with hot, soapy water, rinse thoroughly with clean water, and blow the cooler dry with compressed air. Aim the compressed air in the reverse direction of normal air flow. Carefully inspect the system for cleanliness.

NOTICE

Do not use caustic cleaners, or damage to the aftercooler core will result.

Air Intake Manifold Pressure

Normal air intake manifold pressure with high exhaust temperatures can be caused by a blockage in the cooler core fins. Clean the cooler core fins, refer to "Visual Inspection," for the cleaning procedure. Low air intake manifold pressure and high exhaust manifold temperature can be caused by any of the following conditions:

- A plugged air cleaner. Clean or replace the air cleaner as needed.
- A blockage in the air lines between the air cleaner and turbocharger. All restrictions must be removed.
- Cooler core leakage. Pressure test the cooler core. Refer to "Aftercooler Core Leakage," in this section, for the correct procedure to use. Repair or replace parts as needed.
- Leakage from the pressure side of the induction system. Check and repair leaks.
- Air intake manifold leak. Check for loose, missing and damaged fittings or plugs. Also check the gaskets between the manifold and the cylinder head.

Aftercooler Core Leakage

NOTICE

Remove all air leaks from the system to prevent engine damage. In some operating conditions, the engine can pull a manifold vacuum for short periods of time. A leak in the aftercooler or air lines can let dirt and other foreign material into the engine and cause rapid wear and/or damage to engine parts.

A large leak in the cooler core can often be found during a visual inspection. To check for smaller leaks, use the following procedure:

1. Remove the aftercooler core. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine*, "Aftercooler."

NOTICE

Do not use more than 240 kPa (35 psi) of air pressure, or damage to the aftercooler core can result.

2. Pressurize the aftercooler to 205 kPa (30 psi). Shut off the air supply.

3. Inspect all connections for air leaks.

4. The system pressure should not drop more than 35 kPa (5 psi) in 15 seconds.

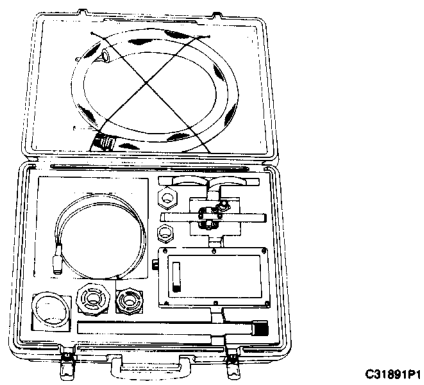
5. If the pressure drop is more than specified, use a solution of soap and water to look for air bubbles in all areas of possible leakage. Replace hoses, or repair the aftercooler core, as needed.

WARNING

To help prevent personal injury when the tooling is removed, relieve all pressure in the system slowly by using air regulator and valve assembly.

6. After testing, remove all the tooling and reinstall the aftercooler core.

Engine Blow-by (Air Flow)



8T-2700 **Indicator Group.**

The 8T-2700 Blow-by/Air Flow Indicator Group is used to check the amount of blow-by.

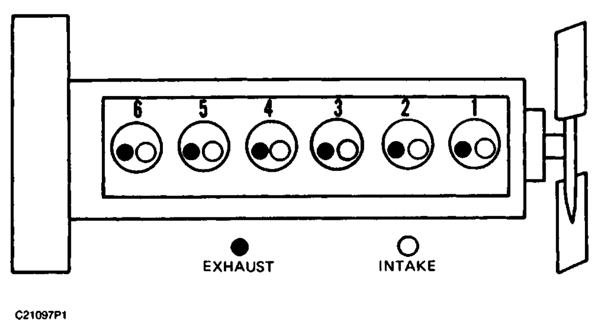
NOTE: Instructions for use of the 8T-2700 Blow-by/Air Flow Indicator Group are included in the tool case.

Valve Lash

Crankshaft Positions for Valve Lash Setting

Crankshaft Positions For Valve Lash Setting	
SAE Standard (Counterclockwise) Rotation Engines As Viewed From Flywheel End	
Check/Adjust With No. 1 Piston On:	TC Compression Stroke*
Intake Valves	1-2-4
Exhaust Valves	1-3-5
Check/Adjust With No. 1 Piston On:	TC Exhaust Stroke*
Intake Valves	3-5-6
Exhaust Valves	2-4-6
Firing Order	1-5-3-6-2-4

*** Put number-one piston at top center position and make identification for the correct stroke. Refer to "Testing and Adjusting, Fuel System, Finding Top Center Position for Number-One Piston." After top center position for a particular stroke is found and adjustments are made for the correct cylinders, remove the top center (TC) bolt and turn the flywheel counterclockwise 360 degrees. This will put number-one piston at top center position on the other stroke. Install the top center bolt in the flywheel and complete the adjustments for the cylinders that remain.**



3100 HEUI Diesel Engine Cylinder and Valve Location.

The valve lash is measured between the valve rocker arm and the valve. All lash measurements and adjustments must be made with the engine stopped, and with the valves fully closed.

Valve Lash Check

⚠ WARNING

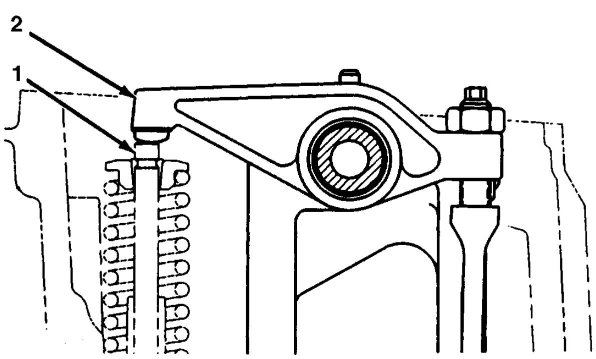
This engine uses high voltage to the electronic unit injectors. Do not come in contact with the unit injector terminals while the engine is running.

The valve lash does not need to be adjusted if the measurement is in the range given in the chart "3100 HEUI DEUCE Engine Valve Lash." If the measurement falls outside of this range, an adjustment is necessary. Use the procedure below to check the valve lash.

1. Put the number-one piston in the top center position. Refer to "Testing and Adjusting, Fuel System, Finding Top Center Position for Number-One Piston" in this module.

2. Remove the valve cover. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine*, "Valve Cover."

3. With the number-one piston in the top center position of the correct stroke, adjustments can be made to the valves, as shown in the chart "Crankshaft Positions for Valve Lash Setting" in this section.



Valve Lash Check.
(1) Valve. (2) Valve rocker arm.

4. Put a feeler gauge of the correct dimension between valve rocker arm (2) and valve (1) for each valve that is to be measured. See the chart "3100 HEUI DEUCE Engine Valve Lash" for the correct specifications.

NOTE: Before any actual checks are made, tap (hit lightly) each valve rocker arm (at the top of the adjustment screw) with a soft mallet to ensure that the lifter roller is seated against the camshaft base circle.

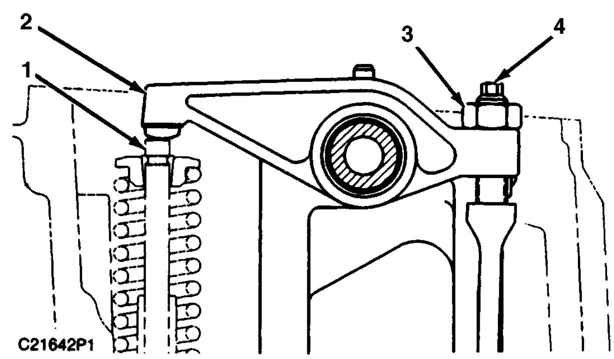
3100 HEUI DEUCE Engine Valve Lash	
Intake Valves	0.38 ± 0.08 mm (0.015 ± 0.003 in)
Exhaust Valves	0.64 ± 0.08 mm (0.025 ± 0.003 in)

Valve Lash Adjustment Procedure

1. Put the number-one piston in the top center position. Refer to "Testing and Adjusting, Fuel System, Finding Top Center Position for Number-One Piston," in this module.

2. With the number-one piston in the top center position of the correct stroke, adjustments can be made to the valves, as shown in the chart "Crankshaft Positions for Valve Lash Setting" in this section.

NOTE: Before any actual adjustments are made, tap each valve rocker arm (at the top of the adjustment screw) with a soft mallet to ensure that the lifter roller is seated against the camshaft base circle.



Valve Lash Adjustment.
(1) Valve. (2) Valve rocker arm. (3) Lock nut. (4) Push rod adjustment screw.

3. Loosen lock nut (3) for push rod adjustment screw (4). If there is not enough clearance for a feeler gauge between valve rocker arm (2) and valve (1), turn push rod adjustment screw (4) counterclockwise, to increase the valve lash.

4. Put a feeler gauge, of the correct dimension, between valve rocker arm (2) and valve (1). Turn the adjustment screw clockwise until the valve lash is set to the specifications in the chart "3100 HEUI DEUCE Engine Valve Lash" in this section.

5. After each adjustment, tighten lock nut (3) to a torque of 25 ± 7 N•m (18 ± 5 lb ft) and check the adjustment again.

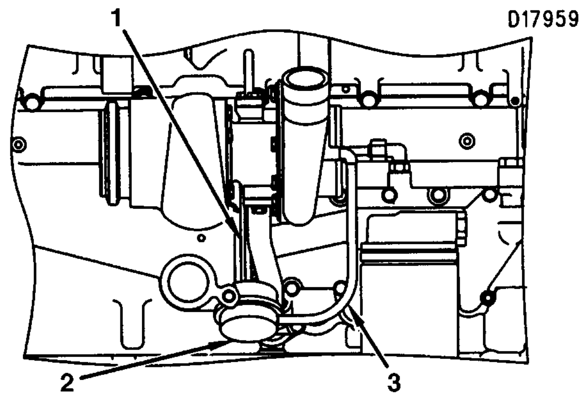
6. Remove the top center bolt and turn the flywheel 360 degrees in the direction of engine rotation. This will put the number-one piston at the top center position on the opposite stroke. Install the top center bolt in the flywheel.

7. With the number-one piston at the top center position on the opposite stroke, adjustments can be made to the remainder of the valves, as shown in the chart "Crankshaft Positions for Valve Lash Setting," in this section.

8. Repeat Steps 3, 4, and 5 to adjust these valves.

9. Remove the top center bolt from the flywheel and install the valve cover when all the valve lashes have been adjusted.

Turbocharger



Waste Gate Valve.
(1) Actuating rod. (2) Canister. (3) Line.

The following may indicate a problem with the wastegate turbocharger:

- Boost pressure is too high at full-load conditions.
- Boost pressure is too low at all lug conditions.

1. Remove the turbocharger. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine*, "Turbocharger."

2. Remove the air line and slowly apply a check pressure to the canister where the air line was removed. Do not exceed 200 kPa (29 psi).

3. The actuating lever should move 0.50 ± 0.25 mm (0.020 ± 0.010 in) when the external supply of air connected to the line reaches 164.1 kPa (23.78 psi). If the actuating lever does not move 0.50 mm (0.020 in), replace the turbine housing assembly (which includes the wastegate) or the complete turbocharger.

NOTE: The wastegate turbine housing assembly is preset at the factory, and no adjustments can be made.

The maximum rpm of the turbocharger is controlled by the boost pressure (which controls the position of the wastegate valve), the engine rating, the high idle rpm setting, and the height above sea level at which the engine is operated.

NOTICE

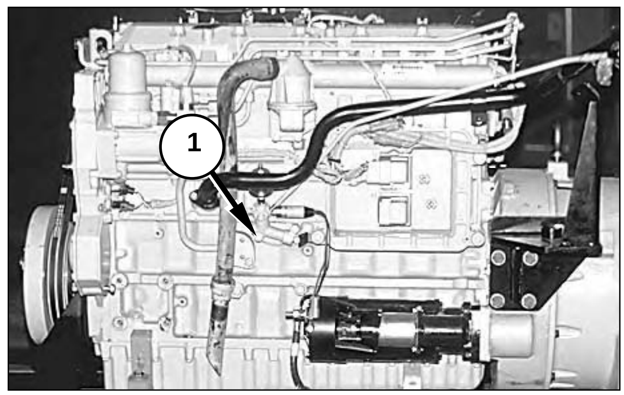
If the high idle rpm or the engine rating is higher than specification for the height above sea level at which the engine is operated, there can be damage to engine or turbocharger parts. Damage will result when increased heat and/or friction due to the higher engine output goes beyond the engine cooling and lubrication systems' abilities.

Lubrication System

Measuring Engine Oil Pressure

Tools Needed		
1U-5470	Engine Pressure Group	1
4M-5317	Reducing Bushing (1/4 NPTF to 1/8 NPTF)	1

NOTE: This procedure requires that the machine be operated. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE)* for information about machine operation.



Left Side of Engine.
(1) Plug.

WARNING

Work carefully around an engine that is running. Engine parts that are hot, or parts that are moving can cause personal injury.

NOTE: The following test must be made with SAE 10W30 oil in the engine crankcase.

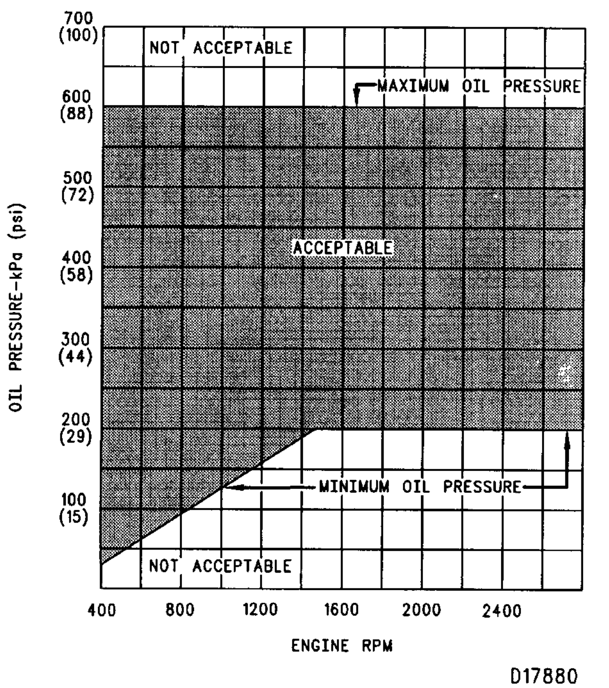
1. Raise the radiator. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Features, Radiator Tilt."

2. Remove plug (1) from the left side of the engine.

3. Install the reducing bushing and the 1U-5470 Engine Pressure Group to this opening.

4. Start and operate the engine until normal operation temperature is reached.

5. With the engine at operating temperature and at high idle (2590 ± 50 rpm), the minimum oil pressure should be 210 kPa (30 psi). With the engine at operating temperature and at low idle (850 ± 50 rpm), the minimum oil pressure should be 104 kPa (15 psi).

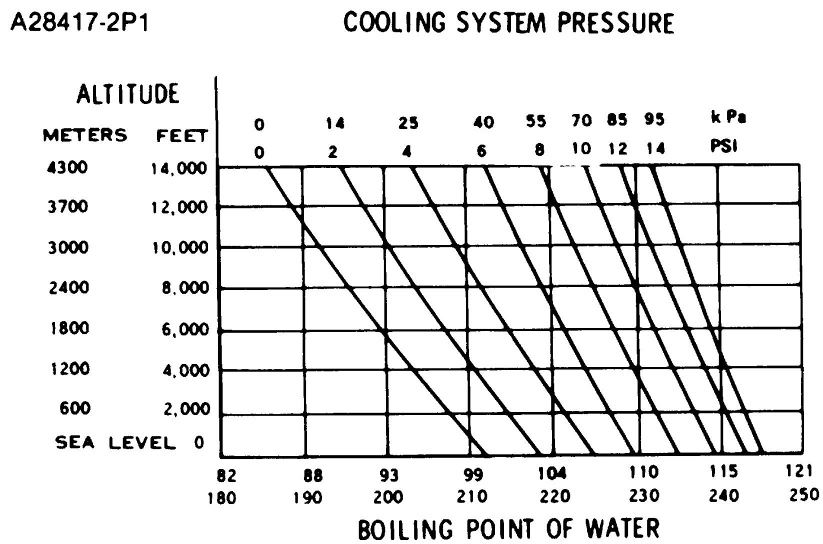


Engine Oil Pressure Graph.

Possible causes for low oil pressure are:

- Failure of the oil filter bypass valve.
- Failure of the oil filter base.
- Wear or damage in the engine oil pump.
- Internal leaks in the engine block and/or cylinder head.

Cooling System



Boiling Point of Water Versus Altitude and Cooling System Pressure.

Temperature and pressure work together. When a cooling system problem is diagnosed, temperature and pressure must both be checked. Cooling system pressure will have an effect on coolant boiling temperatures. The chart above demonstrates the effect of pressure and height above sea level on the boiling (steam) point of water.

Visual Inspection of the Cooling System

1. Check the coolant level in the cooling system.
2. Look for greenish-white corroded areas on the radiator to find leaks in the system.
3. Look for bent radiator fins. Be sure that the air flow through the radiator is not restricted.
4. Inspect the hydraulic fan motor and hoses.
5. Check for damage to the fan blades.
6. Look for air or combustion gas in the cooling system by operating the engine with the radiator cap off; look for bubbles of gas coming out of the radiator cap opening.

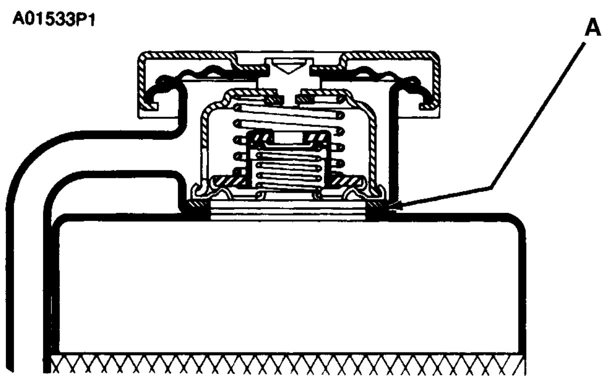
WARNING

DO NOT loosen the filler or pressure cap on a hot engine. Steam or hot coolant can cause severe burns.

7. Inspect the filler cap and the surface that seals the cap. This surface must be clean.

Pressure Cap Test

Tools Needed	
9S-8140 Cooling System Pressurizing Group	1



Cross Section of Pressure Cap.
(A) Sealing surface of cap and radiator.

WARNING

Do not loosen the filler or pressure cap on a hot engine. Steam or hot coolant can cause severe burns.

1. After the engine has cooled, remove the pressure cap from the radiator. Inspect the pressure cap carefully. Look for damage to the seal or to the surface that seals. Any foreign material or deposits on the cap, seal, or surface that seals, must be removed.
2. Put the pressure cap on the 9S-8140 Cooling System Pressurizing Pump Group.
3. Look at the gauge for the exact pressure that makes the pressure cap open. The cap should open at 48 kPa (7 psi).
4. If the pressure cap is defective, install a new pressure cap.

Radiator and Cooling System Leak Test

Tools Needed	
9S-8140 Cooling System Pressurizing Group	1

WARNING

Do not loosen the filler or pressure cap on a hot engine. Steam or hot coolant can cause severe burns.

1. Remove the pressure cap from the radiator.
2. Make sure the radiator is full of coolant.
3. Put the 9S-8140 Cooling System Pressurizing Pump Group on the radiator.
4. Increase the pressure reading on the gauge to 60 kPa (10 psi); this is 20 kPa (3 psi) more than the pressure on the pressure cap.
5. Check the radiator for external leakage.
6. Check all connections and hoses in the cooling system for external leakage.
7. If no leaks are found, and the pressure reading on the gauge is still the same after five minutes, the radiator and cooling system are not leaking. If the reading on the gauge goes down and leaks are not detected, there is leakage on the inside of the cooling system. Make repairs as necessary.

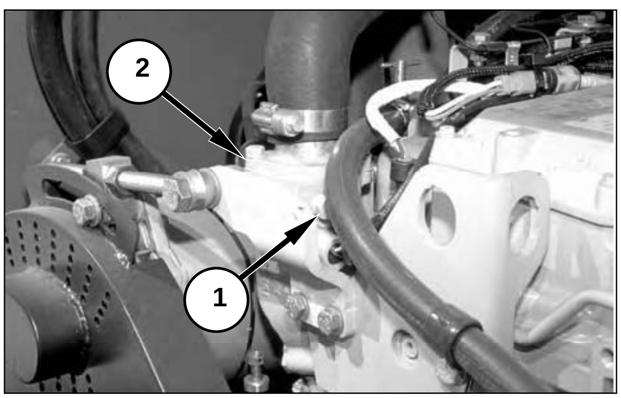
Water Temperature Gauge Test

Tools Needed		
4C-6500	Thermistor Thermometer Group	1
	–or–	
2F-7112	Thermometer	1
3K-0360	O-Ring Seal	1
3B-7721	Reducing Bushing (3/8 NPTF to 1/8 NPTF)	1
	–or–	
5P-2720	Self-Sealing Probe Adapter with	1
5P-2718	Pressure Probe	1

NOTE: This procedure requires that the machine be operated. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE)* for information about machine operation.

1. Raise the radiator. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Features, Radiator Tilt."

2. Raise the cab. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Features, Cab Tilt."



Test Location.
(1) Plug. (2) Water temperature regulator housing.

3. Remove plug (1), and install the reducer and the 8T-0470 Thermistor Thermometer Group, or the 2F-7112 Thermometer. An accurate temperature gauge can also be used to make this check.

WARNING

Work carefully around an engine that is running. Engine parts that are hot, or parts that are moving, can cause personal injury.

4. Lower the cab.

5. Start and run the engine until the temperature reaches the desired range, according to the test thermometer. If necessary, put a cover over part of the radiator.

6. The reading on the water temperature gauge in the cab should agree with the test thermometer within 5°C (10°F).

7. Remove all tooling and lower the radiator.

Water Temperature Regulator Test

1. Remove the regulator from the engine. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine*, “Water Temperature Regulator.”

2. Heat water in a pan until the temperature is 94°C (201°F). Stir the water to ensure that the temperature is evenly distributed.

3. Hang the regulator in the pan of water. The regulator must be below the surface of the water and away from the sides and bottom of the pan.

4. Keep the water at the correct temperature for 10 minutes.

5. After 10 minutes, remove the regulator and immediately measure the distance the regulator has opened. Compare the measured value to the specification in “Specifications, Cooling System, Water Temperature Regulator.”

6. If the distance is less than the minimum opening length specifications, replace the temperature regulator with a new one.

7. Install the regulator.

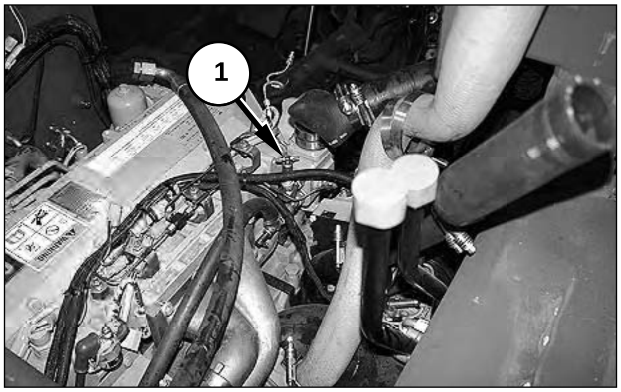
Water Pump Pressure Check

Tools Needed		
6V-7775	Pressure Gauge	1
8J-7844	Adapter (3/4-16 to 1/4 NPTF)	1
3B-0360	O-ring Seal	1
5P-2725	Self-Sealing Probe	1
164-2192	Pressure Probe (if port (1) is used, two tools are required)	1
5P-4487	Adapter 1/2-20 to 1/8 NPTF)	1
1J-9671	O-ring Seal	1
5P-2720	Self-Sealing Probe Adapter	1
5P-2718	Pressure Probe (if port (1) is used, two tools are required)	1

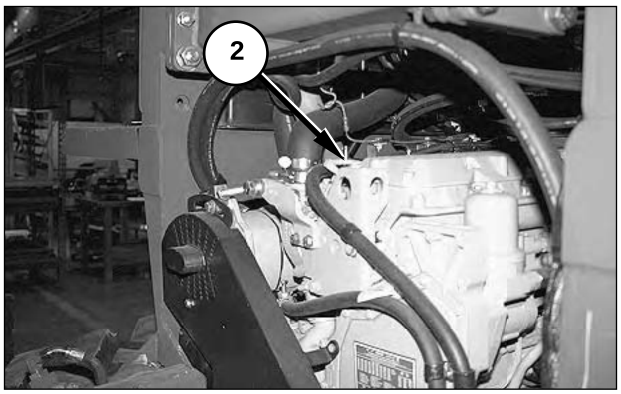
NOTE: This procedure requires that the machine be operated. Refer to *Operator’s Manual, Deployable Universal Combat Earthmover (DEUCE)* for information about machine operation.

1. Raise the radiator. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* “Maintenance Features, Radiator Tilt.”

2. Raise the cab. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* “Maintenance Features, Cab Tilt.”



Right Side of Engine, Machine Partially Disassembled for Photographic Purposes.
(1) Heater valve.



Right Side of Engine.
(2) Heater valve.

3. Remove heater valves (1) and (2), and install one pressure gauge in each of the heater ports.

4. Lower the cab.

NOTICE

Ensure that none of the tooling is damaged by the cab (as it is being lowered), or by moving components (when the engine is operating).

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5. Start the engine and allow the coolant temperature to rise to normal.

6. Measure the pressure rise between the heater ports. With the engine at operating temperature, and at 2200 rpm, the pressure rise must be a minimum of 80 kPa (12 psi).

NOTE: The pressure rise (increase in pressure or pressure differential) indicates that the water pump is operating correctly.

7. Repair or replace the water pump if the pump does not meet the specification.

8. Remove all tooling and lower the radiator.

Basic Block

Connecting Rod Bearings

Connecting rod bearings fit tightly in the bore in the rod. If the bearing joints or backs are worn (fretted), check the bore size. This can be an indication of wear due to a loose fit.

Connecting rod bearings are available with a diameter that is 0.25 mm (0.010 in) or 0.50 mm (0.020 in) smaller inside than the original-size bearings. These bearings are for crankshafts that have been ground (made smaller than the original size).

Main Bearings

Main bearings are available with a diameter that is larger outside than the original-size bearings. These bearings are for cylinder blocks that have the bore for the main bearings “bored” (made larger than the original size). The size available has an outside diameter that is 0.50 mm (0.020 in) larger than the original-size bearings.

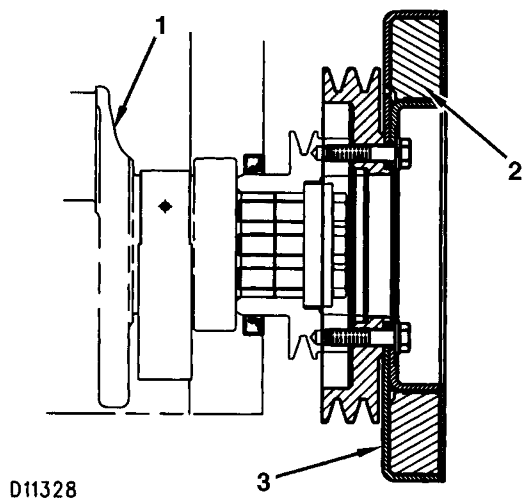
Main bearings are available with a smaller inside diameter than the original-size bearings. These bearings are for cylinder blocks that have a crankshaft that has been ground (made smaller than original size). Main bearings are available with a diameter that is 0.25 mm (0.010 in) or 0.50 mm (0.020 in) smaller inside than the original-size bearings.

Cylinder Block

The bore in the main bearing block can be checked while the main bearing caps are installed without bearings. Tighten the cap nuts to the torque shown in "Specifications, Cylinder Block" in this module. Alignment error in the bores must not be more than 0.08 mm (0.003 in).

Vibration Damper

If the damper is leaking, bent or damaged, or if the bolt holes in the damper are loose, replace the damper. The damper must also be replaced when a crankshaft fails because of the high loads experienced by the vibration damper.



Vibration Damper Assembly.
(1) Crankshaft. (2) Weight. (3) Case.

Inspect the vibration damper for leaks or a dented (damaged) case (3). Either condition can cause weight (2) to make contact with case (3) and affect the damper operation.

TM5-2430-200-24

Disassembly & Assembly

Deployable Universal Combat Earthmover (DEUCE)

3100 HEUI DEUCE Engine

Engine PIN: 4CW00222–Up
Machine PIN: 7RR00003–Up

Important Safety Information

Most accidents involving product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or other persons.

The hazards are identified by the "Safety Alert Symbol" and followed by a "Signal Word" such as "WARNING" as shown below.

The meaning of this safety alert symbol is as follows:

⚠ WARNING

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning, explaining the hazard, can be either written or pictorially presented.

Operations that may cause product damage are identified by NOTICE labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are therefore not all inclusive. If a tool, procedure, work method or operating technique not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and others. You should also ensure that the product will not be damaged or made unsafe by the operation, lubrication, maintenance or repair procedures you choose.

The information, specifications, and illustrations in this publication are on the basis of information available at the time it was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service given to the product. Obtain the complete and most current information before starting any job. Caterpillar dealers have the most current information available. For a list of the most current publication form numbers available, see the Service Manual Contents Microfiche, REG1139F.

Table of Contents

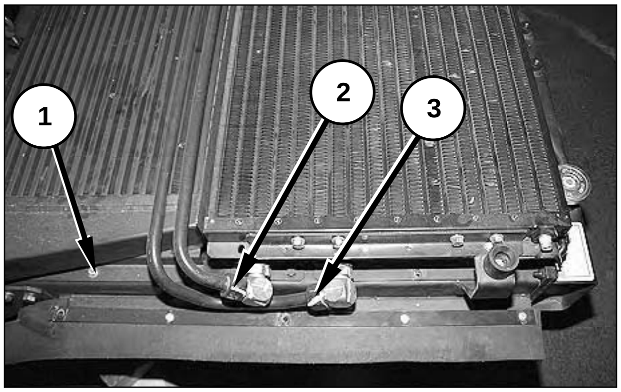
Aftercooler

Remove and Install

Start By:

a. Remove the radiator group.

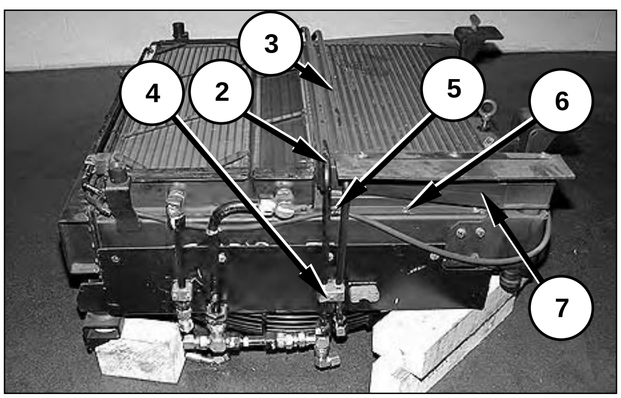
NOTE: The group number related to this procedure is 125-5578.



1. Disconnect tubes (2) and (3).

2. Remove three bolts (1) with the flat and lock washers.

NOTE: Only one of three bolts (1) is visible in the photograph.



3. Remove bolt (4) with the washer, retainer and two clamp halves.

4. Remove tubes (2) and (3).

5. Remove bolt (5) with the flat and lock washers, and the clamp. Remove two bolts (6) with flat and lock washers.

6. Remove aftercooler (7).

NOTE: To install the aftercooler, reverse the removal steps.

End By:

a. Install the radiator group.

Air-Conditioning Compressor

Remove and Install

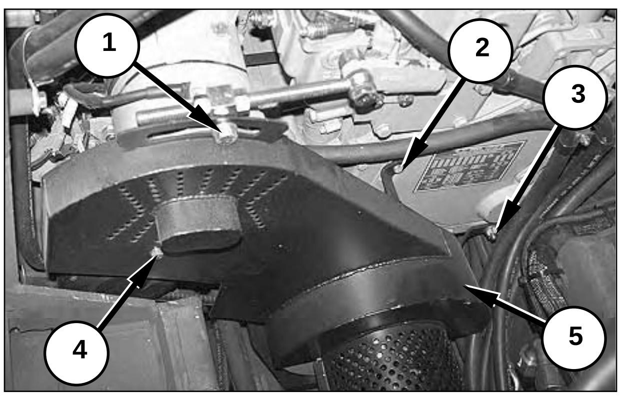
NOTE: Group numbers related to this procedure include 126-5830 and 149-3203.

1. Raise the cab. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* “Maintenance Features, Cab Tilt.”

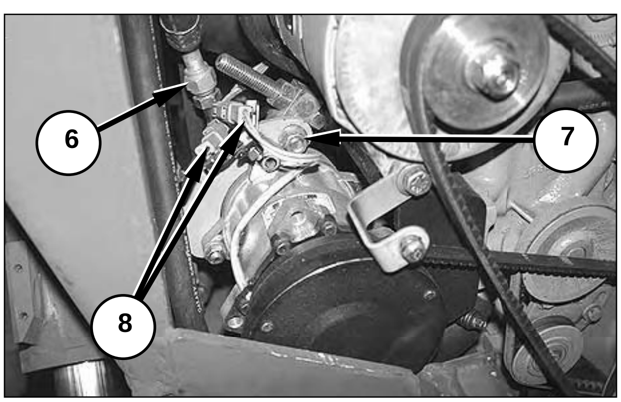
⚠ WARNING

When working on the air-conditioning system, keep all other personnel either away from the machine or within view.

2. Recover the refrigerant from the air-conditioning system and evacuate the system. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Machine Systems,* “Recovering the Refrigerant” and “Evacuating the System.”



3. Remove bolt (1) with the washer, bolt (2), bolt (3) with the nut and two washers, bolt (4) with the washer, and cover (5).

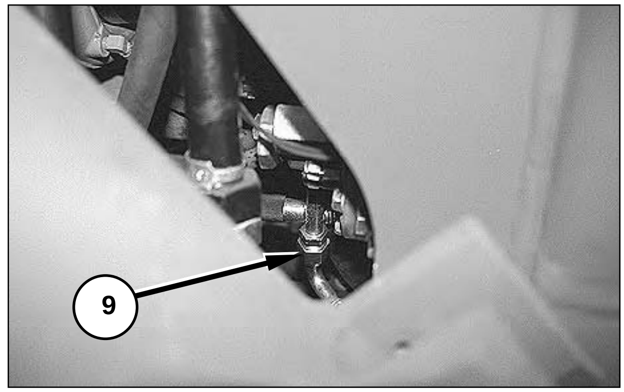


4. Disconnect connectors C221 and C231 (8).

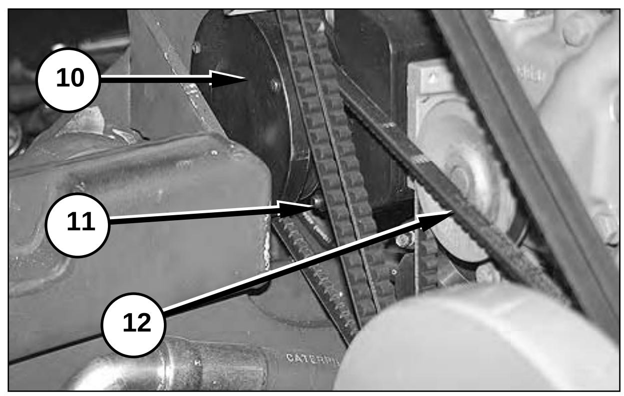
NOTE: Connector C221 is for the air-conditioning pressure switch, and connector C231 is for the air-conditioning clutch solenoid.

5. Remove nut (7) with the bolt, three washers and one spacer block. Upon reassembly, tighten nut (7) to a torque of **105 ± 20 N•m (77 ± 15 lb ft).**

6. Disconnect line (6).



7. Disconnect line (9).



8. Slide V-belt (12) off the front of pulley (10).

9. Remove nut (11) with the washers and bolt. Upon reassembly, tighten nut (11) to a torque of **30 ± 7 N•m (22 ± 5 lb ft).**

10. Remove the air-conditioning compressor.

NOTE: If additional room is needed to remove the air-conditioning compressor, the tension on the alternator belt can be released, and the guard mounting bracket can be rotated out of the way.

NOTE: To install the air-conditioning compressor, reverse the removal steps. For the procedure to charge the air-conditioning system, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Machine Systems,* "Charging the Air-Conditioner System." For the procedure to tighten the V-belts, refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Every 250 Service Hours or Three Months, Engine V-Belts."

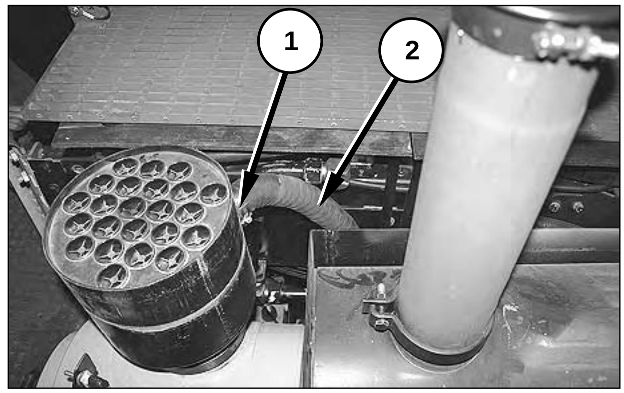
Air Cleaner Group

Remove and Install

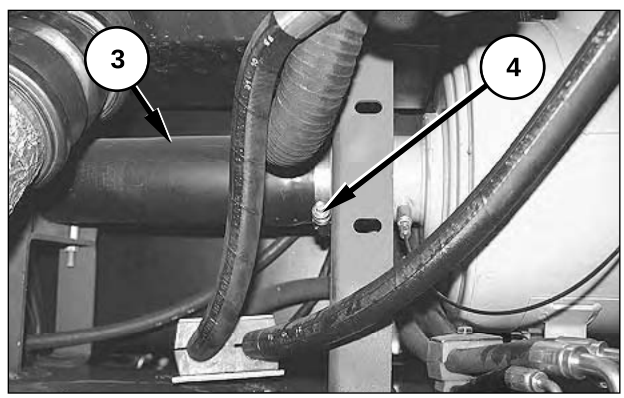
Start By:

a. Remove the middle top cover. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Machine Systems,* "Middle Top Cover."

NOTE: The group number related to this procedure is 145-0071.

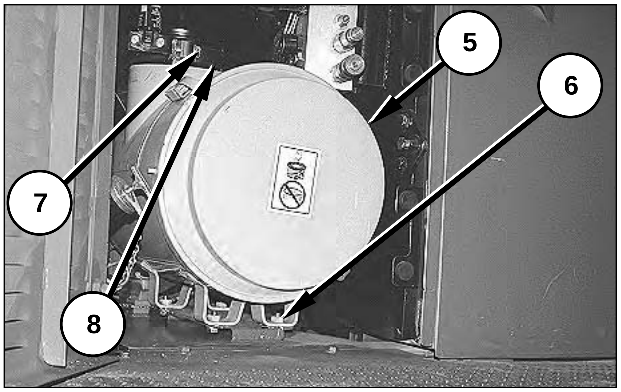


1. Loosen hose clamp (1) and disconnect dust ejector line (2).



Radiator Raised for Photographic Purposes.

2. Loosen hose clamp (4) on air intake line (3).



3. Remove four bolts (6) with the washers, and remove air cleaner group (5) with the precleaner attached.

4. If necessary, remove bolt (7) with nut and washer, and clamp (8). Separate the precleaner and air cleaner group (5).

NOTE: To install the air cleaner group, reverse the removal steps.

End By:

a. Install the middle top cover.

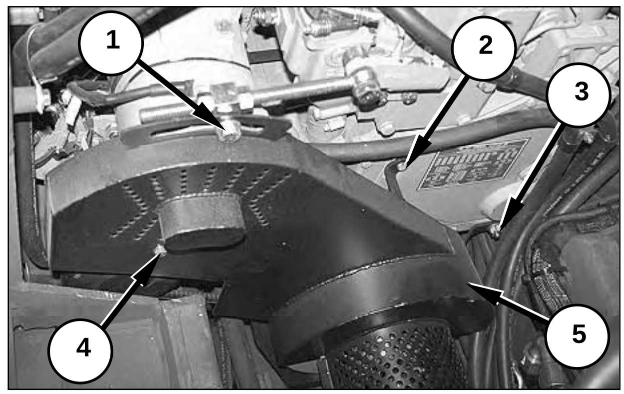
Alternator

Remove and Install

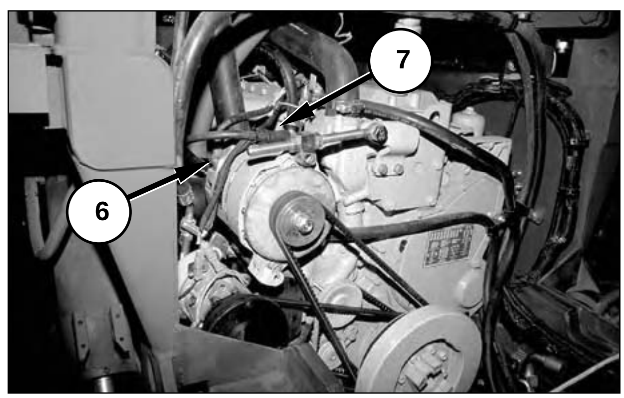
NOTE: Group numbers related to this procedure include 9X-7803 and 130-2789.

1. Turn the main disconnect switch to the OFF position. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Machine Features, Main Disconnect Switch."

2. Raise the cab. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Cab Tilt."

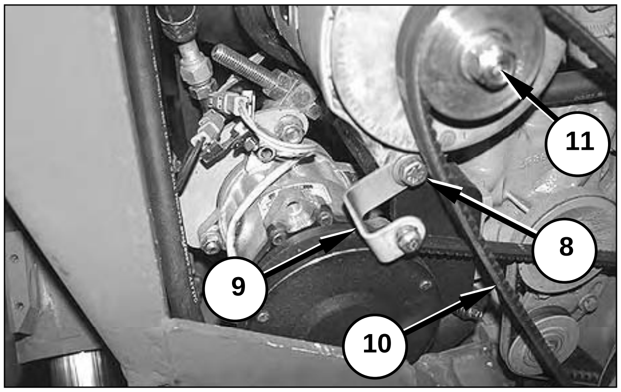


3. Remove bolt (1) with the washer, bolt (2), bolt (3) with the nut and two washers, bolt (4) with the washer, and cover (5).



4. Remove the nut, positive cable (6), and the washer. Mark the wires for correct location during reassembly. Upon reassembly, tighten the nut to a torque of **7.1 ± 0.8 N•m (63 ± 7 lb in)**.

5. Remove the bolt and washer, and disconnect negative cable (7). Mark the wires for correct location during reassembly. Upon reassembly, tighten the bolt to a torque of **6.2 ± 0.6 N•m (55 ± 5.5 lb in)**.



6. Remove bolt (8), with the nut and washers, to remove guard bracket (9).

7 Slide V-belt (10) off pulley (11), and remove the alternator.

NOTE: To install the alternator, reverse the removal steps. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Every 250 Service Hours or Three Months, Engine V-Belts" for the belt tension procedure.

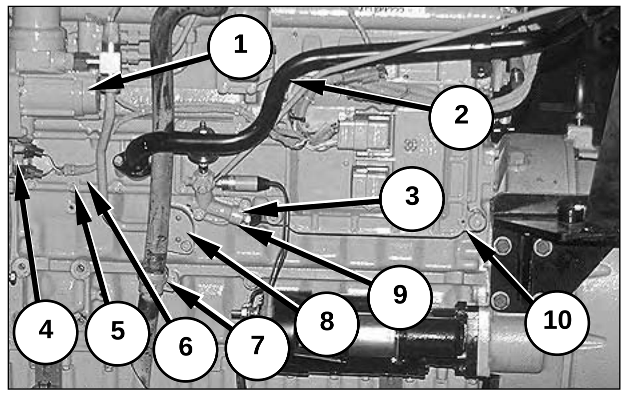
Cam Roller Followers (Lifter Assemblies)

Remove and Install

Start By:

a. Remove the rocker arm assemblies and pushrods.

NOTE: The group number related to this procedure is 101-3263.



1. Remove hydraulic pump (1). Refer to "Hydraulic Pump Group,Remove and Install."

2. Remove the two bolts with washers that hold oil fill tube (2) to the engine block. Move the oil fill tube with O-ring seal out of the way.

NOTE: To provide additional room, oil fill tube (2) can be completely removed. Refer to *Parts Manual, Deployable Universal Combat Earthmover (DEUCE),* "1488882 Filler Gp-Engine Oil" for the location of the additional mounting hardware.

3. Remove two bolts (3) and washers, and oil manifold (9) with the O-ring. Replace the O-ring if it is damaged or worn.

4. Remove bolt (4) with the washer and bracket. Remove the timing sensors from the front housing. Allow the sensors to hang down on the electrical harness.

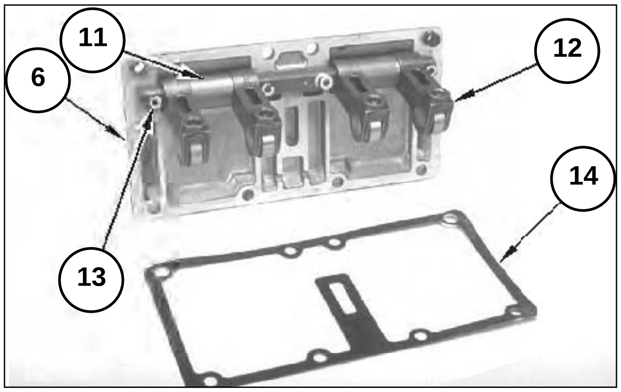
NOTE: If it the timing sensors must be disconnected, mark the connectors for the correct location during reassembly. The connector with the 963-BK and 964-WH wires is for the top sensor, and the connector with the 965-BU and 966-YL wires is for the bottom sensor.

5. Remove bolt (7) with the washer, and allow the crankcase breather hose to hang down.

6. Remove two bolts and washers, and oil supply tube (8) with the O-ring seal. Replace the O-ring seal if it is damaged or worn.

7. Remove electronic control module (ECM) (10). Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* “Electronic Control Module (ECM).”

8. Remove bolts (5) and washers that hold three cylinder block side covers (6) to the engine. Remove the side covers with gaskets (14), and the lifter assemblies from the cylinder block. Replace the gaskets if they are damaged.



9. Remove four bolts (13) and the dowels that hold lifter assemblies (12), the lifter shaft assembly, and spacer (11) from each side cover.

NOTE: Unless replacement is required, be sure the hollow side cover sleeves remain in the side covers.

NOTE: The following steps are for the installation of the lifter assemblies.

10. Install lifter assemblies (12) and spacer (11) on the lifter shaft assembly.

11. Put the lifter shaft and the dowels in position on the side cover. Be sure the oil holes in the lifter shaft assembly are facing the side cover. Apply **9S-3263 Thread Lock (Loctite™ 242)** on the threads of bolts (13) that hold the lifter shaft assembly to side cover (6). Install bolts (13) and tighten them to a torque of **13 ± 3 N•m (10 ± 2 lb ft).** Tighten the two center bolts first; then tighten the end bolts.

12. Lubricate the lifter assemblies with clean engine oil.

13. Be sure the cylinder block and side cover (6) sealing surfaces are thoroughly clean. Use an authorized applicator to apply a continuous uniform film of **1U-8846 Liquid Gasket (Loctite™ 17430)** to the side cover sealing surfaces. The side covers must be installed on the cylinder block within 10 minutes of the sealant application.

14. Put gaskets (14) and side covers (6) in position on the cylinder block. Install bolts (5) and washers.

15. Install ECM (10). Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* “Electronic Control Module (ECM), Remove and Install.”

16. Connect oil fill tube (2) with O-ring seal to the engine block, using two bolts and washers.

17. Install the bracket that holds the crankcase breather hose in place, with bolt (7) and the washer.

18. Install the timing sensors to the front housing using bolt (4) and the washer and bracket.

19. Install oil manifold (9) with the O-ring seal,and two bolts (3) and washers.

20. Install hydraulic pump group (1). Refer to “Hydraulic Pump Group, Remove and Install.”

End By:

a. Install the rocker arm assemblies and pushrods.

Camshaft

Remove and Install

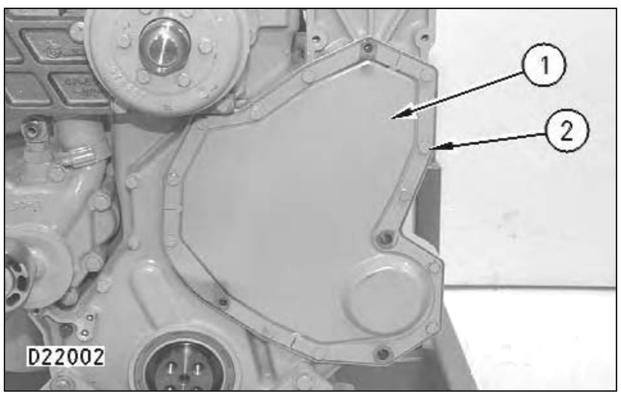
Start By:

a. Remove the cam roller followers (lifter assemblies).

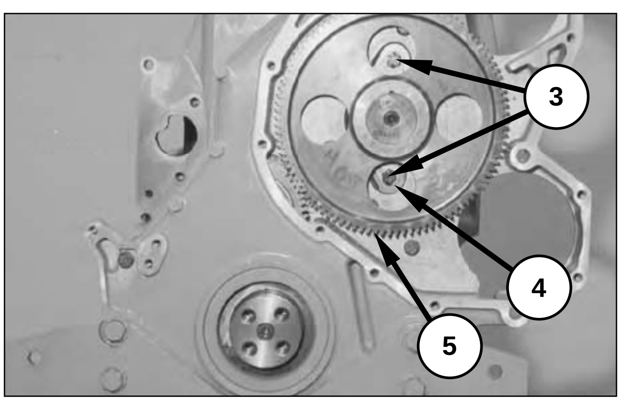
b. Remove the vibration damper, crankshaft pulley, and crankshaft front seal.

NOTE: Group numbers related to this procedure include 7L-0004 and 105-1803.

1. Turn the engine to the top center compression stroke for the number-one piston. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Testing and Adjusting, Fuel System, Finding Top Center Position for Number-One Cylinder."



2. Remove 14 bolts (2), and the washers, from the front housing. Remove front cover (1), and the gasket, from the front housing.

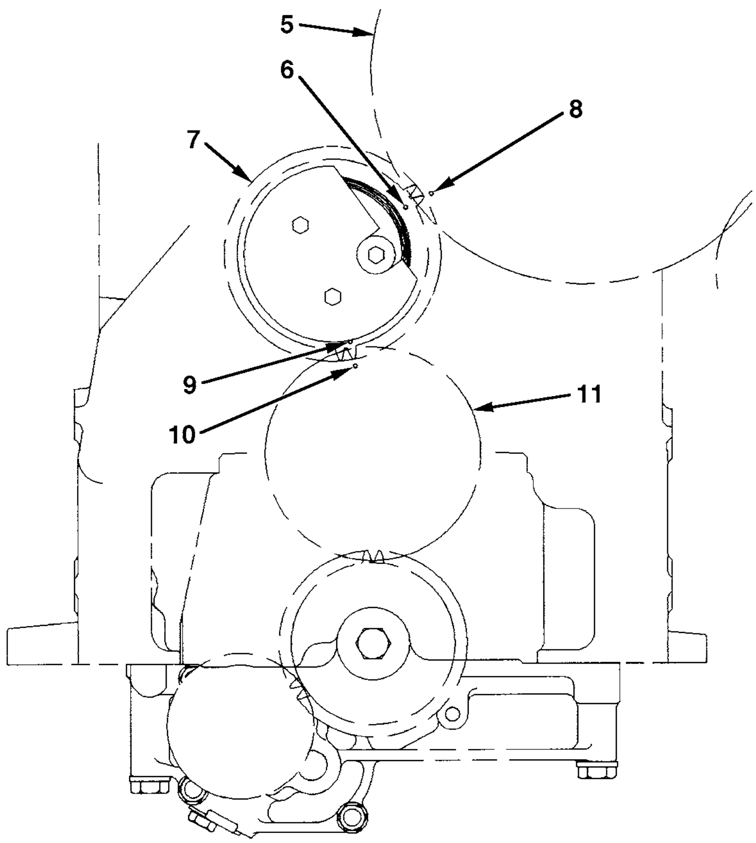


3. Remove two bolts (3), and carefully remove thrust plate (4) and the camshaft assembly from the cylinder block.

4. Use a press to remove camshaft drive gear (5) from the camshaft. Remove the woodruff key from the camshaft.

NOTE: The following steps are for the installation of the camshaft.

5. Install the woodruff key in the camshaft. Heat camshaft drive gear (5) to a maximum temperature of **315° C (600° F).** Do not use a torch to heat the drive gear. Install the drive gear on the camshaft, and allow the drive gear to cool.



NOTE: The camshaft timing is very important. When installing the camshaft assembly, be sure that the number-one cylinder is at top center of the compression stroke. To achieve the correct timing, align timing mark (6) on camshaft idler gear (7) with hole (8) in camshaft drive gear (5), and align timing mark (9) on camshaft idler gear (7) with hole (10) in crankshaft gear (11), as shown.

6. Apply clean engine oil on the lobes and journals of the camshaft. Carefully install the camshaft assembly in the cylinder block.

7. Place thrust plate (4) into position and install two bolts (3).

8. Ensure that mating surfaces of the front housing and front cover (1) are thoroughly clean. Use an approved applicator to apply a uniform film of **1U-8846 Sealant** to the front cover sealing surface. The front cover must be installed on the front housing within 10 minutes of the sealant application.

9. Place the gasket and front cover (1) in position on the front housing. Install 14 bolts (2) and washers that hold the front cover to the front housing.

End By:

a. Install the vibration damper, crankshaft pulley, and crankshaft front seal.

b. Install the cam roller followers (lifter assemblies).

Camshaft Bearings

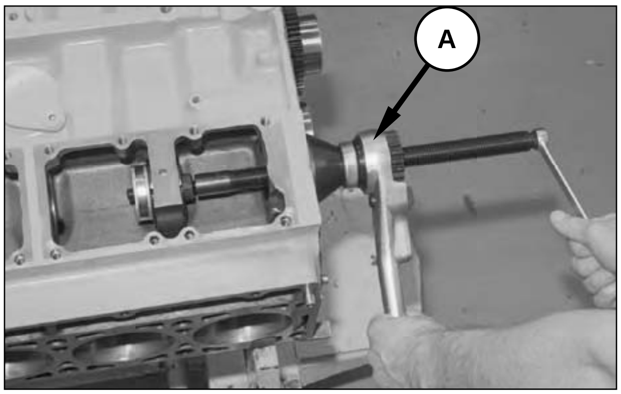
Remove and Install

Tools Needed	A
8S-2241 Camshaft Bearing Installation and Removal Tool	1

Start By:

a. Remove the camshaft.

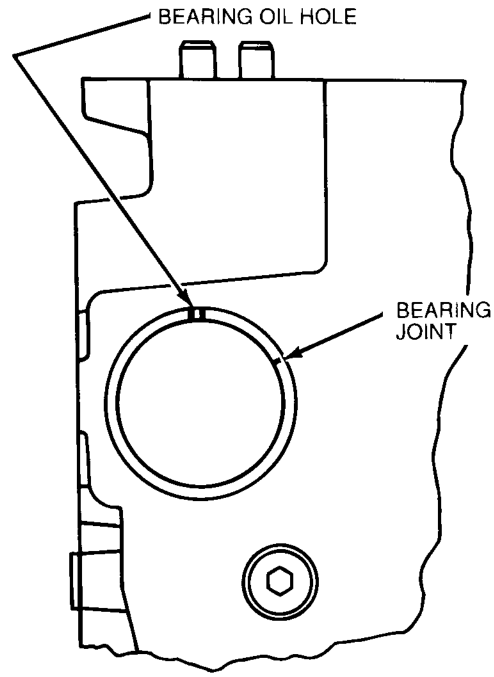
NOTE: The group number related to this procedure is 129-1164.



1. For assembly reference purposes, note the oil hole orientation in each camshaft bearing prior to removal.

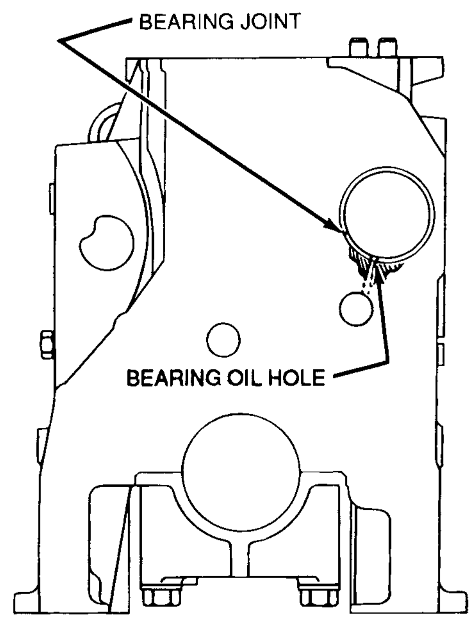
2. Use Tooling (A) to remove the camshaft bearings from the cylinder block.

NOTE: The following steps are for the installation of the camshaft bearings.



C20221P2*

3. Use Tooling (A) to install all camshaft bearings, except the front bearing, into the cylinder block. Locate the oil hole in each bearing, at the top of the bore, as shown.



C20220P2*

4. Use Tooling (A) to install the front camshaft bearing. Align the oil hole in the front camshaft bearing with the oil hole in the cylinder block. Locate the joint in the front camshaft bearing, as shown.

End By:

a. Install the camshaft.

Cooling Fan

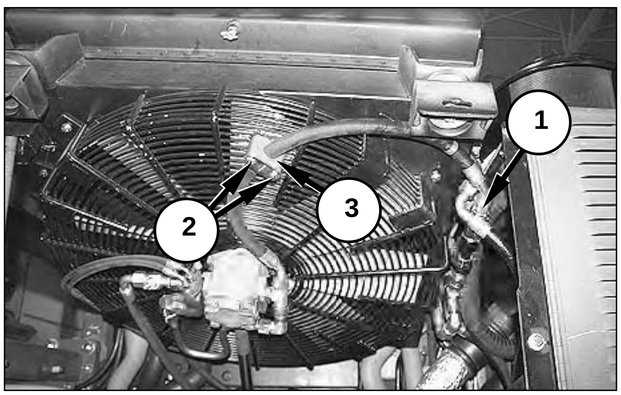
Remove and Install

Tools Needed	A
138-7575 Link Bracket (1/2 in)	2

NOTE: Group numbers related to this procedure include 124-5855, 144-8603, and 145-0072.

1. Raise the radiator. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* “Radiator Tilt.”

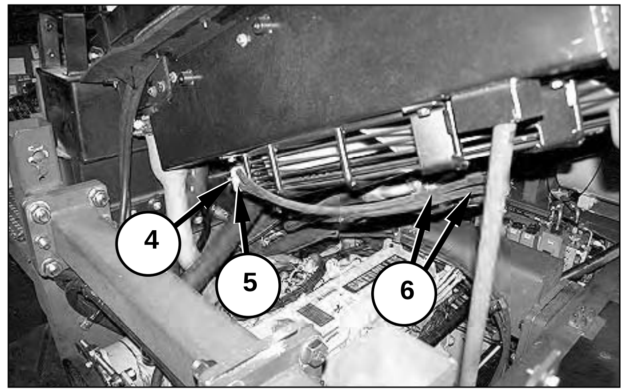
2. Raise the cab. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* “Cab Tilt.”



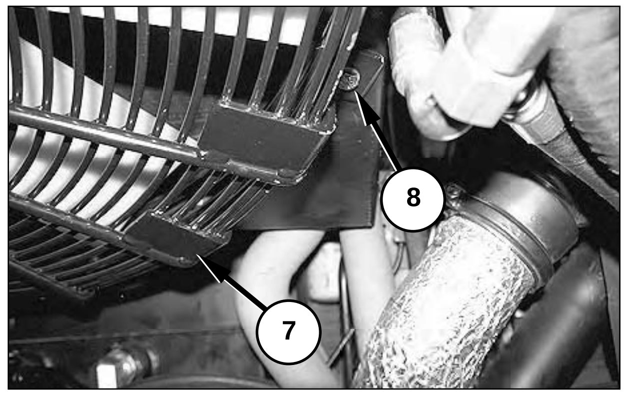
3. Disconnect, cap and then plug fan motor return line (1). Mark line (1) for correct connection during reassembly.

NOTE: Some hydraulic oil may leak from fan motor return line (1) when it is disconnected. Catch the oil in a suitable container, and dispose of the liquid according to local regulations.

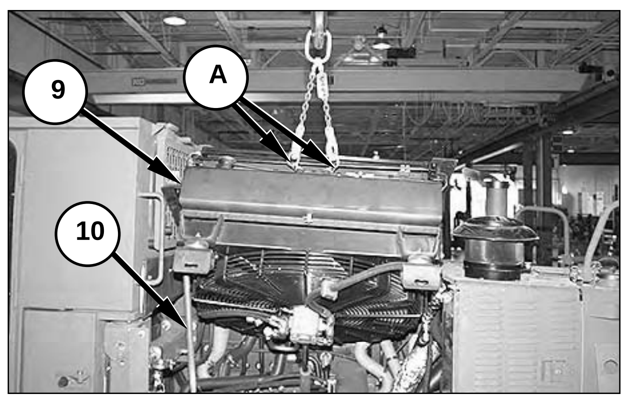
4. Remove two bolts (2) with retainer, and clamp halves (3).



5. Remove bolt (4) with retainer, and clamp assembly (5) from fan pilot control lines (6).

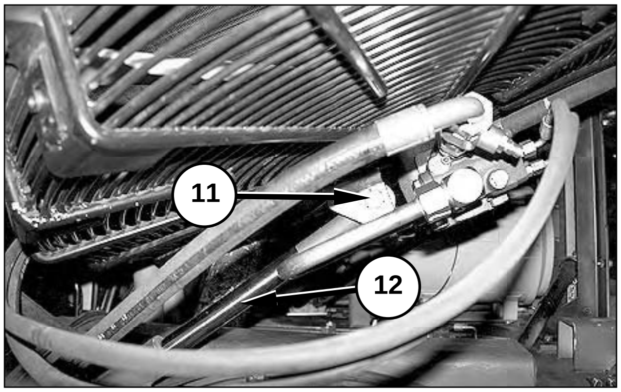


6. Remove two bolts (8) (only one visible in photo) and washers from the right rear corner of fan guard (7).



7. Install Tooling (A), and support radiator assembly (9) with a hoist. Keep radiator support rod (10) in place until the radiator is lowered.

NOTE: The weight of radiator assembly (9) is approximately **450 kg (1000 lb).**



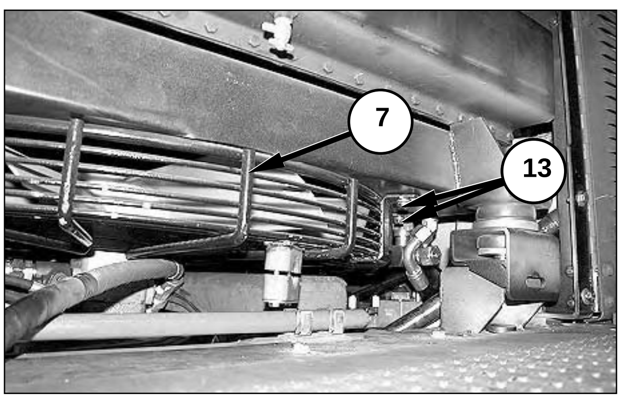
8. Remove bolt (11) and the locking nut with two washers from the rod end of radiator lift cylinder (12). Allow the radiator lift cylinder to rest against the top of the engine. Upon reassembly, tighten bolt (11) until the end of the bolt just begins to protrude through the locking nut.

9. Retract the radiator lift cylinder using the cab and radiator tilt pump.

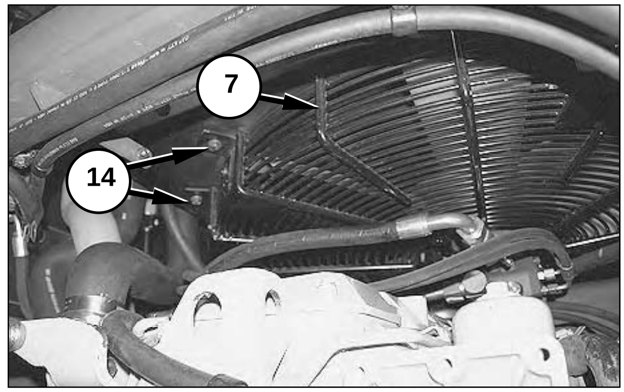
10. Lower the radiator assembly onto the radiator mounts, using the hoist.

NOTICE

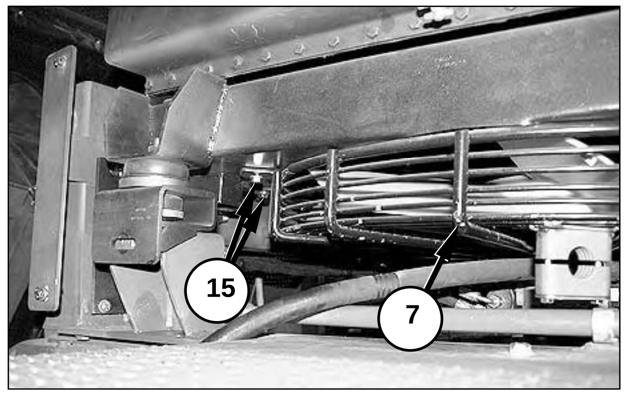
Watch below the radiator to be sure nothing is damaged when the radiator is lowered. Make sure the radiator lift cylinder is fully retracted and in alignment with the bracket on the fan guard.



11. Remove two bolts (13) and washers from the left rear corner of fan guard (7).

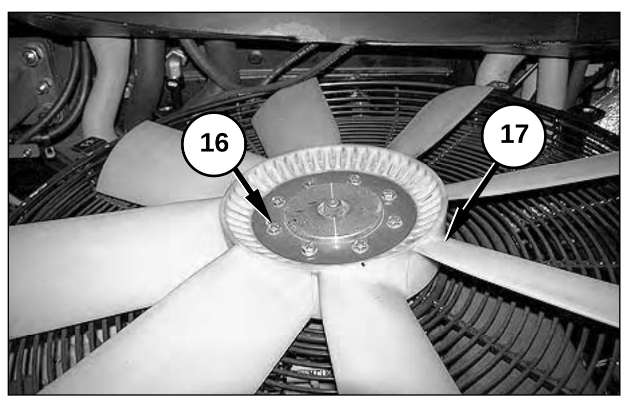


12. Remove two bolts (14) from the right front corner of fan guard (7).



13. Remove two bolts (15) and washers from the left front corner of fan guard (7). Allow the fan guard, fan and fan motor to rest (as a unit) on top of the engine.

14. Slowly raise the radiator assembly with the hoist and allow the fan guard, fan and fan motor to rest on the engine. Raise the radiator support rod to support the radiator in the raised position.



15. Remove eight bolts (16) with the washers, and fan (17). Make note of the orientation of fan (17) for correct installation during reassembly.

NOTE: To install the cooling fan, reverse the removal steps.

Crankshaft

Remove and Install

Tools Needed	A
8T-5096 Dial Indicator Group	1

Start By:

a. Remove the engine assembly and torque converter.

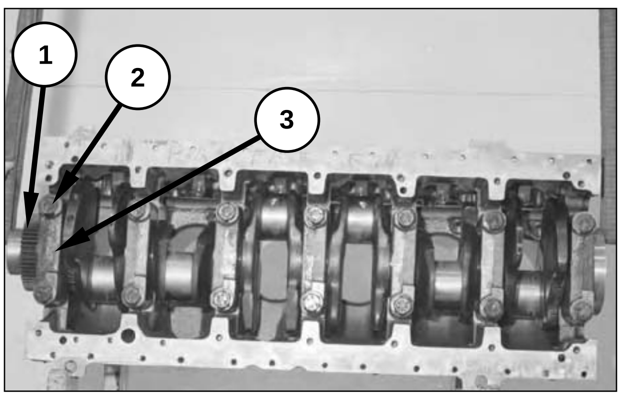
b. Remove the torque converter group. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Torque Converter Group."

c. Remove the cylinder head assembly.

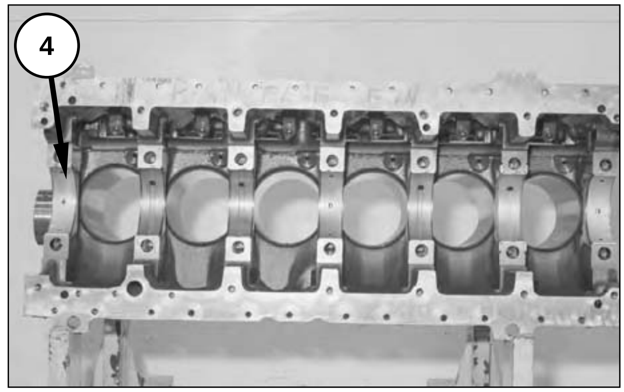
d. Remove the front housing and camshaft idler gear assembly.

e. Remove the pistons and connecting rod assemblies.

NOTE: The group number related to this procedure is 113-6087.



1. Fasten lifting slings and a hoist to each end of crankshaft (1). Remove main bearing cap mounting bolts (2), with the washers, and main bearing caps (3). Carefully remove the crankshaft from the cylinder block. The weight of the crankshaft is approximately **62 Kg (137 lb).**



2. Remove main bearings (4) from the cylinder block. Remove the main bearings from the main bearing caps.

NOTE: The following steps are for the installation of the crankshaft.

3. Check the condition of main bearings (4). Replace worn or damaged bearings.

NOTE: The number-six main bearing is the thrust bearing.

4. Clean the bearing surfaces in the cylinder block for the main bearings. Apply clean engine oil on the upper main bearing half. Do not put oil on the back side of the bearing. Install the upper main bearing halves (bearings with the oil holes) in the cylinder block. Be sure the tab on the back side of the bearing engages with the groove in the cylinder block.

5. Put clean engine oil on the crankshaft bearing journals. Fasten lifting straps and a hoist to crankshaft (1), and carefully install the crankshaft in the cylinder block. The weight of the crankshaft is approximately **62 Kg (137 lb).**

6. Clean the bearing surface of the main bearing caps. Install the lower main bearing halves in the crankshaft main bearing caps. Be sure the tab on the back side of the bearing engages with the groove in the main bearing cap. Apply clean engine oil on the lower main bearing half. Do not put oil on the back side of the bearing.

7. Install the main bearing caps as follows:

NOTICE

Install the main bearing caps with the sequence number to the right, 1 through 7, front to rear.

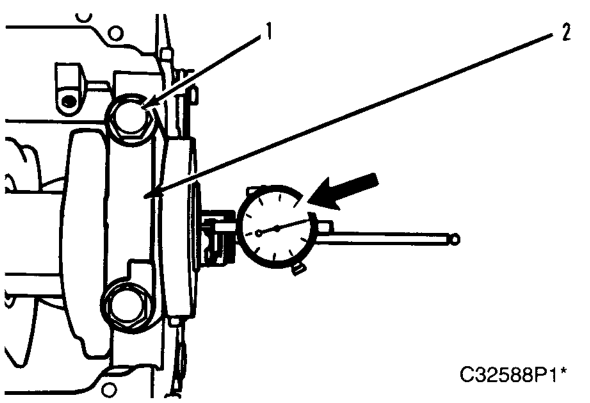
a. Put main bearing caps (3) in position in the cylinder block with the sequence numbers in the correct positions.

b. Apply clean engine oil to the threads of the main bearing cap mounting bolts and on the washer contact faces.

NOTE: When the bolts for the rear main bearing cap are tightened, slide the main bearing cap as far forward as possible (toward the front of the engine) until the cap is against the bolts. Holding the main bearing cap in this position, tighten the bolts. This will prevent interference from the rear main bearing cap.

c. Install main bearing cap mounting bolts (2) and the washers. Tighten both bolts of each main bearing cap to a torque of **54 ± 7 N•m (40 ± 5 lb ft).**

d. Tighten the bolts an additional **90 ± 5 degrees (1/4 turn).**



8. Check the end play of the crankshaft with Tooling (A). The end play of the crankshaft must be **mm (0.003 to 0.013 in).**

End By:

a. Install the pistons and connecting rod assemblies.

b. Install the front housing and camshaft idler gear assembly.

c. Install the cylinder head assembly.

d. Install the torque converter group. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Torque Converter Group."

e. Install the engine assembly and torque converter.

Crankshaft Main Bearings

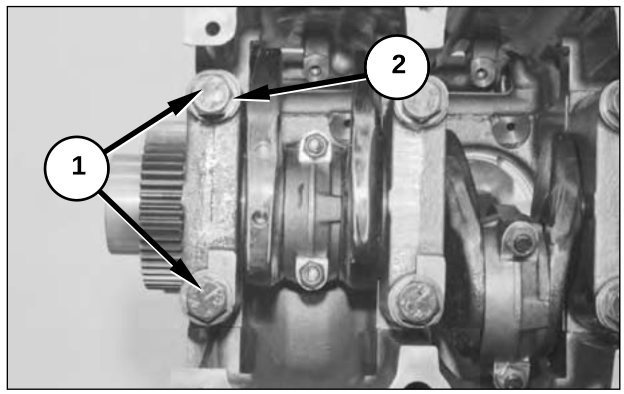
Remove and Install

Tools Needed		A	B
2P-5518	Bearing Removal and Installation Tool	1	
8T-5096	Dial Indicator Test Group		1

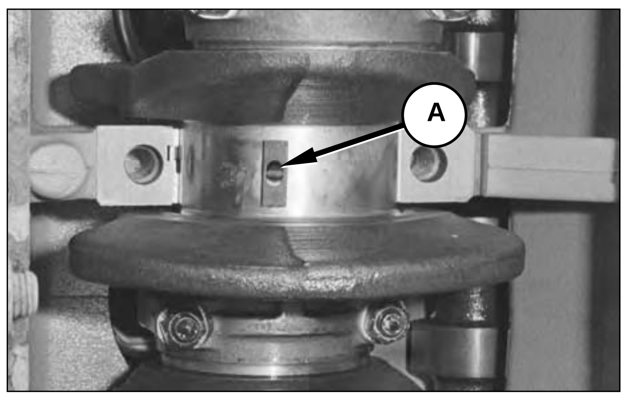
Start By:

a. Remove the oil pump.

NOTE: The group number related to this procedure is 113-6087.



1. Remove main bearing cap mounting bolts (1) with the washers, and main bearing cap (2). Remove the lower main bearing half from the cap.



NOTICE

If the crankshaft is turned in the wrong direction during the removal of the upper half of the main bearing, the tab of the bearing will be pushed between the crankshaft and the cylinder block. This can result in damage to either or both the crankshaft and the cylinder block.

NOTE: Some crankshaft main journals have no oil hole. To remove these upper main bearing halves, put a thin piece of soft material (material that will not damage the crankshaft journal) against the end of the bearing half, opposite the tab. Hit the bearing with the soft material until the tab of the bearing is free from the groove in the cylinder block.

2. Remove the upper half of the main bearings as follows:

a. Turn the crankshaft until Tooling (A) can be installed in the crankshaft journal. Install Tooling (A) as shown.
b. Turn the crankshaft in the direction which will push the upper main bearing half out, tab end first.
c. Check the condition of the main bearings.

NOTE: The following steps are for the installation of the crankshaft main bearings.

3. Clean the bearing surfaces in the cylinder block for the main bearings. Apply clean engine oil on the upper main bearing half. Do not put oil on the back side of the bearing. Use Tooling (A) to install the upper main bearing half (bearings with the oil holes) in the cylinder block. Be sure the tab on the back side of the bearing engages with the groove in the cylinder block.

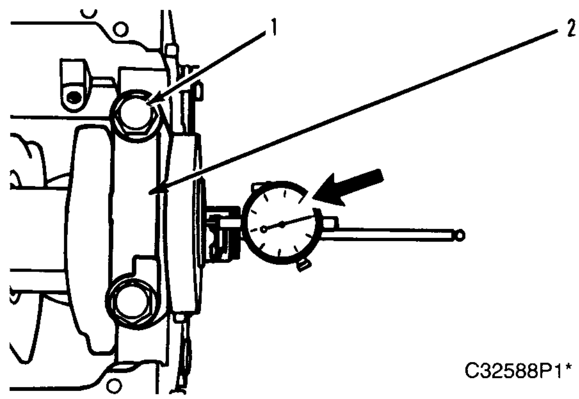
4. Clean the bearing surface of main bearing caps (2). Install the lower main bearing half in the main bearing cap. Be sure the tab on the back side of the bearing engages with the groove in the main bearing cap. Apply clean engine oil on the lower main bearing half. Do not put oil on the back side of the bearing.

5. Install main bearing caps (2) as follows:

NOTICE

With the engine upright, install the main bearing caps with the sequence number facing the turbocharger side, 1 through 7, front to rear.

a. Put main bearing caps (2) in position in the cylinder block, with the sequence numbers in the correct positions.
b. Apply clean engine oil to the threads of the main bearing cap mounting bolts and on the washer contact faces.
c. Install main bearing cap mounting bolts (1) and the washers. Tighten both bolts of each main bearing cap to a torque of **54 ± 7 N•m (40 ± 5 lb ft).**
d. Tighten the bolts an additional **90 ± 5 degrees (1/4 turn).**



C32588P1*

6. Check the end play of the crankshaft with Tooling (B). The end play of the crankshaft must be **0.07 to 0.32 mm (0.003 to 0.013 in).**

End By:

a. Install the oil pump.

Measuring Main Bearing Clearances

Using Plastigage to Measure Main Bearing Clearances

NOTICE

Caterpillar does not recommend checking the actual engine bearing clearances (particularly on small engines) because of the possibility of obtaining inaccurate results, and the possibility of damaging the bearing or journal surfaces. Each Caterpillar engine is quality checked for specific wall thickness.

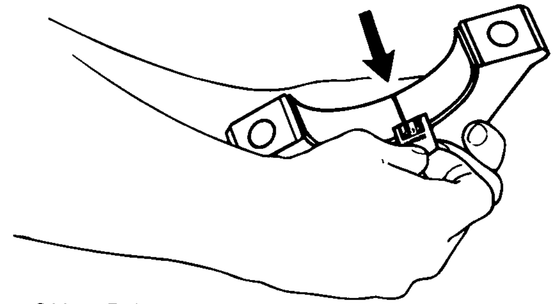
NOTE: If the crankshaft journals and bores for the cylinder block and connecting rods were measured at disassembly and found to be within specification, no further checks are necessary when the correct bearings are used. However, if the serviceman still wants to measure the bearing clearances, Plastigage is an acceptable method. Plastigage is less accurate on small diameter journals where clearances are less than **0.10 mm (0.004 in).**

NOTICE

The use of lead wire, shim stock or a dial bore gauge can damage the bearing surfaces.

1. The serviceman must be very careful to use Plastigage correctly. The following points must be remembered:

a. Ensure that the backs of the bearings and bores are clean and dry.
b. The bearing locking tabs must be properly seated in their slots.
c. The crankshaft must be free of oil where it is in contact with the Plastigage.
d. If the main bearing clearances are checked with the engine upright, or on its side, the crankshaft must be supported. Use a jack, under an adjacent crankshaft counterweight, and hold the crankshaft against the crown of the bearing. If the crankshaft is not supported, the weight of the crankshaft will cause incorrect readings.
e. Put a piece of Plastigage on the crown of the bearing half that is in the cap. Do not allow the Plastigage to extend over the edge of the bearing.
f. Install the bearing cap using the correct torque-turn specifications. Do not use an impact wrench to tighten the bearing cap mounting bolts. Do not dislodge the bearing when the cap is installed.
g. Do not turn the crankshaft while the Plastigage is installed.



C32590P1*

NOTE: When Plastigage is used to measure bearing clearances, the readings can sometimes be unclear. For example, all parts of the Plastigage are not the same width. Measure the major width to be sure they are within the specification range.

h. Carefully remove the bearing cap, but do not remove the Plastigage. Measure the width of the Plastigage while it is in the bearing cap or on the crankshaft journal, as illustrated above.
i. Remove all Plastigage before reinstalling the bearing cap.

Crankshaft Rear Seal

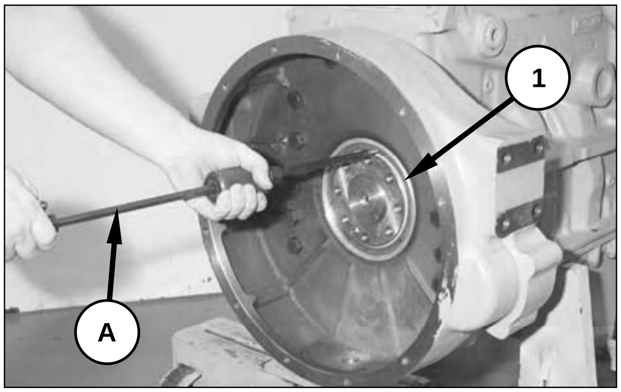
Remove

Tools Needed	A
1U-7600 Slide Hammer Puller Group	1

Start By:

a. Remove the flywheel.

NOTE: The group number related to this procedure is 140-3051.



NOTICE

Do not damage the flange on the crankshaft when crankshaft rear seal (1) is removed. Use of any tool other than Tooling (A) to remove the crankshaft rear seal can result in damage to the crankshaft.

1. Use a **1U-8145 Drill Bit 4.10 mm (0.161 in)** to carefully drill three evenly spaced holes in crankshaft rear seal (1).

NOTE: The **1U-7600 Slide Hammer Puller Group** is equipped with three screw tips**.** Use the **1P-3073 Screw Tip** with the slide hammer puller to remove crankshaft rear seal (1).

2. Remove crankshaft rear seal (1) carefully by alternating the position of the **1U-7603 Hammer** from hole to hole. This will allow the seal to be removed evenly without damage to the rear flange surface of the crankshaft.

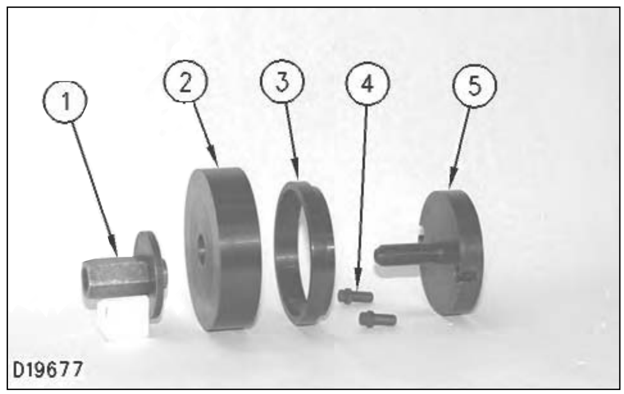
Install

Tools Needed	A
1U-7598 Rear Seal Installer Group	1

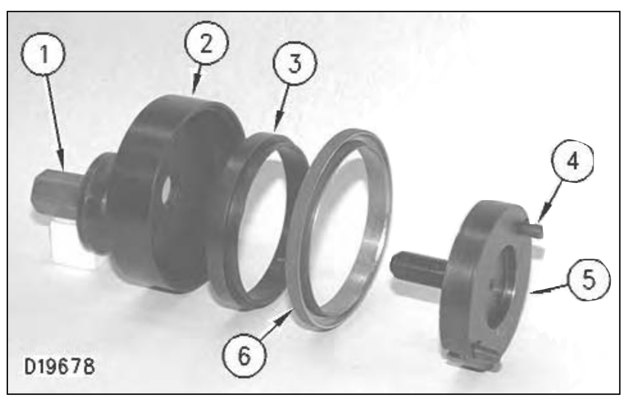
NOTE: Do not install the crankshaft rear seal group if:

a. The seal has been separated from the wear sleeve.
b. The crankshaft rear seal group components were not assembled when removed from the parts package.
c. The crankshaft rear seal group appears to be damaged in any way.
d. The crankshaft rear seal has been lubricated. (The seal is designed to be installed dry.)

1. Be sure the rear of the crankshaft is thoroughly clean and dry prior to installing the crankshaft rear seal group.



(1) 9S-8858 Nut Assembly. (2) 1U-7594 Installer. (3) 1U-7597 Sleeve Ring. (4) 1U-7596 Bolts. (5) 1U-7595 Locator Assembly.



2. Place crankshaft rear seal group (6) in position on **1U-7597 Sleeve Ring** (3) of Tooling (A), with the inside diameter bevel of the crankshaft seal wear sleeve facing **1U-7595 Locator Assembly** (5)

3. Fasten **1U-7595 Locator Assembly** (5) to the rear of the crankshaft with two **1U-7596 Bolts** (4). Tighten the bolts, only finger tight, so that when crankshaft rear seal group (6) and **1U-7597 Sleeve Ring** (3) are installed, they will self-align.

4. Place crankshaft rear seal group (6) and **1U-7597 Sleeve Ring** (3), as a unit, over **1U-7595 Locator Assembly** (5) on the crankshaft.

5. Place **1U-7594 Installer** (2) over **1U-7595 Locator Assembly** (5) and **1U-7597 Sleeve Ring** (3). Install **9S-8858 Nut Assembly** (1). Tighten the nut assembly to install the crankshaft rear seal group.

6. Remove **9S-8858 Nut Assembly** (1), **1U-7594 Installer** (2) and **1U-7597 Sleeve Ring** (3).

7. Turn **1U-7597 Sleeve Ring** (3) over and install it, with **1U-7594 Installer** (2) and **9S-8858 Nut Assembly** (1). Tighten the nut assembly to complete the installation of the crankshaft rear seal group.

8. Remove **9S-8858 Nut Assembly** (1) and **1U-7594 Installer** (2). Check **1U-7597 Sleeve Ring** (3) and **1U-7595 Locator Assembly** (5). If the crankshaft rear seal and wear sleeve are properly installed, the faces of **1U-7597 Sleeve Ring** (3) and **1U-7595 Locator Assembly** (5) will be flush.

9. Remove the remainder of Tooling (A) from the rear of the crankshaft.

End By:

a. Install the flywheel.

Cylinder Head Assembly

Remove and Install, In Chassis

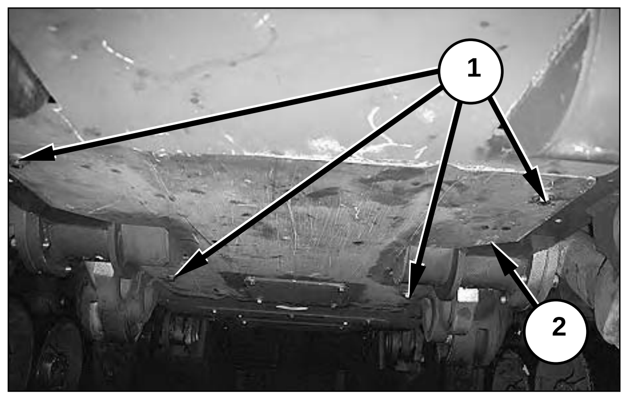
Start By:

a. Remove the radiator group.

NOTE: Group numbers related to this procedure include 124-5844, 128-7367 and 149-3203.

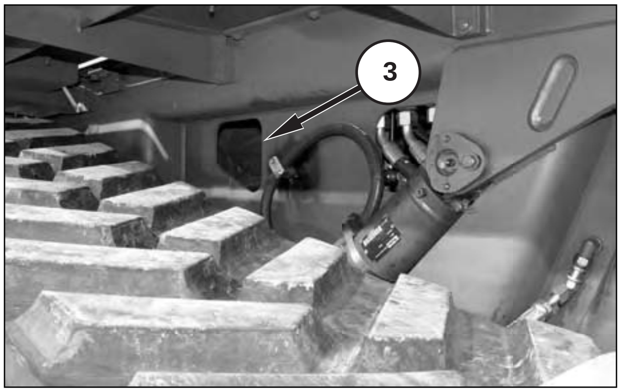
1. Raise the cab. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Cab Tilt."

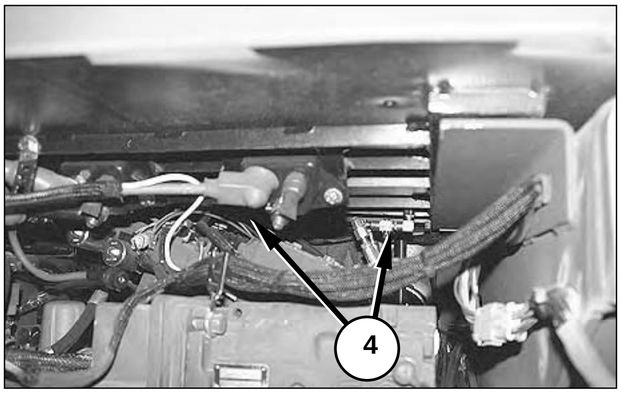
2. Drain the hydraulic tank. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Every 1000 Service Hours or One Year, Hydraulic System, Change Oil and Clean Suction Screens."



3. Remove four bolts (1) with the washers, and cover (2). The weight of cover (2) is **50.5 kg (111 lb).**

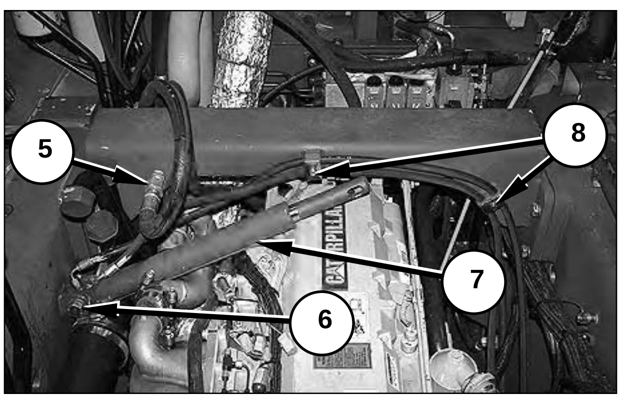
NOTE: If dirt or other debris has accumulated on the top side, the bottom cover may weigh more than **50.5 kg (111 lb)**. Use a suitable floor jack, or other tool, to support the bottom cover if there is a large amount of debris.





Machine Shown Partially Assembled for Photographic Clarity.

4. Reach into two holes (3). There is one hole on each side of the machine. Turn the knob 90 degrees to close two fuel valves (4).

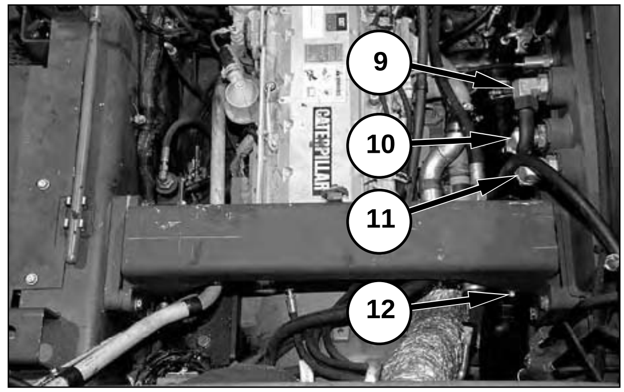


5. Disconnect and plug the hydraulic line at bulkhead fitting (5). Mark the line for correct location during reassembly.

6. Remove the bulkhead nut with the washers, and remove and cap bulkhead fitting (5).

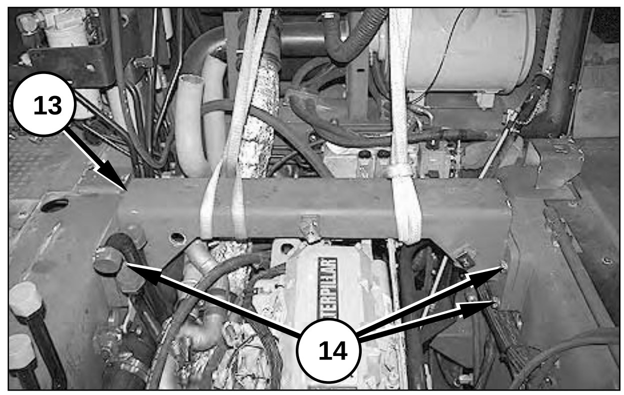
7. Loosen two bolts (8) and remove the hoses from the clamps.

8. Remove bolt (6) with the nut and washers. Move radiator tilt cylinder (7) out of the way.



9. Remove bolt (12) with the washer and nut on the right rear side of the rear crossbeam, to disconnect the air intake line from the crossbeam.

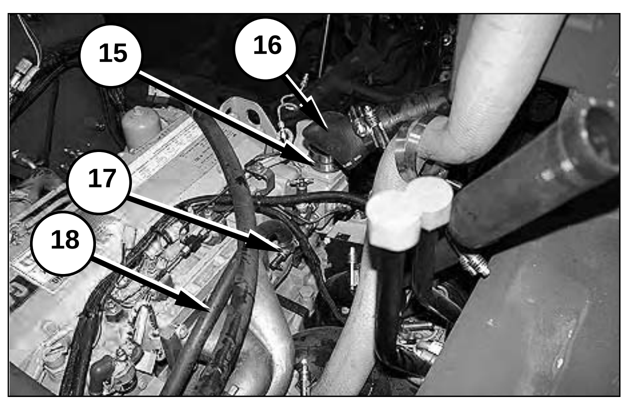
10. Loosen hard lines (9), (10), and (11) at the hydraulic tank.



11. Fasten a hoist to crossbeam (13). Note the configuration of shims which may be present between the crossbeam and the machine frame.

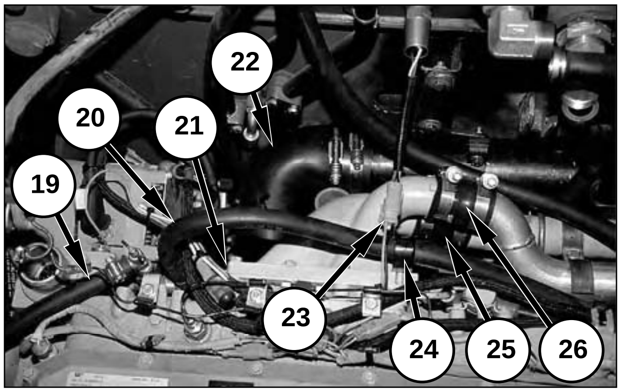
NOTE: Upon reassembly, shim the crossbeam to fit inside the machine frame.

12. Remove eight bolts (14) with the washers, and remove crossbeam (13) and shims. The weight of the crossbeam is **43 kg (95 lb).**



13. Loosen hose clamp (17) and disconnect coolant line (18).

14. Loosen two clamps (15) and disconnect coolant line (16).



15. Loosen two clamps on top air inlet hose (26) on the intake air heater, and remove the hose.

16. Loosen two clamps on bottom air inlet hose (25) on the intake air heater, and remove the hose.

17. Loosen two clamps, and remove hoses (19) and (20) from the gate valves in the temperature regulator housing. Mark the hoses for correct connection during the installation procedure. Move hose (19) out of the way.

18. Remove the mounting bolt with the washer, and remove hose clip (24) with hose (20) from the inlet air elbow. Move hose (20) out of the way.

19. Remove nut (21) and washer, and remove the braided ground strap from the front of the intake air heater.

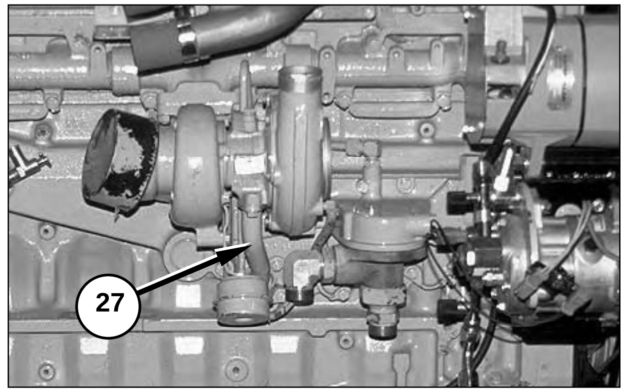
20. Disconnect harness connector (23) for the hydraulic temperature switch. Mark the connector for correct connection during the installation procedure.

NOTE: Harness connector (23) is a three-pin connector with two wires. The wires in the connector are K980-PK and 200-BK.

21. Loosen three clamps (one on the turbocharger side and two on the inlet pipe side), and remove rubber air inlet line (22).

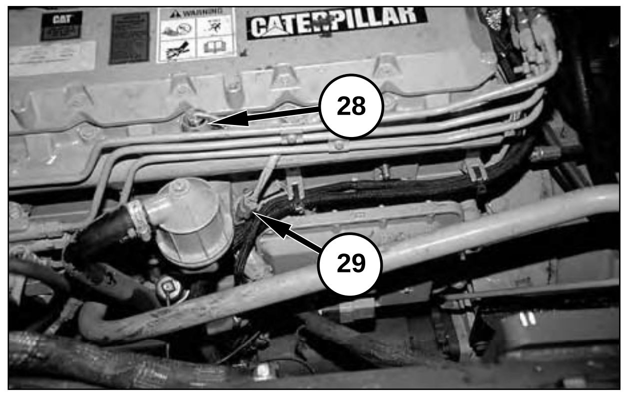
22. Loosen the nut and spread the clamp which connects the exhaust pipe to the exhaust side of the turbocharger. Slide the clamp onto the exhaust pipe.

NOTE: The clamp which holds the exhaust pipe on the turbocharger exhaust port is not shown in this photo. This clamp can be located when the exhaust pipe is traced back to the turbocharger.



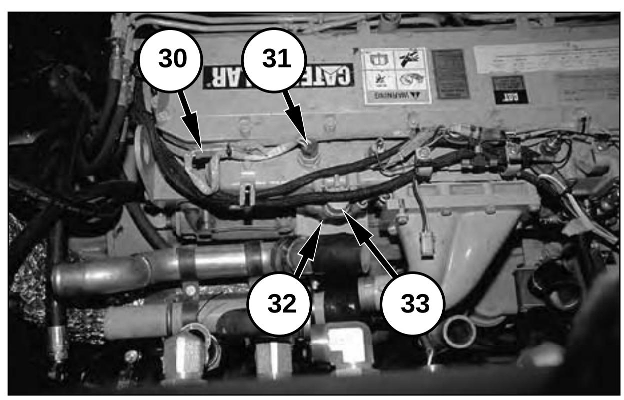
Engine Shown Removed for Photographic Clarity.

23. Disconnect oil drain tube assembly (27) from the turbocharger.



24. Disconnect harness connector (29) for injection actuation pressure sensor (28). Mark the connector for correct connection during the installation procedure.

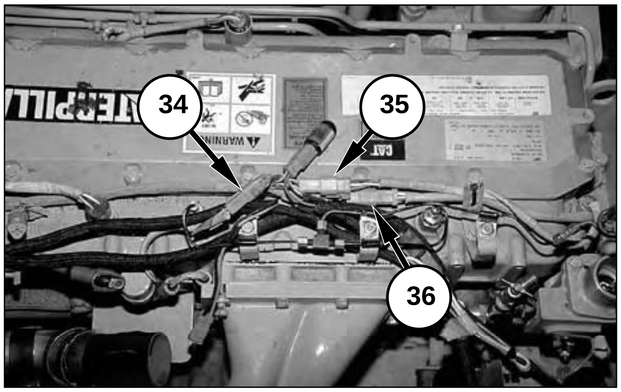
NOTE: Harness connector (29) is a three-pin connector. The wires in the connector are D841-GN, 993-BR, and 997-OR.



25. Disconnect harness connector (30) for intake air temperature sensor (31). Mark the connector to ensure that it is connected in the proper location during the installation procedure.

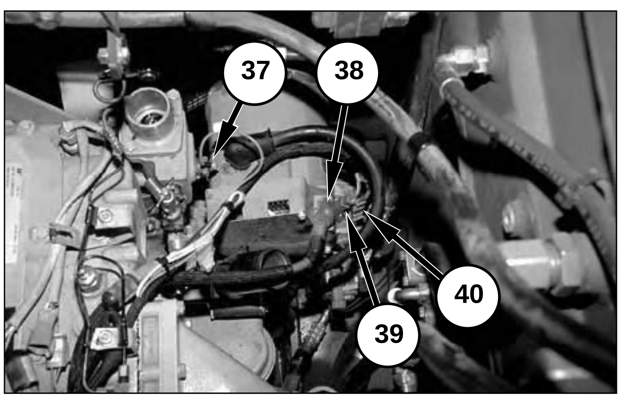
NOTE: Harness connector (30) is a three-pin connector. The wires in the connector are C967-BU, 993-BR, and 997-OR wires are in harness connector (29).

26. Remove the nut and disconnect 315-RD wire (32) from intake air heater relay (33).



27. Disconnect intake air heater relay harness connector (34), boost pressure sensor harness connector (35), and coolant temperature sensor harness connector (36). Mark the connectors for correct connection during the installation procedure.

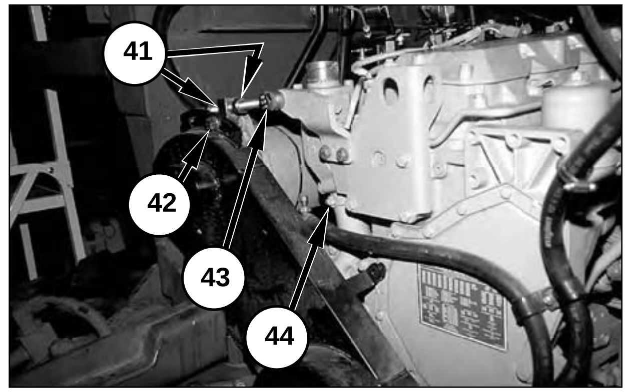
NOTE: Harness connector (34) is a two-pin connector, and harness connectors (35) and (36) are three-pin connectors. The wires in connector (34) are C987-RD and D796-OR; the wires in connector (35) are A746-PK, 993-BR, and 997-OR; and the wires in connector (36) are 995-BU, 993-BR, and 997-OR.



28. Remove the nut and lock washer, and disconnect 109-RD-2 wire (38) from the positive terminal of the alternator.

29. Disconnect wiring harnesses (39) and (40) from the air-conditioning compressor. Mark the harnesses to ensure that they are connected in the proper location during the installation procedure.

30. Remove the nut and washer, and disconnect 441-OR wire (37) from the coolant temperature sensor.

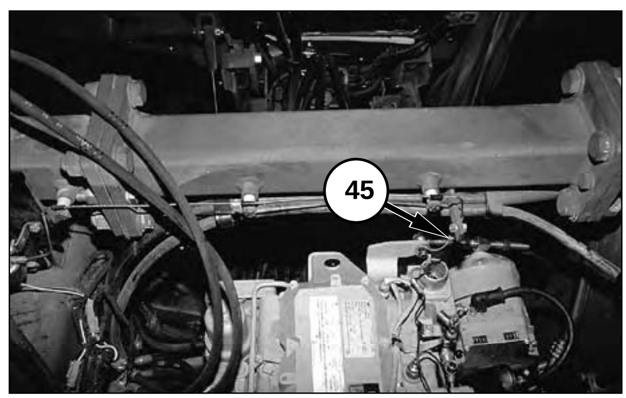


31. Loosen bolt (42) and loosen two lock nuts (41) on the alternator belt tension rod. Release the tension from the alternator belt.

NOTE: During the installation procedure, refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* “Every 250 Service Hours or Three Months, Engine V-Belts” for the belt tension adjustment procedure.

32. Remove bolt (43) and the nut with two washers, and rotate the alternator tension rod out of the way.

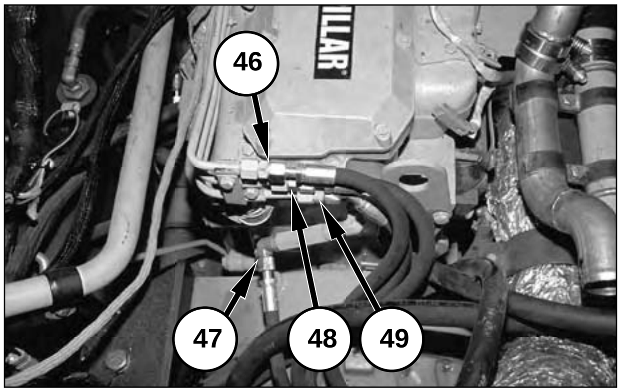
33. Loosen clamp (44), and remove the water hose from the bottom of the temperature regulator housing.



34. Disconnect the ether line at fitting (45), just below the bottom clamp on the back side of the front crossbeam.

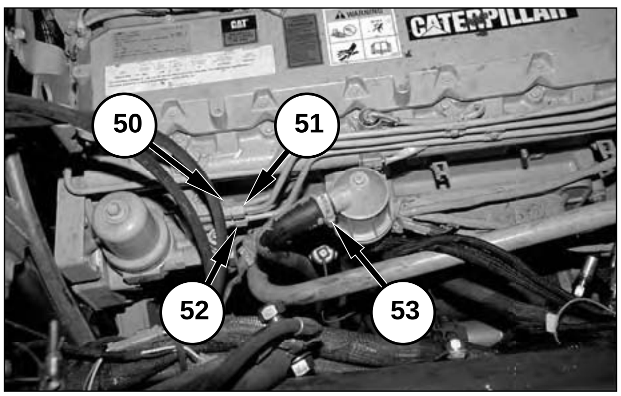
NOTICE

Care must be taken not to damage the ether line when the cylinder head is removed.



35. Disconnect, cap, and plug fuel lines (46), (47), (48), and (49). Mark the hoses for correct connection during the installation procedure. Place the hoses out of the way.

NOTE: Some fuel may leak from the fuel lines when they are disconnected. Catch the fuel in a suitable container, and dispose of the fuel according to local regulations.

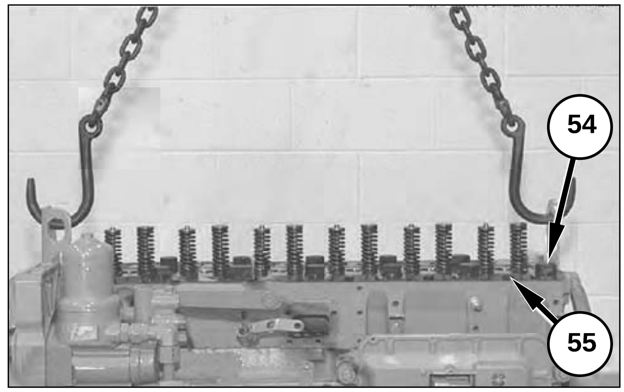


36. Disconnect, cap, and plug fuel lines (50), (51), and (52) from the fuel transfer pump.

NOTE: Some fuel may leak from the fuel lines when they are disconnected. Catch the fuel in a suitable container, and dispose of the fuel according to local regulations.

37. Loosen the clamp on breather hose (53), and remove the hose.

38. Remove the inlet manifold. Refer to "Inlet Manifold, Remove and Install" in this module.



Engine Shown Removed From Machine for Photographic Clarity.

39. Remove bolts (54) and (55) which hold the cylinder head assembly to the cylinder block.

NOTICE

When lifting the cylinder head, take care to keep the cylinder head level, to prevent damage to the two cylinder head-to-block dowels. Also, do not damage the hydraulic pump and ether lines while removing and installing the cylinder head.

---

40. Secure a hoist to the cylinder head assembly, as shown. Carefully remove the cylinder head from the block. Remove the cylinder head gasket. The weight of the cylinder head assembly is approximately **85 Kg (187 lb).**

NOTE: The following steps are for the installation of the cylinder head assembly.

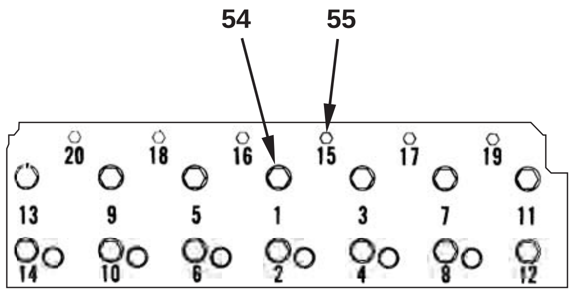
41. Thoroughly clean the cylinder head assembly and the cylinder block surfaces.

42. If the injector sleeves were removed, install them in the cylinder head assembly.

43. Secure a hoist to the cylinder head assembly, and position a new (dry) cylinder head gasket and the cylinder head assembly onto the dowels in the block. Lower the cylinder head assembly onto the block.

NOTE: Bolts (54) are the larger diameter **(M20).** Bolts (55) are the smaller diameter **(M10).**

44. Put clean engine oil on the threads of bolts (54) and (55), then install and tighten the bolts as follows:



Cylinder Head Tightening Sequence.

a. Tighten large bolts (54), in the numerical sequence shown, to a torque of **300 ± 15 N•m (221 ± 11 lb ft).**
b. Loosen large bolts (54), in the numerical sequence shown, until the washers are loose under the bolt heads.
c. Tighten large bolts (54) again, in the numerical sequence shown, to a torque of **130 ± 15 Nm (96 ± 11 lb ft).**
c. Tighten large bolts (54) once more, in the numerical sequence shown, to a torque of **130 ± 15 N•m (96 ± 11 lb ft).**
d. Place a mark on large bolts (54). Rotate the bolts in the numerical sequence shown an additional 90 degrees (1/4 turn).
e. Tighten small bolts (55), in the numerical sequence shown, to a torque of **55 ± 7 N•m (41 ± 5 lb ft).**

45. After the fuel injectors have been installed, adjust the valve clearance.

46. Perform Steps 1 through 37 of this procedure in reverse.

End By:

a. Install the radiator group.

Remove and Install, Out of Chassis

Start By:

a. Remove the engine assembly and torque converter.

b. Remove the water temperature regulator.

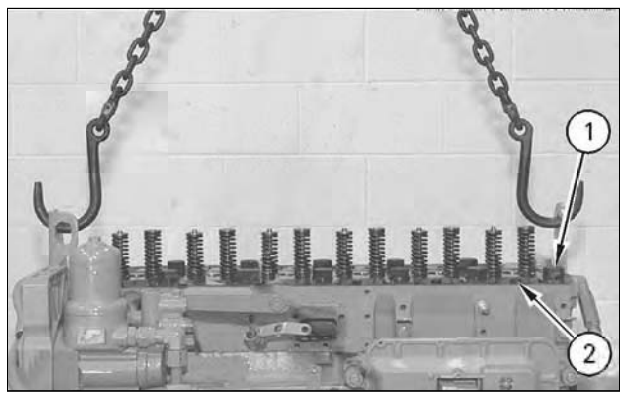
c. Remove the fuel injectors.

d. Remove the crankcase breather base.

e. Remove the inlet manifold.

f. Remove the exhaust manifold.

NOTE: The group number related to this procedure is 115-4078.



1. Remove bolts (1) and (2) that hold the cylinder head assembly to the cylinder block.

NOTICE
When lifting the cylinder head, take care to keep the cylinder head level, to prevent damage to the two cylinder head-to-block dowels. Also, do not damage the hydraulic pump while removing and installing the cylinder head.

2. Secure a hoist to the cylinder head assembly, as shown. Carefully remove the cylinder head from the block. Remove the cylinder head gasket. The weight of the cylinder head assembly is approximately **85 Kg (187 lb).**

NOTE: The following steps are for the installation of the cylinder head assembly.

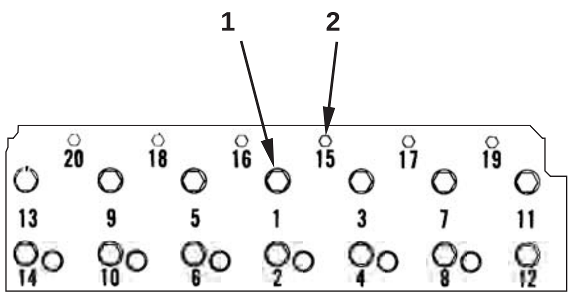
3. Thoroughly clean the cylinder head assembly and the cylinder block surfaces.

4. If the injector sleeves were removed, install them in the cylinder head assembly.

5. Secure a hoist to the cylinder head assembly and position a new (dry) cylinder head gasket, and the cylinder head assembly, onto the dowels in the block. Lower the cylinder head assembly onto the block.

NOTE: Bolts (1) are the larger diameter **(M20).** Bolts (2) are the smaller diameter **(M10).**

6. Put clean engine oil on the threads of bolts (1) and (2), then install and tighten the bolts as follows:



Cylinder Head Tightening Sequence.

a. Tighten large bolts (54), in the numerical sequence shown, to a torque of **300 ± 15 N•m (221 ± 11 lb ft).**
b. Loosen large bolts (54), in the numerical sequence shown, until the washers are loose under the bolt heads.
c. Tighten large bolts (54) again, in the numerical sequence shown, to a torque of **130 ± 15 Nm (96 ± 11 lb ft).**
c. Tighten large bolts (54) once more, in the numerical sequence shown, to a torque of **130 ± 15 N•m (96 ± 11 lb ft).**
d. Place a mark on large bolts (54). Rotate the bolts in the numerical sequence shown an additional 90 degrees (1/4 turn).
e. Tighten small bolts (55), in the numerical sequence shown, to a torque of **55 ± 7 N•m (41 ± 5 lb ft).**

7. After the fuel injectors have been installed, adjust the valve clearance

End By:

a. Install the exhaust manifold.

b. Install the inlet manifold.

c. Install the crankcase breather base.

d. Install the fuel injectors.

e. Install the water temperature regulator.

f. Install the engine assembly and torque converter.

Engine Assembly and Torque Converter

Remove and Install

Tools Needed		A
6V-6146	Load Leveler (10,000 lb)	1

Start By:

a. Remove the hydraulic tank. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Hydraulic System,* "Hydraulic Tank Group."

b. Remove the steering pump drive shaft. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Drive Shaft, Steering."

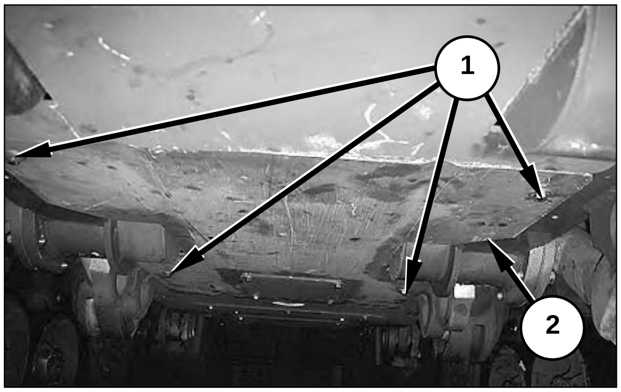
c. Remove the main drive shaft. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Drive Shaft, Main."

NOTE: Group numbers related to this procedure include 122-8638, 124-3860, 124-5844, 124-7025, 124-9756, 126-5835, 126-6559, 144-7062, 144-8603, 144-8606, 145-0071, and 166-5127.

NOTE: Many hoses are disconnected when this procedure is performed. All leaking fluids should be caught in suitable containers and disposed of according to local regulations.

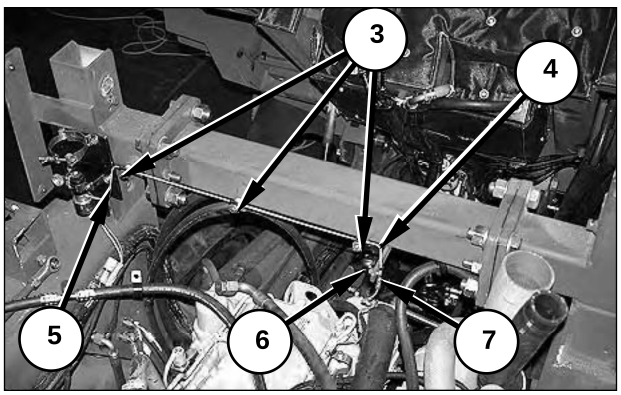
1. Drain the oil from the engine. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Every 250 Service Hours or Three Months, Engine Oil and Filter."

2. Drain the power train oil. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Every 2000 Service Hours or Two Years, Change Oil and Clean Suction Screens."



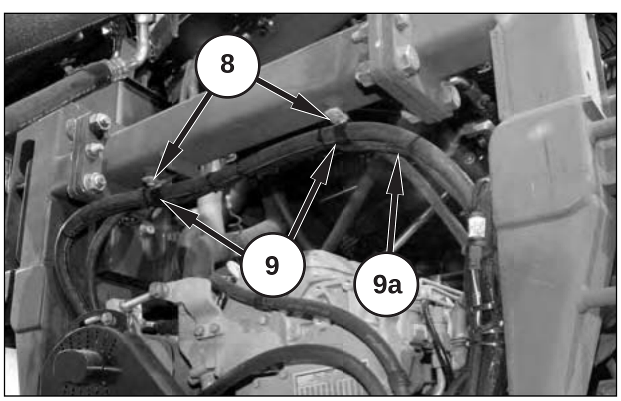
3. Remove four bolts (1) with the washers, and bottom cover (2).The weight of the cover is **50.5 kg (111 lb).**

NOTE: If dirt or other debris has accumulated on the top side, the bottom cover may weigh more than **50.5 kg (111 lb)**. Use a suitable floor jack, or other tool, to support the bottom cover if there is a large amount of debris.

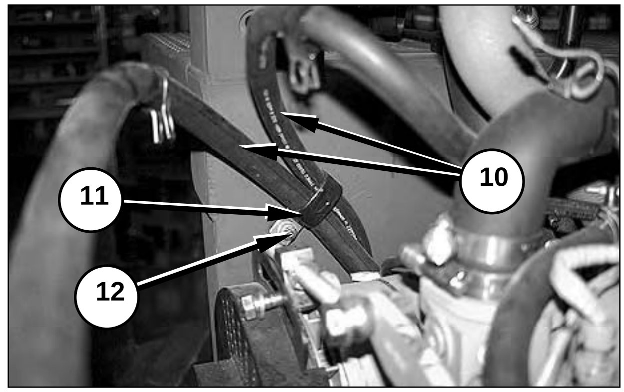


4. Disconnect fittings (5) and (7).

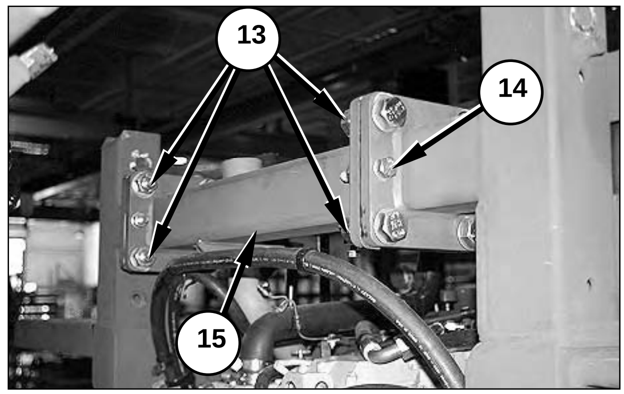
5. Remove three bolts (3) with the washers and spacers, and remove one bolt (6) with the nut and two washers. Remove ether line (4).



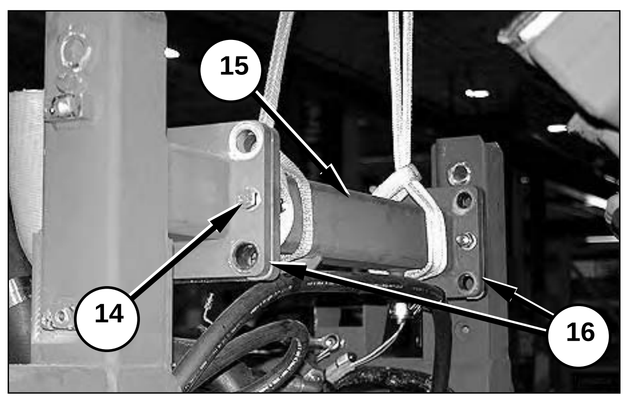
6. Remove two bolts (9) with washers and clamps (8). Cut the wire ties from recoil alert harness (9a). Lay the wire harness aside.



7. Remove bolt (12) with the washer, and clamp (11). Lay air-conditioning lines (10).

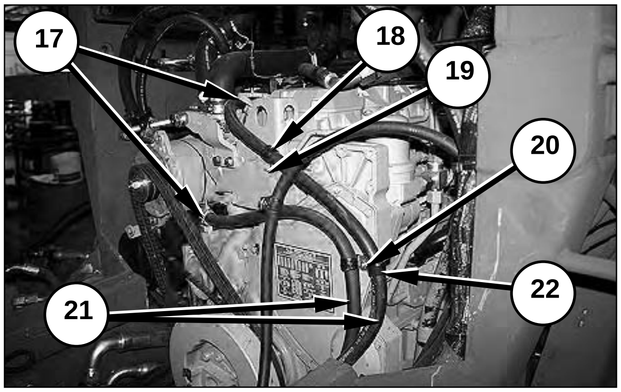


8. Remove four nuts (13) with the bolts and washers, from both sides of crossbeam (15). There are a total of eight nuts. Leave two bolts (14) in each side of the crossbeam for support.



9. Attach a hoist to crossbeam (15), and remove four remaining bolts (14) with the nuts and washers from both sides of the crossbeam. Remove the crossbeam with shims (16). Note the location of the shims for reassembly. The weight of the crossbeam is **27 kg (60 lb).**

NOTE: During reassembly, shim to remove the space between the machine frame and crossbeam (15).



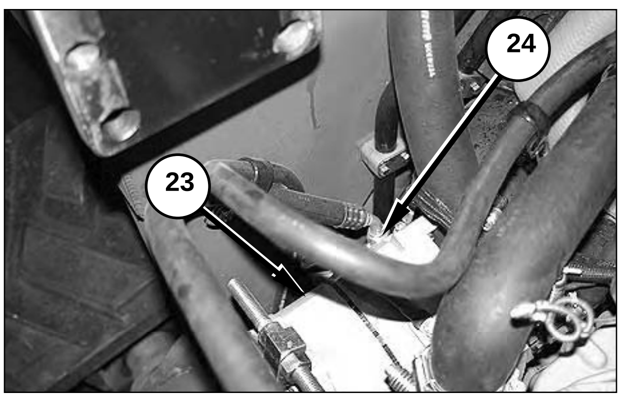
10. Loosen two hose clamps (17) on cab heater lines (21).

11. Remove bolt (19) with the washer, and clamp (18) from the engine lifting bracket.

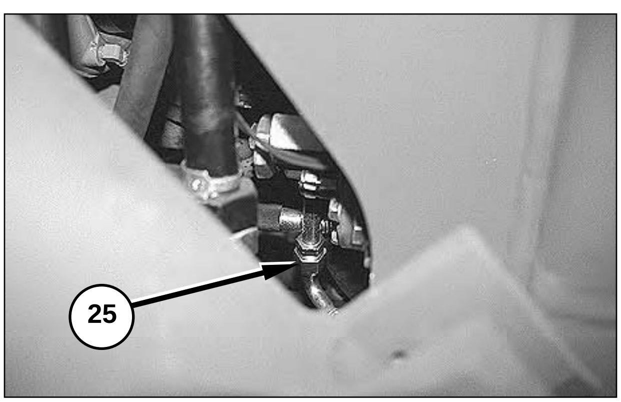
12. Reinstall bolt (19) with the washer, to secure the engine lifting bracket.

13. Remove nut (20) with the washer, and clamp (22).

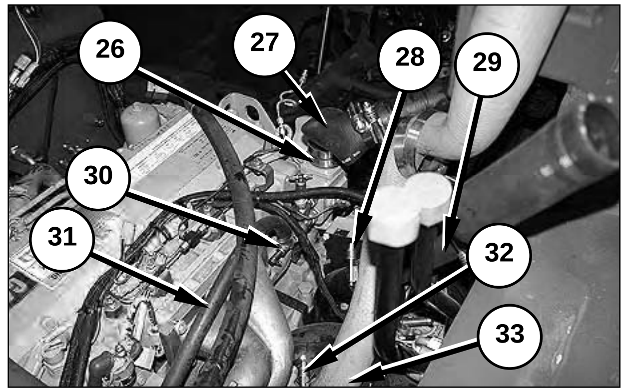
14. Disconnect cab heater lines (21) and move them aside so that they will not interfere with engine removal.



15. Disconnect air-conditioning line (24) from air-conditioning compressor (23).



16. Disconnect air-conditioning line (25) from the air-conditioning compressor.

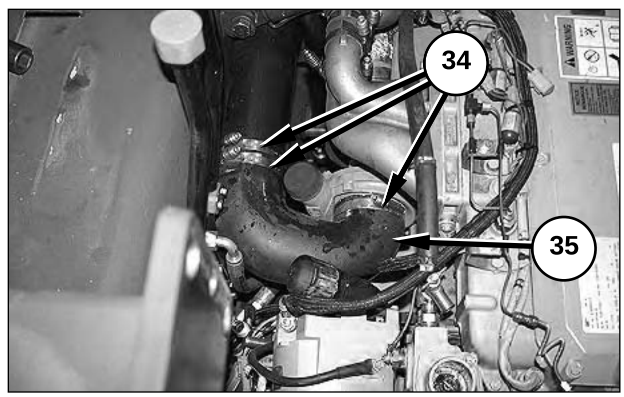


17. Loosen hose clamp (30), and disconnect coolant line (31).

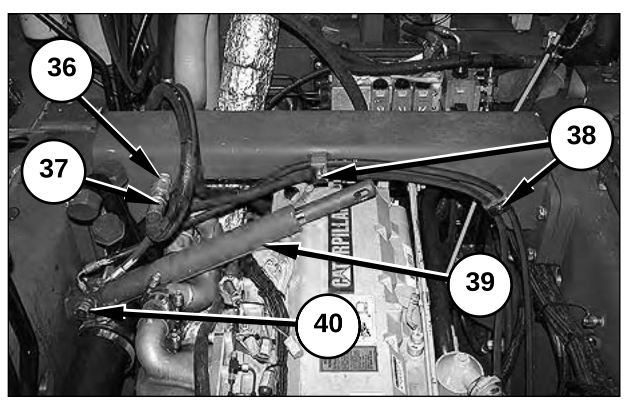
18. Loosen two clamps (26), and disconnect coolant line (27).

19. Loosen two clamps (28),and disconnect coolant line (29).

20. Loosen two clamps (32), and disconnect air intake line (33). Cover the turbocharger inlet.



21. Loosen three clamps (34) and remove air inlet line (35).

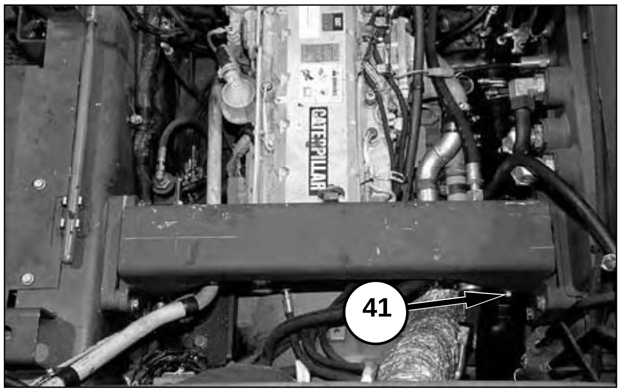


22. Disconnect and plug line (37). Mark line (37) for correct location during reassembly.

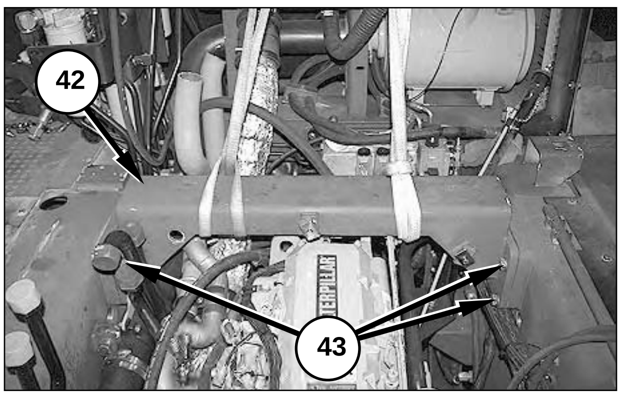
23. Remove bulkhead nut (36) with the washers, and remove and cap the bulkhead fitting.

24. Remove two bolts (38) with clamps.

25. Remove bolt (40) with the nut and washers. Move radiator tilt cylinder (39) out of the way.

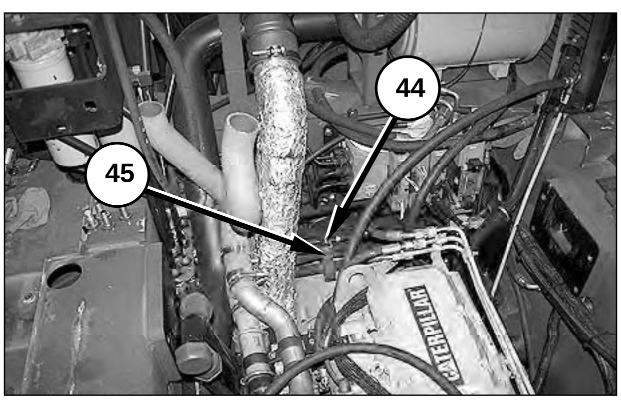


26. Remove the bolt with the washer and nut from the right rear side of crossbeam (41), to disconnect the air inlet line from the crossbeam.

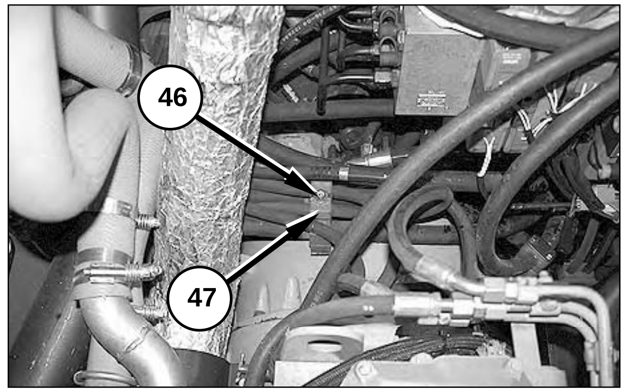


27. Fasten a hoist to crossbeam (42).

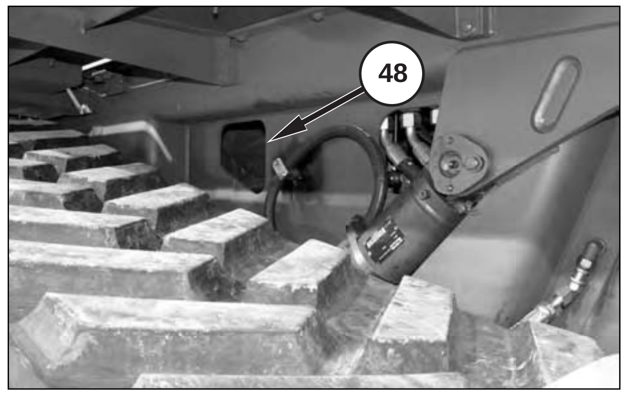
28. Remove eight bolts (43) and crossbeam (42). The weight of the crossbeam is **43 kg (95 lb).**

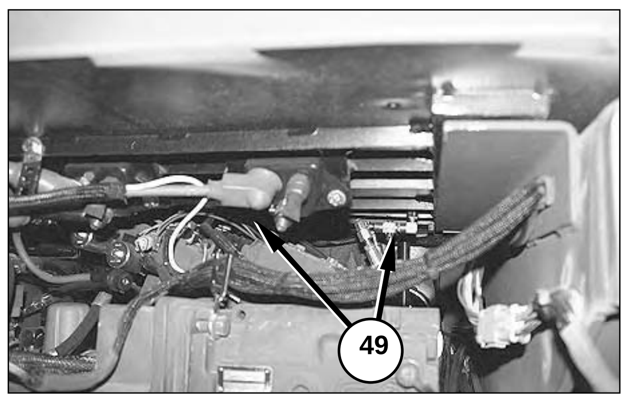


29. Remove bolt (44) with the retainer and two clamp halves. Remove four clips (45), two stacking bolts, and remove two clamp halves.



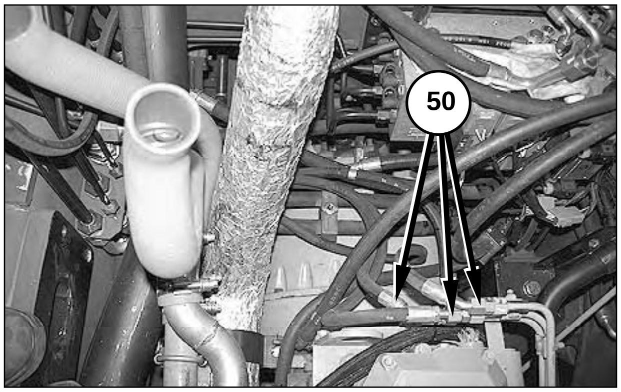
30. Remove bolt (46) with retainer, and remove two clamp halves (47).



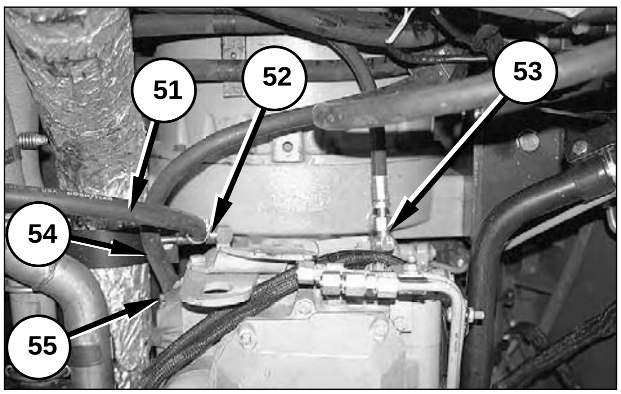


Machine Shown Partially Assembled for Photographic Clarity.

31. Reach into two holes (48). There is one hole on each side of the machine. Turn the knob 90 degrees to close two fuel valves (49).



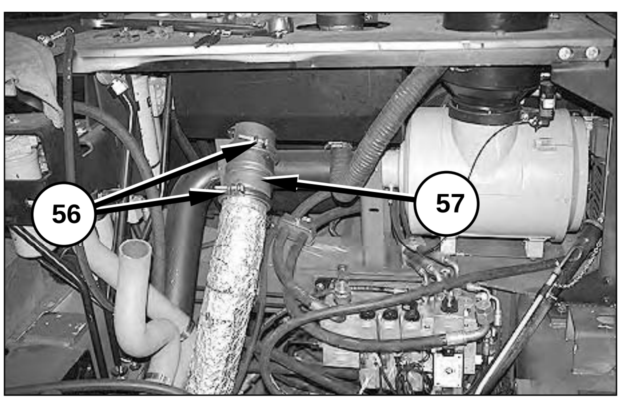
32. Disconnect, cap and then plug three lines (50). Mark the lines for correct connection during reassembly.



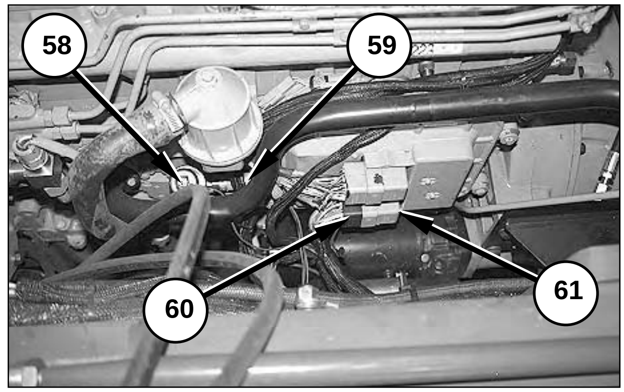
33. Disconnect, cap and then plug fuel line (53). Mark the fuel line for correct connection during reassembly.

34. Loosen two hose clamps (52), and remove coolant line (51).

35. Loosen hose clamp (55), and remove coolant line (54).



36. Remove two bolts (56) with nuts. Slide the bottom portion of exhaust coupling (57) up, to separate the coupling from the exhaust pipe.

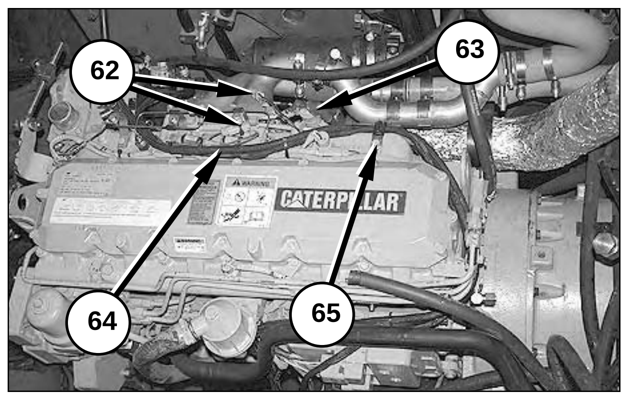


37. Loosen connector locking bolt (61), and disconnect 40-pin connector C201 (60).

38. Remove the nut and disconnect the A476-PU wire from oil pressure sensor (58).

39. Disconnect the harness connector (59) for the oil pressure switch.

NOTE: Harness connector (59) is a three-pin connector. The wires in the connector are H793-PU, H794-GY, and 200-BK.



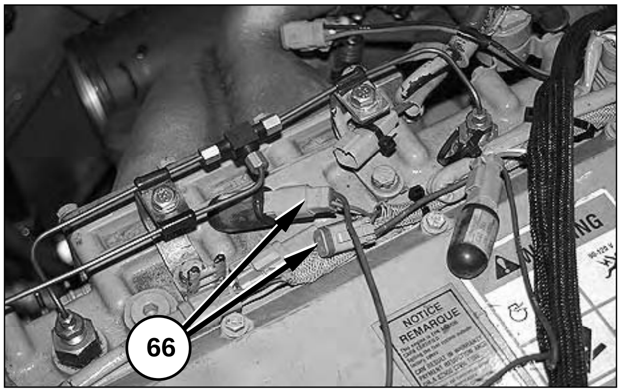
40. Cut the cable ties that fasten harnesses (64) to the engine.

41. Remove one bolt (65) with the washer and clamp.

42. Disconnect F793-RD wire (63) from the air intake heater relay.

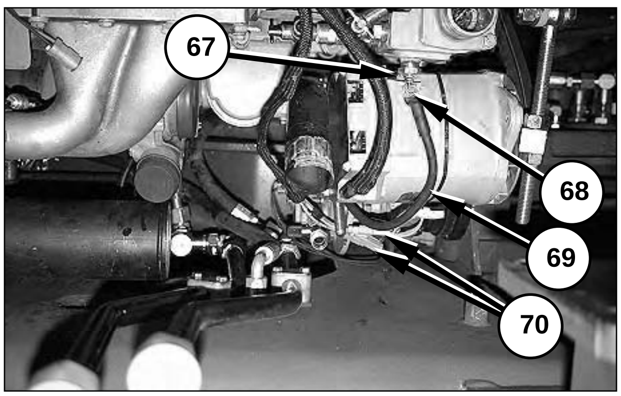
43. Disconnect two connectors (62).

NOTE: One harness connector (62) is a three-pin connector with two wires. This connector is for the hydraulic oil temperature switch. The two wires in the three-pin connector are K908-PK and 200-BK. The other harness connector (62) is a two-pin connector. The two-pin connector is for the intake air heater relay. The wires in the two-pin connector are C987-RD and D796-OR.



44. Use a small screw driver to gently pry the orange cap off of connectors (66).

45. Remove the pin connected to the C987-RD wire in both connectors (66). To remove the pin, insert a small screwdriver to press down the tang, then pull the pin out from the rear of the connector.

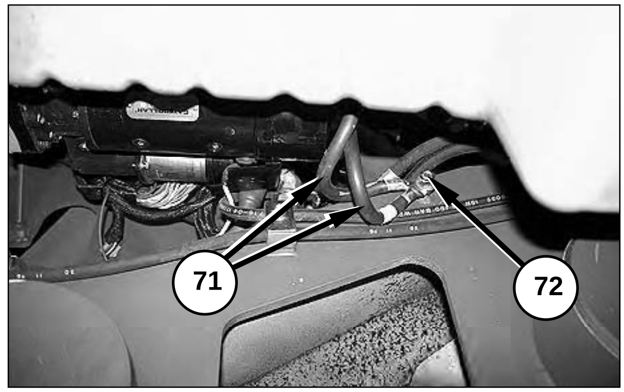


46. Disconnect connectors C221 and C231 (70) from the air-conditioning compressor. Mark the connectors for correct connection during reassembly.

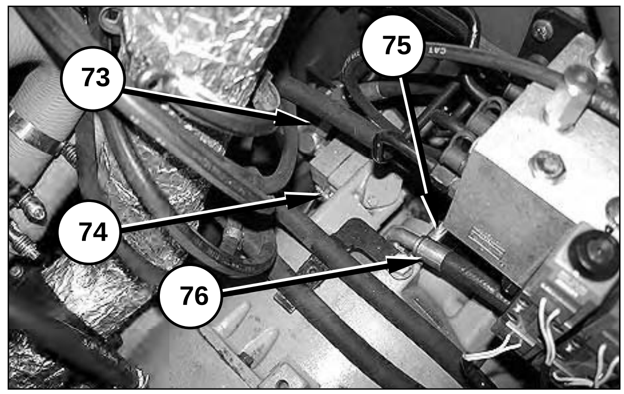
NOTE: Connector C221 is for the air-conditioning pressure switch, and connector C231 is for the air-conditioning clutch solenoid.

47. Remove nut (67) with the washer, and disconnect the 441-OR wire from the engine coolant temperature sensor.

48. Remove nut (68), and disconnect 109-RD-2 cable (69) from the alternator.

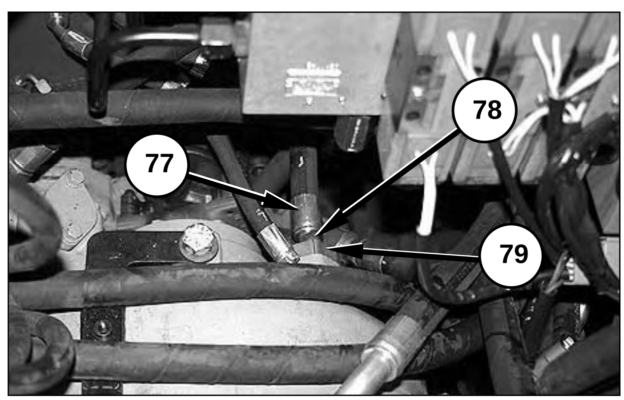


49. Remove nut (72), and disconnect ground cables (71).

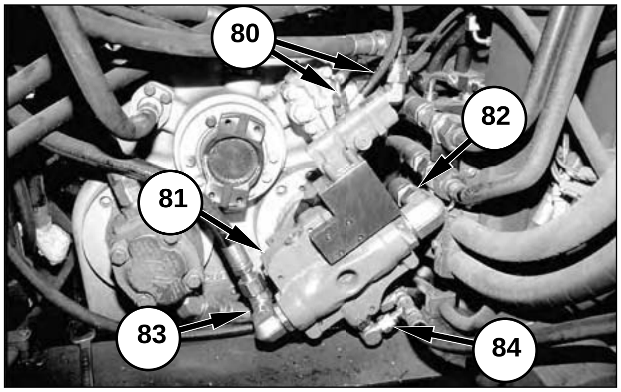


50. Remove nut (74) with the washer, and disconnect 442-GY wire from the transmission oil temperature sensor.

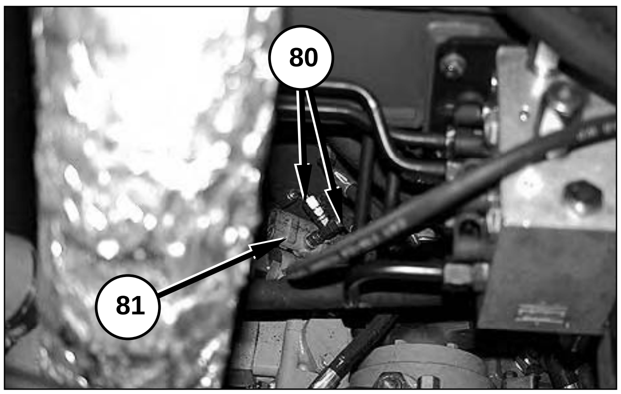
51. Disconnect, cap and then plug three lines (73), (75), and (76) from the torque converter. Mark the lines for correct connection during reassembly.

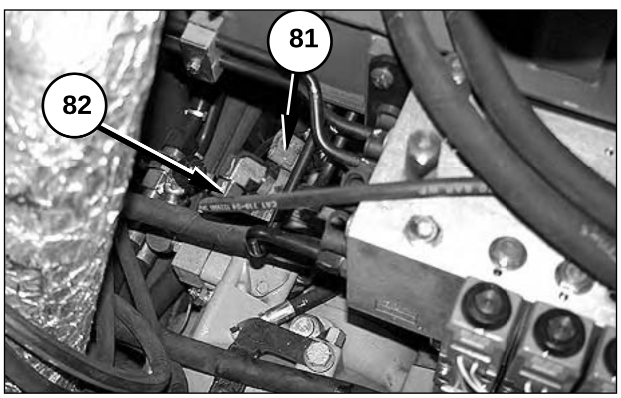


52. Remove four bolts (78) and two split flanges (79). Disconnect, cap and then plug line (77). Mark line (77) for correct connection during reassembly.



Differential Steering Unit and Transmission Shown Removed From Machine for Photographic Clarity.





53. Disconnect, cap and then plug two signal lines (80) on implement pump (81). Mark the lines for correct connection during reassembly.

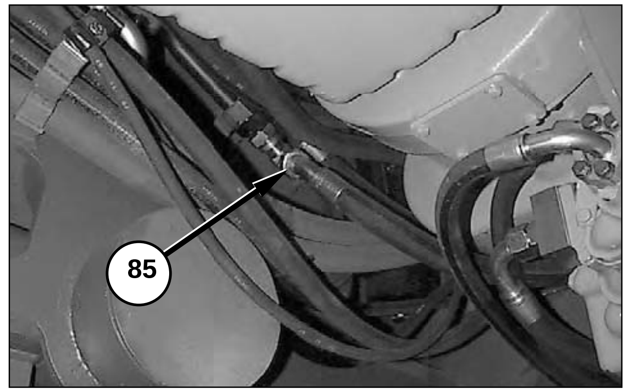
54. Disconnect, cap and then plug line (82) on implement pump (81). Mark the line for correct connection during reassembly.

55. Disconnect, cap and then plug T-fitting (84) on the bottom right side of implement pump (81).

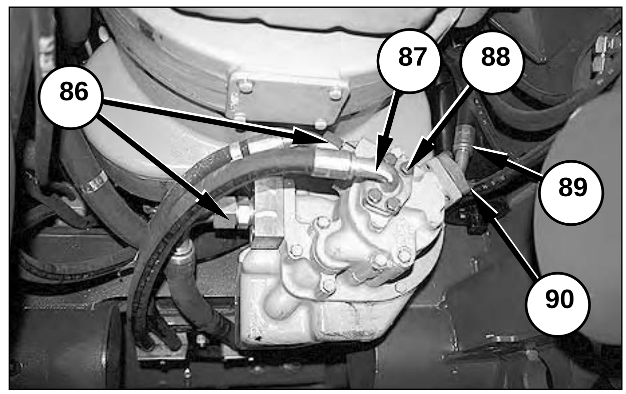
NOTE: Three hydraulic lines are connected to T-fitting (84).

56. Disconnect, cap, and then plug T-fitting (83) on the bottom left side of implement pump (81).

NOTE: Two hydraulic lines are connected to T-fitting (83).



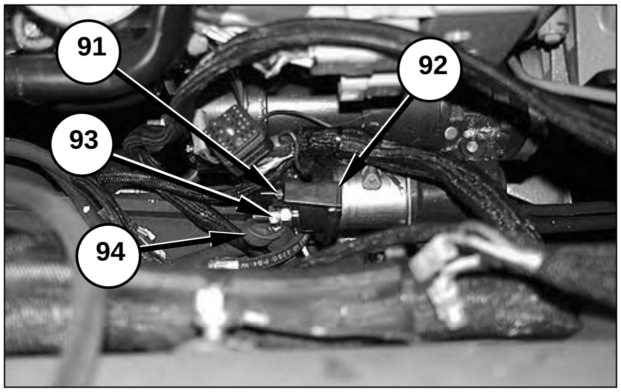
57. Disconnect, cap and then plug fan pump suction line (83). Mark line (83) for correct connection during reassembly.



58. Remove four bolts (88) with split flanges, and disconnect line (87) from the power train hydraulic pump. Cap and then plug the line. Mark the line for correct connection during reassembly.

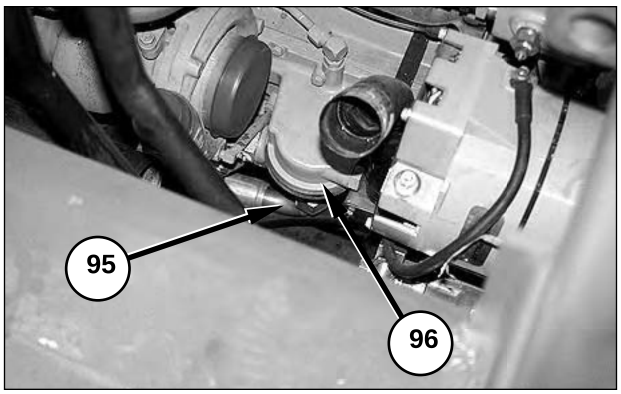
59. Remove four bolts (90) with split flanges, and disconnect line (89) from the power train hydraulic pump. Cap and then plug line (89). Mark the line for correct connection during reassembly.

60. Disconnect, cap and then plug two lines (86) from the power train hydraulic pump. Mark the lines for correct connection during reassembly.

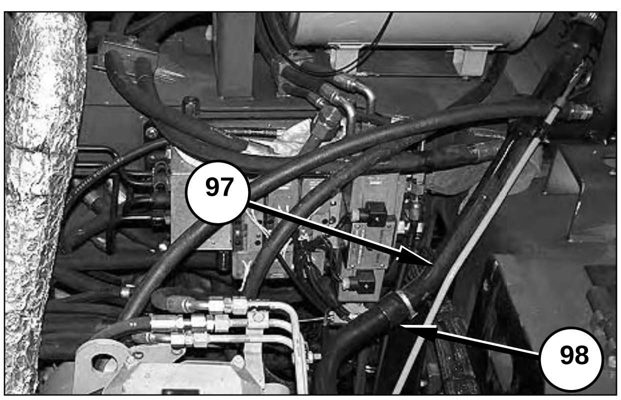


61. Remove nut (93) with the washer, and disconnect 101-RD-00 wire (94) from the starter.

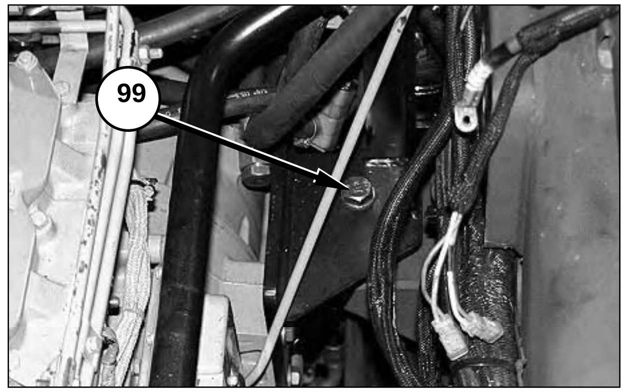
62. Remove nut (91) and terminal cap (92), and then disconnect the 304-WH wire from the starter.



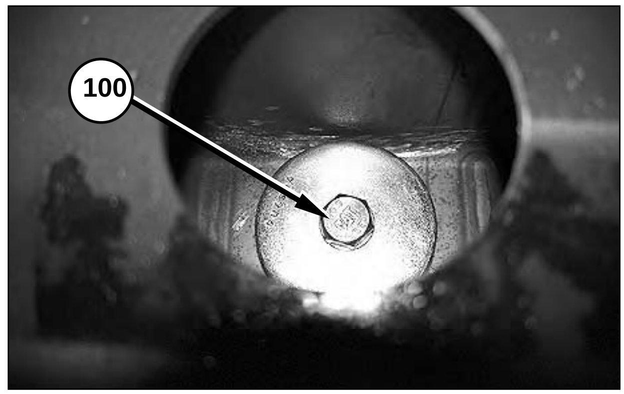
63. Disconnect, cap, and then plug two lines (95) from engine oil filter base (96). Mark the lines for correct connection during reassembly.



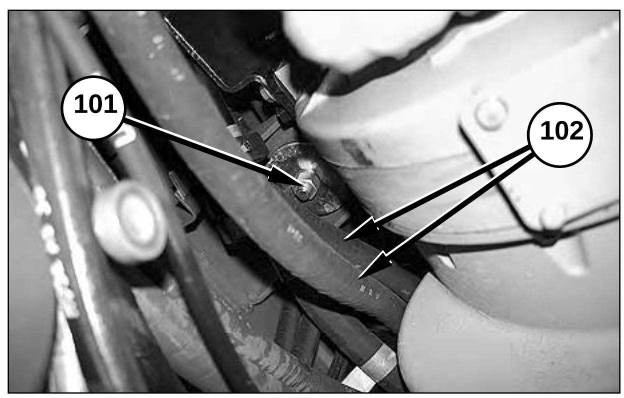
64. Remove the bolt with the washer, and clamp (98) from engine oil fill tube (97).



65. Remove left rear mounting bolt (99).

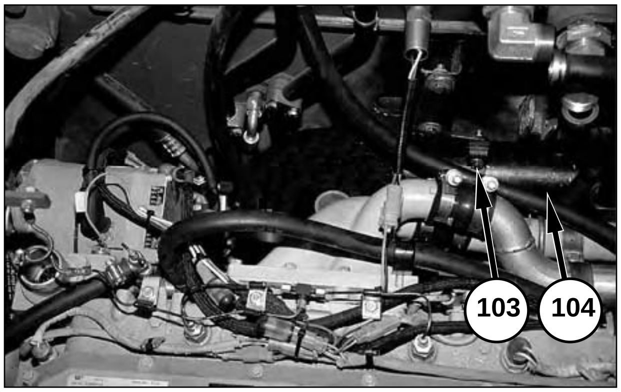


66. Remove front mounting bolt (100) with the washer and rubber mount.



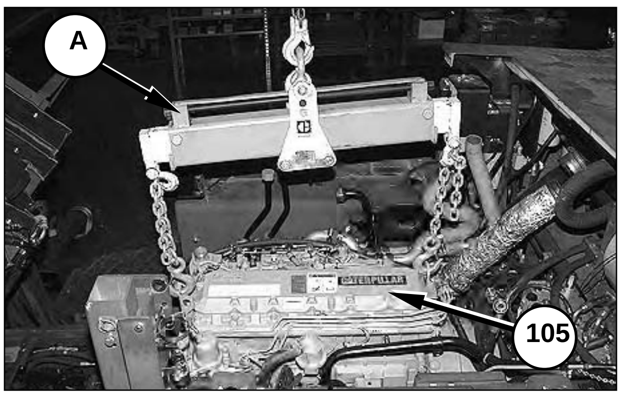
67. Remove nut (101) with the washer and rubber mount, on the right rear engine mount.

NOTE: If necessary, remove a clamp and move lines (102) against the machine frame to gain access to nut (101).



68. Remove bolt (103) with one washer and nut from the clamp on air line (104).

69. Loosen the clamp on the bottom end of the rubber boot at the rear of air line (104), and remove air line (104).



70. Attach Tooling (A) to engine assembly (105), and use a hoist to lift the engine assembly. The weight of the engine assembly and torque converter is approximately **1090 kg (2400 lb).** Bring the engine assembly straight up, until the front of the engine oil pan clears the front crossbeam. Then bring the engine forward and up to remove the assembly.

NOTICE

Lift the engine assembly and torque converter slowly to prevent other components from being damaged. As the engine assembly and torque converter is removed, ensure that everything was disconnected during the procedure.

NOTE: To install the engine assembly and torque converter, reverse the removal steps.

End By:

a. Install the main drive shaft.

b. Install the steering pump drive shaft.

c. Install the hydraulic tank.

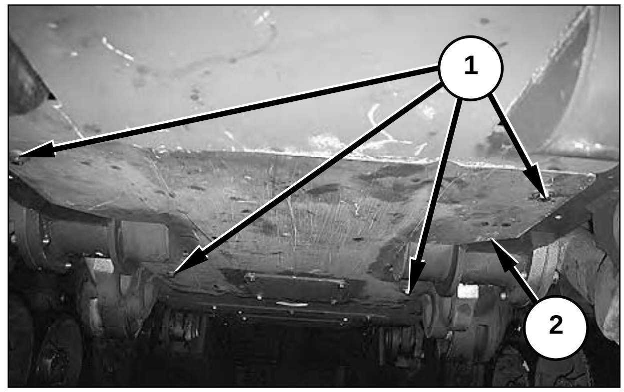
Engine Support, Front

Remove and Install

Start By:

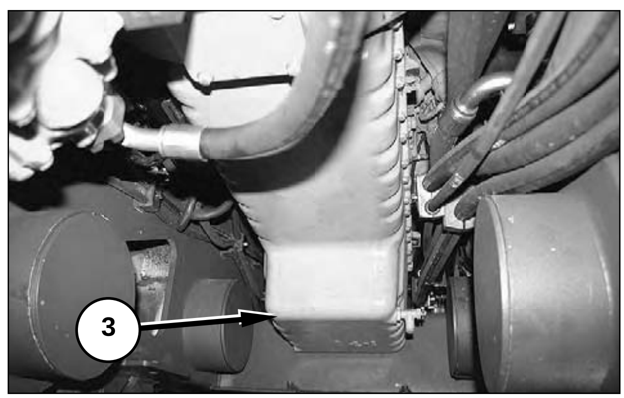
a. Remove the vibration damper.

NOTE: The group number related to this procedure is 122-8638.



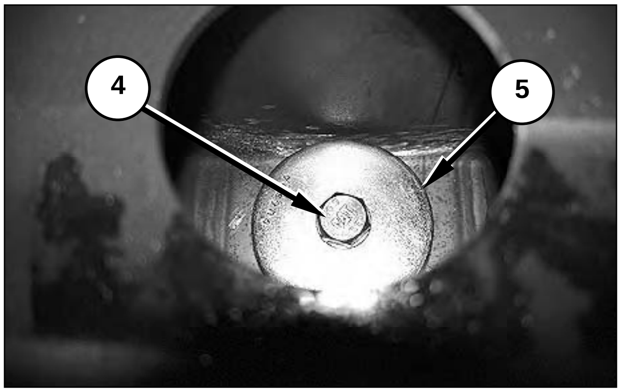
1. Remove four bolts (1) with the washers, and bottom cover (2).The weight of cover (2) is **50.5 kg (111 lb).**

NOTE: If dirt or other debris has accumulated on the top side, the bottom cover may weigh more than **50.5 kg (111 lb)**. Use a suitable floor jack, or other tool, to support the bottom cover if there is a large amount of debris.

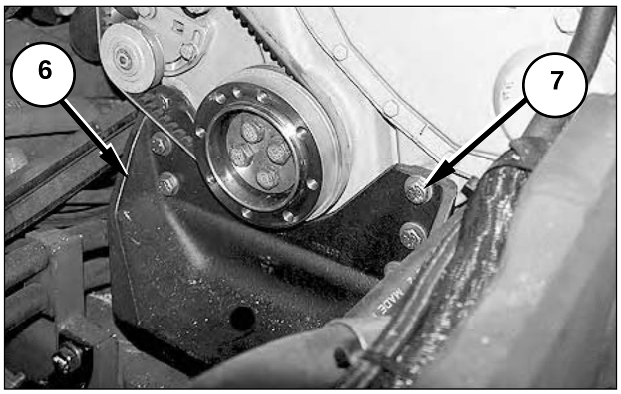


2. Place a block of wood across the bottom of oil pan (3) and support the front of the engine with a floor jack, or other suitable lifting device.

NOTE: The weight of the engine assembly and torque converter is approximately **1090 kg (2400 lb).**



3. Remove bolt (4) with washer (5) and the rubber mount.



4. Remove six bolts (7) with five washers, and engine support (6) with the rubber mount.

NOTE: No washer is installed on the top bolt.

NOTE: To install the front engine support, reverse the disassembly steps.

End By:

a. Install the vibration damper.

Engine Support, Rear

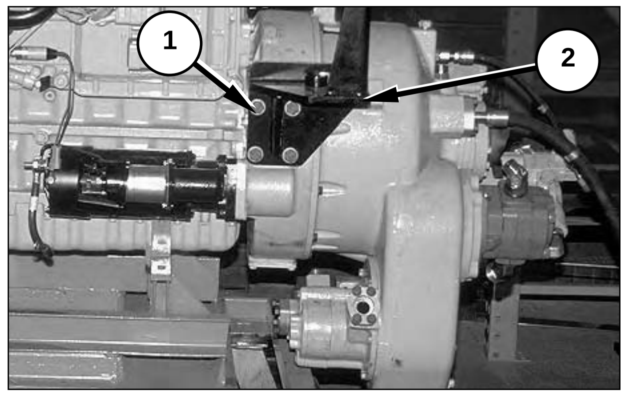
Remove and Install

NOTE: The procedure shows the removal of the left rear engine support. The right rear engine support can be removed using the same procedure.

Start By:

a. Remove the engine assembly and torque converter.

NOTE: The group number related to this procedure is 122-8638.



1. Remove four bolts (1) with the washers, and engine support (2).

NOTE: To install the rear engine support, reverse the disassembly steps.

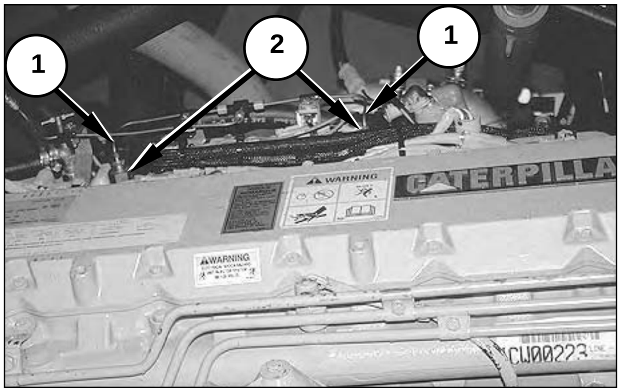
End By:

a. Install the engine assembly and torque converter.

Ether Start-Aid Nozzles

Remove and Install

NOTE: The group number related to this procedure is 126-5835.



1. Disconnect ether lines (1) from ether start-aid nozzles (2).

2. Remove ether start-aid nozzles (2) from the top of the air inlet manifold.

NOTE: To install the ether start-aid nozzles, reverse the removal steps.

NOTICE
At the time of assembly, install the ether start-aid nozzles to direct the spray away from the intake air heater. The nozzle is marked with a dot to indicate the direction of spray. If the dot is not visible, make a new mark on the nozzle in line with the spray orifice.

NOTE: Upon installation, the adapters should be tightened to a torque of **7.8 ± 1 N•m (70 ± 9 in lb)**. The minimum seating torque for the ether start-aid nozzles is **2.8 N•m (25 lb in).**

Exhaust Manifold

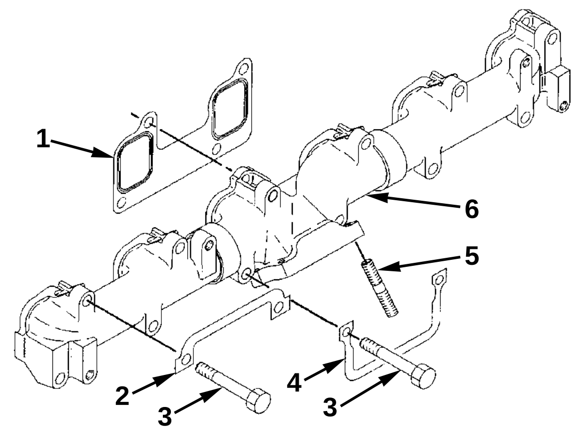
Remove and Install

Start By:

a. Remove the engine assembly and torque converter.

b. Remove the turbocharger.

NOTE: The group number related to this procedure is 6I-2298.



1. Remove 12 bolts (3), five locks (2), lock (4), exhaust manifold (6), and three gaskets (1) from the cylinder head assembly.

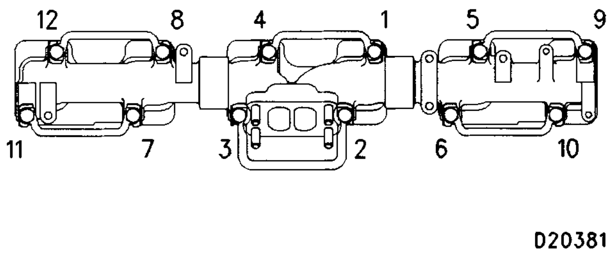
2. Disassemble exhaust manifold (6). The exhaust manifold is in three pieces. If necessary, remove four turbocharger mounting studs (5) from the exhaust manifold.

NOTE: The following steps are for the installation of the exhaust manifold.

3. If the four turbocharger mounting studs were removed from exhaust manifold (6), apply **5P-3931 Anti-Seize Compound** on the studs, install them, and tighten them to a torque of **35 ± 5 N•m (26 ± 4 lb ft).**

4. Install new exhaust manifold gaskets.

5. Apply a thin coat of **2P-2333 Manifold Sealer** to the outside diameter of the male ends of exhaust manifold (6). Coat the inside of the female ends of the manifold with clean engine oil. Assemble the manifold and remove the excess sealer from the assembled joints.



6. Apply **5P-3931 Anti-Seize Compound** to the threads of the bolts that hold exhaust manifold (6) in position. Put the gaskets and the exhaust manifold in position on the cylinder head assembly. Install locks (2) and (4), and bolts (3) that secure the exhaust manifold. Tighten the bolts in the numerical sequence shown above, following the illustration below:

a. Tighten the bolts in numerical sequence to an initial torque of **4 ± 1 N•m (3 ± 1 lb ft).**
b. Tighten the bolts in numerical sequence to a final torque of **45 ± 5 N•m (33 ± 4 lb ft).**
c. Bend the lock tab over the flat of each bolt head.

End By:

a. Install the turbocharger.

b. Install the engine assembly and torque converter.

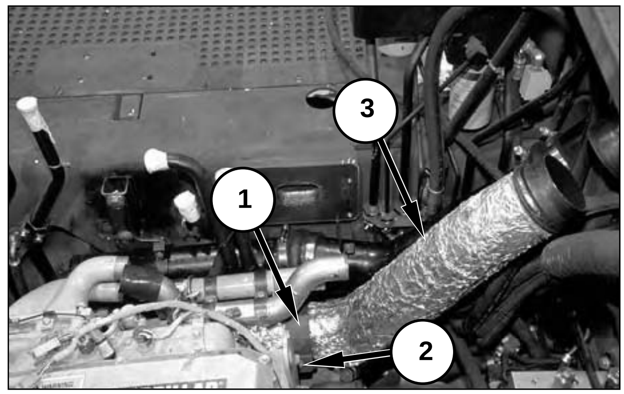
Exhaust Pipe

Remove and Install

Start By:

a. Remove the muffler group.

NOTE: Group numbers related to this procedure include 136-1145.



1. Remove two bolts (2) with two washers, and bracket (1).

2. Loosen the clamp at the joint between the exhaust pipe and the turbocharger exhaust. Slide the clamp off of exhaust pipe (3).

NOTE: The clamp described in Step 2 is not shown. This clamp can be found by examining the turbocharger exhaust outlet. Upon reassembly, apply **4C-5598 Anti-Seize Compound** to the threads of the clamp.

3. Remove exhaust pipe (3). Upon reassembly, the exhaust pipe should be angled slightly towards the center of the machine.

NOTE: If the insulation on exhaust pipe (3) is damaged during installation, repair the damage with aluminum tape which has a heat rating of **177°C (350°F)**.

End By:

a. Install muffler group.

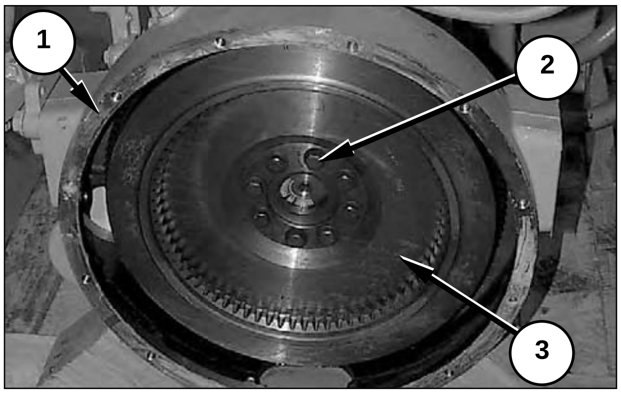
Flywheel

Remove and Install

Start By:

a. Remove the torque converter group. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Torque Converter Group."

NOTE: The group number related to this procedure is 144-3440.



1. Remove top bolt (2,one of eight) and the washer that holds flywheel (3) to the rear of the crankshaft. Install a suitably sized guide bolt, one that is longer in length than bolt (2). Remove remaining seven bolts (2) with the washers.

NOTE: Bolt (2) is a 40 mm **M12 bolt**.

2. Slide the flywheel out until it is clear of flywheel housing (1). Fasten a hoist to the flywheel, and remove it from the guide bolt. The weight of the flywheel is **23.5 Kg (52 lb).**

3. Use a hammer and punch to remove the ring gear from the flywheel.

NOTE: The following steps are for the installation of the flywheel.

4. Heat the ring gear to a maximum temperature of **204°C (400°F)**. Do not use a torch to heat the ring gear. Put the ring gear in position on the flywheel so that the part number on the ring gear faces the engine. After the ring gear has cooled, tap the ring gear with a soft drift to be sure the ring gear is seated against the flywheel shoulder.

5. Fasten a hoist to flywheel (3), and put the flywheel in position on the guide bolt that has been threaded into the rear of the crankshaft. Line up the mark on the flywheel (indicated by an arrow) and the mark on the crankshaft. Slide the flywheel into position against the rear of the crankshaft.

6. Apply **9S-3263 Thread Lock** on the threads of eight bolts (2) which hold the flywheel in position. Install seven bolts and the washers that hold the flywheel to the rear of the crankshaft. Remove the guide bolt, and install the remaining bolt (2) and the washer. Tighten the bolts to a torque of **120 ± 20 N•m (90 ± 15 lb ft).**

End By:

a. Install the torque converter group.

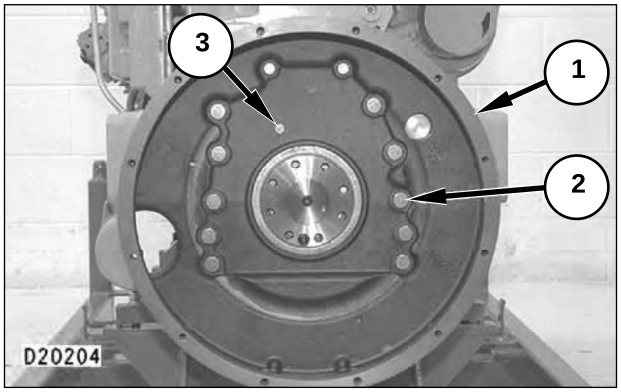
Flywheel Housing

Remove and Install

Start By:

a. Remove the flywheel.

NOTE: The group number related to this procedure is 5R-8847.



1. Fasten a hoist to flywheel housing (1). The weight of the flywheel housing is **26 Kg (57 lb).**

2. Remove twelve bolts (2) and bolt (3) that hold the flywheel housing to the cylinder block. Remove the flywheel housing. The weight of the flywheel housing is **26 Kg (57 lb).**

NOTE: The following steps are for the installation of the flywheel housing.

3. Be sure the mating surfaces of the flywheel housing and the cylinder block are thoroughly clean.

NOTE: Apply **1U-8846 Gasket Maker** to the entire cylinder block mounting face of the flywheel housing, prior to installation.

4. Install the flywheel housing in the reverse order of the removal.

End By:

a. Install the flywheel.

Front Housing and Camshaft Idler Gear Assembly

Remove and Install

Tools Needed	A
1P-0520 Driver Group	1

Start By:

a. Remove the engine assembly and torque converter.

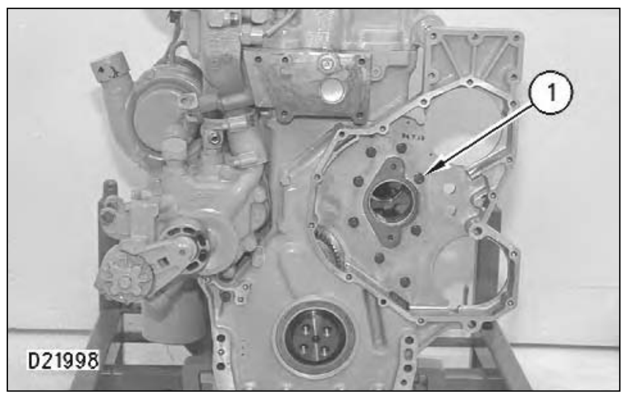
b. Remove the vibration damper, crankshaft pulley, and crankshaft front seal.

c. Remove the front engine support.

d. Remove the oil pan.

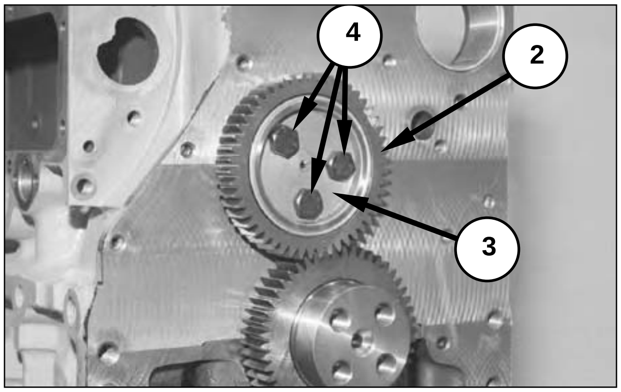
e. Remove the camshaft.

NOTE: Group numbers related to this procedure include 101-4575 and 101-4540.



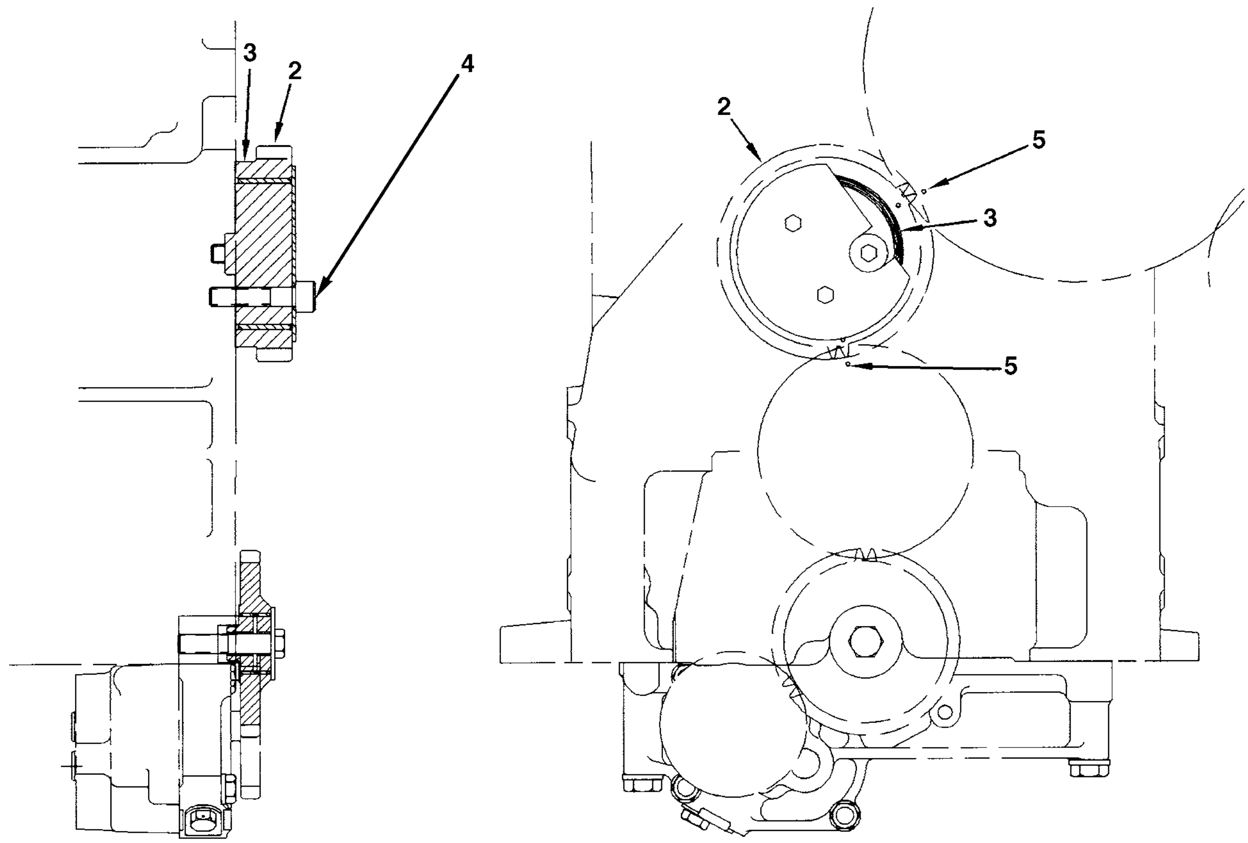
1. Remove external components, if equipped.

2. Remove 12 bolts (1) and washers that hold the front housing to the cylinder block. Remove the front housing. Clean the sealant from the housing and the block.



3. Remove three bolts (4) that hold the idler to the block, and remove idler shaft (3) and camshaft idler gear assembly (2). Separate camshaft idler gear assembly (2) from idler shaft (3), and remove the sleeve bearing from the camshaft idler gear. Use Tooling (A) and a press to remove the bearing.

NOTE: Follow the steps on the next page to install the front housing and the camshaft idler gear assembly.



4. Use Tooling (A) and a press to install the sleeve bearing into the camshaft idler gear. Install the sleeve bearing until it is **0.40 ± 0.25 mm (0.016 ± 0.010 in)** below the front face of the gear.

5. Put idler shaft (3) in position on the cylinder block, and install three bolts (4) that hold it to the block. Tighten the bolts to a torque of **70 ± 15 N•m (51 ± 11 lb ft).**

6. Install camshaft idler gear assembly (2) on idler shaft (3), with timing marks (5) facing out. Align the previously identified timing mark on camshaft idler gear (2), with the identified timing mark on the crankshaft drive gear.

7. Install the front housing as follows:

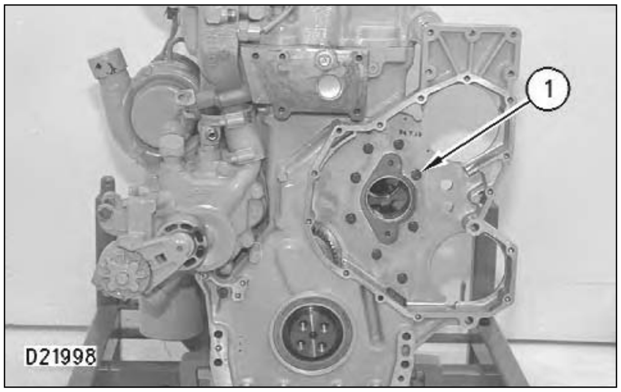
a. Clean the joint face on the front housing with **8T-9011 Component Cleaner.**

b. Apply **6V-1541 Quick Cure Primer** to the joint face. Allow the primer to dry for a minimum of three to five minutes.

c. Apply **1U-8846 Gasket Maker** to the joint face. Spread the gasket maker uniformly. The front housing must be installed within ten minutes after the application of the gasket maker.

NOTICE

Do not allow the 1U-8846 Gasket Maker on the front housing to plug the main oil passage.



8. Put the front housing in position on the cylinder block, and install 12 washers and bolts (1) that hold the front housing.

End By:

a. Install the camshaft.

b. Install the oil pan.

c. Install the front engine support.

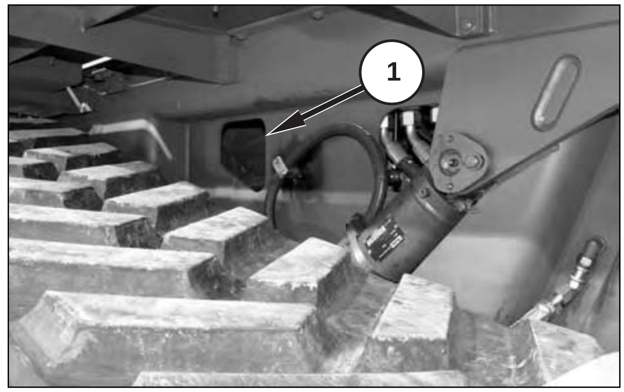
d. Install the vibration damper, crankshaft pulley, and crankshaft front seal.

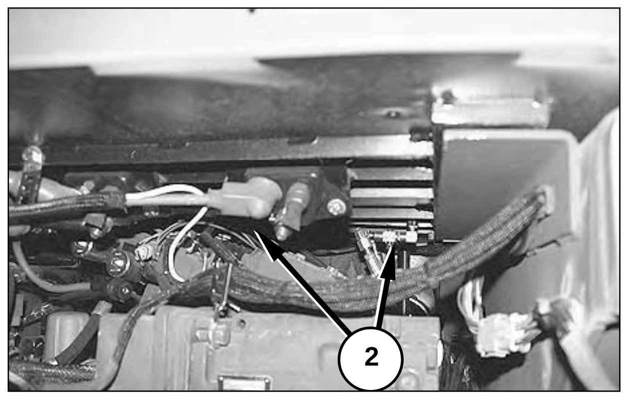
e. Install the engine assembly and torque converter.

Fuel Filter Base

Remove and Install

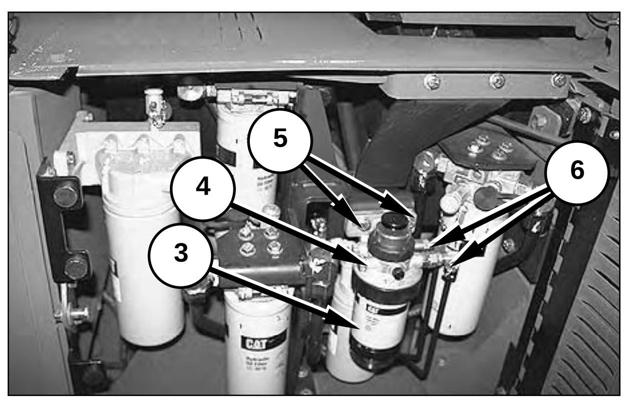
NOTE: The group number related to this procedure is 166-5920.





Machine Shown Partially Assembled for Photographic Clarity.

1. Reach into two holes (1). There is one hole on each side of the machine. Turn the knob 90 degrees to close two fuel valves (2).



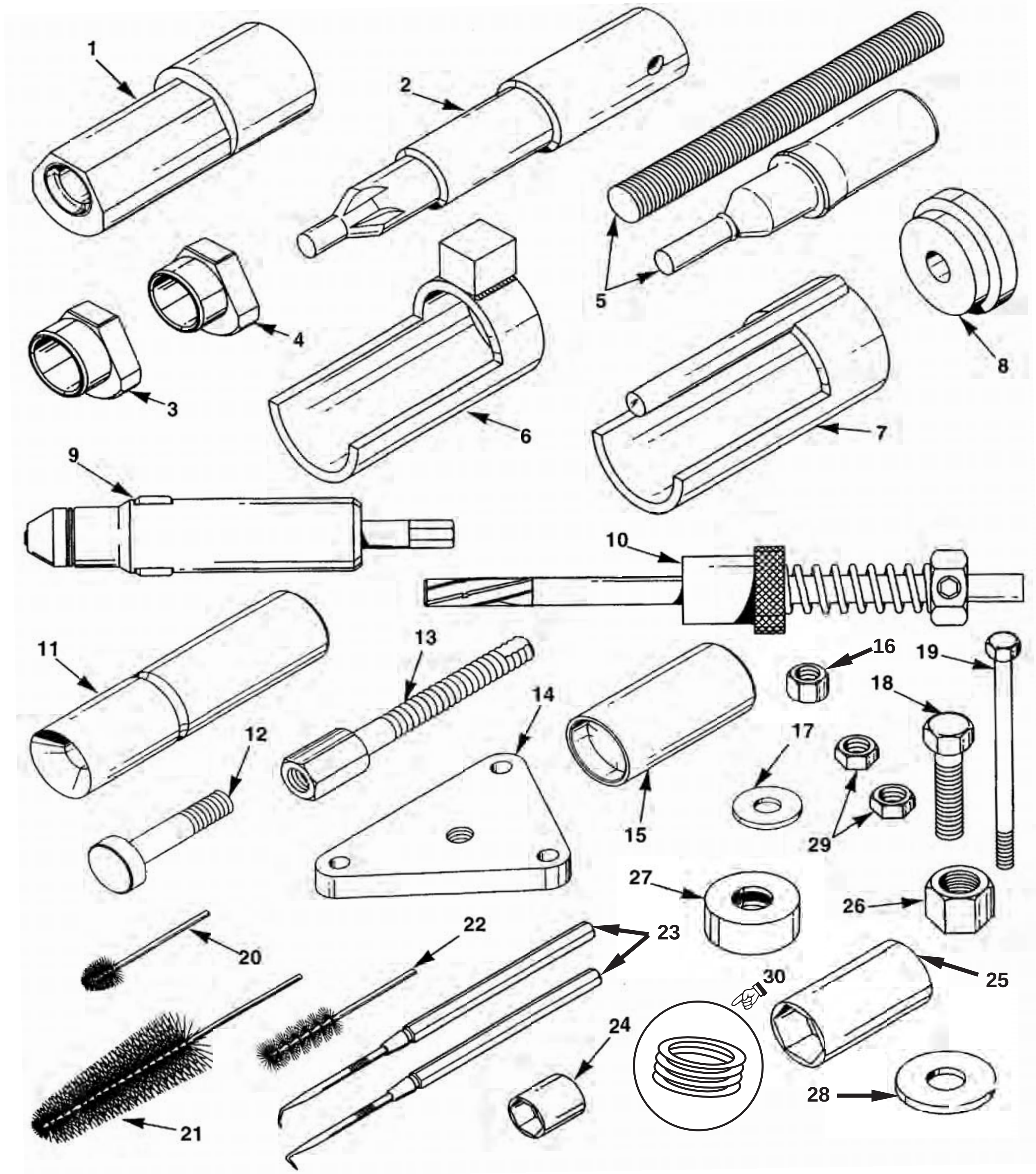
2. Remove fuel filter (3).

3. Disconnect, cap and then plug two fuel lines (6).

4. Remove two bolts and two nuts with four washers (5), and remove fuel filter base (4).

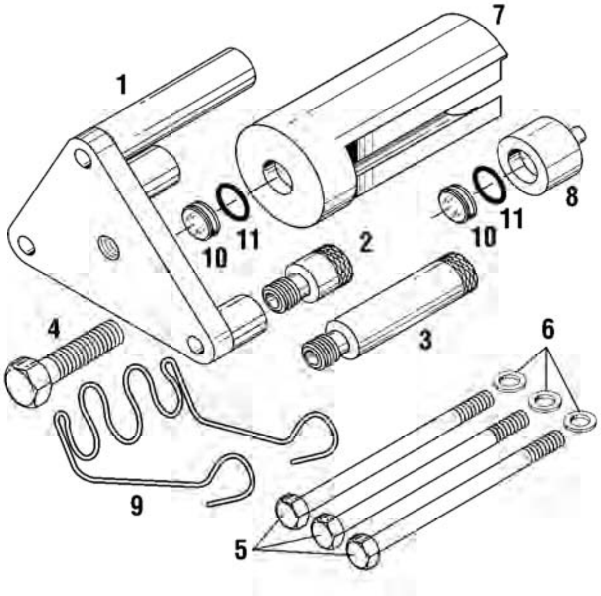
NOTE: To install the fuel filter base, reverse the removal steps.

Fuel Injector Sleeves



Components of Sleeve Replacement Tool Group.
(1) 125-7060 Driver. (2) Reamer Assembly (4C-8713 Shank, 131-8362 Reamer Head, 4C-5502 Setscrew). (3) 4C-8714 Guide Bushing (large). (4) 4C-8715 Guide Bushing (small). (5) Swage Assembly (4C-5573 Swage [sleeve], 4C-5548 Stud [3/4-10 thd. x 5 1/2 in]). (6) 125-7059 Reaction Sleeve. (7) 9U-5671 Reaction Sleeve (not used). (8) 4C-5572 Plate (for reaction sleeve). (9) 121-2920 Roller Expander. (10) 9U-6101 Reamer Group. (11) 142-8278 Swage Tool. (12) 142-8279 Sleeve Puller. (13) 142-8280 Sleeve Stud. (14) 142-8281 Plate. (15) 143-8612 Driver. (16) 1F-7958 Full Nut (1/2-13). (17) 7D-1649 Hard Washer. (18) 3L-2415 Hex Bolt (1/2-20, 63.5 mm [2.5 in] long). (19) 7X-2537 Hex Bolt (M8 x 1.25,110 mm [4.3 in] long). (20) 4C-5553 Sleeve Cleaning Brush (tapered). (21) 126-3297 Large Bore Brush. (22) 4C-5570 Small Bore Brush. (23) 9U-6859 Pick Set. (24) 214-6625 Socket (11 mm, 3/8 inch square drive, six point). (25) 213-3530 Socket (1 1/8 in). (26) 2J-3506 Nut (3/4-10 thd.). (27) 1U-8826 Thrust Bearing. (28) 2S-0115 Hard Washer. (29) 1B-4430 Jam Nut (1/2-20), Shims (30).

Injector Seating Tool Group



Components of Injector Seating Tool Group.
(1) 173-1529 Forcing Bridge. (2) 173-1534 Short Spacer Leg. (3) 173-1535 Long Spacer Leg. (4) 3L-2415 Hex Head Bolt (Forcing Bolt).
(5) 7x-0457 Hex Head Bolt (For Forcing Bridge). (6) 9M-1974 Hard Washer. (7) 173-1531 Injector Forcing Cover (MUI).
(8) 173-1532 Injector Forcing Cover (HEUI). (9) 146-2597 Push Rod Holder. (10) 175-7801 Wear Button. (11) 1P-8116 O-Ring Seal.

Remove and Install

Tools Needed		A
143-2099	Sleeve Replacement Tool Group	1

Start By:

a. Remove the unit injector fuel pump group.

NOTE: The group number related to this procedure is 160-5136.

NOTE: These instructions apply whether the cylinder head is off or on the engine. However, with these tools and procedures, there should be no need to remove the cylinder head just to replace injector sleeves. The sleeves can be replaced after the removal of the rocker arm assembly and unit injector; it is not necessary to remove the valves or valve springs, or the inlet manifold.

1. Remove any loose material or deposits from inside the injector sleeve.

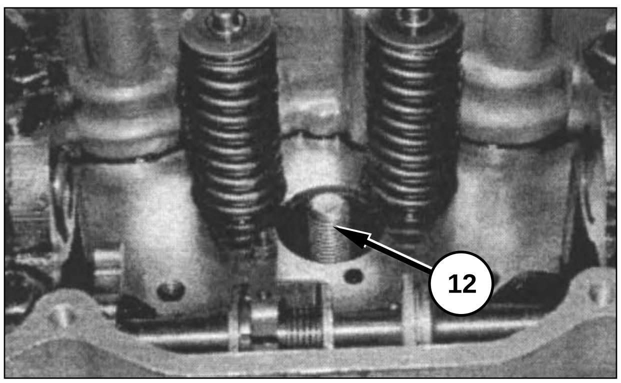


Illustration 1.
(12) 142-8279 Sleeve Puller.

2. Place **142-8279 Sleeve Puller** (12) into the injector sleeve, with the stud centered in the bore.

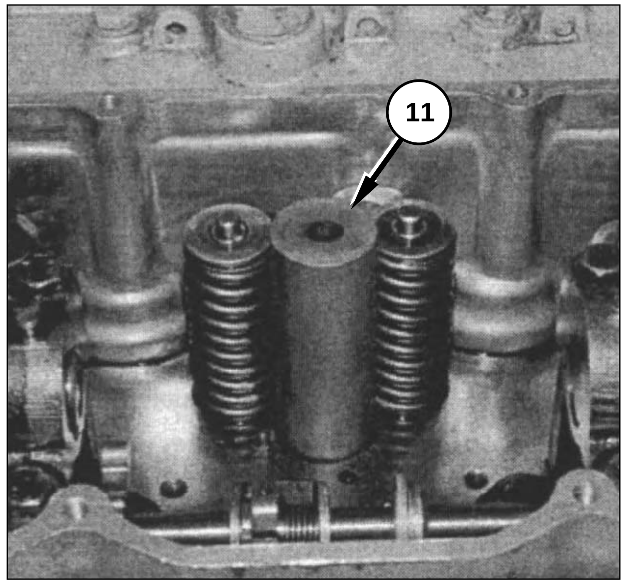


Illustration 2.
(11) 142-8278 Swage Tool.

3. Apply **1P-0808 General Purpose Grease** (or equivalent) to the countersink surface of **142-8278 Swage Tool** (11). Place the swage tool over the stud of **142-8279 Sleeve Puller** (12) in the injector bore. Turn and wiggle the swage tool from side to side in the bore. This will ensure that the tool is as low as it can go into the bore. When properly positioned, the swage tool will fit snugly in the bore, with very little side play possible. The bottom of the swage tool groove should be about **5 mm (0.2 in)** above the cylinder head surface.

NOTICE

The sharp edge of the swage tool must rest directly on the top of the injector sleeve, and not above the sleeve on the iron lip in the head. Damage to the head and tool may result if the tool is not properly seated prior to swaging.

NOTE: Extreme care must be taken to maintain the circular shape and sharp edge on the 142-8278 Swage Tool. Denting or dulling this edge can cause the tool to collapse the sleeve into the water jacket, instead of swaging it. The tool should not be dropped or impacted by other tools. When stored in the case, the **142-8279 Sleeve Puller** should be inserted into the swage tool, and the protective device placed over the end. If the sharp edge becomes damaged or dull, do not attempt to sharpen the edge with a file or other abrasive tools on the outside diameter. Serviceability of the tool may be restored by grinding or turning the 45-degree countersink surface. When performing this operation, the smooth surface finish of the countersink must be maintained.

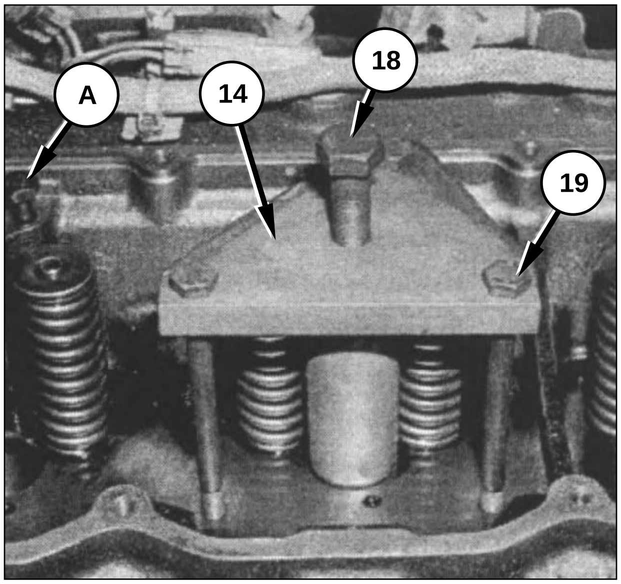


Illustration 3.
Install the 142-8281 Plate.
(A) M8 bolt. (14) 142-8281 Plate. (18) 3L-2415 Hex Bolt. (19) 7X-2537 Hex Bolt. (Jam nuts [29] are not shown in this picture, but should be installed. See Illustration 5.)

4. Remove **M8 bolt(s)** (A) which are closest to the valve springs from the inlet manifold, on those cylinders on which the sleeve is to be removed. **M8 bolt** (A) (shown in Illustration 3) shows the location of the bolt to be removed, not the actual bolt.

5. Screw two **1B-4430 Jam Nuts** (29) (Illustration 5) all the way on to **3L-2415 Bolt** (18). Apply **5P-3931 Anti-Seize Compound** or **6V-4876 Molykote Paste Lube** to the exposed threads and screw the bolt into **142-8281 Plate** (14).

6. Put three **7X-2537 Bolts** (19) through plate (14), from the side marked "TOP," and thread them into the cylinder head. ON HEUI engines, the bolt on the top of the triangular-shaped plate goes through the manifold bolt hole into the cylinder head. All the **M8 bolts** should be threaded into the head the same distance, so the plate is as close as possible to parallel to the cylinder head surface. **3L-2415 Hex Bolt** (18) should now be centered over the swage tool.

7. Thread bolt (18) through the plate, onto the top of the swage tool, until the assembly is hand tight (no slack). Locate jam nuts (29) with a gap of approximately **5.5 mm (.22 in)** from the bottom surface of the nut to the top of the plate. This provides a fixed travel distance for the swage tool and helps prevent pushing the swage tool too deeply into the cylinder head. Once the jam nuts are in place, tighten them against each other.

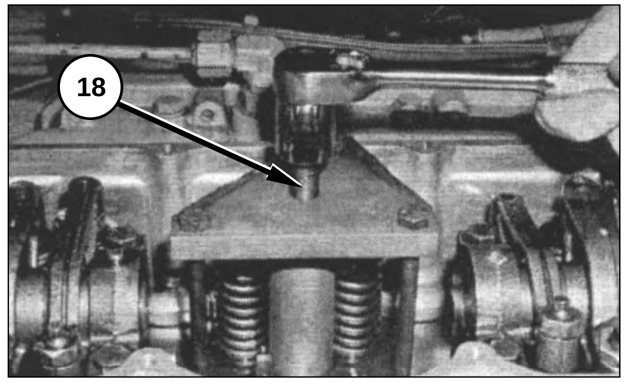


Illustration 4.
(18) 3L-2415 Hex Bolt. (Jam nuts [29] are not shown in this picture, but should be installed. See Illustration 5.)

8. Use a three-quarter inch socket and ratchet, or an adjustable wrench, to tighten bolt (18) approximately **5.5 mm (0.22 in)**, as shown in Illustration 4 (jam nuts are not shown, but are required). This forces swage tool (11) down, swaging the top of the injector sleeve around the disk of the sleeve puller. A high torque will be noticed at the beginning when swaging starts. The torque required to tighten bolt (18) should lessen, until the mass of swaged brass causes the torque to increase again. Depending on the type and amount of grease used, the changes in torque may not be noticeable. The use of power tools in this operation is not recommended. When completed, the bottom of the swage tool groove should be close to the surface of the head.

NOTE: Driving the swage tool down too far can cause the sleeve to collapse below the upper bore in the cylinder head, making the sleeve more difficult to remove.

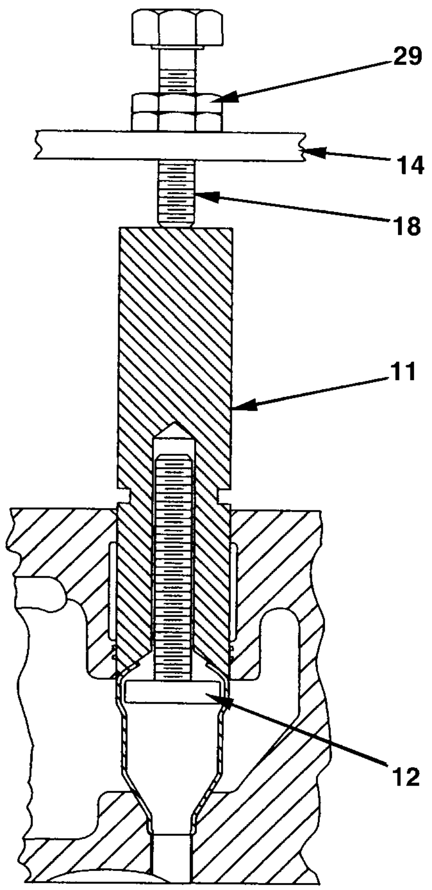


Illustration 5.
Injector Sleeve Swaged Over 142-8279 Sleeve Puller (12).
(11) 142-8278 Swage Tool. (12) 142-8279 Sleeve Puller. (14) 142-8281 Plate. (18) 3L-2415 Hex Bolt. (29) 1B-4430 Jam Nuts.

9. Unscrew bolt (18), remove three bolts (19), **142-8281 Plate** (14), and **142-8278 Swage Tool** (11).

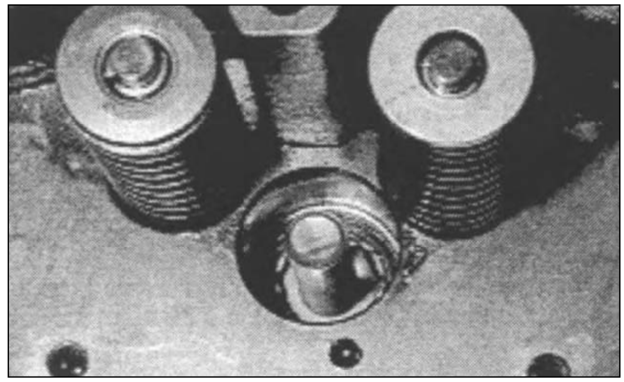


Illustration 6.
Injector Sleeve Swaged Inward, Ready for Removal.

10. Check the swage of the injector sleeve, as shown in Illustration 6. The brass should be evenly swaged with a **6.4 mm (.25 in)** gap around the sleeve puller stud. If the swage appears to be incomplete, reassemble the swaging hardware and repeat the swaging procedure, by moving the two jam nuts an additional **2.0 mm (0.08 in).** If the swage is forced too deep, the sleeve may expand into the water passage in the head, making it difficult or impossible to pull the sleeve out through the bore. Once the swage is complete, remove the hardware.

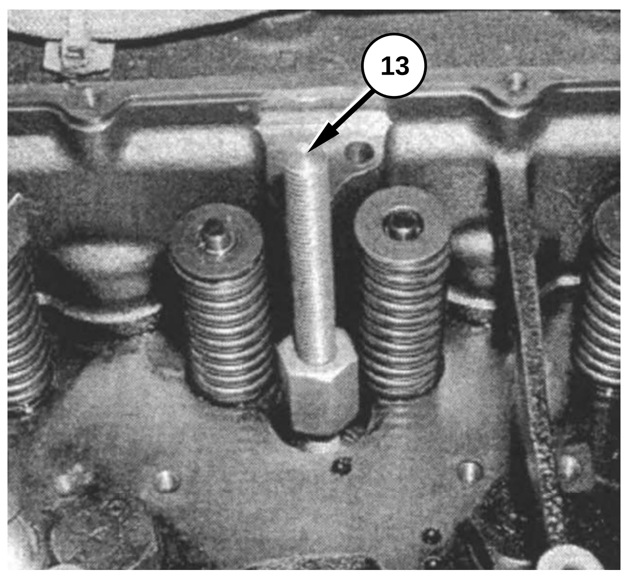


Illustration 7.
(13) 142-8280 Sleeve Stud.

11. Thread **142-8280 Sleeve Stud** (13) onto **142-8279 Sleeve Puller** (12).

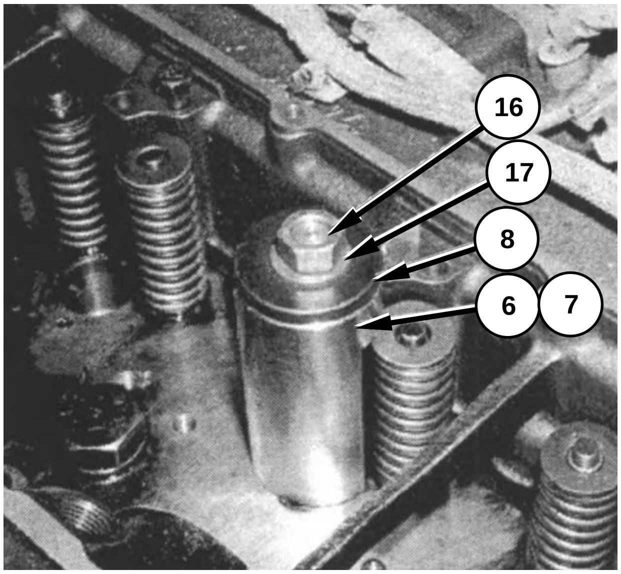


Illustration 8.
Removing Injector.
(6) 125-7059 Reaction Sleeve. (7) 9U-5671 Reaction Sleeve [not used]. (8) 4C-5572 Plate. (16) 1F-7958 Full Nut. (17) 7D-1649 Hard Washer.

12. Center **125-7059 Reaction Sleeve** (6) over the sleeve bore, with the stud extending through the top. Apply **5P-3931 Anti-Seize Compound** or **6V-4876 Molykote Paste Lube** to the threads of the stud.

NOTE: The sleeve puller and sleeve stud assembly must be centered within the injector bore. Failure to do so can cause the sleeve to bind inside the bore during the pulling operation.

13. Put **4C-5572 Plate** (8), **7D-1649 Washer** (17), and **1F-7958 Full Nut** (16) on the stud, as shown in Illustration 8. Use a three-quarter-inch deep-well socket with a ratchet, or an adjustable wrench, to tighten the nut and pull the sleeve from the injector bore.

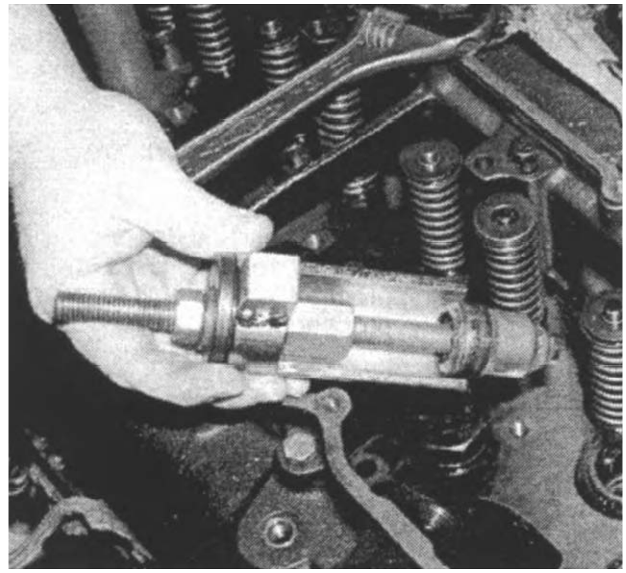


Illustration 9.
Injector Sleeve Removed from Cylinder Head.

14. Disassemble the removal tools down to the sleeve puller and the sleeve. Clamp the sleeve in a vise with the sleeve puller ring resting as low as it will go on the sleeve chamfer. This allows extra room for cutting the sleeve free from the sleeve puller.

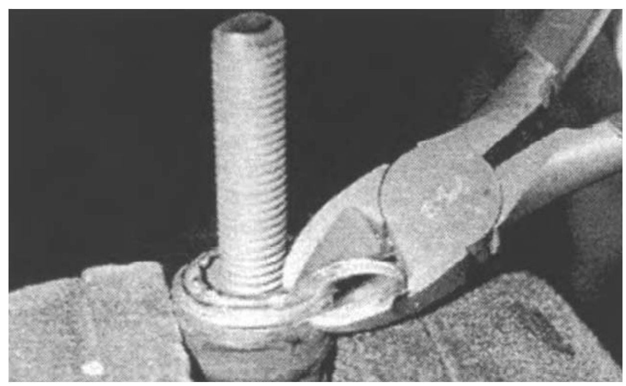


Illustration 10.
Remove Injector Sleeve from Sleeve Puller.

15. Use a pair of side cutters, as shown in Illustration 10, to cut through the brass down to the sleeve puller ring diameter, and then to pry the brass outward. Continue until the sleeve puller can be pulled out of the sleeve.

WARNING

Because of the sharp edges of the sleeve, which are produced when excess material is removed with the side cutters, gloves are highly recommended. An alternate removal method is to clamp the sleeve/puller assembly in the vise sideways with the nozzle end out. Use a hacksaw to cut off the small end of the sleeve, below the disk.

16. Thoroughly clean the injector sleeve bore.

Injector Sleeve Installation

NOTICE

Before installing a new injector sleeve, make sure the grooves in the injector bore are free of metal shavings. Remove any copper shavings from the grooves with a 9U-6859 Pick Set. If the shavings are not removed, the injector sleeve will not be correctly installed and engine damage could result.

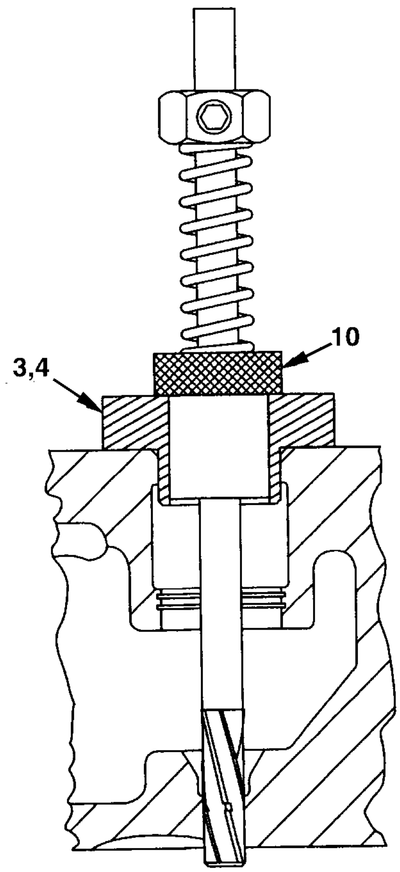


Illustration 1.
(3 or 4) Guide Bushing. (10) 6U-6101 Reamer Group.

1. Select guide bushing (3 or 4) that best fits into the cylinder head injector bore, above the injector sleeve that is to be removed. Use large guide bushing (3) if the bushing will slip into the bore with hand force. If the larger guide bushing cannot be installed with hand force, select small guide bushing (4).

2. Apply a coat of grease to the reamer. This will aid in keeping copper chips from falling through the injector bore and collecting on top of the piston.

3. Install previously selected guide bushing (3 or 4) and **9U-6101 Reamer Group** (10).

a. If the reamer can be pushed into the lower bore and turned by hand, reaming is not necessary; proceed to Step 4. If reaming is necessary, proceed with Step 3b.

b. Use an electric drill with reamer group (10) to ream the small bore at the bottom of the injector sleeve bore.

NOTE: Due to the machining tolerances for this hole in the cylinder head, Step 2 is necessary to make sure the hole is the correct size. The hole is used as a pilot for the small end of swage assembly (5) during the injector sleeve installation. The hole is also used for the pilot of reamer assembly (2) during injector seat reaming.

4. Remove reamer group (10) and guide bushing (3 or 4) from the cylinder head.

5. Use a suction tool to clean any debris from the injector bore. Compressed air is required to operate the vacuum gun.

6. Wipe away any excess grease from the injector bore and injector sleeve (A).

7. Use **126-3297 Large Bore Brush** (21), with an electric drill, to clean the injector sleeve bore(s) in the cylinder head. If necessary, use a small pick and/or an emery cloth to remove any remaining particles of copper or retaining compound.

NOTICE

To prevent engine damage, remove all cutting chips and debris from the cylinder head fuel gallery and coolant passages. Use a cotton swab, lightly coated with grease, to aid in the removal of any particles.

8. Small bore brushes (20 and 22) can be used, with an electric drill, to clean the small bore at the bottom of the cylinder block. If either brush does not reach the bottom bore, use a drill extension (9U-7237).

9. Using **4C-4079 Component Cleaner,** spray the inside of each injector sleeve bore in the cylinder head and the outside of each injector sleeve. Permit the cleaner to dry thoroughly.

10. Use **6V-1541 Quick Cure Primer** to spray the inside of each injector sleeve bore in the cylinder head. Permit the primer to dry thoroughly.

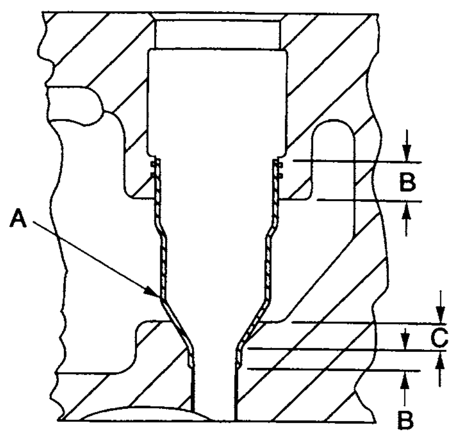


Illustration 2.
(A) Injector sleeve. (B) Locations to coat with 7M-7456 Bearing Mount or 9S-3263 Thread Lock. (C) Do not apply bearing mount or thread lock in this area.

11. Apply a coat of **7M-7456 Bearing Mount** or **9S-3263 Thread Lock** to the injector sleeve bore in the cylinder head at locations (B).

a. Apply the bearing mount or thread lock to the cylinder head, using a cotton swab.
b. Make sure there is no bearing mount or thread lock at location (C).

NOTICE

Bearing mount or thread lock applied in area C may result in improper sealing of the injector sleeve.

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12. Install all injector sleeves (A) into the cylinder head before proceeding with Step 13. Wipe away any excess retaining compound from inside or around the injector sleeve.

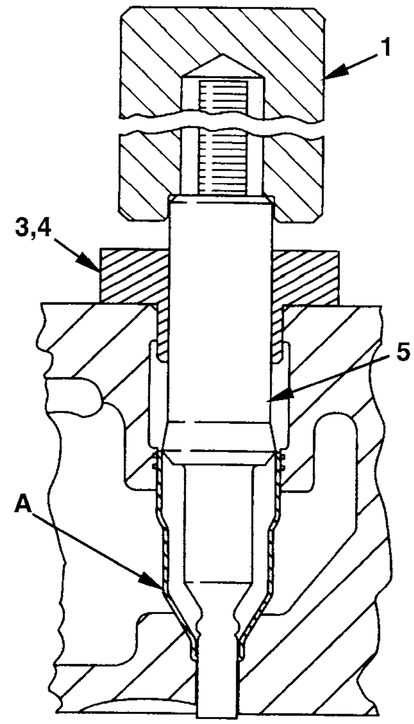


Illustration 3.
(A) Injector sleeve. (1) 125-7060 Driver. (3 or 4) Guide bushing. (5) Swage assembly.

13. Use **5P-3931 Anti-seize Compound** or **6V-4876 Molykote Paste Lubricant,** to lubricate swage assembly (5) and the upper inside bore of injector sleeve (A).

14. Put swage assembly (5) into injector sleeve (A). Push the injector sleeve all the way to the bottom of its bore, in the cylinder head.

15. Install previously selected guide bushing (3 or 4) over the shank of swage assembly (5).

16. Position **125-7060 Driver** (1) (Illustration 3), or a **143-8612 Driver** over swage assembly (5).

a. To drive the swage down through the sleeve, use either **125-7060 Driver** (1) (Illustration 3), or a **143-8612 Driver**. Use the **125-7060 Driver** if the head is off the engine, or if there is sufficient room to swing a hammer. If the clearance is very limited, use the **143-8612 Driver**.

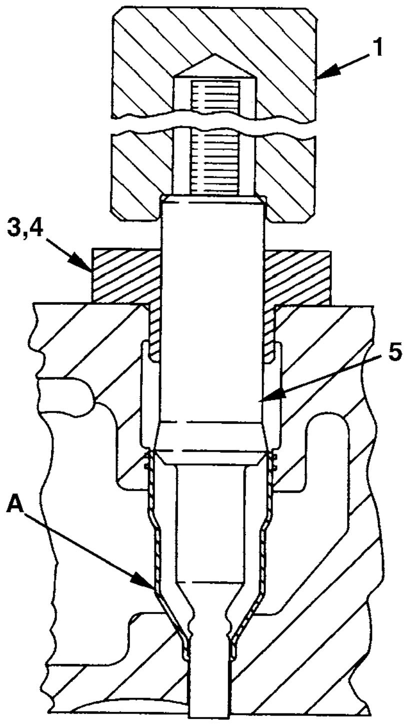


Illustration 4.
(A) Injector sleeve. (1) Driver. (3 or 4) Guide bushing.
(5) Swage assembly.

Using **125-7060 Driver**:

b. Use a 1-to-2 kg (2 to 4 Lb) hammer to drive the swage assembly into the injector sleeve. Avoid excessive hammer force when completing the stroke of the tool. Heavy hammer blows will be needed at the beginning of the installation, but only light hammer blows will be required at the finish of the installation procedure.

c. The last two or three hammer blows should only be hard enough to make sure that the driver has "bottomed out" against the guide bushing.

Using **143-8612 Driver**:

d. Remove the **4C-5548 Stud** from the swage tool.

e. Thread the **3L-2415 Bolt** into the **142-8281 Plate,** and secure the plate onto the cylinder head using three **7X-2539 Bolts**.

f. Use a 3/4 inch socket and ratchet to force the swage tool down into the sleeve. Use a piece of paper as a feeler gauge between the driver and guide bushing to determine when the swage tool is at the completed depth.

g. When the swage process is complete, remove the tooling and reinstall the **4C-5548 Stud** in the swage tool.

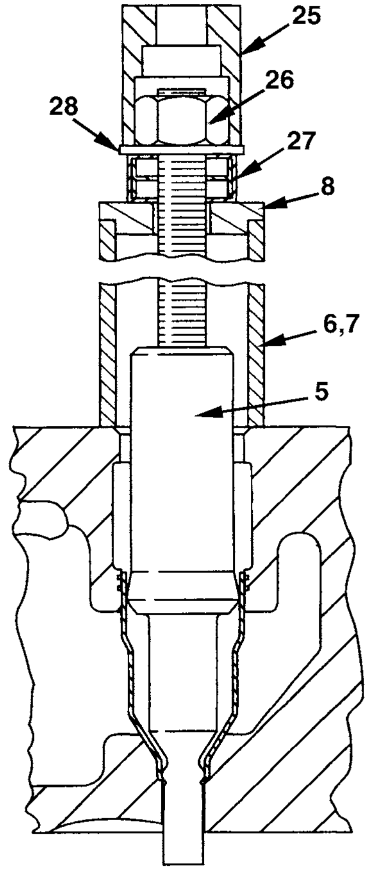


Illustration 5.
(5) Swage assembly. (6 or 7) Reaction sleeve. (8) Plate. (25) Socket. (26) Nut. (27) Thrust bearing. (28) Hard washer.

17. Use reaction sleeve (6 or 7), plate (8), thrust bearing (27), hard washer (28), nut (26), and socket (25) to pull the swaging tool from the installed sleeve.

a. Install reaction sleeve (6 or 7) and plate (8) over the threaded stem of swage assembly (5).
b. Put **5P-3931 Anti-Seize Compound** or **6V-4876 Molykote Paste Lubricant** on the threaded stem of swage assembly (5).
c. Position thrust bearing (27) on plate (8).
d. Put hard washer (28) on thrust bearing (27).
e. Install nut (26) on the threaded stem of swage assembly (5).
f. Use deep socket (25) and a one-half-inch square drive impact wrench (or a one-half-inch square drive ratchet wrench) to pull the swage assembly from the cylinder head.
g. Wipe away any excess lubricant or retaining compound that may be in the injector bore, or inside the injector sleeve.
h. Wipe away any excess retaining compound from swage assembly (5).

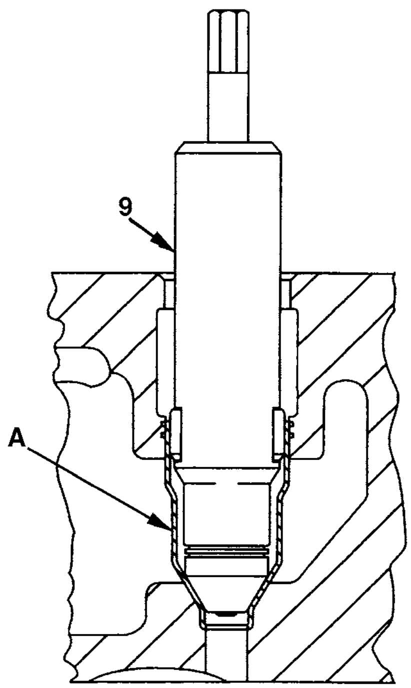


Illustration 6.
(A) Injector sleeve. (9) 121-2920 Roller Expander.

18. Coat **121-2920 Roller Expander** (9) with clean engine oil. Make sure the rollers are completely covered with oil.

19. Pull the mandrel out of roller expander (9), as far as possible. While holding the mandrel out, insert roller expander (9) all the way into the injector sleeve.

20. Install **1U-7845 Socket** (24) or equivalent on a **4C-6936 Torque Wrench** or equivalent. Put the torque wrench with socket (24) on the hex portion of the roller expander mandrel. Turn the torque wrench clockwise until a torque of **11 N•m (100 lb in or 8.0 lb ft)** is achieved, or the turning torque stops increasing.

NOTE: A click-type **4C-6936 Torque Wrench** is more convenient for Step 20, although a dial-type torque wrench is acceptable. If a dial-type **9S-7354 Torque Wrench** is to be used, set the dial for **11 N•m (100 lb in).**

21. When the specified torque is reached, or the turning torque stops increasing, stop turning the roller expander clockwise. Now turn the roller expander counterclockwise, until it is loose inside the injector sleeve.

22. Remove roller expander (9) from injector sleeve (A).

23. Clean the roller expander, especially the rollers, to remove any traces of retaining compound that may have come from the injector sleeve.

NOTE: When the use of roller expander (9) is completed, clean it thoroughly using either **1U-8803 Cleaner Concentrate** or **4C-4079 Component Cleaner**. After cleaning, put a coat of either **1U-8265 Penetrating Oil** or **1U-8809 Rust Preventive** on the roller expander, and then store in a tool case.

24. Wipe away any excess lubricant or retaining compound that may be in either the injector bore or in the injector sleeve.

25. Install previously selected guide bushing (3 or 4) into the cylinder head injector bore.

NOTICE

Guide bushing (3 or 4) must be used to be sure the reamer is properly centered in the hole and to prevent cutting the injector sleeve too deeply. If the reaming procedure is not done correctly, the injector sleeve must be removed and replaced.

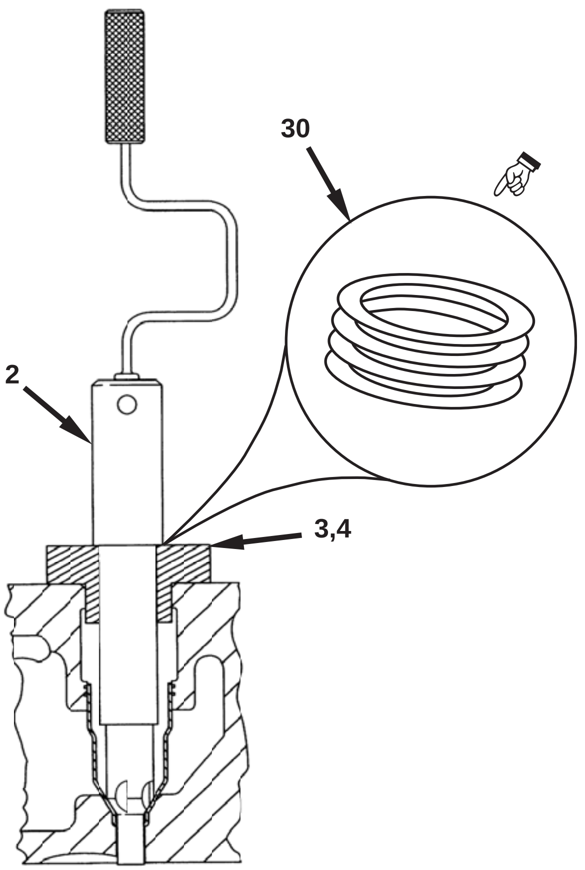


Illustration 7.
(2) Reamer assembly. (3 or 4) Guide bushing. (30) Shims.

26. Apply a generous amount of clean grease to the cutting area of reamer assembly (2). This will not only lubricate the reamer assembly, but will help retain the cutting chips from the reaming process and keep them from falling on the piston.

27. Install four shims (30) between reamer assembly (2) and guide bushing (3 or 4).

a. Insert reamer assembly (2) into guide bushing (3 or 4).

NOTICE

To correctly seal combustion gas, the injector seat must be free of machining chatter and scratches, including vertical lines left by the reamer at the end of the cut.

28. Using a **1U-7153 Speed Handle**, with light, but even, pressure, turn reamer assembly (2) clockwise. (The reamer assembly will cut aggressively.) Ream sleeve until reamer shank contacts shims (30). If there is an obstruction directly over the hole, use a **6V-0094 Universal Joint** in the reamer assembly**.**

a. Check cutting progress often. Remove **0.25 mm (0.010 in)** shims (30) one at a time, and repeat until the proper seat depth is obtained.

NOTE: If the injector seat does not machine to a **360 degree, full face,** as required, the injector sleeve must be removed. Install a new injector sleeve and repeat the reaming procedure.

NOTE: Stop cutting immediately when the seat is full face, so only the minimum amount of material is removed. Retain as much material as possible, in case a future reaming procedure is necessary. Maximum reamer depth occurs when the shoulder of the reamer assembly contacts the guide bushing.

NOTE: To prevent the sleeve from being reamed too deeply, the **0.25 mm (0.010 in)** shims used between the reamer assembly and the guide bushing provide a positive stop during the operation. Remove only the number of shims required to achieve clean-up of the injector seat, as described above.

NOTICE

Do not resharpen the reamer head of reamer assembly (2). If the reamer becomes dull, order a replacement 131-8362 Reamer Head. The reamer head is precision machined and resharpening will cause an improperly reamed injector seat. This will result in combustion gas leaks between the injector and the injector sleeve.

29. Remove any lubricants (grease) or copper particles that may be in or on the injector sleeve. Be sure to thoroughly clean the cylinder head fuel gallery.

30. Turn the engine crankshaft to put the piston back to the top center position. Remove the 0-ring seals that were installed on the valve stems.

31. Reinstall the valve springs, retainers, and locks, if they were removed. Make adjustments as necessary. Install the unit injector(s).

32. Install all other parts that were removed from the engine. Make any necessary adjustments.

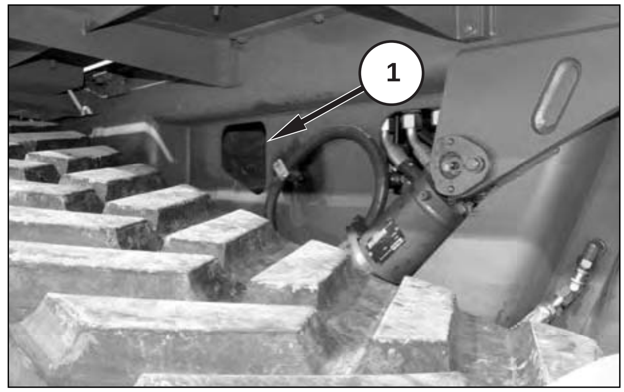
End By:

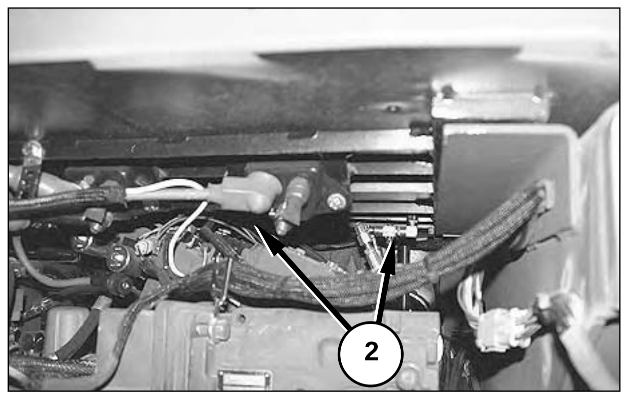
a. Install the unit fuel injection pump group.

Fuel Pressure Relief Valve

Remove and Install

NOTE: The group number related to this procedure is 126-0458

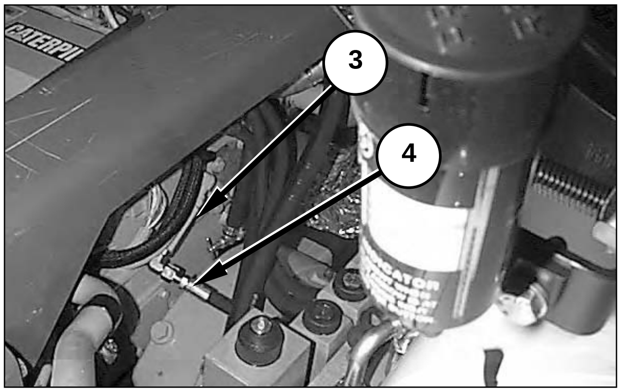




Machine Shown Partially Assembled for Photographic Clarity.

1. Reach into hole (1), located on the right side of the machine, and turn the knob 90 degrees to close fuel valve (2).

NOTE: Fuel valve (2) is open when the knob is in line with the hose, and closed when the knob is perpendicular to the hose.



View From Air Intake Compartment.

2. Disconnect, cap and then plug line (4).

3. Remove fuel pressure relief valve (3) from the cylinder head assembly.

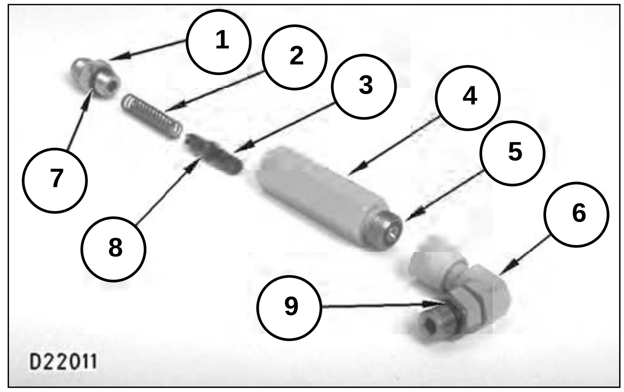
NOTE: To install the fuel pressure relief valve, reverse the removal steps.

Disassemble and Assemble

Start By:

a. Remove the fuel pressure relief valve.

NOTE: The group number related to this procedure is 126-0458.



1. Remove connector (1), O-ring seal (7), spring (2), valve (3) and O-ring seal (8) from valve housing (4).

2. Remove elbow (6) and O-ring seal (9) from valve housing (4). Remove O-ring seal (5) from the valve housing.

3. Use new O-ring seals (5), (7), (8), and (9) in valve housing (4).

NOTE: The following steps are for the assembly of the valve.

4. Be sure that the orifice in the valve housing is open and clean. Install O-ring seal (5) in valve housing (4). Install O-ring seal (9) on elbow (6), and install the elbow on the valve housing.

5. Install O-ring seal (8) on valve (3). Install spring (2) and valve (3) in valve housing (4).

6. Install O-ring seal (7) on connector (1). Install connector (1) in valve housing (4).

End By:

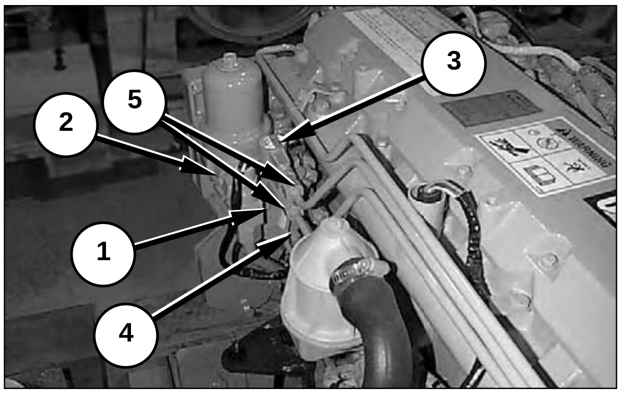
a. Install the fuel pressure regulating valve.

Fuel Transfer Pump

Remove and Install

NOTE: The group number related to this procedure is 148-0954.

1. Raise the radiator. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Radiator Tilt."



1. Disconnect and plug the fuel supply line. Remove tube assembly (5) from fuel transfer pump (3).

2. Remove the bolt and washer (4). Cut the strap that secures the wiring harness to the fuel transfer pump.

3. Remove clip and bolt (1), and carefully remove the fuel transfer pump and O-ring seal from hydraulic oil pump (2). Remove the fuel inlet and outlet port connectors from the fuel transfer pump.

4. Remove the O-ring seal from the hydraulic oil pump.

NOTE: The following steps are for the installation of the fuel transfer pump.

5. Check the condition of all parts of the fuel transfer pump. If any of the parts are worn or damaged, use new parts for replacement. Install the O-ring seal to hydraulic oil pump (2).

6. Install the fuel inlet and outlet port connectors to the fuel transfer pump. Tighten the inlet and outlet port connectors to a torque of **35 ± 3 N•m (26 ± 2 lb ft).**

7. Place fuel transfer pump (3) in position on hydraulic oil pump (2). Install the clip and bolt (1). Install bolt and washer (4). It may be necessary to compress the fuel transfer pump spring, or rotate the crankshaft, to get the bolts to line up for installation. Tighten bolts (1) and (4) to a torque of **24.5 ± 2.5 N•m (18 ± 2 lb ft).**

8. Install tube assembly (5), and the fuel supply line to the fuel transfer pump.

9. Secure the wiring harness to the fuel transfer pump with a strap.

Hydraulic Pump Group

Remove and Install

Start By:

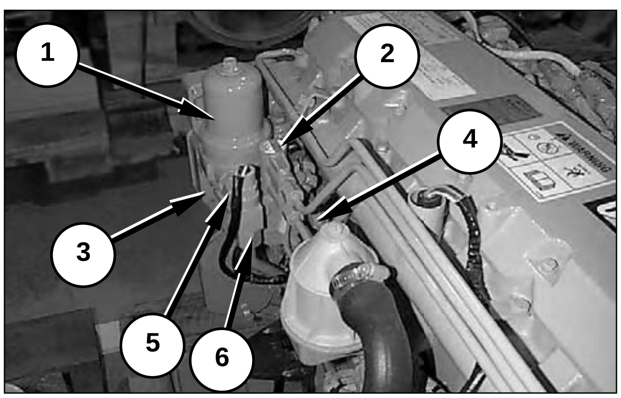
a. Remove the injection actuation pressure control valve.

NOTE: The group number related to this procedure is 107-1228.

1. Raise the radiator. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Radiator Tilt."

WARNING

At operating temperature, the engine oil is hot and under pressure. Hot oil can cause burns. Remove the hydraulic pump only when the engine is stopped and the hydraulic pump is cool enough to touch with your bare hand.

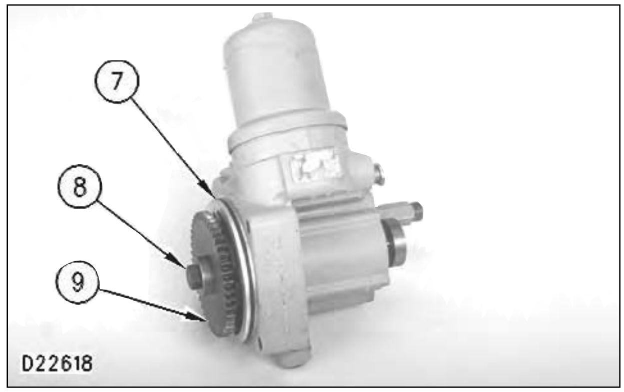


2. Remove fuel transfer pump (2). Refer to "Fuel Transfer Pump, Remove and Install."

3. Disconnect tube assemblies (4) and (6) from hydraulic pump group (1). The tube assemblies should be plugged as soon as the hydraulic pump group is removed from the engine.

4. Remove the three bolts that hold hydraulic oil pump group (1) to the front housing. Remove the hydraulic pump group.

5. Remove oil inlet connector (5) and oil outlet connector (3) from the hydraulic oil pump group (1).



6. Remove bolt (8) and the washer that holds hydraulic pump gear (9) to hydraulic pump group (1). Remove O-ring seal (7) from the hydraulic pump group.

NOTE: The following steps are for the installation of the hydraulic pump group.

7. Be sure the mounting surfaces for the hydraulic pump group are thoroughly clean.

8. Use bolt (8) and the washer to secure pump gear (9) on hydraulic pump group (1). Tighten bolt (8) to a torque of **108.8 ± 13.6 N•m (80 ± 10 lb ft).**

9. Lubricate with engine oil and install new O-ring seal (7) on hydraulic pump group (1).

10. Install oil inlet connector (5) and oil outlet connector (3) on hydraulic pump group (1).

11. Use three bolts and washers to install the hydraulic pump group to the front housing.

12. Use new O-ring seals to connect tube assemblies (4) and (6) to hydraulic pump group (1).

13. Install fuel transfer pump (2). Refer to "Fuel Transfer Pump, Remove and Install."

End By:

a. Install the injection actuation pressure control valve.

Injection Actuation Pressure Control Valve

Remove and Install

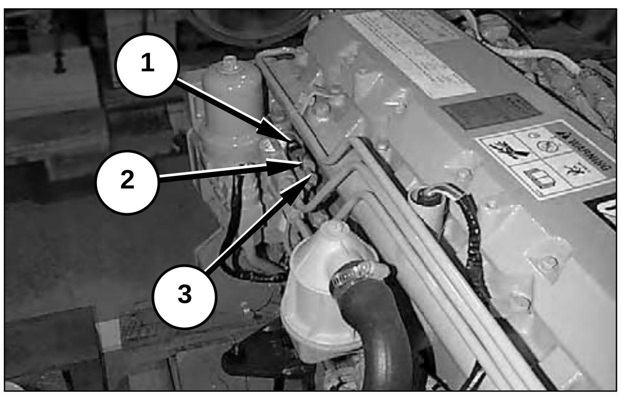
NOTE: The group number related to this procedure is 107-1228.

Tools Needed		A
5P-0333	Crowsfoot Wrench	1

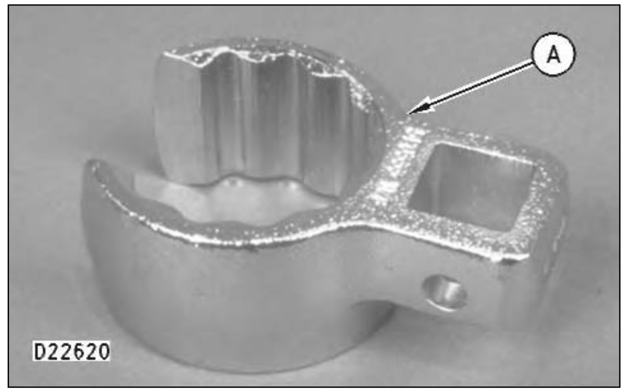
NOTICE

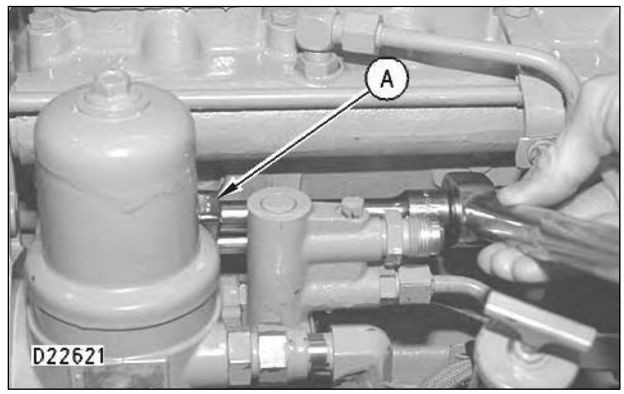
The removal procedure for the injection actuation pressure control valve requires caution. Use of unapproved tooling can result in damage to the injection actuation pressure control valve.

1. Raise the radiator. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Radiator Tilt."

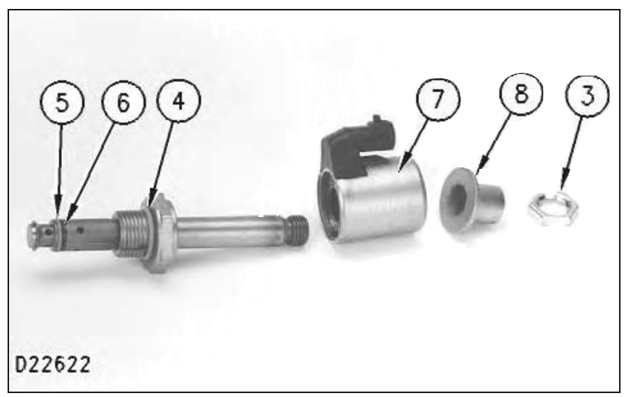


2. Disconnect wiring harness plug assembly (2) from the injection actuation pressure control valve.





3. Use Tooling (A) and an extension to remove the injection actuation pressure control valve from the hydraulic oil pump group.



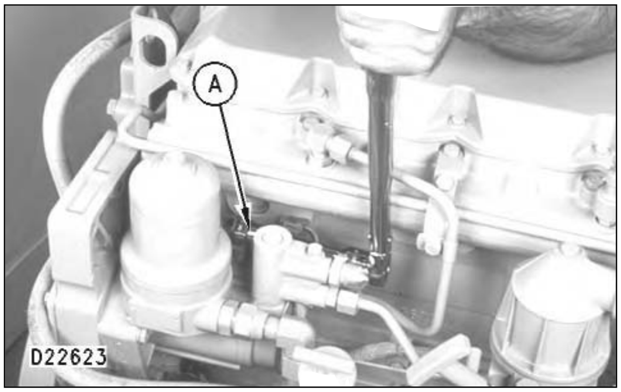
4. Remove nut (3), spacer (8), and coil assembly (7) from the injection actuation pressure control valve.

5. Remove O-ring seals (4) and (6), and backup ring (5) from injection actuation pressure control valve (1).

NOTE: The following steps are for the installation of injection actuation pressure control valve (1).

6. Install new O-ring seals in injection actuation pressure control valve (1).

7. Install new O-ring seals (4) and (6), and backup ring (5) on injection actuation pressure control valve (1). Lubricate the seals with clean engine oil.



8. Install solenoid valve (7), spacer (8), and nut (3) onto injection actuation pressure control valve (1). Tighten nut (3) to a torque of **5.5 ± 1.5 N•m (49 ± 13 lb in).**

9. Use Tooling (A) to install injection actuation pressure control valve (1) into the hydraulic oil pump group. Tighten the injection actuation pressure control valve to a torque of **50 ± 5 N•m (37 ± 4 lb ft)**.

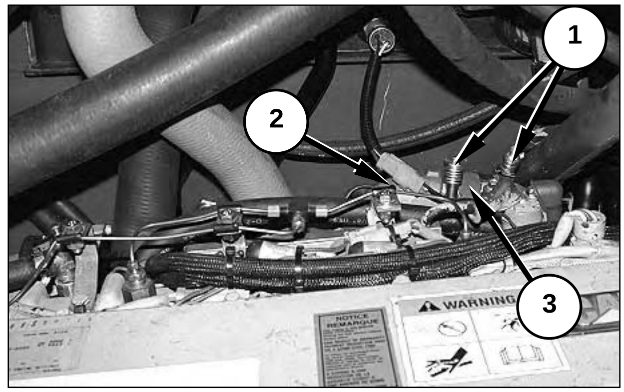
10. Connect wiring harness plug assembly (2) to injection actuation pressure control valve (1). Use a new weather pac seal on the wiring harness plug assembly for installation.

Intake Air Heater

Remove and Install

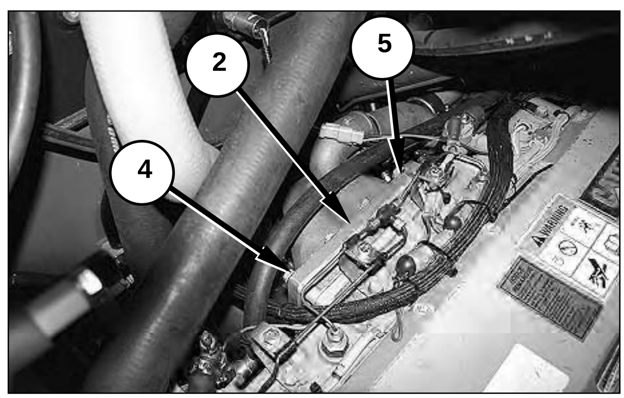
1. Raise the radiator. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* “Radiator Tilt.”

NOTE: Group numbers related to this procedure include 118-7284, 136-3939, and 148-0768.

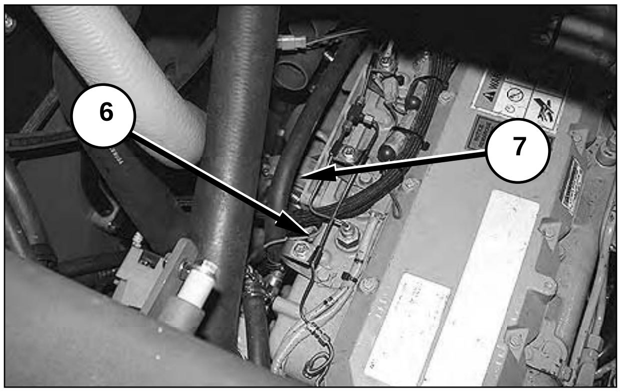


2. Loosen four hose clamps (1) and slide two intake hoses (3) off of intake elbow (2).

NOTE: Only the top intake hose (3) and hose clamps (1) are visible in the picture. There is another intake hose (3) with two hose clamps just below the visible top intake hose.



3. Remove three short bolts (5) and five long bolts (4), with the washers, from air inlet elbow (2).



4. Remove two nuts (6), and disconnect the wires leading to the intake air heater.

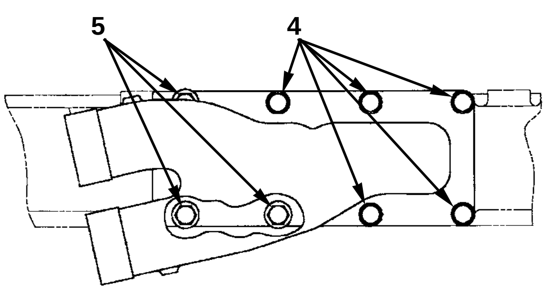
NOTE: Only one of two nuts (6) is visible in the photograph. The other nut and wire are on the opposite side of the intake air heater.

5. Remove intake air heater (7).

NOTE: The following steps are for the installation of the intake air heater.

6. Clean the intake air heater joint face with solvent. Apply **6V-1541 Quick Cure Primer** onto the joint face. Allow the primer to air dry for a **minimum of three to five minutes.**

7. Apply **1U-8846 Sealant** to the joint face of intake air heater (7) and on the joint face of air inlet elbow (2). The intake air heater and inlet elbows must be installed and tightened in position within ten minutes after the sealant is applied.



8. Put intake air heater (7) and inlet elbow (2) in position on the engine. Install three short bolts (5) and five long bolts (4) with the washers. Tighten all eight bolts to a torque of **30 ± 7 N•m (22 ± 5 lb).**

9. Connect two wires with nuts (6) to the intake air heater. Tighten the nuts to a torque of **13 ± 1 N•m (10 ± 1 lb ft).**

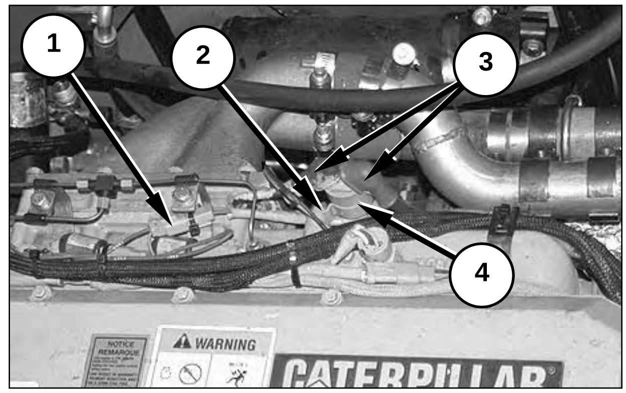
10. Install two intake hoses (3) and four hose clamps (1) on intake elbow (2).

Intake Air Heater Relay

Remove and Install

NOTE: The group number related to this procedure is 152-3385.

1. Raise the radiator. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* “Radiator Tilt.”



2. Disconnect two wire assemblies (3) from intake air heater relay (4). Mark the wires for correct location during reassembly. Cut the tie wrap and disconnect intake air heater relay connector (1).

NOTE: Intake air heater relay connector (1) is a two-pin connector. The wires in the connector are C987-RD and D796-OR.

3. Remove two bolts (2), and washers, and remove intake air heater relay (4).

NOTE: The following steps are for the installation of the intake air heater relay.

4. Use two bolts (2) and install intake air heater relay (4) onto the inlet manifold.

5. Connect intake air heater relay connector (1) and install a new tie wrap to secure the connector.

6. Connect two wire assemblies (3) to intake air heater relay (4). Tighten the nut that holds wire assemblies (3) to the solenoid, to a torque of **6 ± 0.5 N•m (53 ± 4 lb in).**

Inlet Air Lines Group

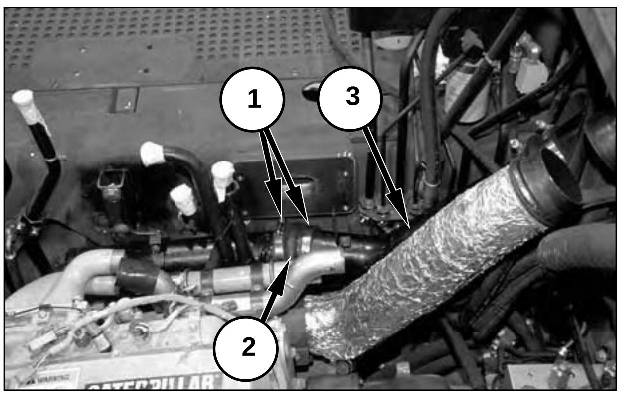
Remove and Install

Start By:

a. Remove the alternator.

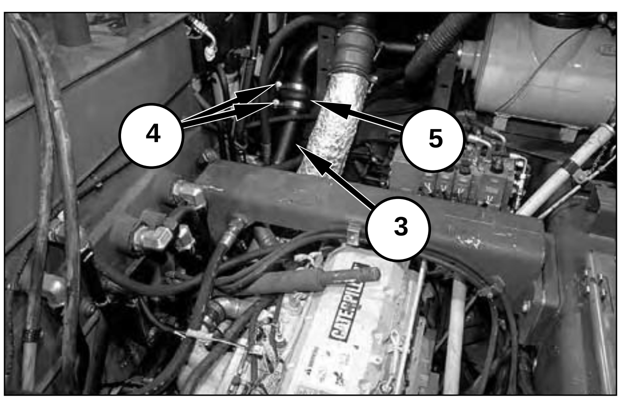
NOTE: This procedure can be performed with the cooling system assembly installed and the radiator raised. However, more room is available if the cooling system assembly has been removed. If the cooling system assembly is removed, the alternator does not need to be removed to perform this procedure.

NOTE: Group numbers related to this procedure include 145-0071 and 165-9001.



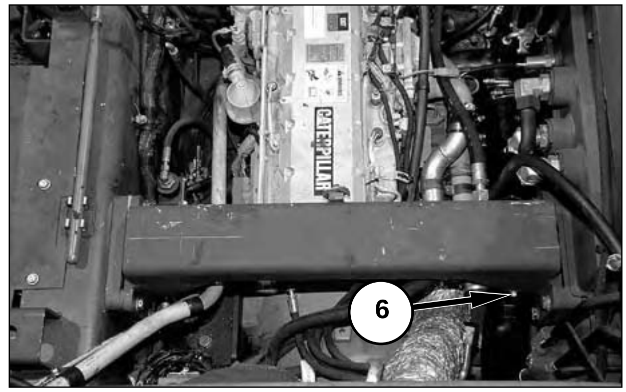
Machine Shown Partially Disassembled for Photographic Purposes.

1. Loosen clamps (1), and slide hose (2) onto middle pipe section (3).



Machine Shown Partially Disassembled for Photographic Purposes.

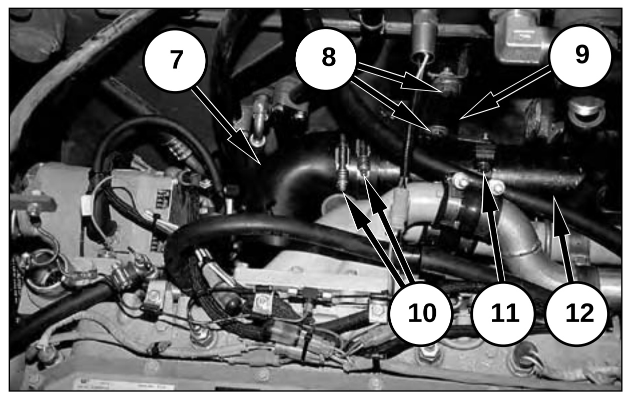
2. Loosen clamps (4), and slide hose (5) onto middle pipe section (3).



Machine Shown Partially Disassembled for Photographic Purposes

3. Remove bolt (6) and the nut and two washers.

4. Remove middle pipe section (3) with clamps (1) and (4) and hoses (2) and (5).



Machine Shown Partially Disassembled for Photographic Purposes

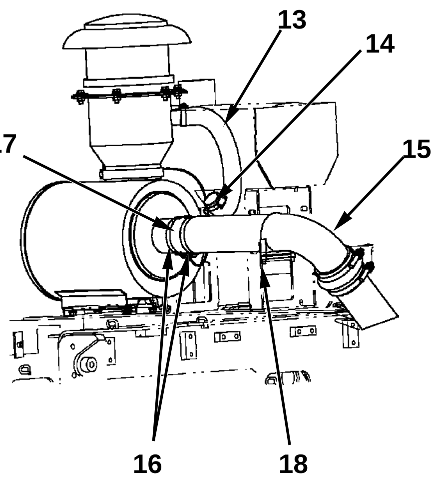
5. Loosen three clamps (10) and remove hose (7).

NOTE: Only two of three clamps (10) are visible. The third clamp is on the other end of hose (7), where the hose connects to the turbocharger.

5. Remove bolt (11) with the washer and nut, and remove the clamp.

6. Remove two bolts (8) with the large washers. Remove plate (9) and remove pipe (12).

NOTE: During reassembly, orient pipe (12) so the angle on the end of the pipe points up and towards the center of the machine.



7. Loosen clamp (14), and disconnect dust ejector line (13).

8. Loosen two clamps (16).

9. Remove two nuts, and remove pipe clamp (18).

10. Remove upper pipe section (15) from hose (17).

11. Remove upper pipe section (15) from machine.

11. Remove hose (17) with two clamps (16) from the air cleaner.

NOTE: To install the inlet air lines group, reverse the removal steps.

End By:

a. Install the alternator.

Inlet Manifold

Remove and Install

Tools Needed	A
125-2588 Allen Wrench	1

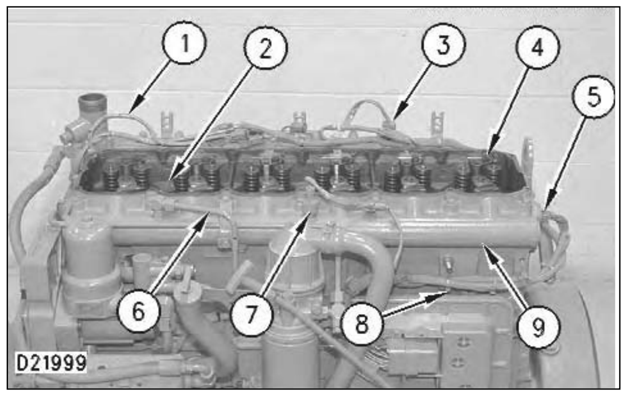
Start By:

a. Remove the rocker arm assemblies and pushrods.

b. Remove the intake air heater.

c. Remove the intake air heater relay.

NOTE: Group numbers related to this procedure include 117-1678 and 150-9573.



1. Disconnect coolant temperature sensor (1) from the wiring harness. Cut the straps that hold the coolant temperature sensor to inlet manifold (9).

2. Mark for identification the top and bottom speed and timing sensor wires. Disconnect the wiring harness plug assemblies from the two speed and timing sensors.

NOTE: For location of the speed and timing sensors, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Engine Electrical System, Electronic Control System."

3. Disconnect injection actuation pressure sensor (7) from the wiring harness, and remove the sensor from the engine.

4. Cut straps (8) that hold the wiring harness to the engine.

5. Disconnect tube assembly (6) from inlet manifold (9).

6. Remove six wiring harness plug assemblies (2) from the fuel injector pumps.

7. Cut the straps that hold the wiring harness to the inlet manifold. Use Tooling (A) and remove the screw from grommet (5). Remove grommet (5), and the stop, from inlet manifold (9). Remove the wiring harness from the inlet manifold.

8. Remove 18 bolts (4) that hold inlet manifold (9) to the cylinder head assembly. Remove the inlet manifold and the gasket from the cylinder head assembly.

9. Disconnect air temperature sensor (3) from the wiring harness, and remove the sensor from inlet manifold (9).

10. Remove five plugs (2) from inlet manifold (9). Remove the O-ring seals from the six plugs.

NOTE: The following steps are for the installation of the inlet manifold (9).

11. Install new O-ring seals on the six plugs (2). Install the six plugs in inlet manifold (9).

12. Install air temperature sensor (3) in inlet manifold (9).

13. Use new straps to install the wiring harness to inlet manifold (9). Install grommet (5) in the inlet manifold. Use Tooling (A) to tighten the wiring harness grommet screw to a torque of **9 ± 0.1 N•m (7 ± 0.1 lb ft)**. Do not overtighten the grommet screw.

14. Be sure the mating surfaces of inlet manifold (9) and the cylinder head assembly are thoroughly clean. Use a new gasket and 18 bolts (4) to install inlet manifold (9) to the cylinder head assembly.

15. Install six wiring harness plug assemblies (2) to the fuel injector pumps.

16. Connect tube assembly (6) to inlet manifold (9).

17. Secure the wiring harness to the engine with new straps (8).

18. Install injection actuation pressure sensor (7) to the engine.

19. Install the two wiring harness plug assemblies to the two speed and timing sensors.

20. Connect coolant temperature sensor (1) to the wiring harness. Use new straps and secure the coolant temperature sensor to inlet manifold (9).

End By:

a. Install the intake air heater relay.

b. Install the intake air heater.

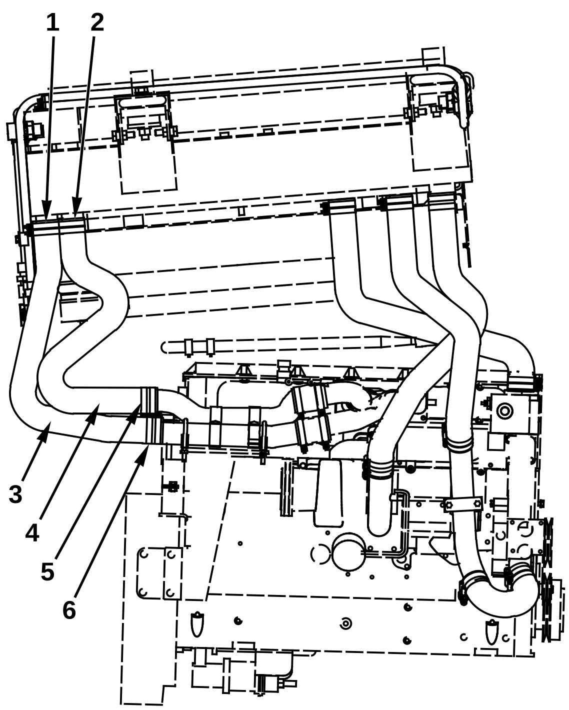
c. Install the rocker arm assemblies and pushrods.

Intercooler Lines

Remove and Install

NOTE: The group number related to this procedure is 136-3939.

1. Raise the radiator. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Radiator Tilt."



Right Hand Side View.

2. Loosen two clamps (5) on hose (4), and remove the hose from the air inlet elbow.

3. Loosen two clamps (6) on hose (3), and remove the hose from the air inlet elbow.

4. Loosen clamp (2), and remove hose (4) from the intercooler.

5. Loosen clamp (1), and remove hose (3) from the intercooler.

NOTE: To install the intercooler lines, reverse the removal steps.

NOTICE

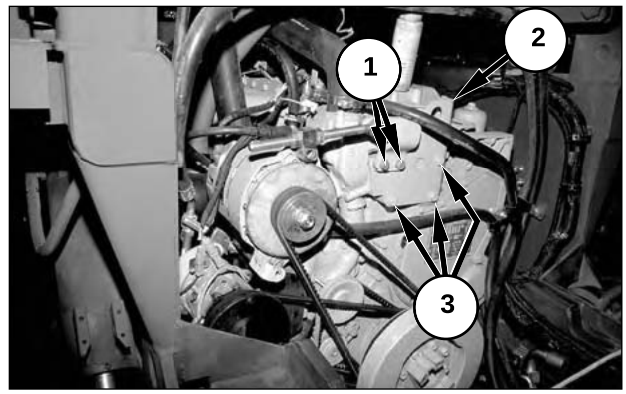
Improper installation of the intercooler hoses may result in black smoke from the exhaust and a loss of engine power.

Lifting Group, Front

Remove and Install

NOTE: Group numbers related to this procedure include 130-2789 and 141-8267.

1. Release the tension on the alternator belt. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Maintenance Intervals, Every 250 Service Hours or Three Months, Engine V-Belts."



2. Remove two bolts (1) with the washers, three bolts (3) with washers, and front lifting group (2).

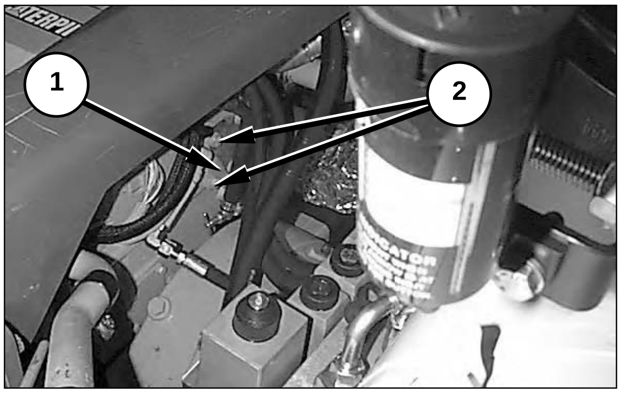
NOTE: To install the front lifting group, reverse the removal steps.

Lifting Group, Rear

Remove and Install

NOTE: The group number related to this procedure is 141-8267.

1. Raise the radiator. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* “Radiator Tilt.”



View through air intake compartment.

2. Remove four bolts (1), with the washers, that hold rear engine lifting plate (2) to the cylinder head assembly. Remove the rear engine lifting plate.

NOTE: To install the rear lifting group, reverse the removal steps.

Muffler Group

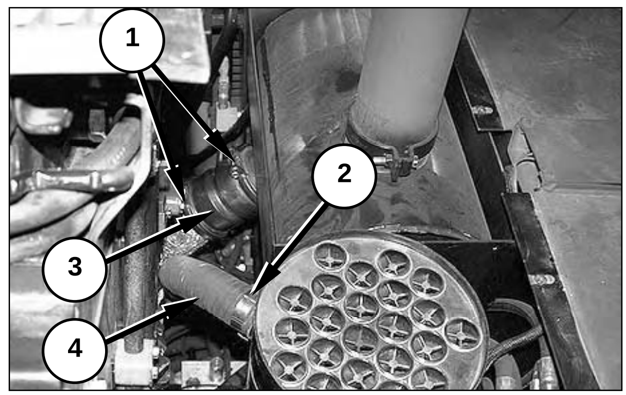
Remove and Install

Start By:

a. Remove the middle top cover. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Machine Systems,* “Middle Top Cover.”

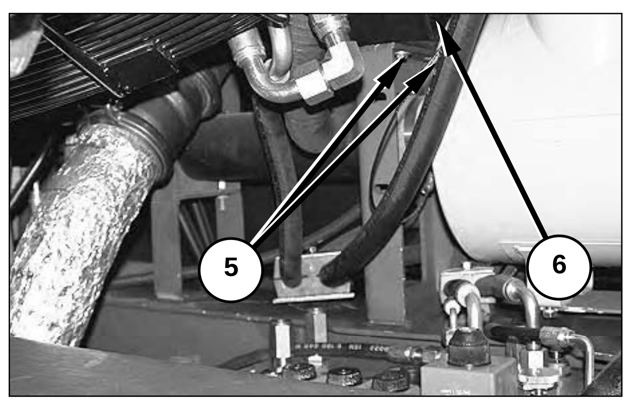
NOTE: Group numbers related to this procedure include 124-3608, 136-1145 and 145-0071.

1. Raise the radiator. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* “Radiator Tilt.”



2. Remove two bolts (1), with nuts, on muffler adapter (3). Slide the muffler adapter with the clamps and gaskets up, so that the adapter is disconnected from the exhaust tube.

3. Loosen hose clamp (2), and disconnect dust ejector line (4) from the air cleaner group.



4. Remove four bolts (5), with the washers, from the bottom of muffler group (6).

NOTE: Two bolts (5) are visible in the picture. There are two more bolts in the same location, on the right side of muffler group (6).

NOTE: To install the muffler group, reverse the removal steps.

End By:

a. Install the middle top cover.

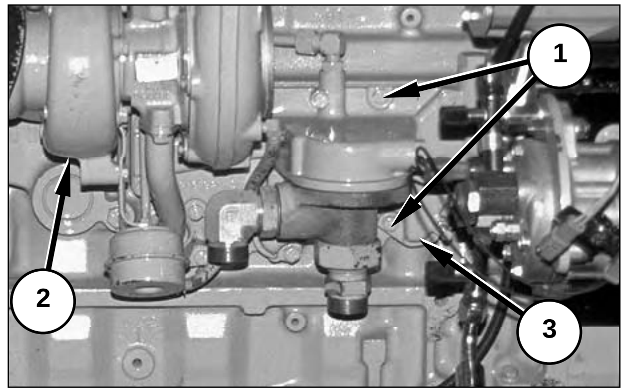
Oil Cooler

Remove and Install

Start By:

a. Remove the engine assembly and torque converter.

NOTE: The group number related to this procedure is 100-6269.



1. Remove turbocharger (2). Refer to “Turbocharger, Remove and Install.”

2. Remove 15 bolts (1), with the washers, and engine oil cooler (3), with the gasket and O-ring. Replace the gasket and O-ring if they are damaged or worn.

NOTE: To install the oil cooler, reverse the removal steps.

End By:

a. Install the engine assembly and torque converter.

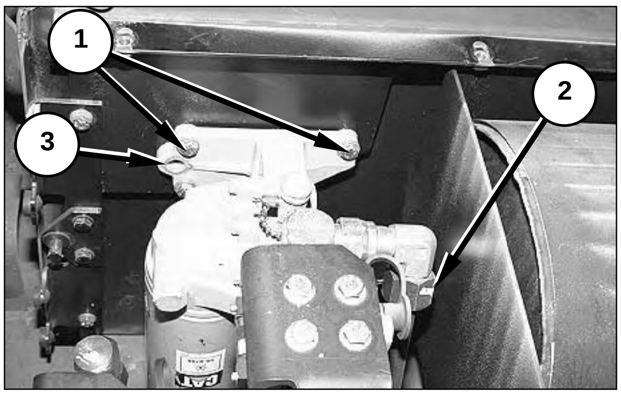
Oil Filter Base

Remove and Install

Start By:

a. Remove the middle top cover. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Machine Systems,* "Middle Top Cover."

NOTE: Group numbers related to this procedure include 180-9106 and 175-3222.



1. Remove the engine oil filter on filter base (3).

NOTE: Some oil may leak from the engine oil filter and filter base (3) when the engine oil filter is removed. Catch the oil in a suitable container, and dispose of the liquid according to local regulations.

2. Disconnect, cap and then plug two lines (2).

NOTE: Only one of two lines (2) is visible in the photograph.

NOTE: Some oil may leak from lines (2) when they are disconnected. Catch the oil in a suitable container, and dispose of the liquid according to local regulations.

3. Remove three bolts (1) with the washers, and oil filter base (3).

NOTE: To install the oil filter base, reverse the removal steps.

End By:

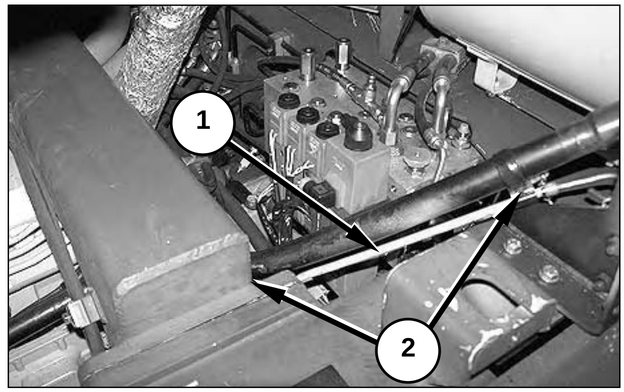
a. Install the middle top cover.

Oil Level Gauge Group

Remove and Install

NOTE: The group number related to this procedure is 145-7262.

1. Raise the radiator. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Radiator Tilt."



2. Remove two bolts (2) with the washers, and clamps.

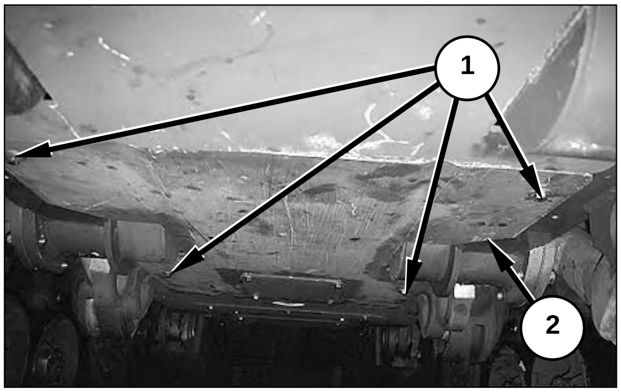
3. Loosen the nut which secures oil level gauge group (1) to the engine block, and remove the oil level gauge group.

NOTE: To install the oil level gauge group, reverse the removal steps.

Oil Pan

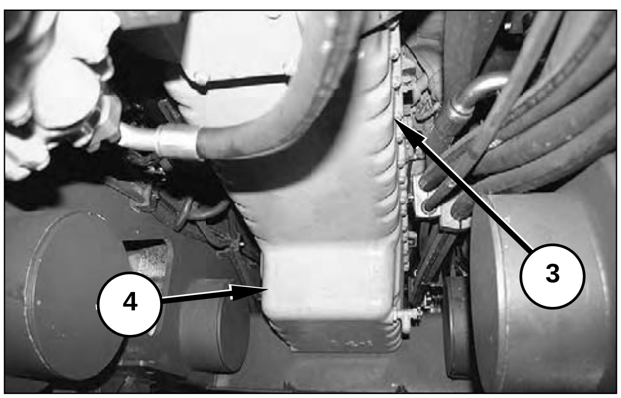
Remove and Install

NOTE: The group number related to this procedure is 126-5931.



1. Remove four bolts (1) with the washers, and cover (2). The weight of the cover is **50.5 kg (111 lb).**

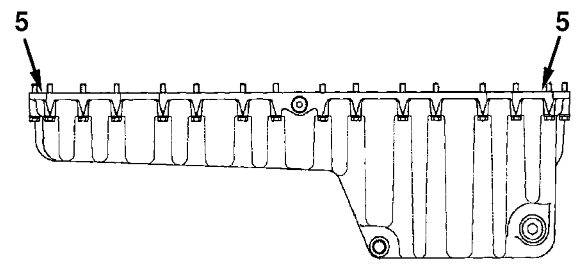
NOTE: If dirt or other debris has accumulated on the top side, the bottom cover may weigh more than **50.5 kg (111 lb)**. Use a suitable floor jack or other tool to support the bottom cover if there is a large amount of debris.



2. Drain the oil from the engine into a suitable container, and dispose of the liquid according to local regulations.

3. Remove 36 bolts (3) and washers that hold oil pan (4) to the cylinder block. Remove the oil pan and the gasket. Do not pry or gouge oil pan sealing surface. Tap the oil pan with a rubber mallet to loosen the oil pan, if necessary.

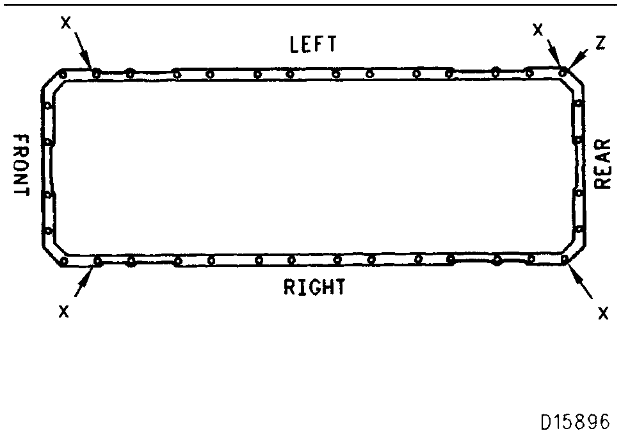
NOTE: The following steps are for the installation of the oil pan.



4. Clean the mating surfaces of the oil pan and the cylinder block. Apply **1U-8846 Sealant** to the four places (5) at the T-joints of the front housing to the cylinder block and at the flywheel housing to the cylinder block. Use approximately **0.5 mm (0.02 in)** at each of the four places. Do not apply liquid gasket on the oil pan gasket or on the gasket surface of the oil pan.

NOTICE

At the time of installation, do not overtighten the oil pan drain plug. The threads for the oil pan drain plug can be damaged if the drain plug is overtightened. Prior to filling the engine with oil, tighten the drain plug to a torque of 25 ± 5 N•m (18 ± 4 lb ft).



5. Put a new gasket and oil pan (4) in position on the cylinder block. Install all 36 washers and bolts (3) that hold the oil pan in position. Tighten four bolts (3) marked “X,” as shown above, to a torque of **31 ± 3 N•m (23 ± 2 lb ft)**. Then, starting at the left rear corner of the oil pan and working counterclockwise, tighten the 32 remaining bolts (3).

6. Torque all bolts a second time, counterclockwise, starting at the bolt marked “Z” and working counterclockwise, to a torque of **31 ± 3 N•m (23 ± 2 lb ft).**

7. Fill the engine with the correct amount and type of oil. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Every 250 Service Hours or Three Months, Engine Oil and Filter, Replace."

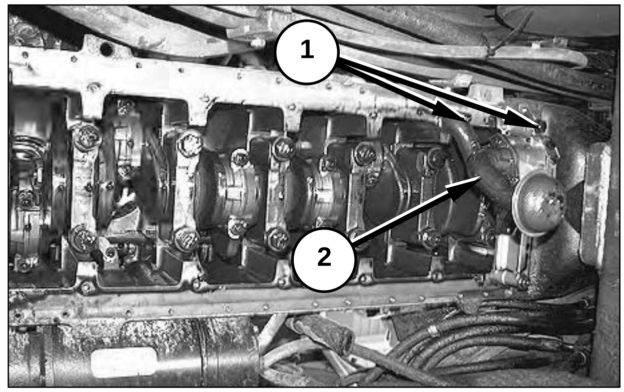
Oil Pump (Engine)

Remove and Install

Start By:

a. Remove the oil pan.

NOTE: The group number related to this procedure is 210-5559.



1. Remove three bolts (1) (two shown) and the washers that hold the oil pump in position. Remove oil pump (2) and the O-ring seal.

NOTE: The following steps are for the installation of the oil pump.

2. Be sure the mounting surfaces for the oil pump are thoroughly clean. Be sure the O-ring seal at the disconnect face is new and in place.

3. Install the oil pump in the reverse order of removal.

4. Fill the engine with the correct quantity and type of oil. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Lubricant Viscosities and Refill Capacities."

End By:

a. Install the oil pan.

Piston and Connecting Rod Assemblies

Remove and Install

Tools Needed	A
1U-6684 Piston Ring Compressor	1

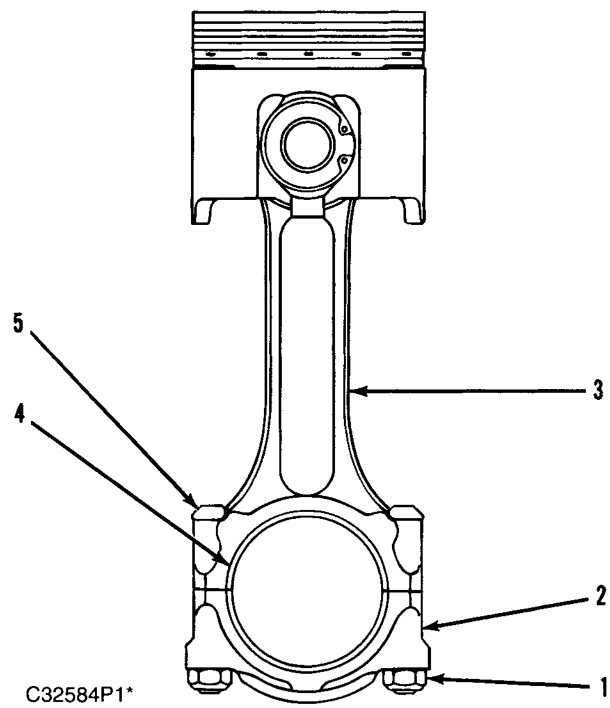
Start By:

a. Remove the cylinder head assembly.

b. Remove the oil pump.

c. Remove the piston cooling tubes.

NOTE: The group number related to this procedure is 147-9592.



C32584P1*

1. Check the connecting rods and caps for their identification and location.

2. Remove rod cap nuts (1) and rod bearing cap (2) from connecting rod (3). Remove the lower half of rod bearing (4) from rod bearing cap (2).

NOTICE
To protect the crankshaft from the threaded portion of connecting rod bolts (5), cut short pieces of rubber hose and install them over both rod bolts (5).

3. Remove the piston and the connecting rod, then remove the upper half of rod bearing (4).

NOTE: The following steps are for the installation of the pistons and the connecting rod assemblies.

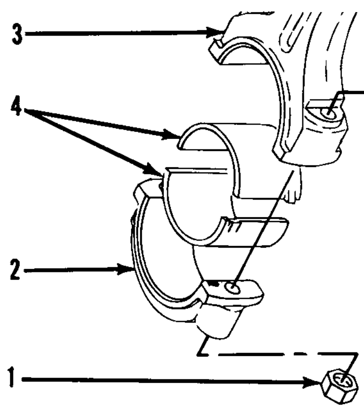
4. Put clean engine oil on the piston rings, the connecting rod bearings and the cylinder bore.

5. Position the piston ring end gaps **120 degrees** apart and install Tooling (A).

6. Put the short pieces of hose over the threaded portion of rod bolts (5), to protect the crankshaft.

7. With the number-one crankshaft throw at bottom center, carefully install the piston and the connecting rod.

8. Taking care to line up the connecting rod and the crankshaft, and carefully tap the piston into the cylinder bore until Tooling (A) comes off the piston.



C32585P1*

9. Before connecting rod (3) comes in contact with the crankshaft, install the upper half of rod bearing (4). Be sure the bearing tab engages the groove in the connecting rod.

10. Put clean engine oil on the upper surface of rod bearing (4), and then tap the piston down, guiding the connecting rod onto the crankshaft.

11. Position the lower half of rod bearing (4) in the corresponding numbered rod bearing cap (2). Be sure the bearing tab engages the groove in the rod bearing caps.

12. Put clean engine oil on the lower surface of rod bearing (4). Install rod bearing cap (2). Install the rod bearing cap on the connecting rod, with the number on the rod bearing cap on the same side as the number on the connecting rod.

13. Put clean engine oil on the threads of rod bolts (5). Install rod cap nuts (1) and tighten them to a torque of **54 ± 7 N•m (40 ± 5 lb ft).**

14. Put an alignment mark on each rod cap nut (1). Tighten each nut an additional **60 ± 5 degrees (1/6 turn).**

15. Repeat the steps for the remainder of the pistons and the connecting rods.

End By:

a. Install the piston cooling tubes.

b. Install the oil pump.

c. Install the cylinder head assembly.

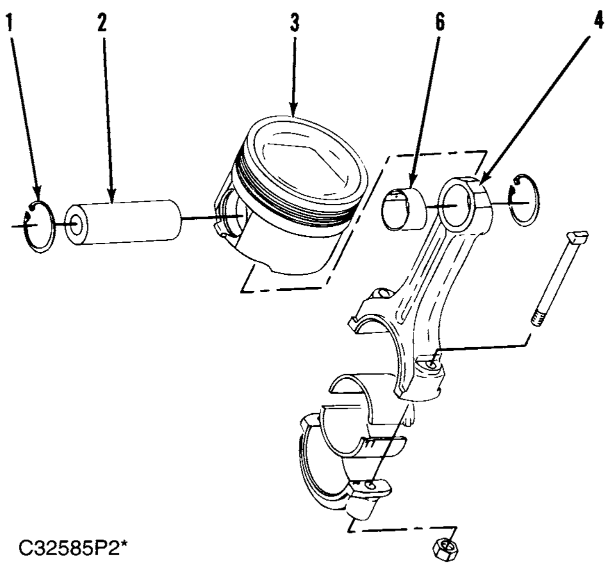
Disassemble and Assemble

Tools Needed	A
4C-3601 Piston Ring Expander	1

Start By:

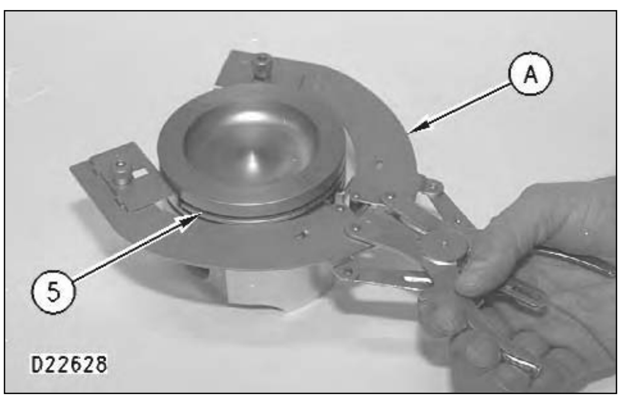
a. Remove the pistons and connecting rod assemblies.

NOTE: The group number related to this procedure is 147-9592.



C32585P2*

1. Remove snap rings (1) and piston pin (2) from piston (3). Separate the piston and connecting rod (4). Remove rod bearing (6) from the connecting rod.



D22628

2. Use Tooling (A) to remove three piston rings (5) from the piston.

NOTE: The following steps are for the assembly of the pistons and connecting rods.

3. Check the clearance between the ends of piston rings (5).

NOTE: The oil ring is to be installed over the spring, with the end gap **180 degrees** from the oil ring spring joint.

4. Install the oil ring onto the piston with Tooling (A).

5. Install the second (intermediate) piston ring with the marking “UP-2” toward the top of the piston. Use Tooling (A) to install the ring.

6. Install the first (top) piston ring with the marking “UP-1” facing the top of the piston. Use Tooling (A) to install the ring.

NOTE: After the installation of all three piston rings (5), put the piston rings in position so the end gaps are **120 degrees** apart.

7. Replace rod bearing (6) by pressing the new bearing into place.

8. Put piston (3) in position on connecting rod (4). Coat piston pin (2) with clean engine oil, and install the pin. Install snap rings (1). Make sure the snap rings are in the grooves of piston (3).

End By:

a. Install the pistons and connecting rod assemblies.

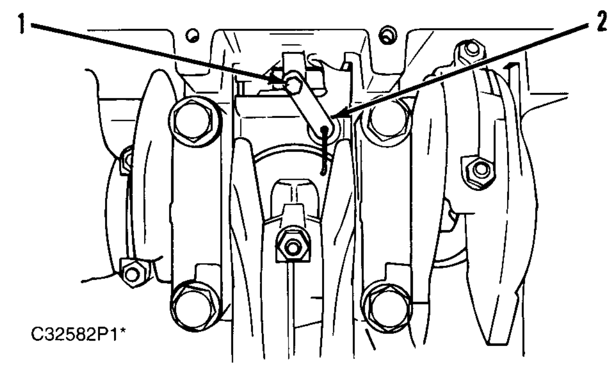
Piston Cooling Tubes

Remove and Install

Start By:

a. Remove the oil pump.

NOTE: The group number related to this procedure is 147-9592.



1. Remove bolt (1) and piston cooling tube (2).

2. Remove the remainder of the piston cooling tubes as in Step 1.

NOTE: The following steps are for the installation of the piston cooling tubes.

NOTICE

Seat piston cooling tube (2) properly, prior to tightening bolt (1), which holds the tube in place.

3. Put piston cooling tube (2) in position, in the cylinder block.

4. Be sure the piston cooling tube is seated properly; then install bolt (1) which holds the tube in position.

NOTICE

Hold the piston cooling tube in position when the mounting bolt is tightened. If the cooling tube is not held in position, the cooling tube may bend or break.

5. Install the remainder of the piston cooling tubes as in Steps 3 and 4.

End By:

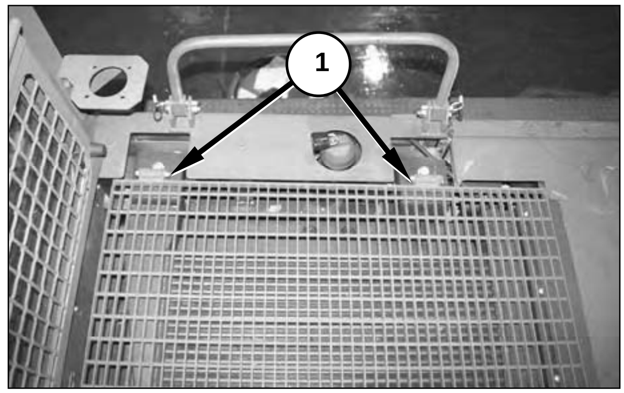
a. Install the oil pump.

Radiator Group

Remove and Install

Tools Needed	
138-7573 Link Bracket	4

NOTE: Group numbers related to this procedure include 124-5855, 124-9756, 125-5578, 136-3939, and 144-8603.



1. Remove two bolts with the washers, and two pins (1). Remove the guard. Upon reassembly, apply a thin coat of **5P-0960 Multipurpose Grease** to the bolts.

WARNING

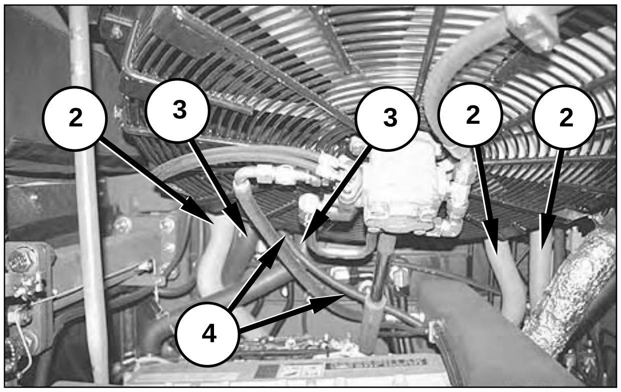
At operating temperature, the engine coolant is hot and under pressure. Steam can cause personal injury. Check the coolant level only after the engine has been stopped and the fill cap is cool enough to touch with your bare hand. Remove the fill cap slowly to relieve the pressure in the cooling system. The cooling system conditioner contains alkali. Avoid contact with the skin and eyes to prevent personal injury.

2. Drain the coolant from the radiator. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Cooling System."

WARNING

The air-conditioning system is charged with an air-conditioning refrigerant. Inhaling the refrigerant through a lit cigarette could cause violent illness. This system is under pressure at all times, whether the engine is running or not. Heat should never be applied to a charged system.

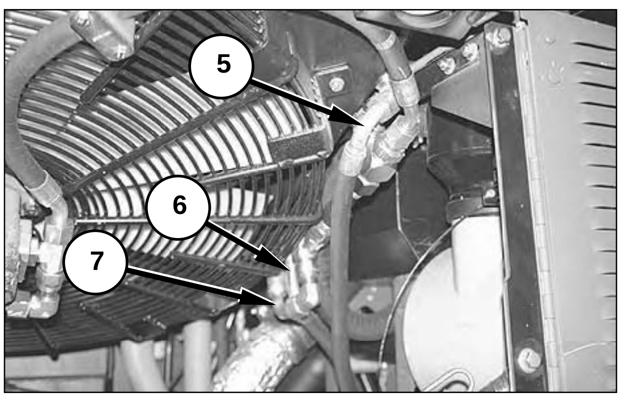
3. Recover the refrigerant from the air-conditioning system. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Machine Systems,* "Testing and Adjusting, Recovering the Refrigerant."



4. Remove six hose clamps and three aftercooler lines (2). Mark the lines for correct connection during reassembly.

5. Remove four hose clamps and two coolant lines (3). Mark the lines for correct connection during reassembly.

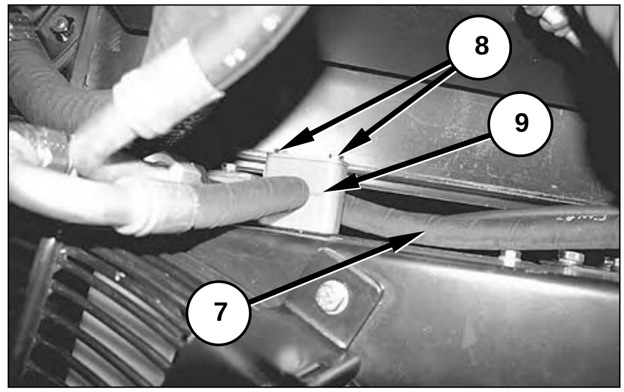
6. Remove one hose clamp and disconnect, cap and then plug coolant lines (4).



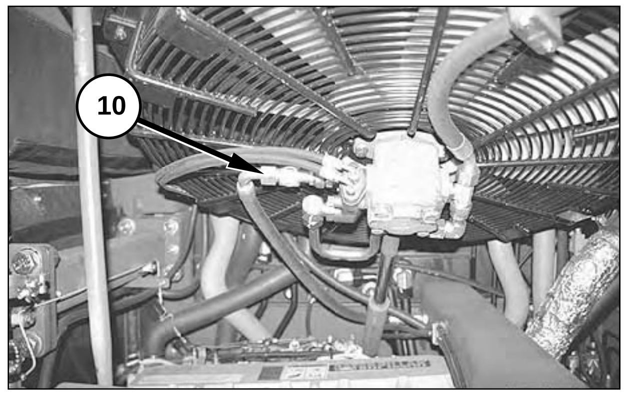
7. Disconnect, cap and then plug line (7).

8. Disconnect, cap and then plug line (6).

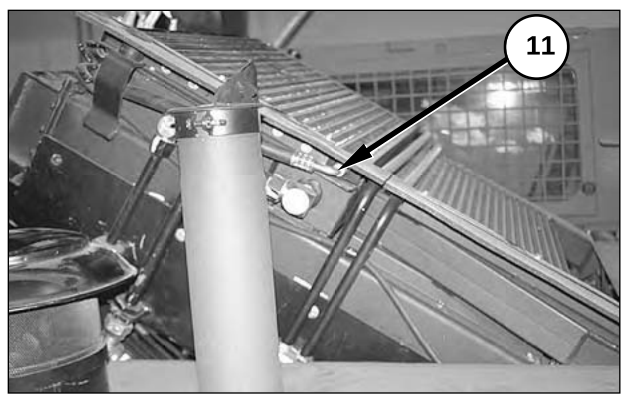
9. Disconnect, cap and then plug line (5).



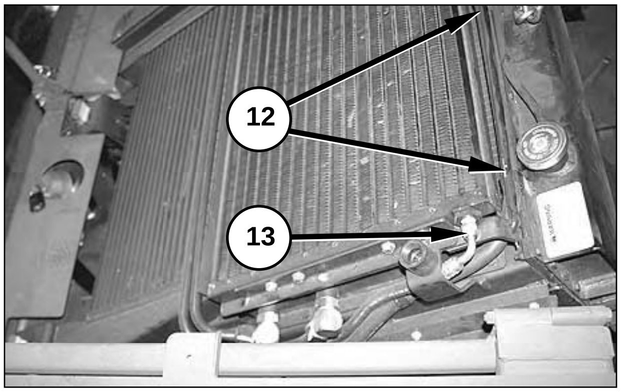
10. Remove two bolts (8) with the washers, and clamp assembly (9) from line (7).



11. Disconnect, cap and then plug fan supply line (10).

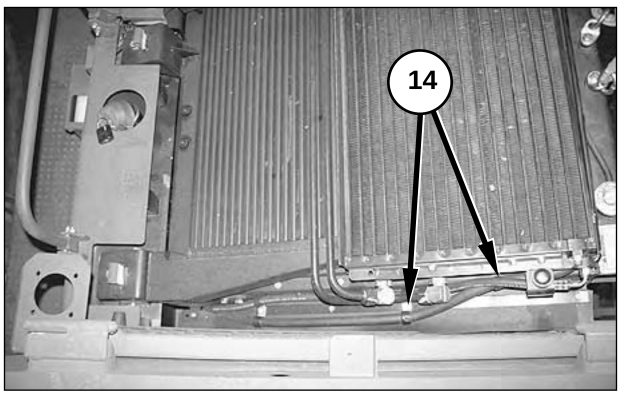


12. Disconnect air-conditioning line (11).

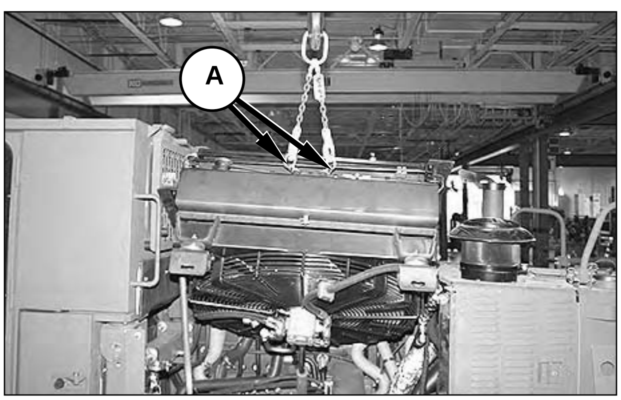


13. Remove two clamps (12) with bolts, nuts and washers that fasten the air-conditioning line to the front of the radiator.

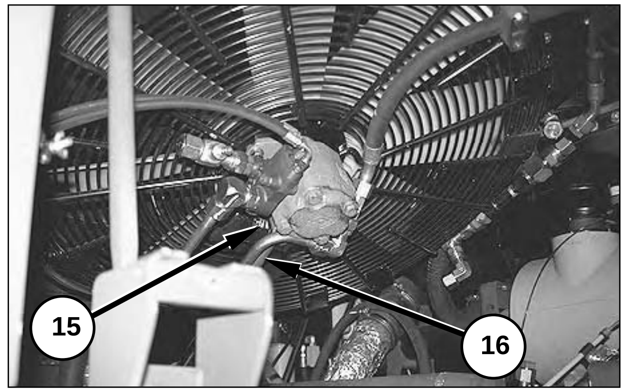
14. Disconnect air-conditioning line (13).



15. Remove two clamps (14) with the bolts, nuts and washers.



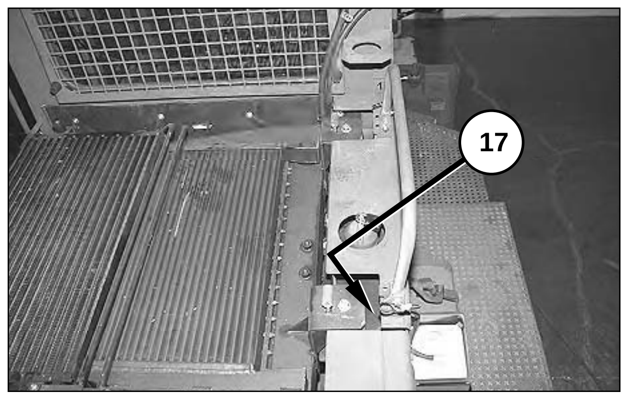
16. Install Tooling (A), and support the left side of the radiator assembly with a hoist.



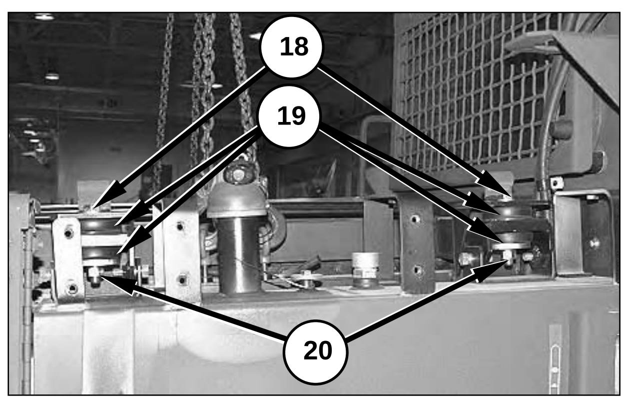
17. Remove bolt (15) with two spacers and one nut from radiator tilt cylinder (16).

18. Retract radiator tilt cylinder (16), and use the hoist to lower the radiator.

19. Remove the hydraulic tank cover. Refer to *Disassemble and Assemble, Deployable Universal Combat Earthmover (DEUCE), Machine Systems,* "Hydraulic Tank Cover."



20. Remove bolt (17) with clamp, and lay overflow hose on top of the radiator group.



21. Install Tooling (A) to the right side of the radiator, and fasten the hoist to Tooling (A).

22. Remove two bolts (18), with four isolation mounts (19), two nuts (20), and four washers.

23. Remove the radiator assembly. The weight of the radiator assembly is **365 kg (800 lb).**

NOTE: To install the cooling system assembly, reverse the removal steps.

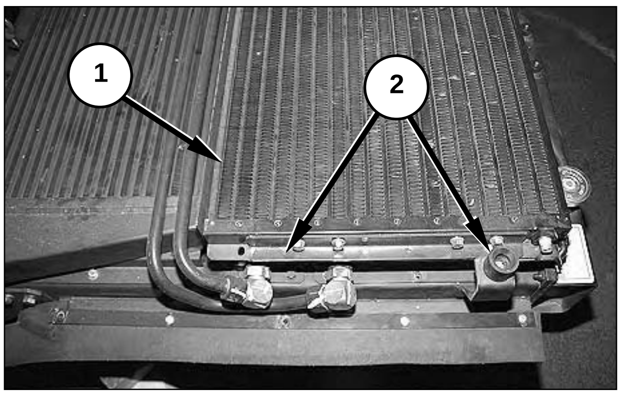
Disassemble and Assemble

Tools Needed	A
138-7575 Link Bracket (1/2 in)	2

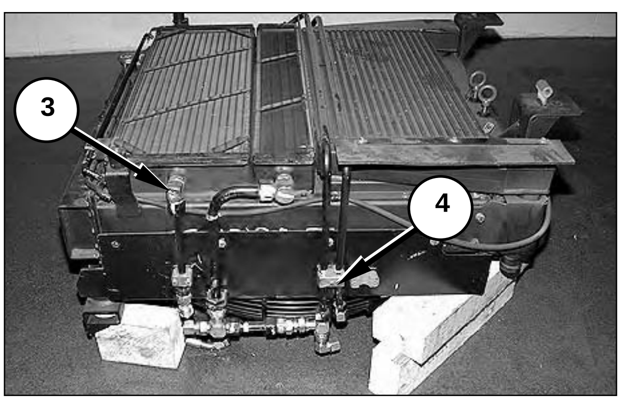
Start By:

a. Remove the radiator group.

NOTE: Group numbers related to this procedure include 125-5579 and 145-5009.

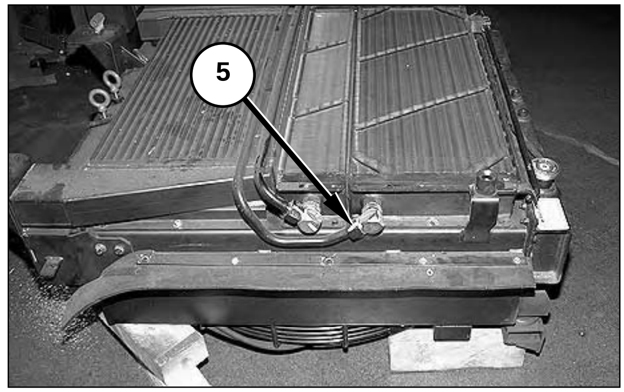


1. Remove two bolts (2), with two nuts and four washers, from both sides of air-conditioning condenser (1), and remove the air-conditioning condenser.

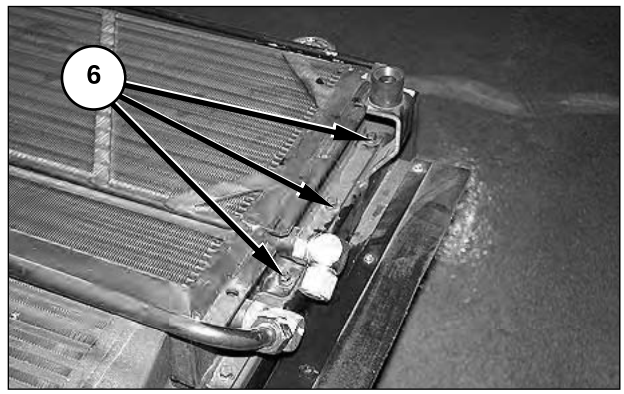


2. Remove bolt (4) with the retainer, and two clamp halves.

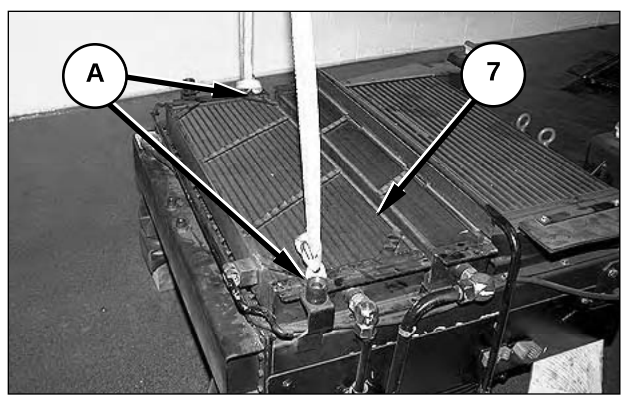
3. Disconnect line (3).



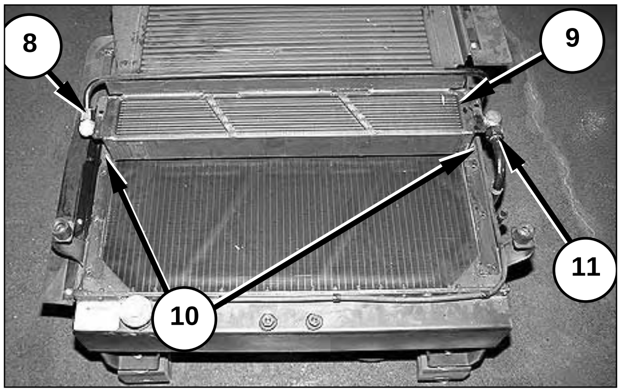
4. Disconnect, cap, plug and remove line (5).



5. Remove three bolts (6) with the flat and lock washers from both sides of the power train oil cooler.



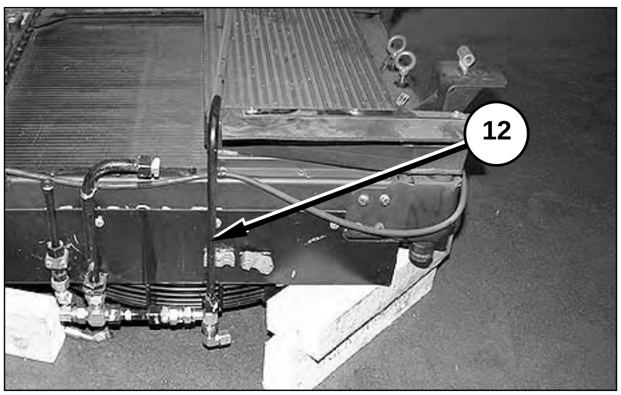
6. Attach Tooling (A) and fasten a hoist to power train oil cooler (7). Remove the power train oil cooler. The weight of the power train oil cooler is **45 kg (99 lb).**



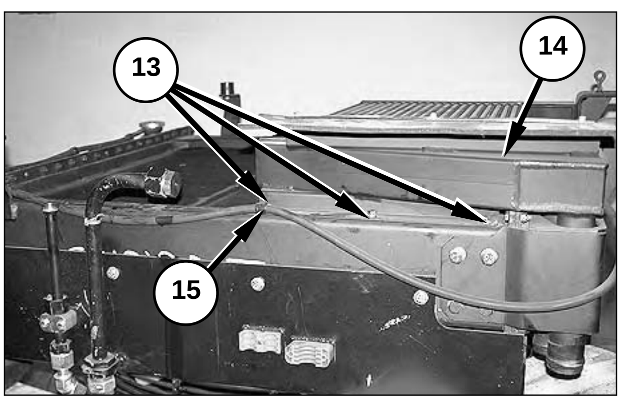
7. Disconnect, cap and then plug lines (8) and (11) from hydraulic oil cooler (9).

8. Remove four bolts (10, only two shown) with the flat and lock washers from hydraulic oil cooler (9).

9. Remove hydraulic oil cooler (9).

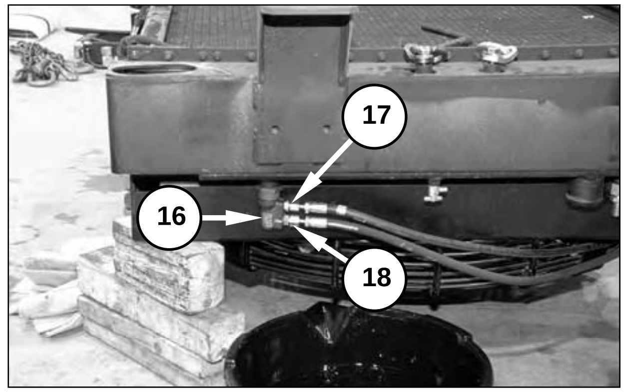


10. Disconnect, cap and then plug line (12). Remove line (12).

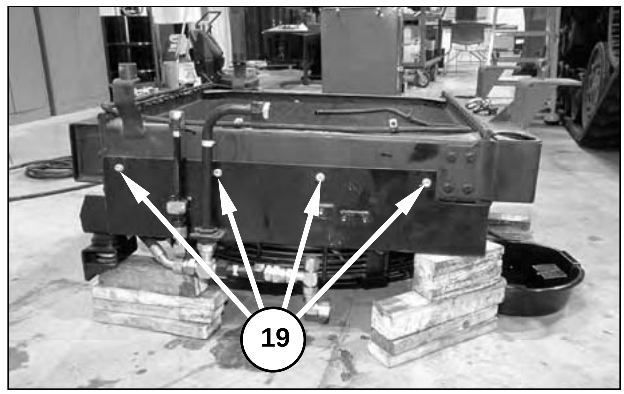


11. Remove three bolts with flat and lock washers (13), and remove clamp (15) from air-to-air aftercooler (14). Remove three bolts the with flat and lock washers from the other side of the air-to-air aftercooler.

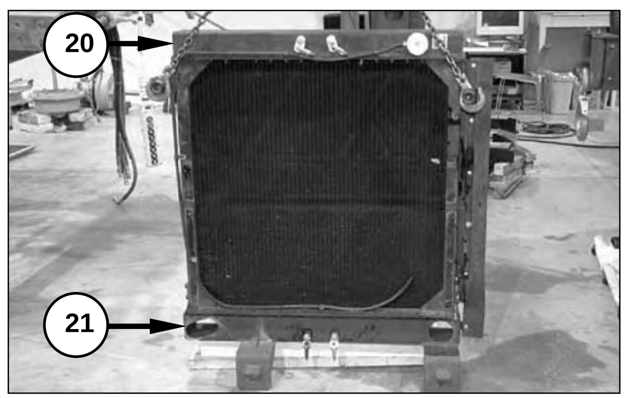
12. Remove air-to-air aftercooler (14).



13. Disconnect, cap and plug inlet line (18) and outlet line (17) from fan motor coolant temperature valve (16).



14. Remove four bolts (19) with the washers from both sides of the radiator.



15. Attach a lifting device to the radiator assembly, and set the radiator on bottom tank (21). The radiator assembly weighs approximately **75 kg (165 lb)**.

NOTICE

When the radiator assembly is positioned, care should be taken to prevent damage to components which are mounted to the bottom tank.

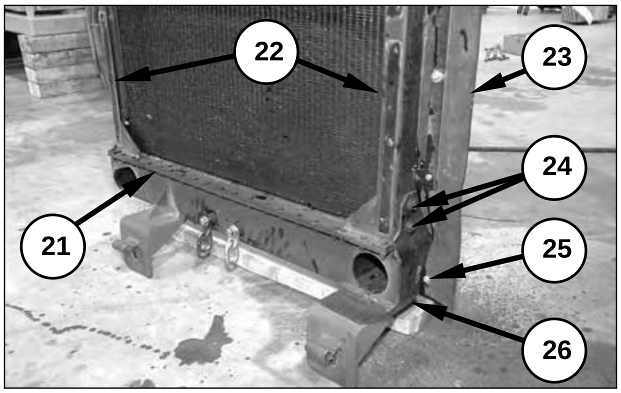
16. Support the radiator, and remove a total of four long bolts, 44 short bolts, 42 lock nuts, six lock washers, two washer plates, and three hose clips from top tank (20).

NOTE: Upon reassembly one of the long bolts should be installed in each corner. The six lock washers go on the bolts which are installed in each end of top tank (20), between the long bolts. To facilitate alignment during reassembly, the bolts with lock washers should be installed first. All lock nuts should be replaced.

17. Remove top tank (20) with the gasket. Replace the gasket during reassembly.

NOTICE

Do not damage the copper flange when the top tank is removed.



18. Support the radiator, and remove bolt (25) with the washer from the bottom of flap (23).

19. Remove four bolts (24,only two shown) with the flat and lock washers from each side of the radiator, and remove bottom mounting plate (26).

NOTE: Only two of the eight bolts are shown. Two bolts are located behind flap (23), and four bolts are located on the opposite end of the radiator. A total of eight bolts with flat and lock washers must be removed before bottom mounting plate (26) can be removed.

20. Remove three bolts with lock washers, two long bolts with lock nuts, and four bolts with lock nuts from both ends of bottom tank (21), and remove side braces (22).

NOTE: Upon reassembly, replace the vibration damper inside the side braces (between the radiator core and the side braces).

21. Remove the remaining 30 bolts with lock washers from bottom tank (21), and remove two washer plates.

NOTE: Upon reassembly, one long bolt should be installed in each corner. The six lock washers go on the bolts which are installed in either end, between the long bolts. All lock nuts should be replaced.

22. Remove bottom tank (21) with the gasket. Replace the gasket during reassembly.

NOTICE

Do not damage the copper flange when the bottom tank is removed.

NOTE: To assemble the radiator group, reverse the disassembly steps.

End By:

a. Install the radiator group.

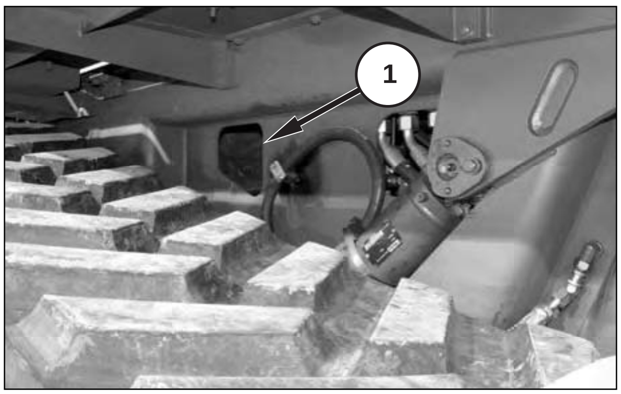
Remote Fuel Filter Base

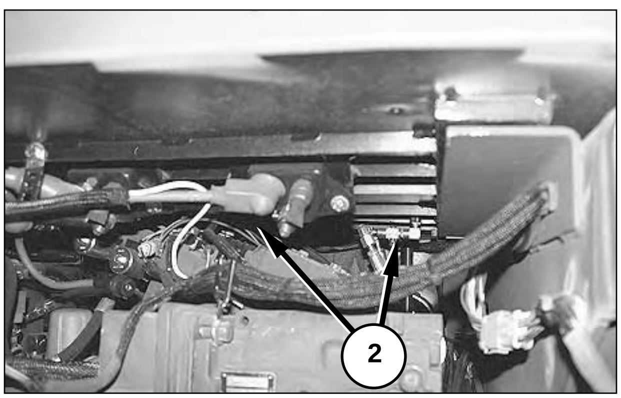
Remove and Install

Start By:

a. Remove the middle top cover. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Machine Systems,* “Middle Top Cover.”

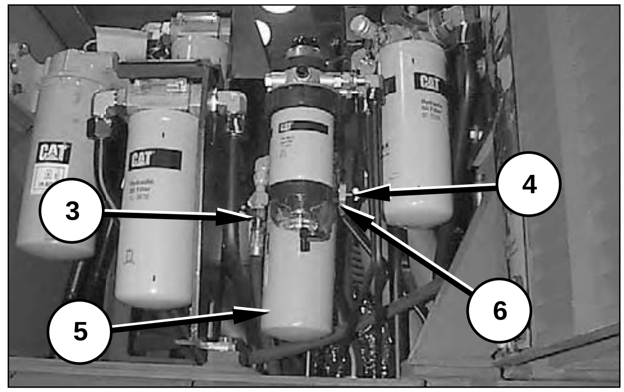
NOTE: The group number related to this procedure is 130-4550.





Machine Shown Partially Assembled for Photographic Clarity.

1. Reach into two holes (1). There is one hole on each side of the machine. Turn the knob **90 degrees** to close two fuel valves (2).



2. Remove fuel filter (5).

NOTE: Some fuel may leak from fuel filter (5) when it is removed. Catch the fuel in a suitable container, and dispose of the liquid according to local regulations.

3. Disconnect, cap and then plug three fuel lines (3).

NOTE: Only one of three fuel lines (3) is visible in the photograph.

NOTE: Some fuel may leak from lines (3) when they are disconnected. Catch the fuel in a suitable container, and dispose of the liquid according to local regulations.

4. Remove two bolts (4) and two nuts with four washers, and remove fuel filter base (6).

NOTE: To install the fuel filter base, reverse the removal steps.

End By:

a. Install the middle top cover.

Rocker Arm Assemblies and Pushrods

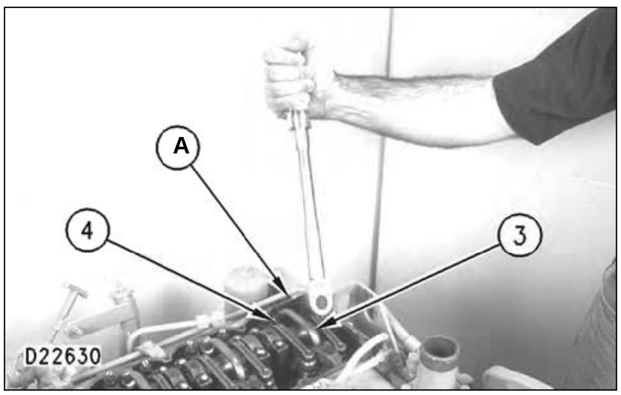
Remove and Install

Tools Needed	A	B	C
5P-0144 Socket	1		
125-2584 Hex Ball		1	
123-4941 Feeler Gauge Assembly			1

Start By:

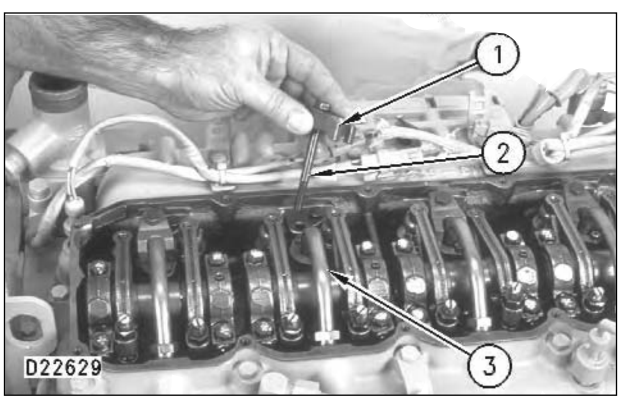
a. Remove the valve cover.

NOTE: Group numbers related to this procedure include 101-3263, 101-3266, and 115-4180.

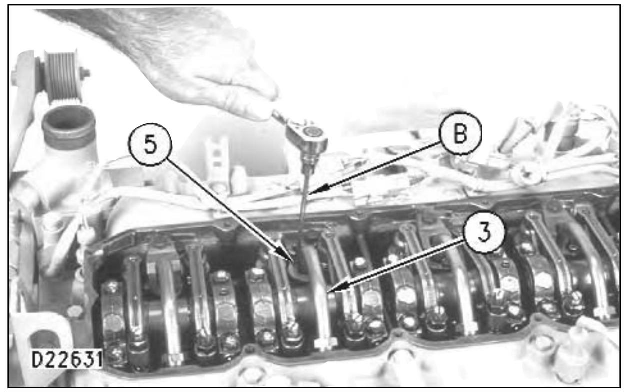


1. Use Tooling (A) to loosen nut (4), which holds jumper tube assembly (3) to the manifold.

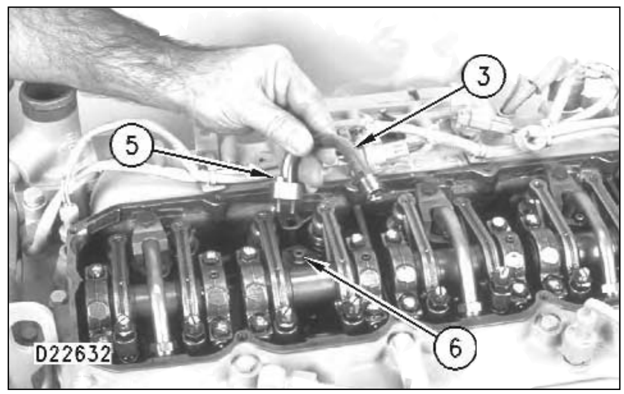
NOTE: Be careful when removing the jumper tube assembly. There is a small flare washer that is loose between the jumper tube assembly and the top of the fuel injection pump. Do not loose the flare washer when removing the jumper tube assembly.



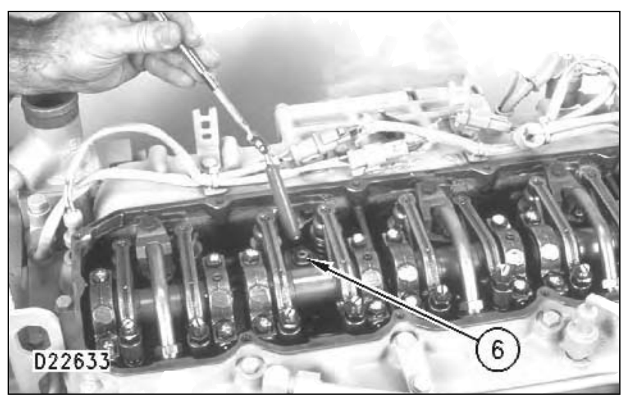
2. Loosen injector clamp bolt (2) from injector clamp (1). Remove injector clamp bolt (2) and the injector clamp from the engine.



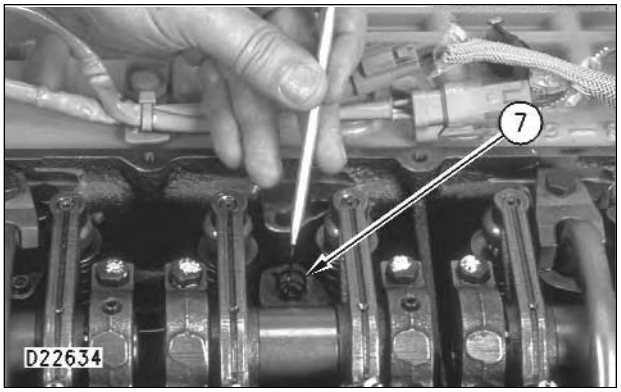
3. Use Tooling (B) to loosen two jumper tube assembly bolts (5), which hold jumper tube assembly (3) to the top of the fuel injection pump.



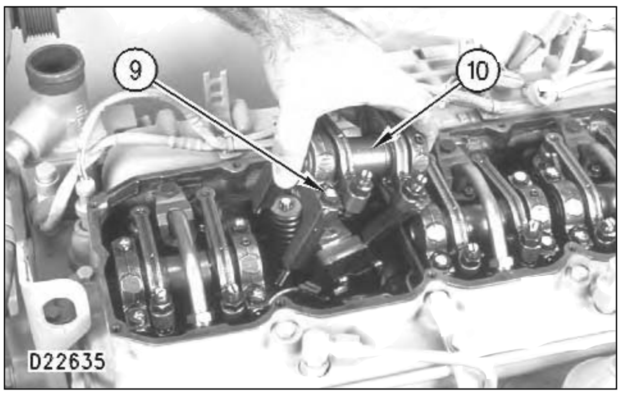
4. Remove jumper tube assembly (3) and two bolts (5) from the manifold.



5. Remove loose seat (6) from the top of the fuel injection pump.

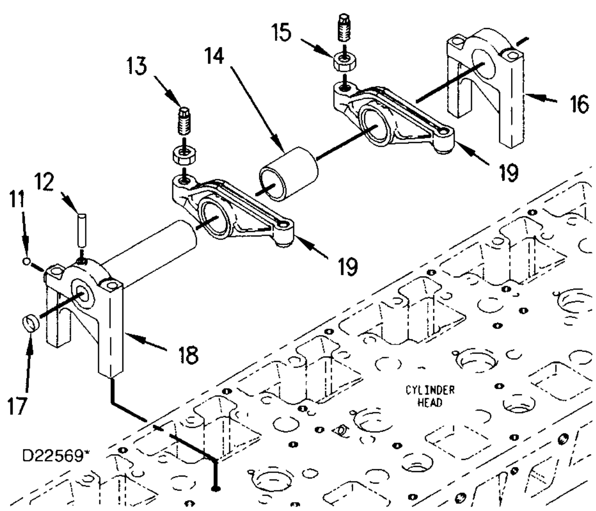


6. Remove O-ring seal (7) from the top groove of the fuel injection pump.



7. Loosen four bolts (9) which hold valve rocker arm group (10) to the cylinder head assembly. Remove the four bolts and the valve rocker arm assembly

NOTE: Be sure to hold valve rocker arm assembly (10) together, or the assembly will slide apart. The assembly is pinned on one end only.



8. Remove rocker arm shaft support (16), two rocker arm assemblies (19), and spacer (14) from arm shaft assembly (18).

9. Remove valve adjustment screw (13) and nut (15) from each rocker arm assembly (19).

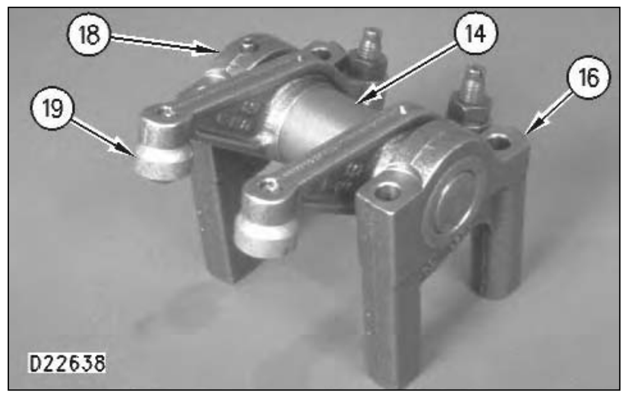
10. Remove pin (12), ball (11), and cup plug (17) from arm shaft assembly (18).

NOTE: The following steps are for the installation of the rocker arm assemblies and the pushrods.

11. Be sure all parts of the rocker arm assemblies are clean.

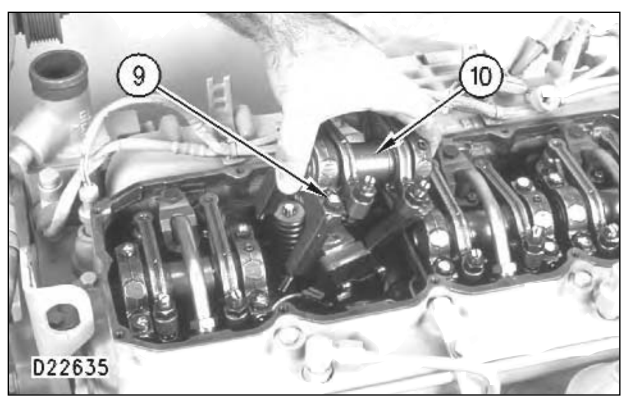
12. Install cup plug (17), ball (11), and pin (12) into arm shaft assembly (18).

13. Install valve adjustment screw (13) and nut (15) on each rocker arm assembly (19).

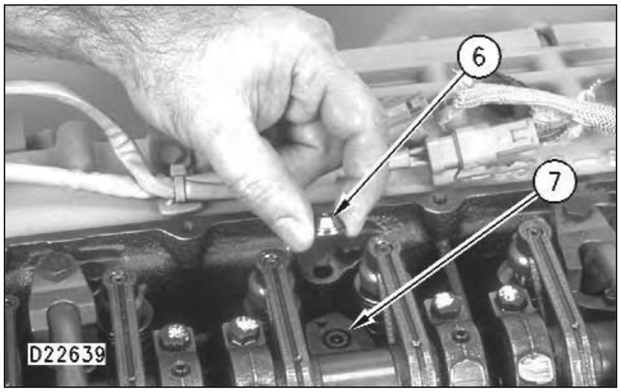


14. Assemble two rocker arm assemblies (19), spacer (14), and rocker arm shaft support (16) on arm shaft assembly (18).

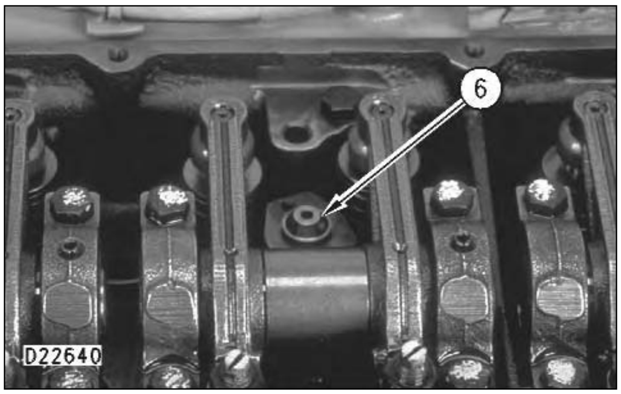
15. Apply clean engine oil on the push rods, and install them in their original positions in the engine. Be sure the push rods are seated in the lifter assemblies.



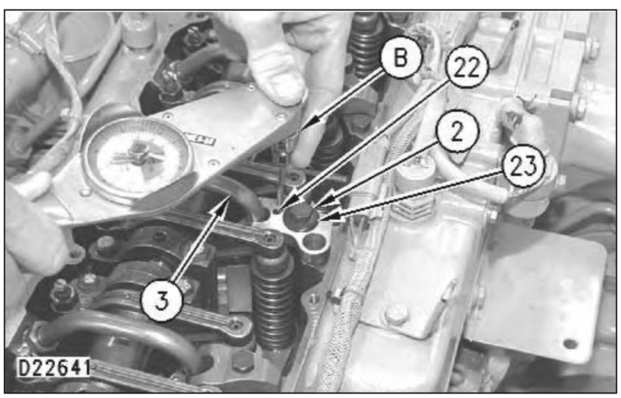
16. Position valve rocker arm assembly (10) on the cylinder head assembly, and install four bolts (9).



17. Install new O-ring seal (7) into the top groove of the fuel injection pump.



18. Position seat (6) on top of the fuel injection pump.



19. Slip jumper tube assembly (3) into the manifold, and then onto the fuel injector pump and O-ring seal (7). Install, and hand tighten, the nut into the manifold. Install two jumper tube assembly bolts (5) that hold the jumper tube assembly to the fuel injection pump, and tighten evenly, until they are hand tight.

20. Use tooling (A) to tighten nut (4) at the manifold to a torque of **40 ± 5 N•m (30 ± 4 lb ft).** Loosen the nut until tube is centered in the flange, and retighten the nut to a torque of **40 ± 5 N•m (30 ± 4 lb ft).**

21. Use tooling (B) to tighten bolts (5) to a torque of **3 N•m (27 lb in)** then tighten each bolt (5) to **5 N•m (45 lb in).**

22. Install the clamp with a washer, beveled washer and bolt. Tighten the bolt to **30 ± 4 N•m (22 ± 3 lb ft).**

23. Use tooling (A) to tighten the flare nut at the manifold to a torque of **40 ± 5 N•m (30 ± 4 lb ft).**

24. Tighten the clamp bolt to **30 ± 4 N•m (22 ± 3 lb ft).**

25. Use tooling (B) to tighten bolts (5) to a torque of **5 ± 1 N•m (45 ± 9 lb in).**

26. Use Tool (C) to adjust the valve lash. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Testing and Adjusting, Air Intake and Exhaust System, Valve Lash."

End By:

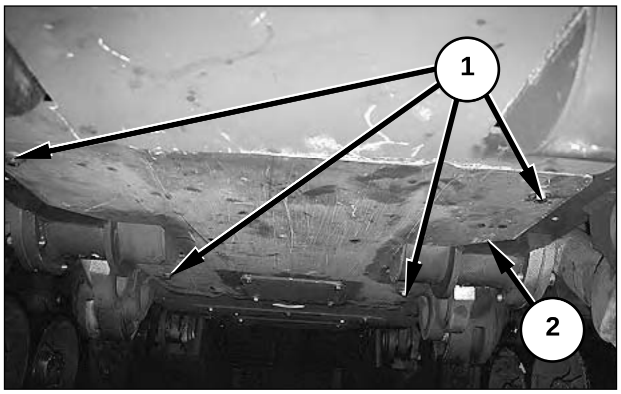
a. Install the valve cover.

Starter

Remove and Install

NOTE: Group numbers related to this procedure include 5R-8847, 124-5844, 145-2413, and 149-1125.

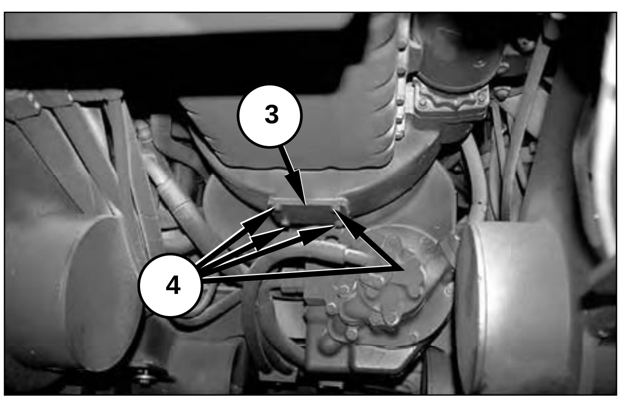
1. Turn the main disconnect switch to the OFF position. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Machine Features, Main Disconnect Switch."



2. Remove four bolts (1) with the washers, and engine cover (2). The weight of the cover is **36 kg (79 lb).**

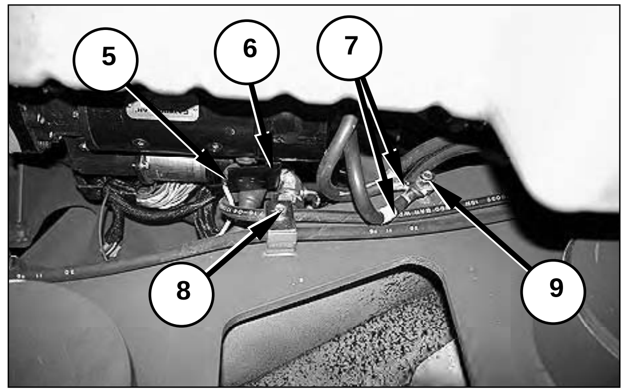
NOTE: If dirt or other debris has accumulated on the top side, the engine cover may weigh more than **36 kg (79 lb)**. Use a suitable floor jack or other tool to support the engine cover if there is a large amount of debris.

3. Raise the radiator. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Radiator Tilt."



4. Remove four bolts (4) with the washers, and remove plate (3) with the gasket to drain the oil from the flywheel housing. Drain the oil into a suitable container, and discard the oil according to local regulations.

NOTE: Plate (3) can be reinstalled after the oil has been drained. Replace the gasket if necessary.

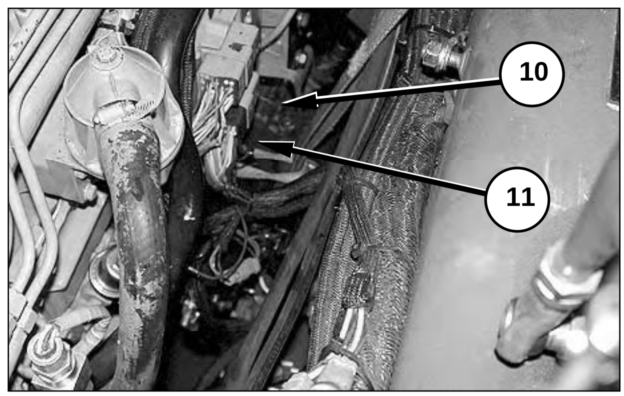


5. Remove the nut, and disconnect solenoid wire (5).

6. Remove one nut, and remove solenoid cap (6).

7. Remove nut (9), and disconnect ground cables (7).

8. Remove bolt (8), with the retainer, and two clamp halves.

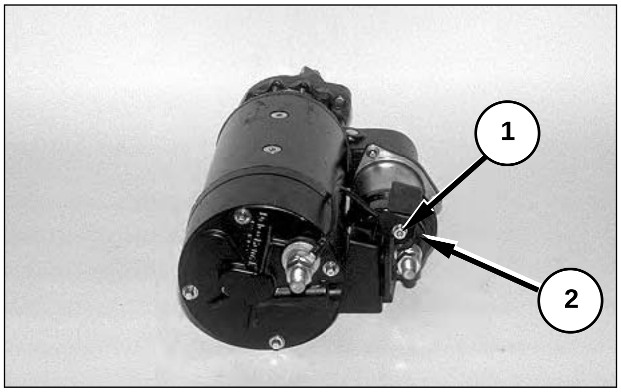


9. Fasten a strap to the starter. The weight of the starter is **27 kg (60 lb).**

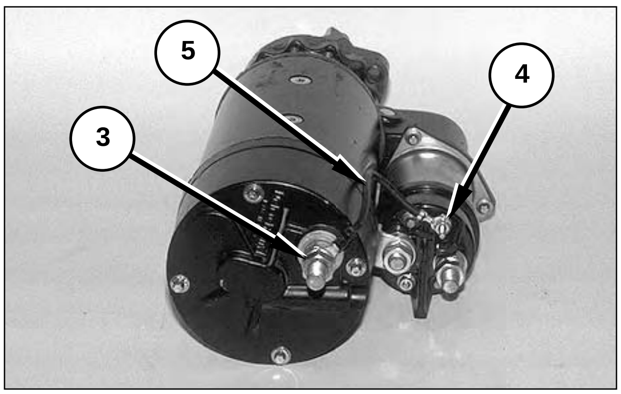
10. Remove three bolts (10, one shown), which fasten starter (11) to the engine, and use two people to lower the starter out the bottom of the machine. The weight of the starter is **27 kg (60 lb).** Replace the gasket that is installed between the starter motor and the engine if the gasket is worn or damaged.

NOTE: To install the starter, reverse the removal steps.

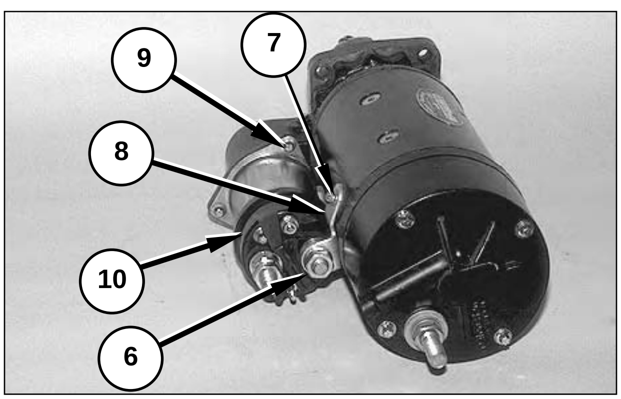
Disassemble and Assemble



1. Remove bolt (1) and plastic cover (2), if they have not already been removed.

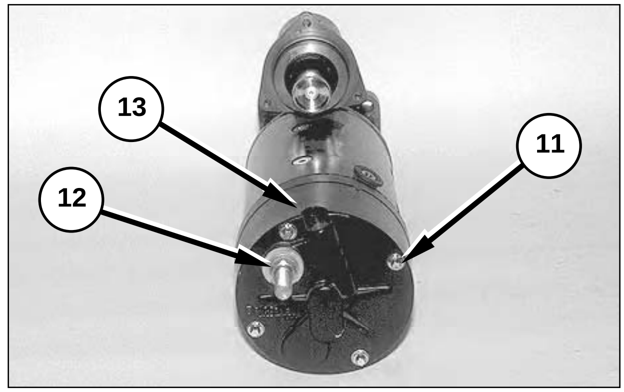


2. Remove negative terminal nut (3). Remove nut (4) from the solenoid. Remove wire (5) between the motor and the solenoid. Upon reassembly, tighten negative terminal nut (3) to a torque of **30.5 ± 3.5 N•m (22.5 ± 2.5 lb in),** and nut (4) to a torque of **2.25 ± 0.25 N•m (20 ± 2 lb in).**

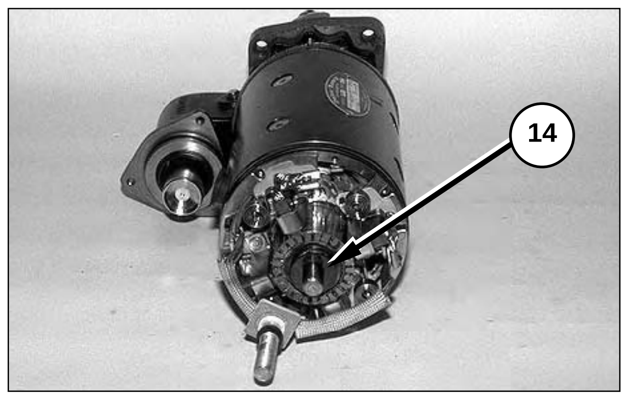


3. Remove terminal nut and washer (6). Remove bolt (7) and connector (8) from the motor terminal.

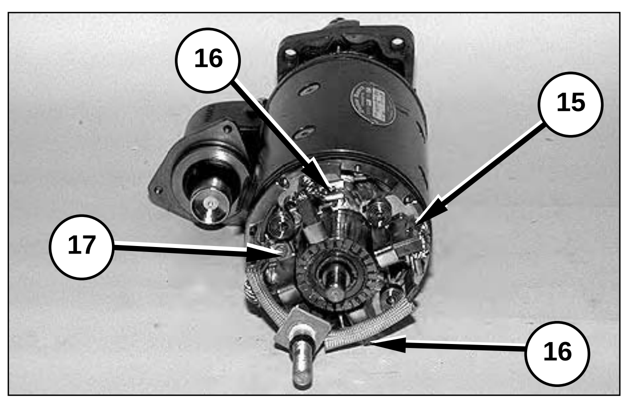
4. Remove three bolts (9), which secure the solenoid assembly. Remove solenoid assembly (10) from the housing. Upon reassembly, tighten three bolts (9) to a torque of **17.8 ± 3.7 N•m (158 ± 33 lb in),** terminal nut (6) to a torque of **30.5 ± 3.5 N•m (22.5 ± 2.5 lb in),** and bolt (7) to a torque of **8 ± 3 N•m (71 ± 26.5 lb in).**



5. Remove four bolts (11) and negative terminal nut (12). Remove housing assembly (13) from the motor. Upon reassembly, tighten four bolts (11) to a torque of **5.7 ± 1.1 N•m (50 ± 10 lb in),** and negative terminal nut (12) to a torque of **30.5 ± 3.5 N•m (22.5 ± 2.5 lb in).**

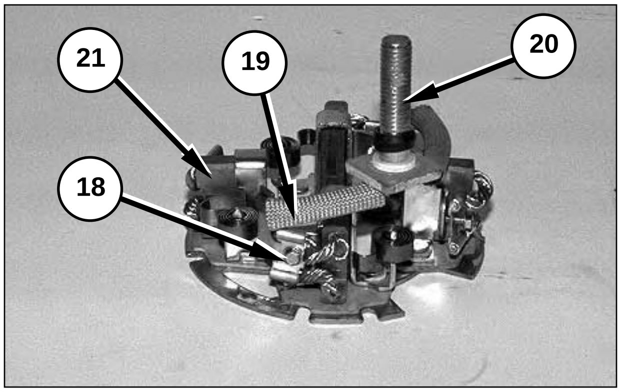


6. Remove thrust washer (14).

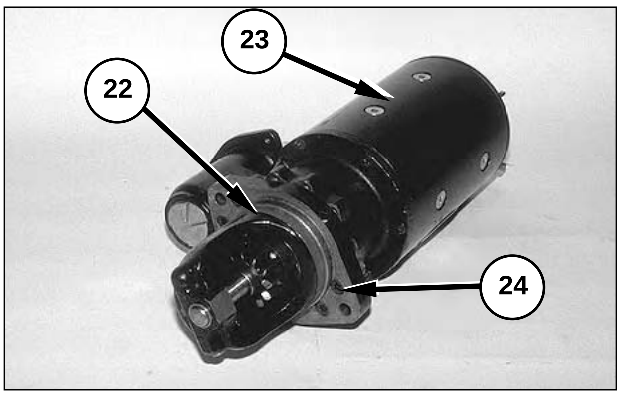


7. Lift brushes out of the brush holders and secure them with springs (15). Remove two screws (16) that secure the field winding wires to brush holders.

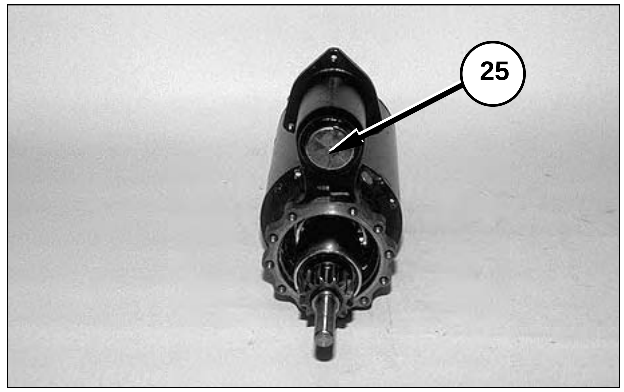
8. Remove brush holder assembly (17) from the motor. Upon reassembly, tighten two screws (16) that secure field winding wires to a torque of **2.9 ± 1.0 N•m (26 ± 9 lb in).**



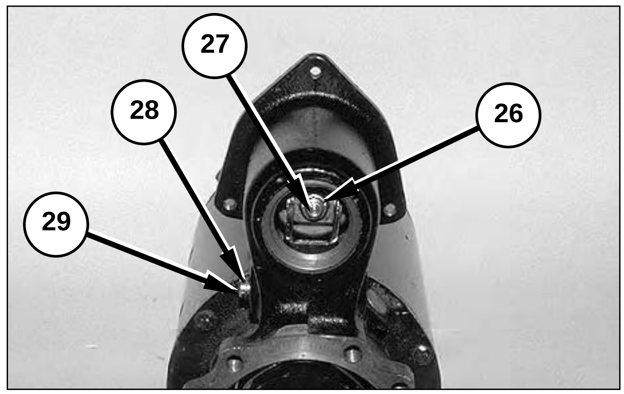
9. Remove two screws (18) that secure wires (19) to negative terminal (20). Remove the negative terminal and brushes (21) from the brush holder assembly. Upon reassembly, replace brushes if brush length is less than **10 mm (0.39 in).** Tighten two screws (18) that secure wires (19) to a torque of **2.9 ± 1.0 N•m (26 ± 9 lb in).**



10. Scribe a line on drive assembly housing (22) and motor (23) for reassembly. Remove six bolts (24) and the housing assembly with the O-ring seal from the motor. Upon reassembly, tighten six bolts (24) to a torque of **23.7± 6.1 N•m (210 ± 54 lb in).** Replace the O-ring seal if the seal is worn or damaged. Pinion clearance should be **9.1 ± 0.8 mm (0.36 ± 0.03 in).** Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* "Testing and Adjusting, Starter Tests."

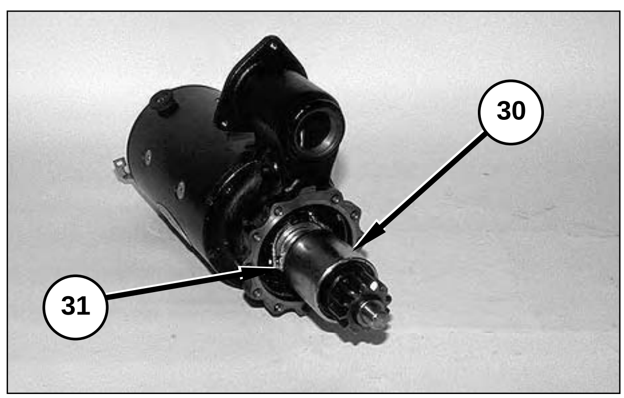


11. Remove plug and gasket (25) from the housing assembly. Upon reassembly, replace the gasket if the gasket is worn or damaged.

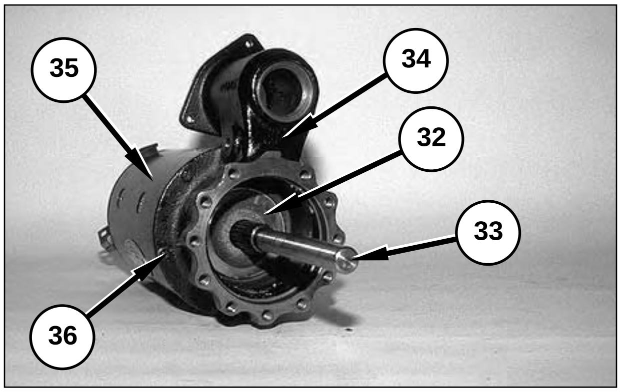


12. Remove nut (26) from plunger assembly (27).

13. Remove retaining ring (28) from shift lever pin (29). Remove the shift lever pin with the O-ring seal. Upon reassembly, replace the O-ring if it is worn or damaged.

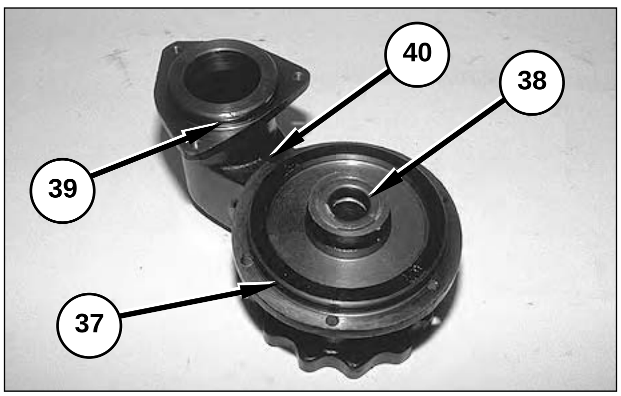


14. Remove drive assembly (30) and shift lever (31) from the housing assembly.

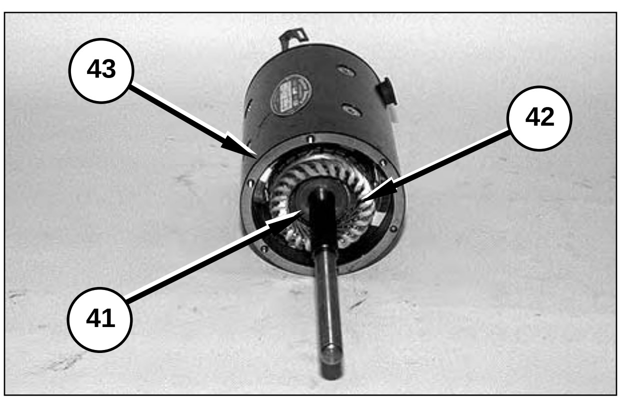


15. Remove brake disk (32) from armature shaft (33). (the brake disk is fastened with adhesive.) Scribe a line on housing assembly (34) and motor (35) for reassembly. Remove five bolts (36), and the housing assembly from the motor.

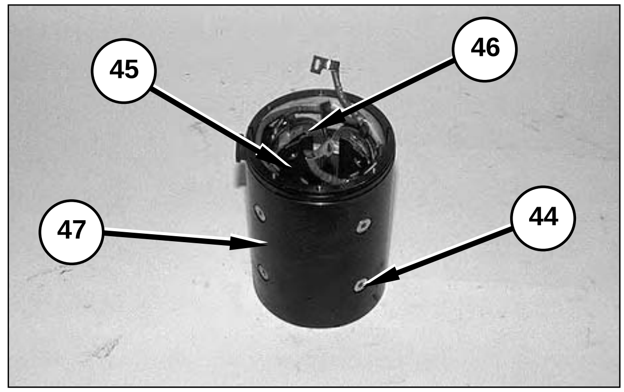
16. Upon reassembly, tighten five bolts (36) to a torque of **18.9 ± 2.6 N•m (167 ± 23 lb in).** To install brake disk (32), apply **8T-9021 Adhesive.**



17. Remove lip seal (37), shaft seal (38), and O-ring (39) from housing assembly (40). Upon reassembly, replace the lip seal, shaft seal, and O-ring if there is wear or damage.



18. Remove washer (41) from the armature shaft, and remove armature assembly (42) from motor housing (43).



19. Remove eight screws (44), four shoe poles (45), and field coil assembly (46) from motor housing (47).

20. Upon reassembly, apply **9S-3263 Thread Lock** on threads of screws (44) and tighten to a torque of **20.3 ± 2.3 N•m (180 ± 20 lb in).**

NOTE: To assemble the starter motor, reverse the disassembly steps.

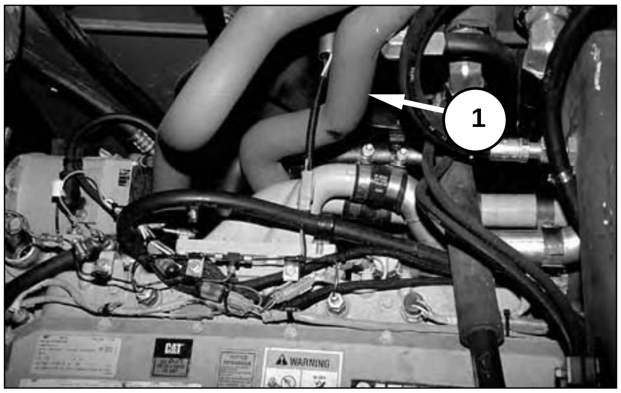
Turbocharger

Remove and Install

Start By:

a. Remove the alternator.

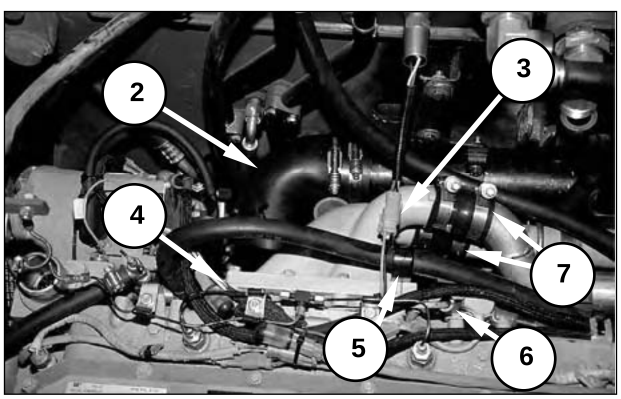
NOTE: Group numbers related to this procedure include 7C-2476, 118-7284, 133-4969, 136-1145, 145-0071, and 148-0768.



Radiator Shown Removed for Photographic Clarity.

1. Loosen clamps and move air hose (1) out of the way.

2. At the junction between the exhaust pipe and turbocharger outlet, loosen the nut and spread the clamp apart.



Radiator Shown Removed for Photographic Clarity.

3. Loosen four clamps and remove hoses (7) from the top and bottom ports of the air inlet elbow.

4. Disconnect hydraulic oil temperature connector (3), and move the connector out of the way.

NOTE: Hydraulic oil temperature connector (3) is a three-pin connector with two wires. The wires in the connector are K980-PK and 200-BK.

5. Loosen three clamps and remove rubber elbow (2) from the inlet side of the turbocharger.

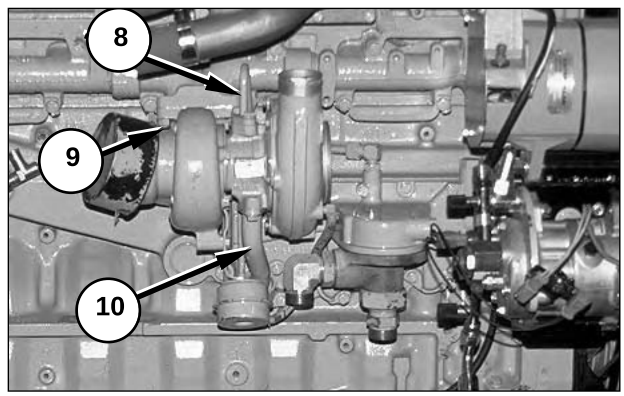
6. Disconnect the nut, and remove the ground strap from the front side of the intake air heater (4).

7. Disconnect 106-PU wire (6) between the intake air heater and the intake air heater relay.

8. Remove the bolt and large washer, and move hose (5) with a clip out of the way.

9. Remove the remaining seven bolts with two large washers and five small washers from the air inlet elbow, and remove the air inlet elbow and the intake air heater.

NOTE: The larger washers correspond to the bolts which are installed in the slotted positions (slots in the elbow).



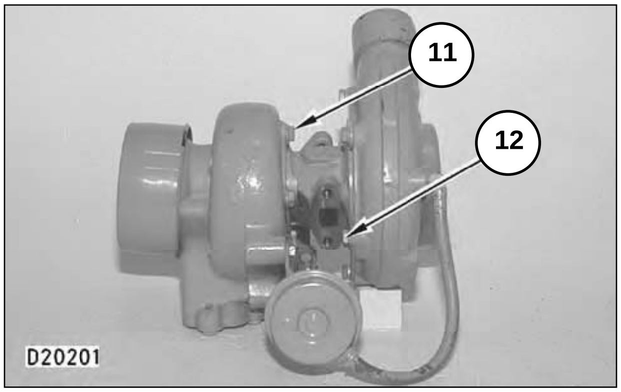
10. Remove two bolts with the washers, and disconnect oil supply tube assembly (8) from the turbocharger.

11. Disconnect oil drain tube assembly (10) from the turbocharger.

NOTE: Some oil may leak from drain tube assembly (10) when it is disconnected. Catch the oil in a suitable container, and dispose of the liquid according to local regulations.

12. Remove four lock nuts (9), the turbocharger and gasket from the exhaust manifold.

NOTE: Some of the turbocharger mounting studs may come out when the nut is removed.



13. Remove six bolts (12), and remove the turbine end housing from the cartridge.

14. Remove four bolts (11), and remove the compressor housing from the cartridge.

NOTE: The cartridge, turbine end, and compressor housings are serviced as complete units. Internal parts are not serviced.

NOTE: The wastegate mechanism is part of the turbine housing assembly and is preset at the factory. There are no adjustments or serviceable parts of the wastegate mechanism.

NOTE: The following steps are for the installation of the turbocharger.

15. Install a new gasket between the turbocharger and the exhaust manifold.

16. Install the turbine and compressor end housings to the cartridge. Apply **5P-3931 Anti-Seize Compound** to the threads of bolts (11) and (12). Tighten the bolts that hold the compressor housing to the cartridge to a torque of **7.3 ± 0.5 N•m (65.00 ± 5.00 lb in).** Tighten the bolts that hold the turbine housing to the cartridge to a torque of **15.8 ± 0.5 N•m (140.00 ± 5.00 lb in).** The end play for the shaft is **0.051 to 0.083 mm (0.0020 to 0.0033 in)**. Do not overtighten bolts (11) and (12).

17. Apply **5P-3931 Anti-Seize Compound** on the threads of the turbocharger mounting studs.

18. Put the gasket and turbocharger in position on the exhaust manifold. Install four lock nuts (9) that secure the turbocharger. Tighten the lock nuts to a torque of **54 ± 5 N•m (40 ± 4 lb ft).**

19. Check the condition of the gaskets between the turbocharger and the oil supply and drain tube assemblies. Install new gaskets if necessary. Check the condition of the O-ring seal between the oil drain tube and the block. Install a new seal, if necessary. Check the condition of the O-ring seal at the oil cooler end of the oil supply line (in the elbow). Install a new seal if necessary.

20. Lightly lubricate the bore for the oil drain tube assembly in the block, with clean engine oil.

21. Connect oil drain tube assembly (10) and oil supply tube assembly (8) to the turbocharger.

22. Clean the joint faces with solvent, and apply **1U-8846 Liquid Gasket (Loctite™ 17430)** on the face of the inlet heater. Install the bolt with the large washer and the hose clip with hose (5), and then install the remaining seven bolts in the air inlet elbow. Tighten the eight bolts to a torque of **30 ± 7 N•m (22 ± 5 lb ft)**.

NOTE: The three larger washers should be placed on the bolts which are installed in the slotted positions.

NOTE: If the air inlet elbow and the intake air heater are separated, clean the joint faces with solvent and apply **1U-8846 Liquid Gasket (Loctite™ 17430)** to the connecting faces.

23. Install the ground strap and nut on the stud on the right side of intake air heater (4).

24. Connect 106-PU wire (6) between intake air heater (4) and the intake air heater relay.

25. Install rubber elbow (2), and tighten the three clamps.

26. Install the clamp which connects the exhaust pipe to the turbocharger outlet, and tighten the nut.

27. Connect hydraulic oil temperature connector (3).

NOTE: Hydraulic oil temperature connector (3) is a three-pin connector with two wires. The wires in the connector are K980-PK and 200-BK.

28. Install hoses (7) and clamps on the top and bottom ports of the air inlet elbow.

29. Install air hose (1) and the clamps.

End By:

a. Install the alternator.

Unit Fuel Injection Pump Group

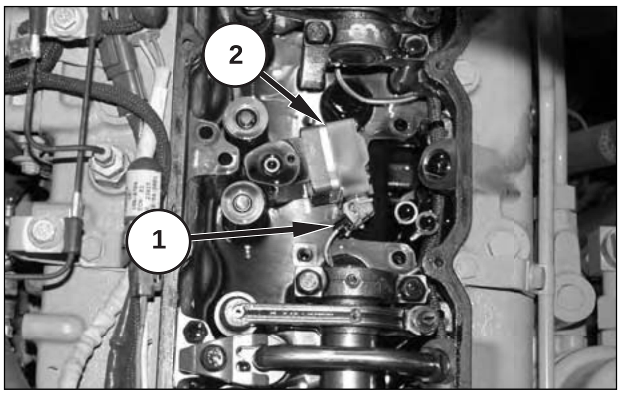
Remove and Install

Tools Needed	A	B	C
1U-7587 Pry Bar	1		
143-2099 Sleeve Replacement Tool Group		1	
173-1530 Injector Seating Tool Group			1

Start By:

a. Remove the rocker arm assemblies and pushrods.

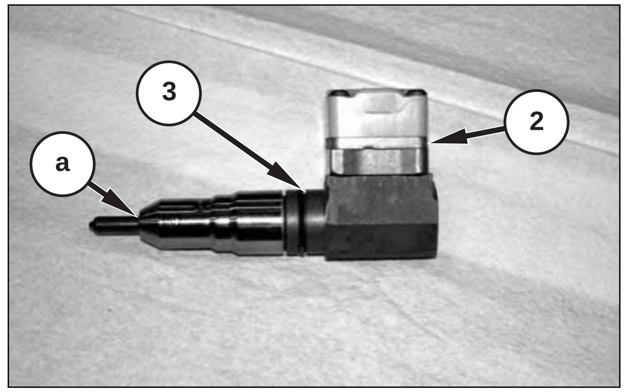
NOTE: The group number related to this procedure is 119-7001.



1. Disconnect wiring harness plug assembly (1) from unit fuel injection pump group (2). Use a new weather pac seal on the wiring harness plug assembly for installation.

2. Remove unit fuel injection pump group (2) by hand, if possible, by twisting and pulling. If necessary, use Tooling (A) to loosen unit fuel injection pump group. Be sure to pry only on the injector body to prevent damage to the unit fuel injection pump group.

NOTICE
Do not pry on the hydraulic fuel injection solenoid assembly, or damage to the injector could occur. Pry only on the fuel injection body using Tooling (A).



3. Remove O-ring seal (3) from unit fuel injection pump group (2).

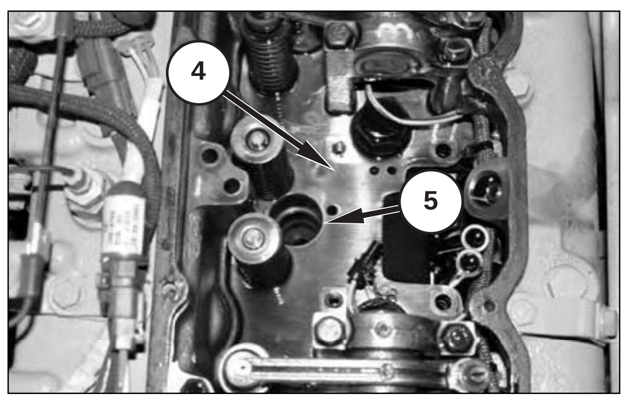
NOTE: Older unit fuel injection pump groups may have a second smaller O-ring seal around their base (a). This seal is to be removed without replacement prior to reinstallation.

NOTE: The following steps are for the installation of the unit fuel injection pump group.

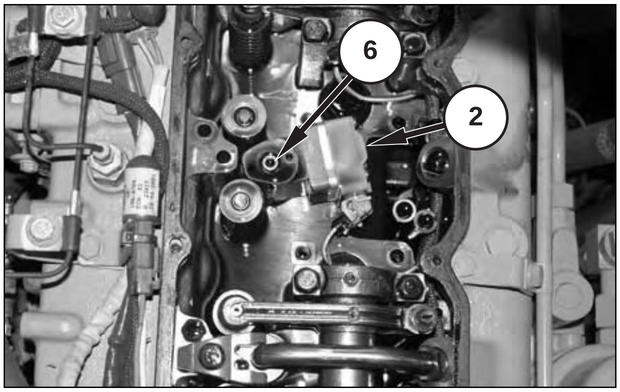
4. Inspect the cylinder head sleeve to insure that there is no damage to the sleeve and that the injector sealing surface (seat), is clean. Use the **9U-6101 Reamer Head** (part of Tooling B), to clean the seat area of the brass sleeve, if necessary. Refer to “Fuel Injector Sleeves, Remove and Install,” in this chapter.

5. Install new O-ring seal (3), on unit fuel injection pump group (2).

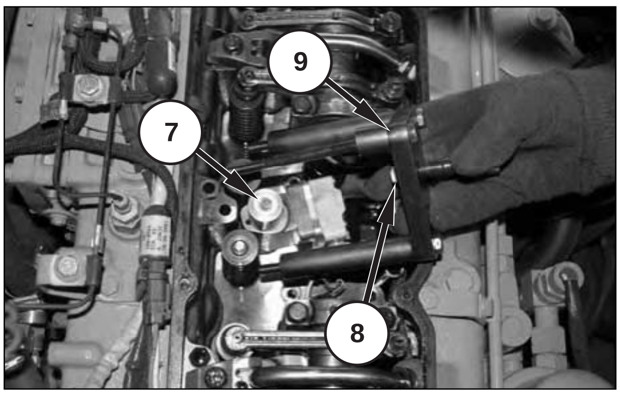
6. Lubricate O-ring seal (3), on fuel injection pump (2) with clean engine oil.



7. Position unit fuel injection pump group (2), into cylinder head assembly (4), so the O-ring seal slides into bore (5), of the cylinder head assembly.



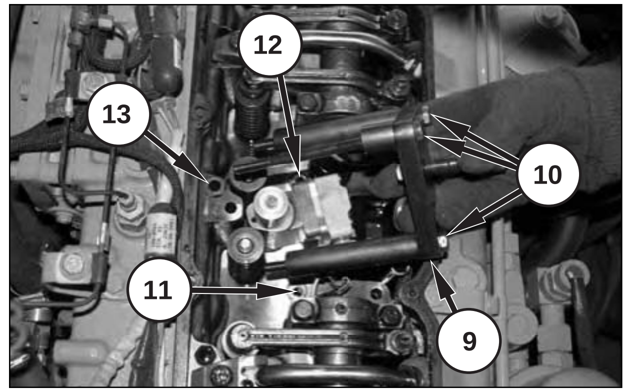
8. Install the **173-1532 Injector Forcing Cover** with the dowel tip placed into oil supply hole (6) in the top of unit fuel injection pump group (2).



9. Place a small amount of **4C-5591 Thread Lubricant** on the top of **175-7801 Wear Button** (7), and the threads of **3L-2415 Forcing Bolt** (8).

NOTICE

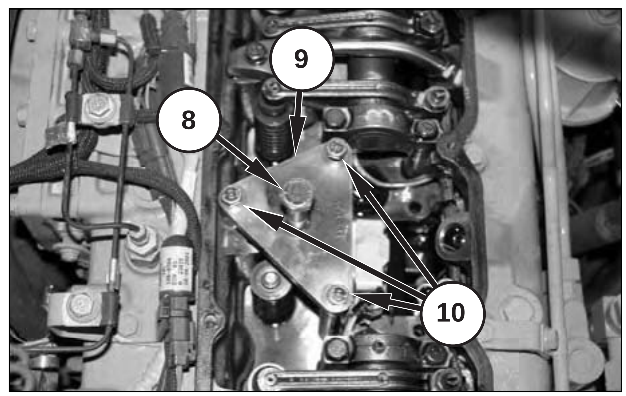
Complete lubrication of the wear button and the forcing bolt must be accomplished for each fuel injection pump. Failure to relubricate each part prior to continuing with the next injection pump may cause premature wear or damage to the tool.



10. Install **173-1530 Forcing Bridge** (9), with three **7X-0457 Bolts**, and three **9M-1974 Hard Washers** (10). Place the two long legs of the forcing bridge into rocker arm shaft support holes (11) and (12), with the short leg bolted into the intake manifold bolt boss (13).

NOTICE

To avoid damage to the unit fuel injection pump group, loosen forcing bolt (8) completely prior to installation of the forcing bridge.



11. Tighten three **7X-0457 Forcing Bridge Bolts**, with **9M-1974 Hard Washers** (10), to **28 ± 7 N•m (21 ± 5 lb ft)**.

12. Tighten **3L-2415 Forcing Bolt** (8) finger tight.

13. Tighten **3L-2415 Forcing Bolt** (8) to **34 ± 1.4 N•m (25 ± 1 lb ft)**. Wait five seconds and retorque the bolt to **34 ± 1.4 N•m (25 ± 1 lb ft)**.

14. Loosen and remove **173-1530 Forcing Bridge** (9).

15. Be sure the seal is in position on wiring harness plug assembly (1). Connect the wiring harness plug assembly to the unit fuel injection pump group (2).

End By:

a. Install the rocker arm assemblies, pushrods, and adjust the valve clearance.

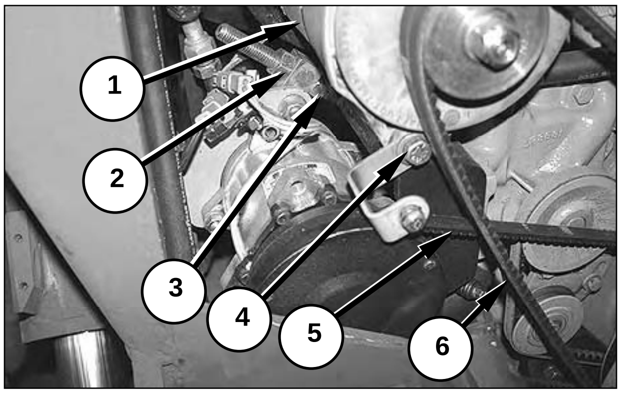
V-Belts

Remove and Install

Start By:

a. Remove the steering pump drive shaft. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Drive Shaft Steering."

NOTE: Group numbers related to this procedure include 120-6657, 126-5830, and 130-2789.

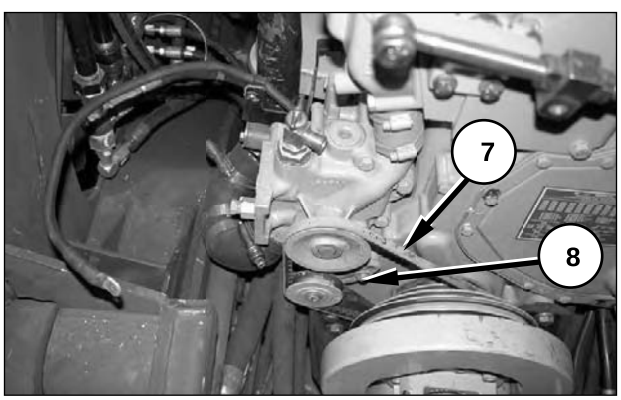


1. Loosen bolt (4), and rotate alternator (1) clockwise to release the tension on two alternator V-belts (6).

2. Remove two alternator V-belts (6).

3. Loosen the pivot bolt, lock nut (2), and adjustment nut (3) to release the tension on air-conditioning compressor V-belt (5).

4. Remove air-conditioning compressor V-belt (5).



Alternator and compressor shown removed for photographic purposes.

5. Loosen the pivot bolt and bolt (8), and remove water pump belt (7).

NOTE: To install the V-belts, reverse the removal steps. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Every 250 Service Hours or Three Months, Engine V-Belts" for the belt tension adjustment procedure.

End By:

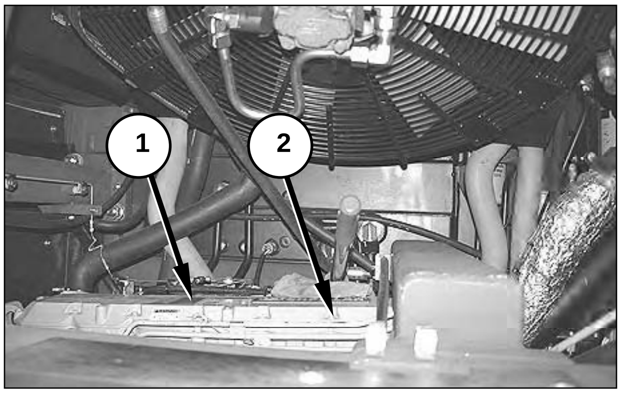
a. Install the steering pump drive shaft.

Valve Cover

Remove and Install

NOTE: The group number related to this procedure is 100-4943.

1. Raise the radiator. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Radiator Tilt."

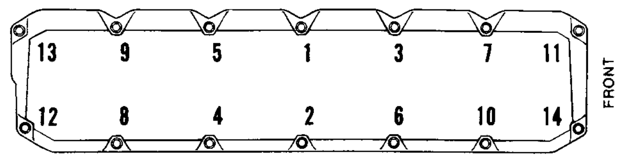


2. Remove 14 bolts (2) and the washers that hold valve cover (1) to the inlet manifold. Remove the valve cover and the gasket.

3. Remove the gasket from the valve cover. Use **8T-9011 Component Cleaner** to clean the valve cover.

NOTE: The following steps are for the installation of the valve cover and gasket.

4. Be sure the mating surfaces of valve cover (1) and the inlet manifold are thoroughly clean. Apply **8T-9021 Depend No-Mix Adhesive** to the mating surface of the valve cover, between each mounting bolt hole. Position a new valve cover gasket in the valve cover.



Valve Cover Tightening Sequence.

5. Put valve cover (1) in position on the inlet manifold. Install 14 bolts (2) and the washers that secure the valve cover.

6. Tighten bolts (2), in the number sequence shown in the illustration, to a torque of **12 ± 3 N•m (9 ± 2 lb ft).**

Valve Guides

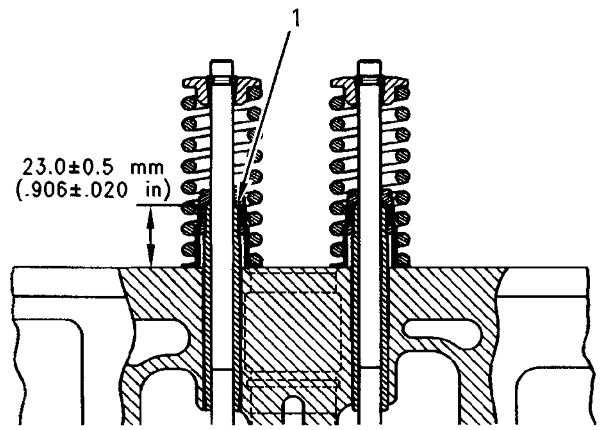
Remove and Install

Tools Needed	A
1U-6685 Guide and Insert Tool Group	1

Start By:

a. Remove the valves.

NOTE: The group number related to this procedure is 119-3066.



1. Use Tooling (A) and drive valve guide (1) from the cylinder head assembly.

NOTE: The following steps are for the installation of the valve guides.

2. Position the valve guide. Carefully tap valve guide (1) to start the guide into the cylinder head assembly. Position Tooling (A) to finish driving the valve guide into the cylinder head assembly. After installation, the valve guide must protrude above the cylinder head assembly **23.0 ± 0.5 mm (0.90 ± 0.02 in).**

End By:

a. Install the valves. Adjust the valve lash. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Testing and Adjusting, Air Intake and Exhaust System, Valve Lash."

Valve Seat Inserts

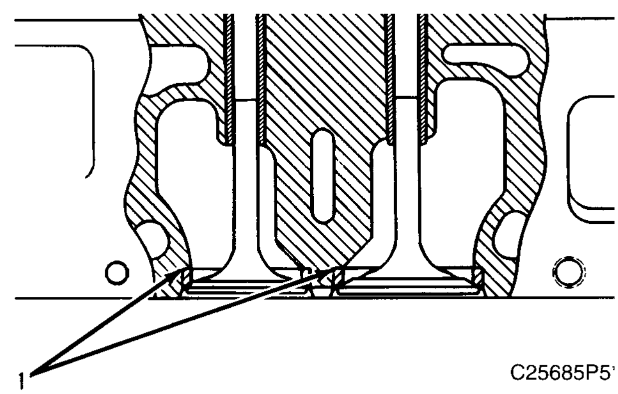
Remove and Install

Tools Needed	A
1U-6685 Guide and Insert Tool Group	1

Start By:

a. Remove the valves.

NOTE: The group number related to this procedure is 119-3066.



1. Use Tooling (A) to remove valve seat inserts (1).

NOTE: The following steps are for the installation of the valve seat inserts.

2. Lower the temperature of the new valve seat inserts. Use Tooling (A) to install valve seat inserts (1) into the cylinder head assembly.

3. Once valve seat inserts (1) are installed, they must be ground to the final specification. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Specifications, Valves."

End By:

a. Install the valves. Adjust the valve lash. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Testing and Adjusting, Air Intake and Exhaust System, Valve Lash."

Valves

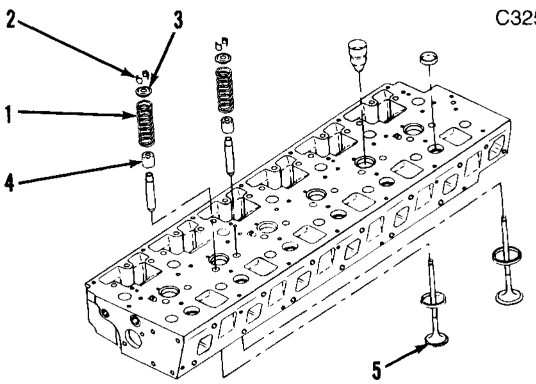
Remove and Install

Tools Needed	A
5S-1330 Valve Spring Compressor	1

Start By:

a. Remove the cylinder head assembly.

NOTE: The group number related to this procedure is 119-3066.



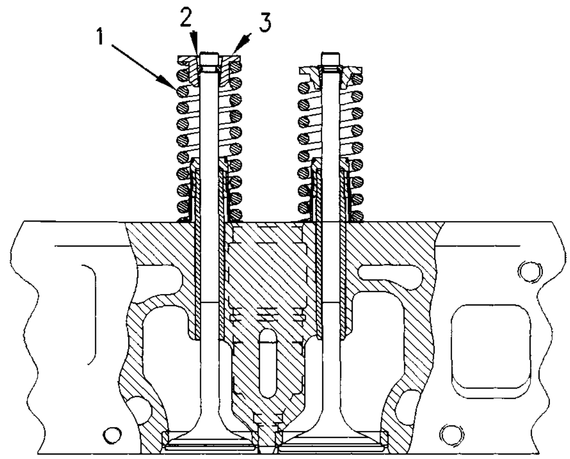
C32575P1*

1. Use Tooling (A) to compress valve spring (1). Remove retainer locks (2), spring retainer (3) and valve spring (1).

NOTE: The exhaust valve spring retainers (3) and valve springs (1) are not the same as the intake valve spring retainers and springs.

2. Remove valve seal (4) and valve (5). Repeat this process for all valves.

NOTE: The following steps are for the installation of the valves.



D22565

3. Lubricate the valves with clean engine oil, and install the valves into the cylinder head. Install new valve seals down against the valve guides.

4. Position valve spring (1) and spring retainers (3). Use Tooling (A) to compress valve spring (1). Install retainer locks (2). A small amount of grease can be used to hold the retainer locks in position during assembly.

5. Repeat this process for all valves.

End By:

a. Install the cylinder head assembly, and adjust the valve lash. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Testing and Adjusting, Air Intake and Exhaust System, Valve Lash.”

Vibration Damper, Crankshaft Pulley and Crankshaft Front Seal

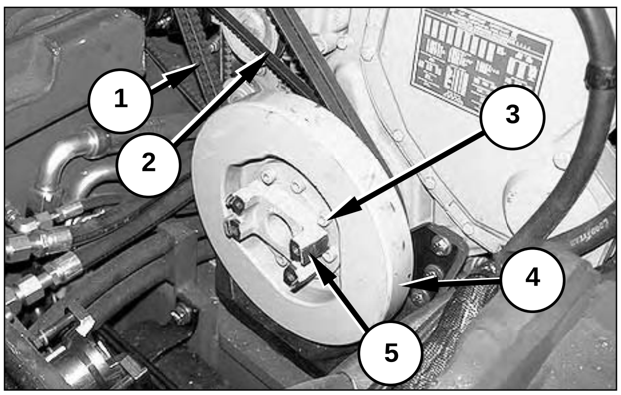
Tools Needed	A	B	C
1U-7600 Slide Hammer Puller	1		
1U-7430 Front Seal Installer		1	
171-7212 Repair Sleeve			1

Remove and Install

Start By:

a. Remove the steering pump drive shaft.

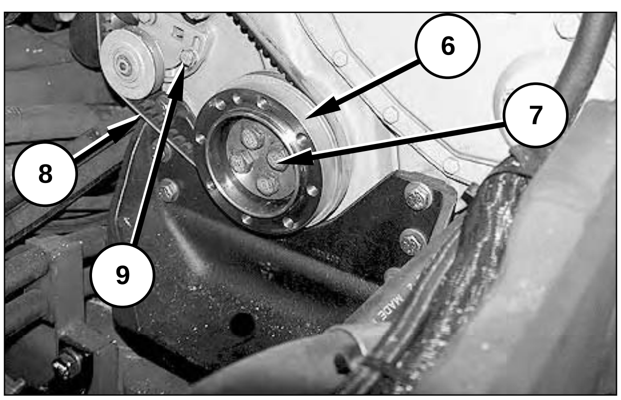
NOTE: Group numbers related to this procedure include 4W-5429, 133-1345, and 140-3051.



1. Remove eight bolts (3) and yoke (5).

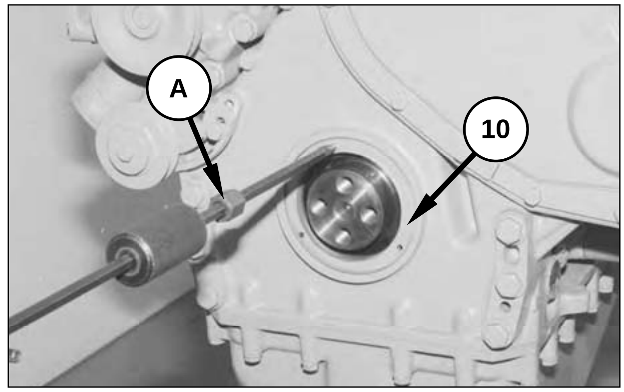
NOTE: Yoke (5) is easier to install when the tension is released from the belts.

2. Remove damper assembly (4) and alternator and air-conditioning compressor V-belts (1) and (2). Refer to "V-Belts" in this module.



3. Loosen the pivot bolt and bolt (9), and remove water pump drive V-belt (8).

4. Remove four bolts (7) and crankshaft pulley (6). Tighten the bolts to a torque of **190 ± 30 N•m (140 ± 22 lb ft)**.



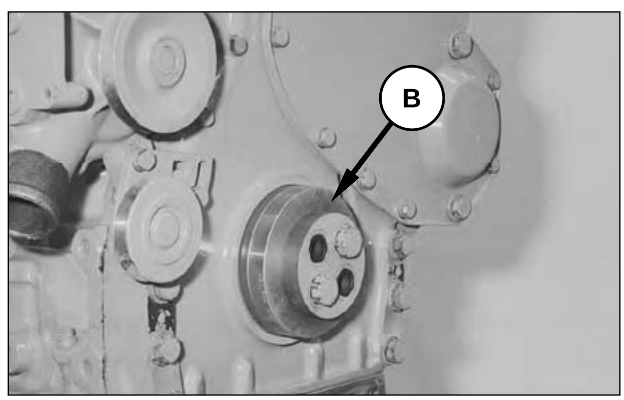
Engine Shown Removed From Machine for Photographic Purposes.

5. Carefully drill three evenly spaced **4.1 mm (0.161 in)** diameter holes in the crankshaft front seal. Alternating between the drilled holes, use Tooling (A) to evenly remove crankshaft front seal (10) from the crankshaft. Do not damage the flange of the crankshaft during the seal removal.

NOTE: If the crankshaft hub is damaged by the crankshaft seal, the **171-7212 Repair Sleeve** is used with Tooling (B) for quick repair. The crankshaft seal will run completely on the wide surface of the repair sleeve.

NOTE: The following steps are for the installation of vibration damper (4), crankshaft pulley (6) and crankshaft front seal (10).

6. Be sure the flange of the crankshaft is thoroughly clean prior to installing the crankshaft front seal and the crankshaft pulley.



Engine shown removed from machine for photographic purposes.

7. With the shipping sleeve in position, install crankshaft front seal using Tooling (B).

NOTE: The distance between the front face of crankshaft front seal (10) and the front face of the front housing must be **2.5 ± 0.5 mm (0.10 ± 0.02 in)** after the seal installation. For additional information, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Specifications, Basic Engine, Crankshaft Seals.”

8. Remove the shipping sleeve from crankshaft front seal (10). Be sure that the seal surface of crankshaft pulley (6) is thoroughly clean,dry, and in good condition before installation. The seal is designed to be installed dry.

9. Put crankshaft pulley (6) in position on the crankshaft, and install the washers and four bolts (7). Tighten bolts (7) to a torque of **190 ± 30 N•m (140 ± 22 lb ft).**

10. Install water pump drive V-belt (8).

11. Install damper assembly (4) and yoke (5) using eight bolts (3).

12. Install the alternator and air-conditioning compressor V-belts (1) and (2). Refer to “V-Belts” in this module.

13. Adjust the tension of V-belts (1), (2) and (8). Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* “Every 250 Service Hours or Three Months, Engine V-Belts, Inspect/Adjust.”

Water Pump

Remove and Install

⚠ WARNING

At operating temperature, the engine coolant is hot and under pressure. Steam can cause personal injury. Check the coolant level only after the engine has been stopped and the fill cap is cool enough to touch with your bare hand. Remove the fill cap slowly to relieve the pressure in the cooling system. The cooling system conditioner contains alkali. Avoid contact with the skin and eyes to prevent personal injury.

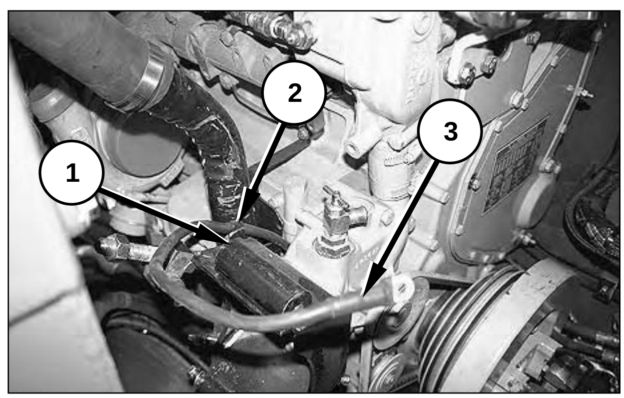
Start By:

a. Remove the alternator.

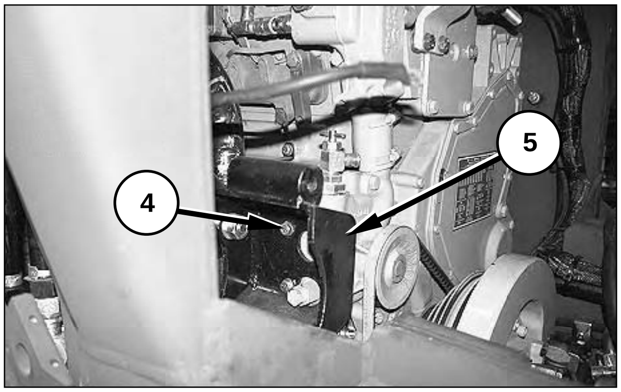
b. Remove the air-conditioning compressor.

NOTE: Group numbers related to this procedure include 120-6657, 120-8402, and 121-4328.

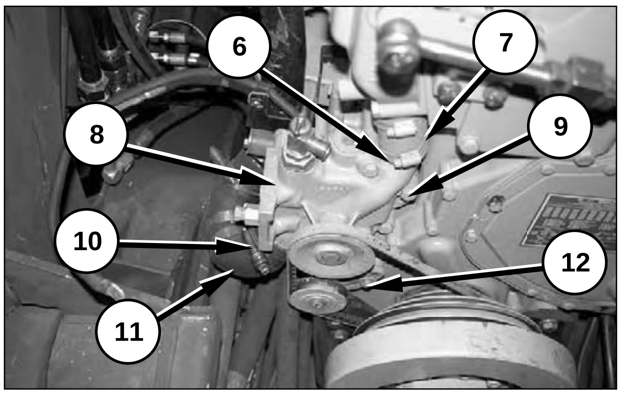
1. Drain the coolant from the cooling system. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* “Every 2000 Service Hours or Two Years, Cooling System, Change Coolant, Clean System.”



2. Remove bolt (1) with the washer, and clamp (2). Allow ground wire (3) to hang down, out of the way.



3. Remove four bolts (4) with the washers, and bracket (5).



4. Loosen the pivot bolt and bolt (12), and remove the water pump V-belt.

5. Loosen hose clamp (6), and disconnect radiator hose (7). Be sure to catch any remaining coolant in an appropriate manner.

6. Loosen hose clamp (10).

7. Remove six bolts (9), with the washers, and remove water pump (8) with two O-ring seals. Upon reassembly, ensure that the mounting surfaces are clean.

NOTE: To install the water pump, reverse the removal steps. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* “Every 250 Service Hours or Three Months, Engine V-Belts” for the belt tension adjustment procedure.

End By:

a. Install the air-conditioning compressor.

b. Install the alternator.

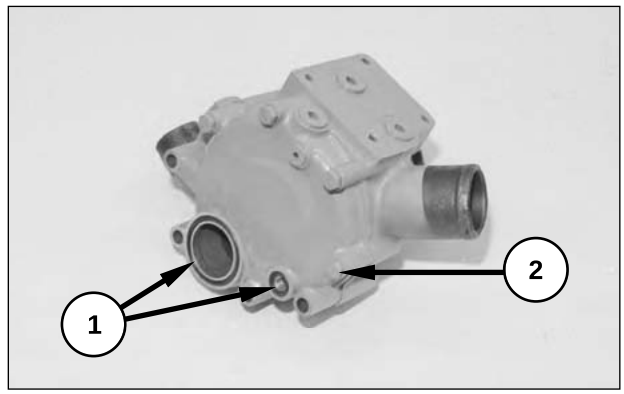
Disassemble and Assemble

Tools Needed	A	B	C
1P-0510 Driver Group	1		
1P-0520 Driver Group		1	
5P-9722 Seal Driver			1

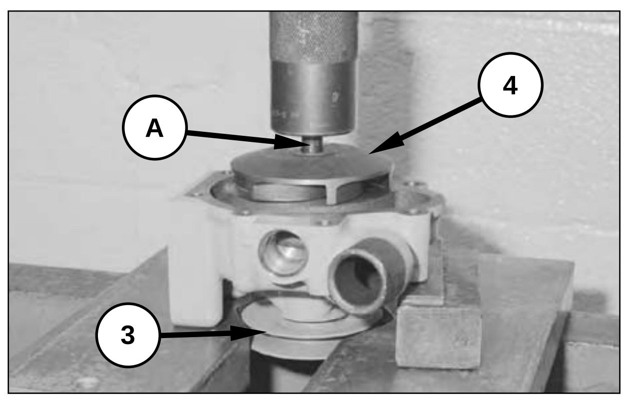
Start By:

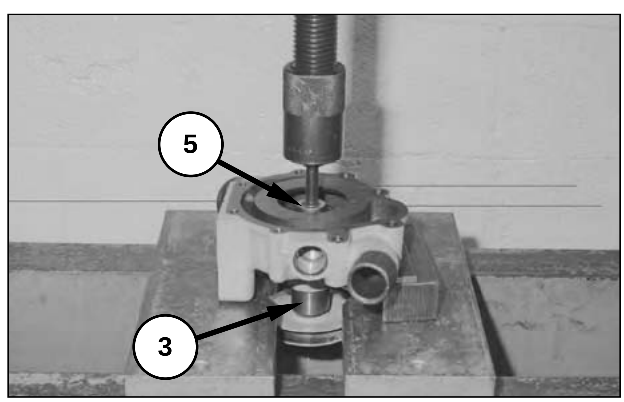
a. Remove the water pump.

NOTE: Group numbers related to this procedure include 120-8402 and 121-4328.



1. Remove two O-ring seals (1) from the rear cover of the water pump. Remove four bolts (2) and the washers. Remove the rear cover and gasket.





2. Put the water pump in a press. Use spacer plates to level the water pump, as shown.

3. Use a suitably sized drive plate from Tooling (A), and a press, to push the shaft and pulley (3), as a unit, out of impeller (4). Remove the impeller.

NOTICE

Do not allow the shaft and pulley to fall to the floor when being removed from seal (5) and the water pump housing. Damage to the shaft and pulley will result.

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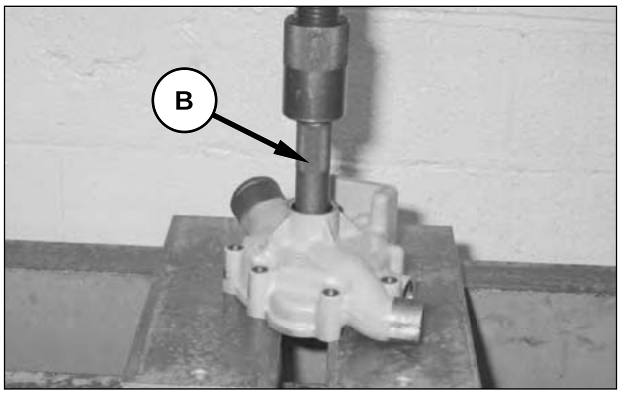
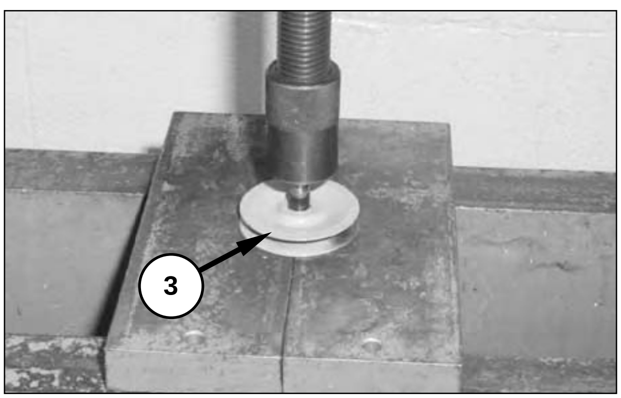
4. Continue to push the shaft and pulley out of seal (5) and the water pump housing.

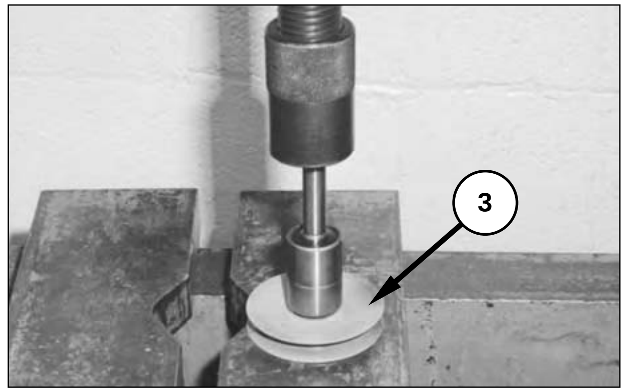


5. Use the handle from Tooling (B), and a press, to remove seal (5) from the water pump housing.

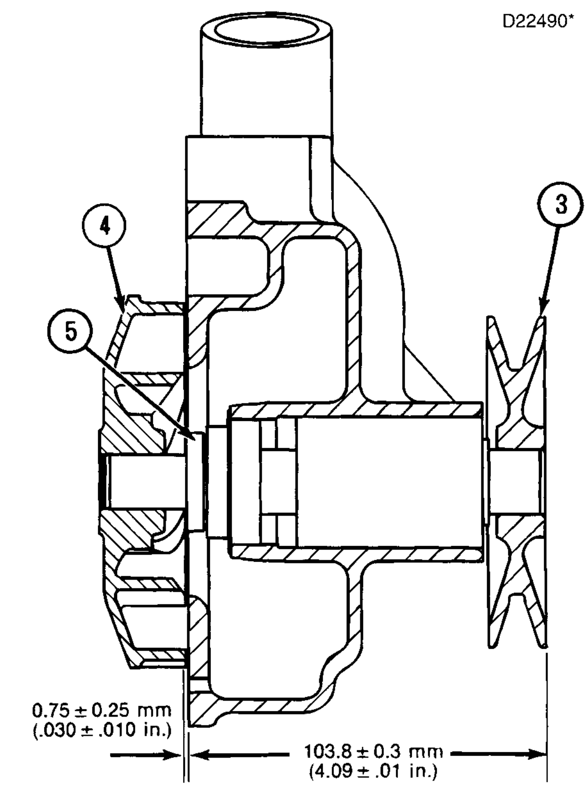


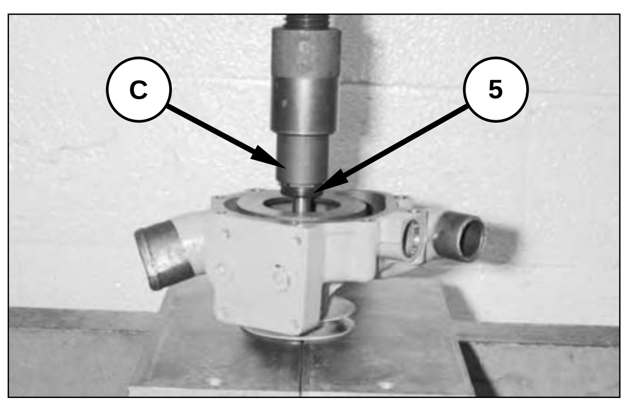
6. Use a press to remove the shaft and bearing assembly from pulley (3).

NOTE: The following steps are for the assembly of the water pump.



7. Use a press to install the shaft and bearing assembly into pulley (3). Install the shaft until it is flush with the end of the pulley.

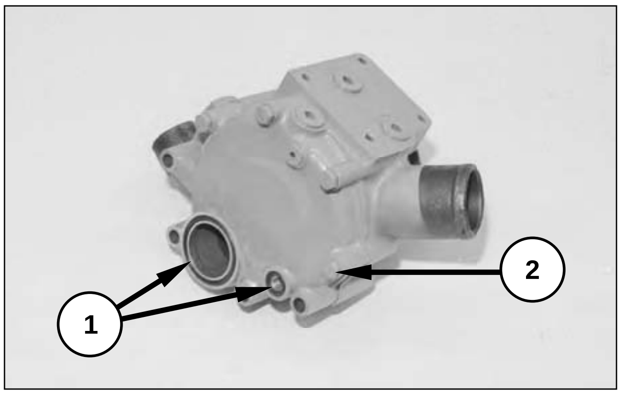




8. Press the shaft, bearing assembly and the pulley, as a unit, into the water pump housing. Install the unit until the distance between the front face of pulley (3) and the machined surface of the water pump housing is **103.8 ± 0.3 mm (4.09 ± 0.01 in).**

9. Use Tooling (C) and a press to install seal (5) in the water pump housing.

10. Use a press to install impeller (4) on the shaft of the water pump. Install the impeller until the distance between the impeller and the machined surface of the water pump housing is **0.75 ± 0.25 mm (0.030 ± 0.010 in).**



11. Use a new gasket between the rear cover of the water pump and the water pump housing. Place the gasket and cover in position, on the water pump housing. Install four bolts (2) and the washers that hold the rear cover in position.

12. Use two new O-ring seals (1), and install the O-ring seals in the rear cover.

End By:

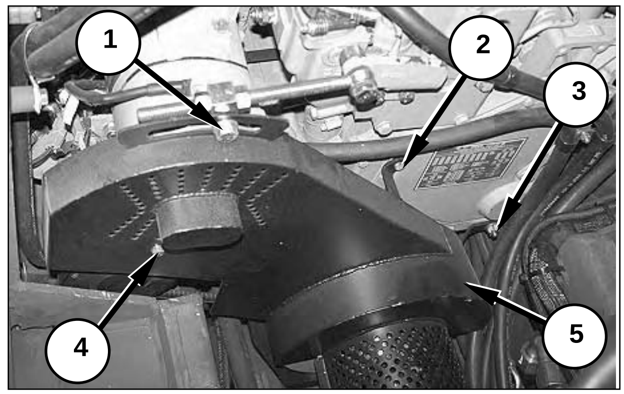
a. Install the water pump.

Water Pump Idler Pulley

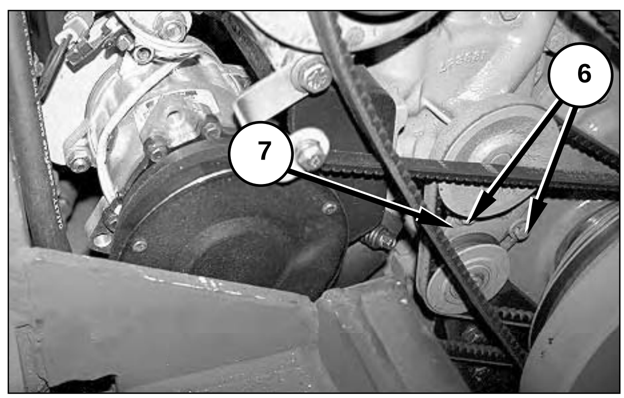
Remove and Install

NOTE: Group numbers related to this procedure include 120-6657 and 149-3203.

1. Raise the cab. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Features, Cab Tilt."



2. Remove bolt (1) with washer, bolt (2), bolt (3) with nut and two washers, bolt (4) with washer, and cover (5).



3. Remove two bolts (6), and the washers that hold water pump idler pulley (7) to the front housing.

4. Remove water pump idler pulley (7).

NOTE: The following steps are for the installation of the water pump idler pulley.

5. Install the water pump idler pulley in the reverse order of removal.

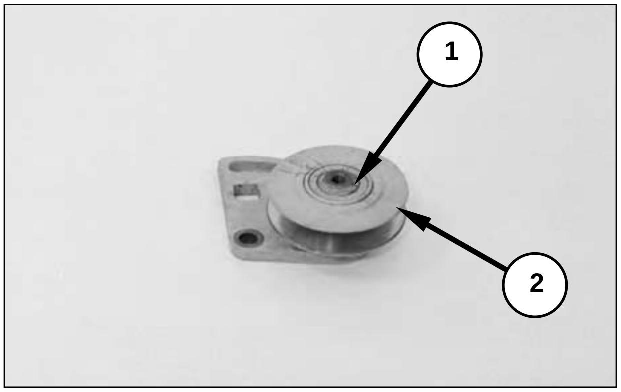
6. Adjust the tension of the water pump idler pulley V-belt. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Every 250 Service Hours or Three Months, Engine V-belts, Inspect/Adjust."

Disassemble and Assemble

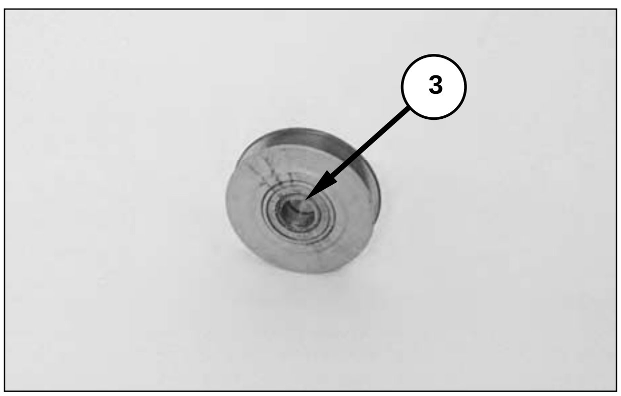
Tools Needed	A	B
1P-1855 Retaining Ring Pliers	1	
1P-0510 Driver Group		1

Start By:

a. Remove the water pump idler pulley.

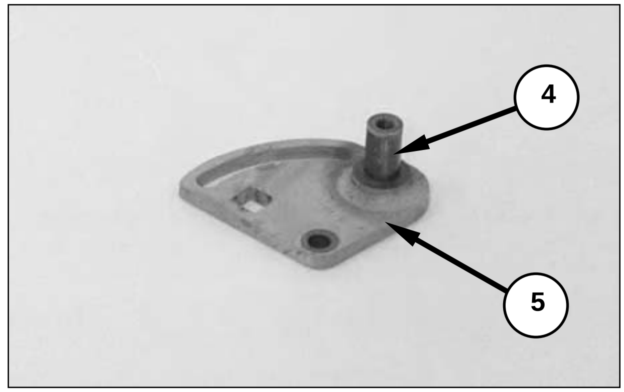


1. Use Tooling (A) to remove lock ring (1). Remove pulley assembly (2) from the idler plate assembly.



2. Remove bearing (3) from the pulley.

NOTE: The following steps are for the assembly of the water pump idler pulley.



NOTE: Shaft (4) is part of idler plate assembly (5). The shaft is not serviceable.

3. Check the condition of shaft (4) in idler plate assembly (5). If the shaft is worn, replace the idler plate assembly.

4. Use Tooling (B) to install bearing (3) in the pulley. Put **2S-3230 Bearing Lubricant** on the inner race of bearing (3) and on the shaft of the idler plate assembly.

5. Install pulley assembly (2) on idler plate assembly (5). Install lock ring (1), using Tooling (A) to hold the pulley assembly to the idler plate assembly.

End By:

a. Install the water pump idler pulley.

Water Temperature Regulator

Remove and Install

NOTE: The group number related to this procedure is 100-4942.

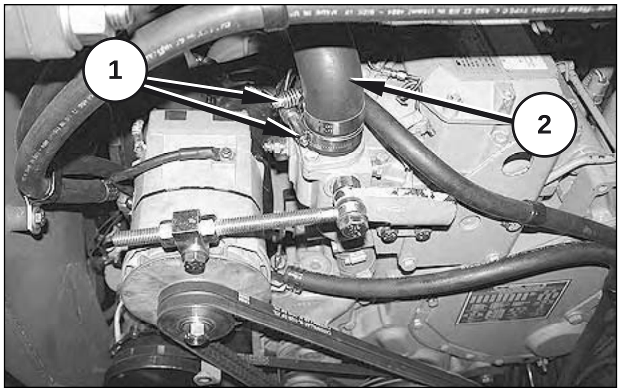
⚠ WARNING

At operating temperature, the engine coolant is hot and under pressure. Steam can cause personal injury. Check the coolant level only after the engine has been stopped and the fill cap is cool enough to touch with your bare hand. Remove the fill cap slowly to relieve the pressure in the cooling system. The cooling system conditioner contains alkali. Avoid contact with the skin and eyes to prevent personal injury.

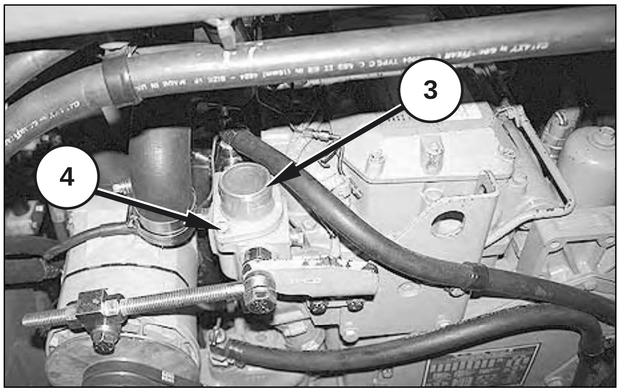
1. Drain the coolant from the cooling system. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* “Every 2000 Service Hours or Two Years, Cooling System, Change Coolant/Clean System.”

2. Raise the cab. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* “Maintenance Features, Cab Tilt.”

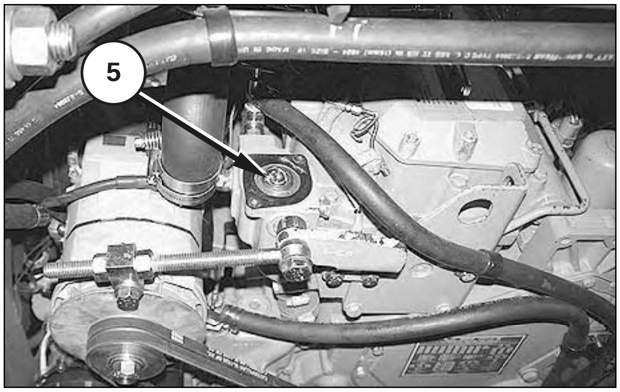
3. Raise the radiator. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* “Maintenance Features, Radiator Tilt.”



4. Loosen hose clamps (1), and disconnect coolant hose (2).



5. Remove two bolts (4) with the washers, and flange (3). Upon reassembly, replace the gasket, if necessary.



6. Remove water temperature regulator (5).

NOTE: To install the water temperature regulator, reverse the removal steps.

TM5-2430-200-24

Specifications
Systems Operation
Testing & Adjusting

Deployable Universal Combat Earthmover (DEUCE)

Transmission and Torque Converter

PIN: 7RR00003-Up

Important Safety Information

Most accidents involving product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “WARNING” as shown below.

The meaning of this safety alert symbol is as follows:

⚠ WARNING

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning, explaining the hazard, can be either written or pictorially presented.

Operations that may cause product damage are identified by NOTICE labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are therefore not all inclusive. If a tool, procedure, work method or operating technique not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and others. You should also ensure that the product will not be damaged or made unsafe by the operation, lubrication, maintenance or repair procedures you choose.

The information, specifications, and illustrations in this publication are on the basis of information available at the time it was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service given to the product. Obtain the complete and most current information before starting any job. Caterpillar dealers have the most current information available. For a list of the most current publication form numbers available, see the Service Manual Contents Microfiche, REG1139F.

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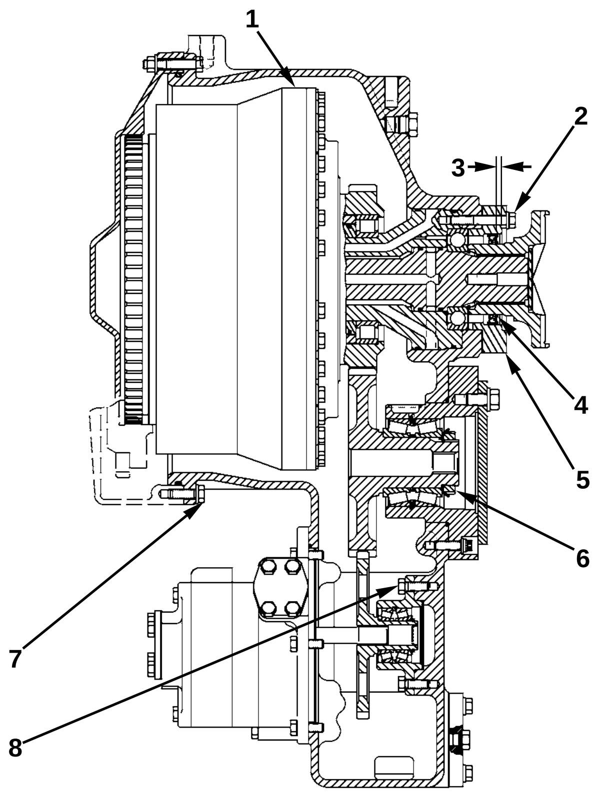
Torque Converter Group



(1) Apply 1U-8846 Gasket Maker to stator carrier prior to assembly in housing.

(2) Tighten bolt to a torque of ....50 ± 7 N•m (37 ± 5 lb ft)

(3) Install seal to a depth of ....4.4 ± 0.2 mm ....(0.17 ± 0.008 in)

(4) Coat sealing lips with lubricant that is to be sealed.

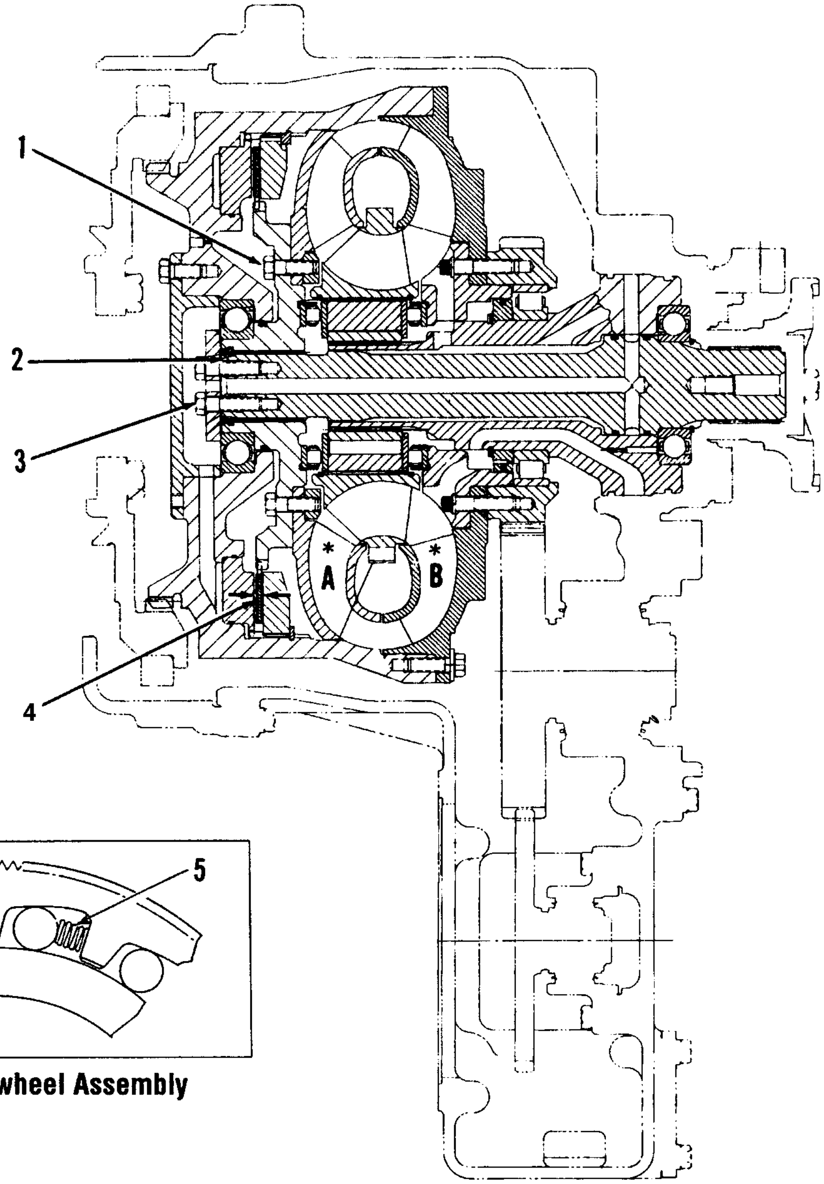
(5) Apply 5P-3413 Pipe Sealant to carrier prior to assembly of lip seal.

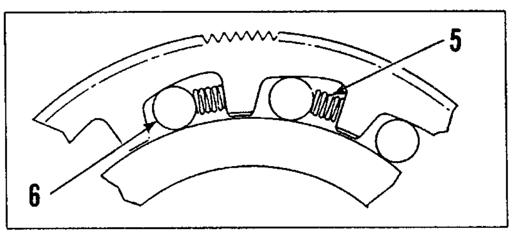
(6) Tighten nut to a torque of..................220 ± 25 N•m ....(162 ± 18 lb ft)

(7) Tighten 12 bolts to a torque of ....50 ± 7 N•m ....(37 ± 5 lb ft)

(8) Tighten 12 bolts to a torque of ....55 ± 10 N•m ....(41 ± 7 lb ft)

Torque Converter





Detail of Freewheel Assembly

(1) Tighten eight cover bolts to a torque of..50 ± 7 N•m (37± 5 lb ft)

(2) Install shims with thickness totalling 0.025 to 0.076 mm (0.001 to 0.003 in) less than the measured gap, with bolts (2) tightened to a torque of..10 N•m (7 lb ft)

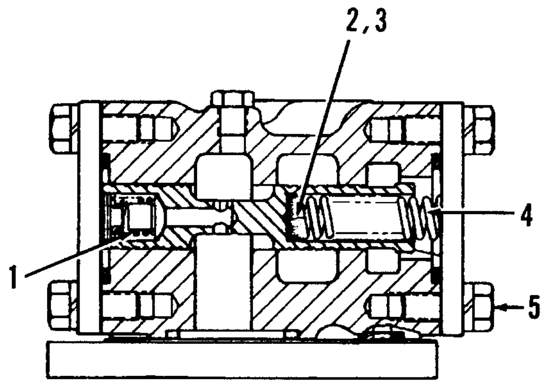
(3) Tighten four bolts to a torque of............50 ± 7 N•m ....(37± 5 lb ft)

(4) Thickness of one new 9P-4878 Disk ....4.87 to 5.03 mm (0.192 to 0.198 in)

Always install new springs (5) and rollers (6) in the freewheel assembly. Install the springs with the maximum number of loops to the outside of the cam. The stator should turn freely in a counterclockwise direction only.

The clearance between the stator and turbine (A), and between the stator and impeller (B) should be 1.12 to 1.88 mm (0.044 to 0.074 in) across in diameter when new. The maximum worn clearance is 3.05 mm (0.120 in) in both cases. The running clearance is half the clearance of the diameter.

Torque Converter Outlet Relief Valve



(1) 5M-9548 Spring:

Length under test force..............21.34 mm (0.84 in)
Test force....................4.1 to 4.9 N (0.92 to 1.08 lb)
Free length after test ....34 mm (1.34 in)
Outside diameter........................12.19 mm (0.48 in)

(2) 4M-1751 Spacer:

Thickness...................................0.41 mm (0.016 in)
Outside diameter......................15.09 mm (0.594 in)
One spacer changes pressure.........19 kPa (2.7 psi)

(3) 5S-7001 Spacer:

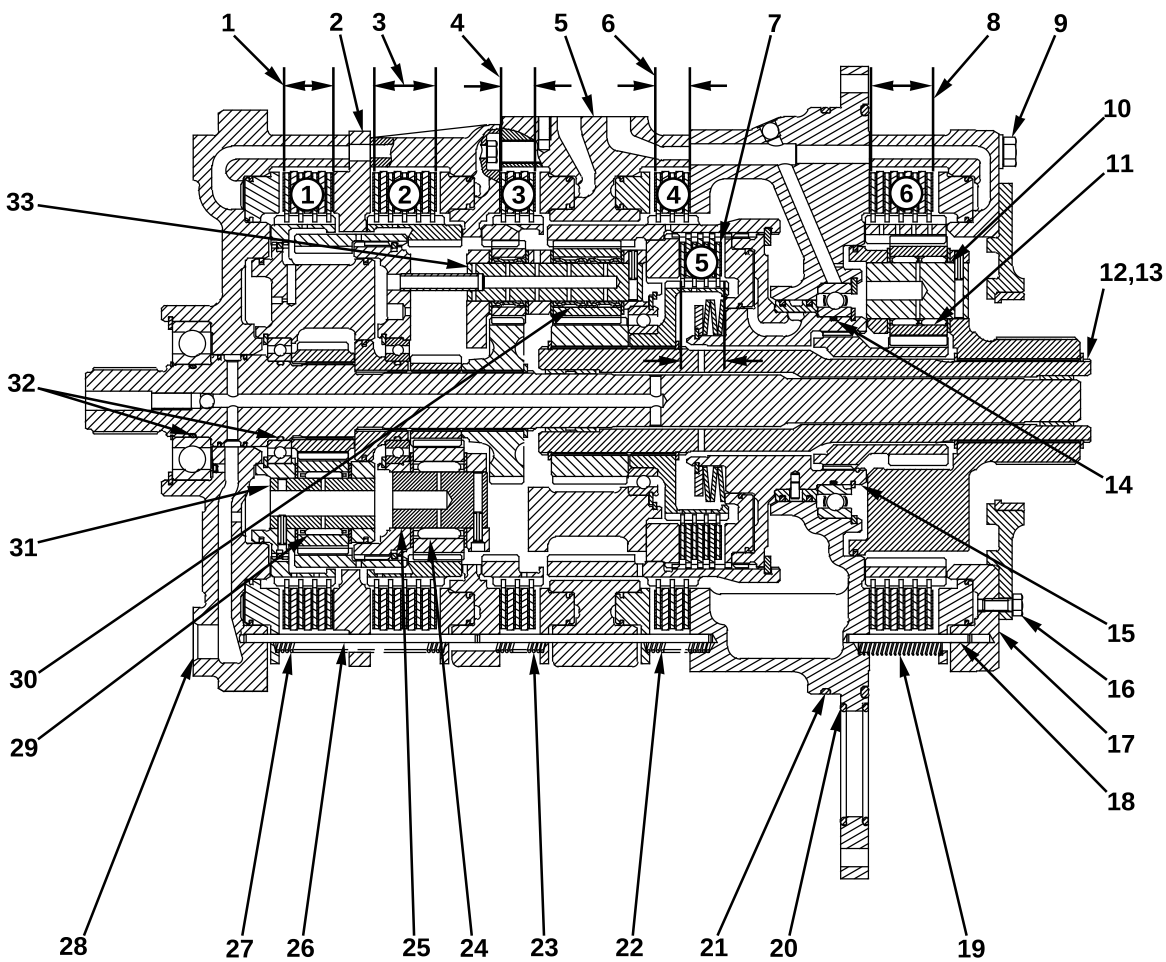
Thickness...................................0.91 mm (0.036 in)
Outside diameter.......................14.10 to 14.20 mm
....(0.555 to 0.559 in)
One spacer changes pressure............40 kPa (6 psi)

(4) 2S-1382 Spring:

Length under test force................33.2 mm (1.31 in)
Test force....................95 to 111 N (21.3 to 24.9 lb)
Free length after test ....50.04 mm (1.97 in)
Outside diameter......................15.09 mm (0.594 in)

(5) Tighten four bolts to a torque of............48 ± 7 N•m
....(35 ± 5 lb ft)

Planetary Transmission



(1) Thickness of four new disk assemblies and three new plates for number-1 clutch ....36.80 to 37.92 mm (1.449 to 1.493 in)

(2) Project two pins on 5H-6202 Plate Assembly.......... ....9.5 to 10.5 mm (0.37 to 0.41 in)

(3) Thickness of five new disk assemblies and four new plates for number-2 clutch ....47.23 - 48.67 mm ....(1.860 - 1.916 in)

(4) Thickness of three new disk assemblies and two new plates for number-3 clutch ....26.37 to 27.17 mm (1.038 to 1.070 in)

(5) Project four dowels on 1A-2223 Housing Assembly ....10.5 to 11.5 mm (0.41 to 0.45 in)

(6) Thickness of three new disk assemblies and two new plates for number-4 clutch ....26.31 to 27.23 mm (1.036 to 1.076 in)

(7) Thickness of four new disk assemblies and three new plates for number-5 clutch ....31.16 to 32.44 mm (1.227 to 1.277 in)

(8) Thickness of five new disk assemblies and four new plates for number-6 clutch...47.13 to 48.67 mm (1.856 to 1.916 in)

Thickness of one new 9P-7390 Disk Assembly (for number-1, 2 and 3 clutches) or one new 6Y-5911 Disk Assembly (for number-4 and number-6 clutches).......................................5.49 to 5.69 mm ....(0.216 to 0.224 in)

Thickness of one new 6Y-5912 Disk Assembly (for number-5 clutch) ....4.85 to 5.05 mm ....(0.191 to 0.199 in)

Thickness of one new 8P-2051 Plate (for number 1, 2, 3, 4 and 6 clutches) ....4.92 to 5.08 mm (0.194 to 0.200 in)

Thickness of one new plate (for number-5 clutch)........................3.92 to 4.08 mm (0.154 to 0.160 in)

(9) Tighten ten bolts to a torque of.......................................115 ± 7 N•m (85 ± 5 lb ft)

(10) Diameter of new 8P-7898 Shaft............42.387 to 42.403 mm (1.6688 to 1.6694 in)

(11) Bore of new 8P-7899 Planet Gear............51.938 to 51.958 mm (2.0448 to 2.0456 in)

(12) After assembly diameter of 9F-1847 Bearing for 8P-7894 Shaft.......................40.649 to 40.931 mm ....(1.601 to 1.611 in)

(13) After assembly diameter of 9G-7197 Bearing for 8P-7894 Shaft.......................31.685 to 31.763 mm ....(1.247 to 1.250 in)

(14) Lubricate each groove and O-ring seal with oil immediately before assembling each bearing.

(15) Countersink 6B-6863 Clutch Housing Assembly Pin ....1 to 3 mm (0.04 to 0.12 in)

(16) Apply 6V-6640 Gasket Maker to the threads of six bolts prior to assembly.

(17) Project two 1A-2223 Clutch Housing Dowels............................10.5 to 11.5 mm (0.41 to 0.45 in)

(18) Five 4M-1677 Dowels:

Length ....92.96 mm (3.660 in)
Outside diameter...................12.624 to 12.650 mm ....(0.497 to 0.498 in)

(19) Ten 7M-1199 Springs for number-6 clutch:

Length under test force................55.1 mm (2.17 in)
Test force..................118 to 138 N (26.5 to 31.1 lb)
Free length after test ....70.9 mm (2.79 in)
Outside diameter......................14.27 mm (0.562 in)

(20) Adjust 7M-1201 Manifold Assembly Dowel...14.5 to 15.5 mm (0.57 to 0.61 in)

(21) Coat bore lightly with lubricant that is to be sealed.

(22) Ten 8J-6704 Springs for number-4 clutch:

Length under test force............42.06 mm (1.656 in)
Test force..................118 to 138 N (26.3 to 30.9 lb)
Free length after test ....62.51 mm (2.46 in)
Outside diameter......................14.22 mm (0.560 in)

(23) Ten 4M-9592 Springs for number-3 clutch:

Length under test force............34.93 mm (1.375 in)
Test force..................110 to 122 N (24.9 to 27.5 lb)
Free length after test ....44.7 mm (1.76 in)
Outside diameter......................14.27 mm (0.562 in)

(24) Bore of new 6Y-4420 Planet Gear............58.388 to 58.308 mm (2.2948 to 2.2956 in)

(25) Diameter of new 6Y-4422 Shaft............42.387 to 42.403 mm (1.6688 to 1.6694 in)

(26) Ten 3K-2511 Dowels:

Length ....176.23 mm (6.938 in)
Outside diameter...................12.624 to 12.650 mm ....(0.497 to 0.498 in)

(27) Ten 7H-7658 Springs for number-1 and number-2 clutches:

Length under test force..............105.7 mm (4.16 in)
Test force........................176 to 204 N (40 to 46 lb)
Free length after test ....140.5 mm (5.53 in)
Outside diameter..........................14.2 mm (0.56 in)

(28) Tighten 3P-7009 Plug in 112-3632 Housing Assembly to retain.............................1.0 to 1.5 mm ....(0.04 to 0.06 in) clearance.

(29) Bore of new 8P-1919 Planet Gear............47.645 to 47.661 mm (1.8758 to 1.8764 in)

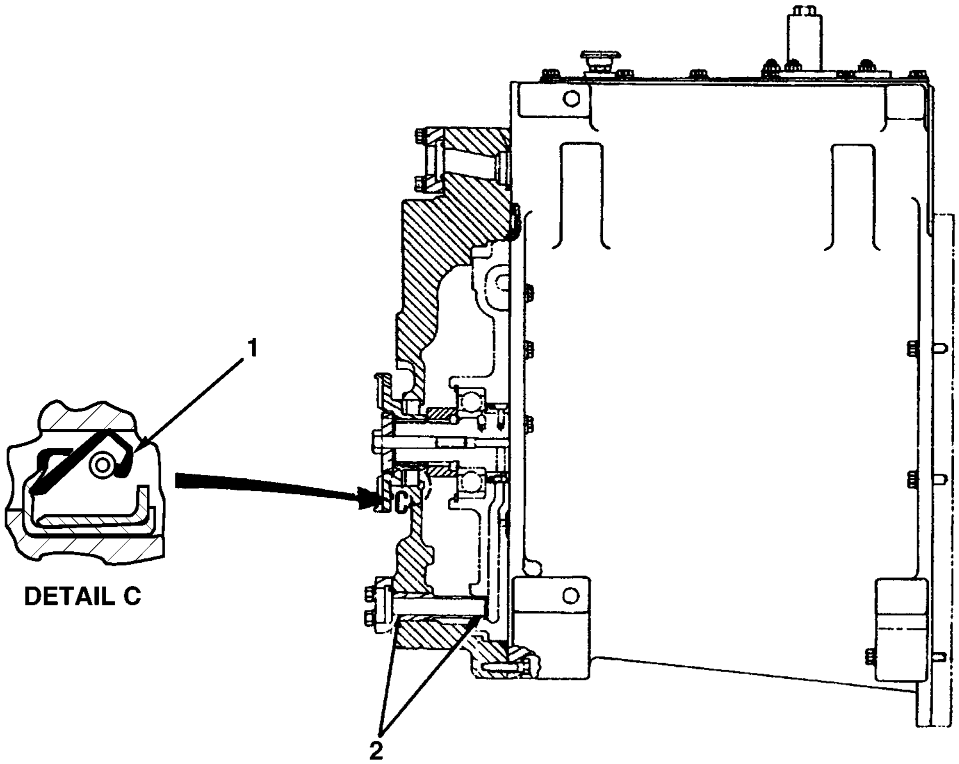
(30) Bore of new 6Y-4421 Planet Gear............38.115 to 38.131 mm (1.5006 to 1.5012 in)

(31) Diameter of new 8P-2043 Shaft............38.087 to 38.103 mm (1.4995 to 1.5001 in)

(32) Lubricate each groove and O-ring seal with oil immediately before assembling each bearing.

(33) Diameter of new 6Y-4425 Shaft............28.565 to 28.575 mm (1.1246 to 1.1250 in)

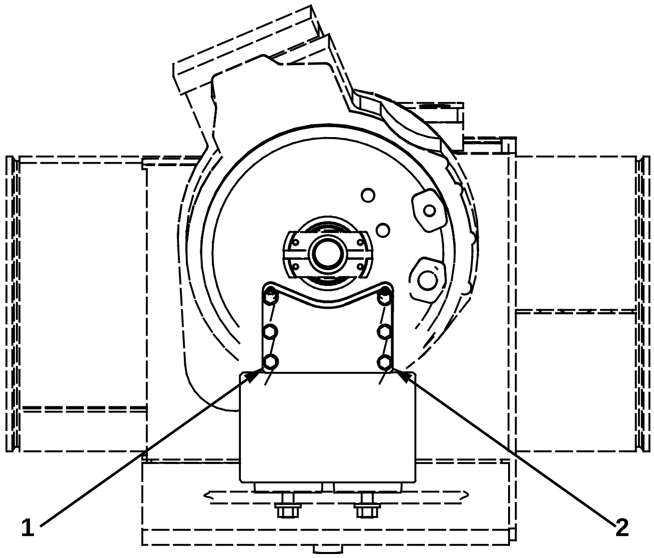
Transmission Case Group



(1) Coat sealing lip with lubricant that is to be sealed.

(2) Coat bore lightly with lubricant that is to be sealed.

Transmission Mounting Group



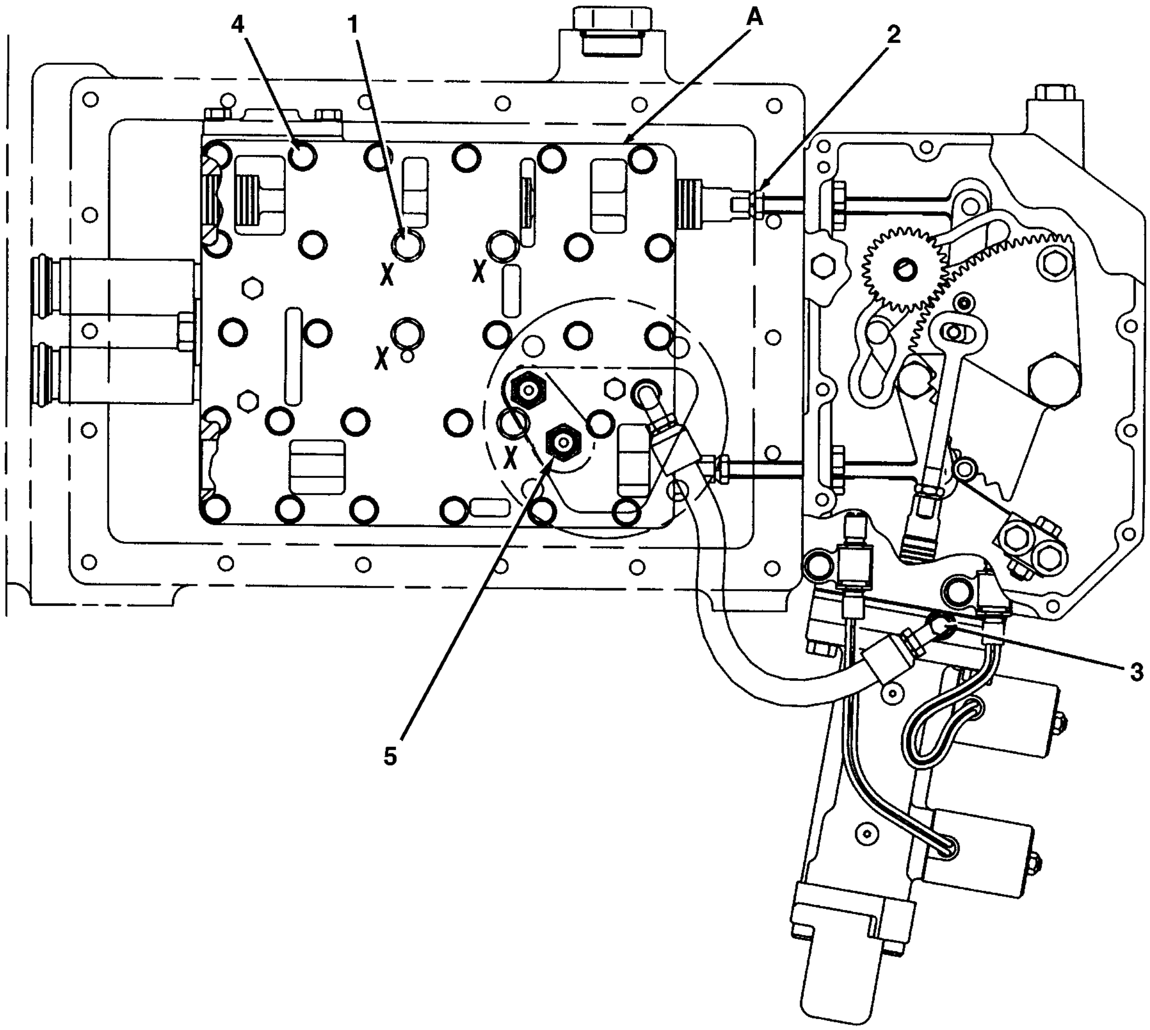
(1) Three bolts:

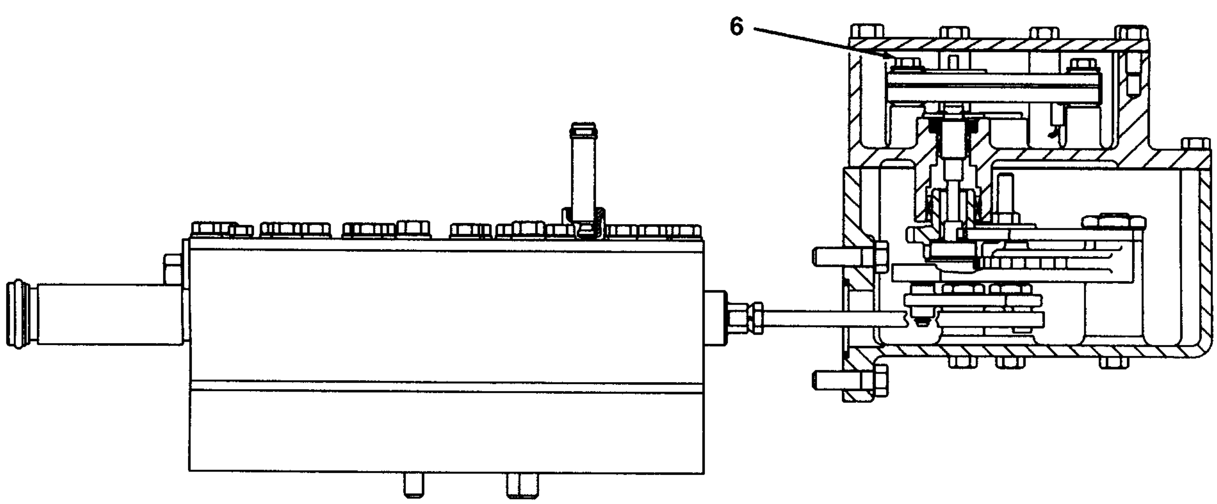
Apply 4C-4030 Thread Lock to threads.
Tighten to a torque of........................120 ± 20 N•m
....(88 ± 15 lb ft)
Install wire.

(2) Three bolts:

Apply 4C-4030 Thread Lock to threads.
Tighten to a torque of........................120 ± 20 N•m
....(88 ± 15 lb ft)
Install wire.

Transmission Hydraulic Control Valve Group





(A) Transmission selector and pressure control valve (see following pages).

(1) Tighten four bolts (marked X) to a torque of ....44 to 52 N•m (32 to 38 lb ft)

(2) Tighten three nuts to a torque of........27 to 41 N•m ....(20 to 30 lb ft)

(3) Tighten connector to a torque of ....12 to 20 N•m (9 to 15 lb ft)

(4) Tighten 26 bolts to a torque of..26 to 34 N•m (19 to 25 lb ft)

(5) Tighten two adapters to a torque of...12 ± 4 N•m (9 ± 3 lb ft)

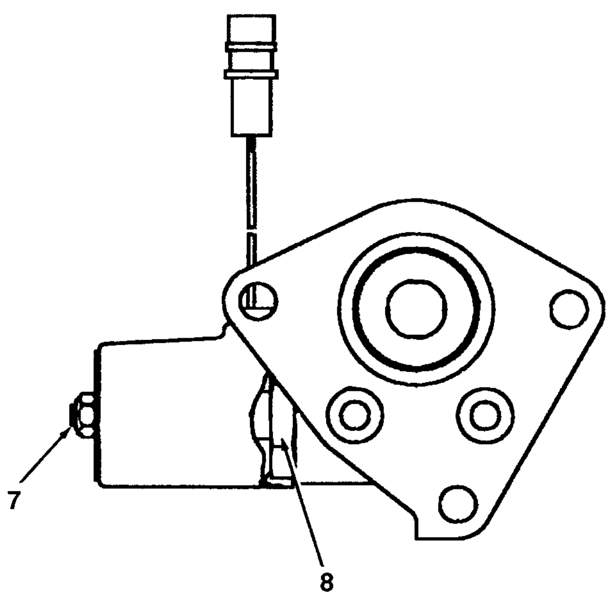
(6) Remove two mounting bolts from control group and reassemble from reverse direction to assemble to cover assembly. Tighten to a torque of...8 to 16 N•m (6 to 12 lb ft)

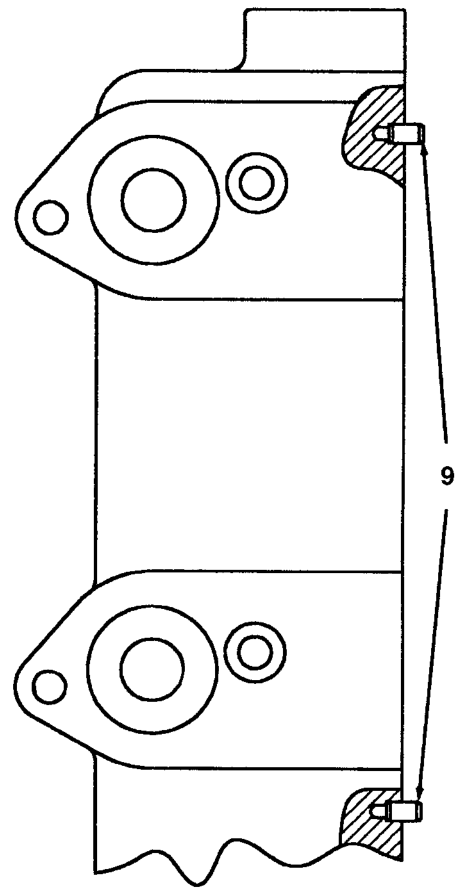
(7) Torque for two 9U-9338 Solenoid Lock nuts ....4.5 to 5.5 N•m (3 to 4 lb ft)

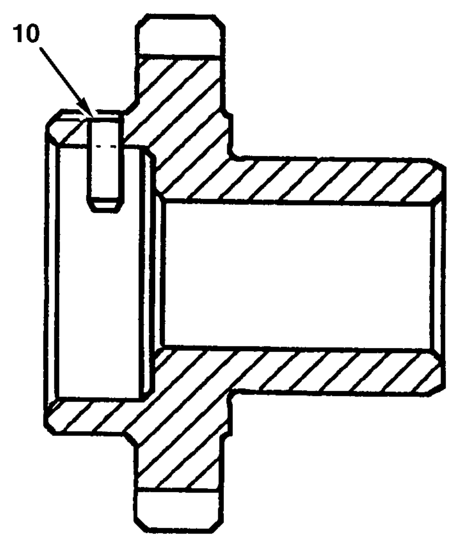
(8) Torque for two 9U-9338 Solenoid Valves ....45 to 55 N•m (33 to 41 lb ft)

(9) Projection of two 9U-9363 Housing Assembly Dowels.....................5.5 to 6.5 mm (0.22 to 0.26 in)

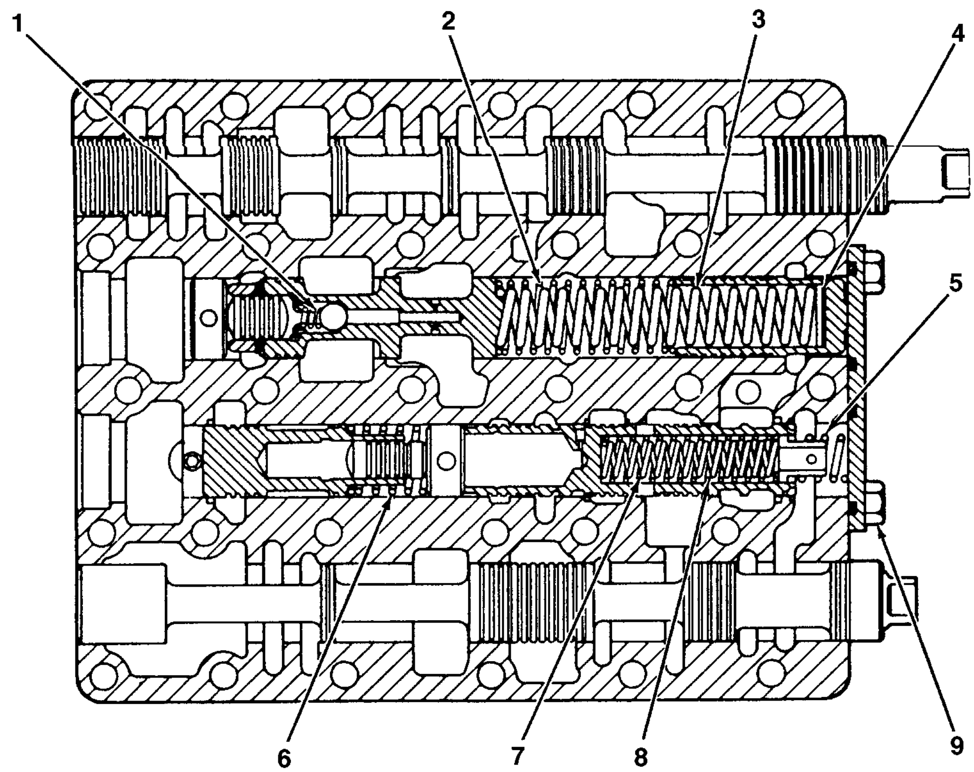
(10) Projection of 119-4341 Gear Assembly Dowel ....0.55 to 1.05 mm (0.022 to 0.041 in)







Transmission Selector and Pressure Control Valve



(1) 4M-2381 Spring:

Length under test force................12.2 mm (0.48 in)
Test force............2.12 to 2.48 N (0.476 to 0.558 lb)
Free length after test ....22.6 mm (0.89 in)
Outside diameter........................7.62 mm (0.300 in)

(2) 7G-4842 Spring (outer):

Length under test force..............36.35 mm (1.43 in)
Test force..................161 to 189 N (36.0 to 42.4 lb)
Free length after test ....68.45 mm (2.695 in)
Outside diameter......................27.79 mm (1.094 in)

(3) 9P-3041 Spring (inner):

Length under test force............90.09 mm (3.547 in)
Test force..................247 to 289 N (55.2 to 64.8 lb)
Free length after test ....117.4 mm (4.62 in)
Outside diameter......................21.21 mm (0.835 in)

(4) 5M-9622 Spacer:

Thickness...................................1.58 mm (0.062 in)
Outside diameter......................20.63 mm (0.812 in)
One spacer will change speed clutch pressure by approximately................................98 kPa (14.2 psi)

5M-9623 Spacer:

Thickness...................................0.91 mm (0.036 in)
Outside diameter......................20.63 mm (0.812 in)
One spacer will change speed clutch pressure by approximately..................................57 kPa (8.2 psi)

5M-9624 Spacer:

Thickness...................................0.25 mm (0.010 in)
Outside diameter......................20.63 mm (0.812 in)
One spacer will change speed clutch pressure by approximately.................................16 kPa (2.3 psi)

(5) 6P-9785 Spring:

Color code ....yellow stripe
Length under test force............19.48 mm (0.767 in)
Test force................22.3 to 24.7 N (5.01 to 5.55 lb)
Free length after test ....32.0 mm (1.26 in)
Outside diameter......................14.83 mm (0.584 in)

(6) 6P-4978 Spring:

Length under test force............27.15 mm (1.069 in)
Test force............63.6 to 70.4 N (14.34 to 15.86 lb)
Free length after test ....38.1 mm (1.50 in)
Outside diameter......................24.61 mm (0.969 in)

(7) 6P-9784 Spring (outer):

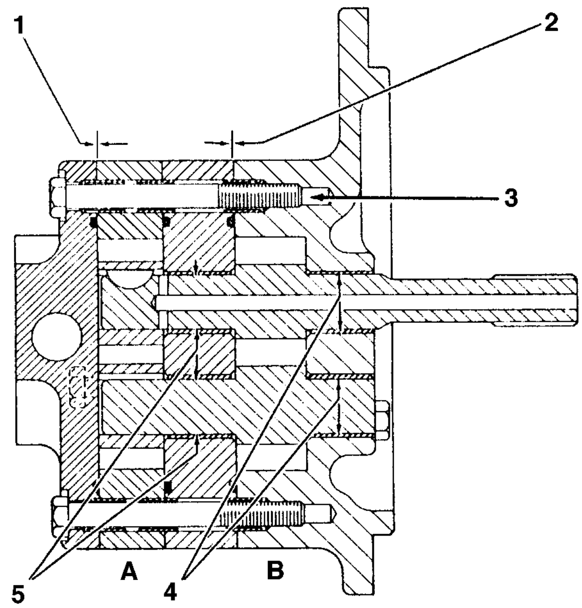
Color code ....yellow stripe
Length under test force..............56.39 mm (2.22 in)
Test force........123.5 to 136.5 N (27.84 to 30.76 lb)
Free length after test ....88.6 mm (3.49 in)
Outside diameter........................16.26 mm (0.64 in)

(8) 6P-9783 Spring (inner):

Color code ....yellow stripe
Length under test force..............56.39 mm (2.22 in)
Test force......................59 to 65 N (13.2 to 14.6 lb)
Free length after test ....88.6 mm (3.49 in)
Outside diameter......................11.02 mm (0.434 in)

(9) Tighten three bolts to a torque of..............................
...................................23 to 37 N•m (17 to 27 lb ft)

Power Train Lubrication Pump



Pump must turn freely by hand.

NOTICE
Before running, lubricate pump with hydraulic oil.

(1) Clearance between gears and cover (new) ....
................0.061 to 0.112 mm (0.0024 to 0.0044 in)

(2) Clearance between gears and cover (new) ....
................0.061 to 0.117 mm (0.0024 to 0.0046 in)

(3) Project two dowels........................4.33 to 5.33 mm
....(0.171 to 0.210 in)

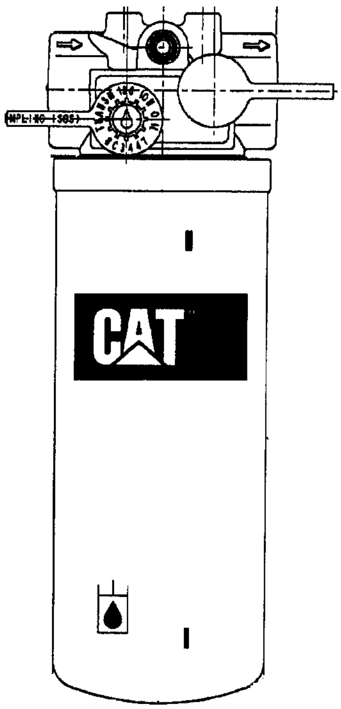
(4) Bore in 2S-7931 Bearings........22.258 ± 0.008 mm
....(0.876 ± 0.0003 in)
In a bore of...................................25.4 ± 0.013 mm
....(1.0 ± 0.0005 in)

Torque converter scavenge pump (section A):
Output (minimum) ....40.9 liters per min
....(11 U.S. gpm)
At a pressure of..............................410 kPa (60 psi)
With pump at...900 rpm

Transmission charging pump (section B):
Output (minimum) ....65 liters per min (17 U.S. gpm)
At a pressure of..........................2410 kPa (350 psi)
With pump at...1800 rpm

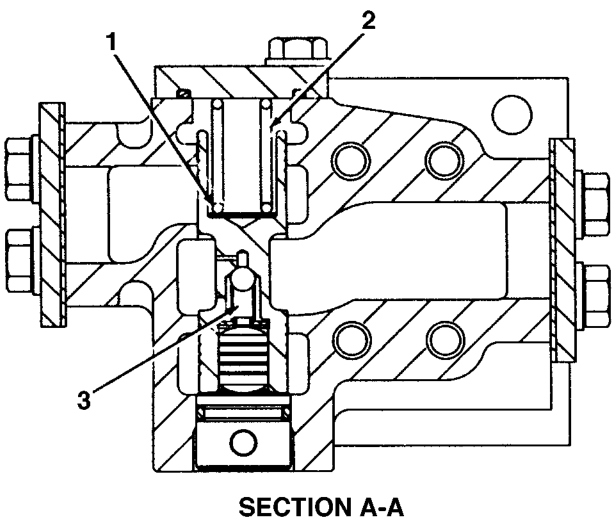
(5) Diameter of 124-9404 and 124-9405 Shafts ....
................22.217 ± 0.008 mm (0.8747 ± 0.0003 in)

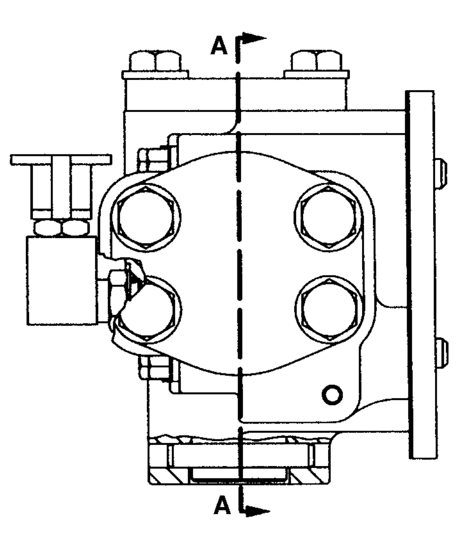
Transmission Oil Filter



Pressure difference at which bypass relief valve opens ....172 ± 12 kPa (25 ± 2 psi)

Priority Valve Group





(1) 5M-9624 Shims:

Quantity 6
Thickness ....0.25 mm (0.10 in)
Outside diameter ....20.37 to 20.87 mm
....(0.802 to 0.822 in)
One spacer changes pressure.......79 kPa (11.4 psi)

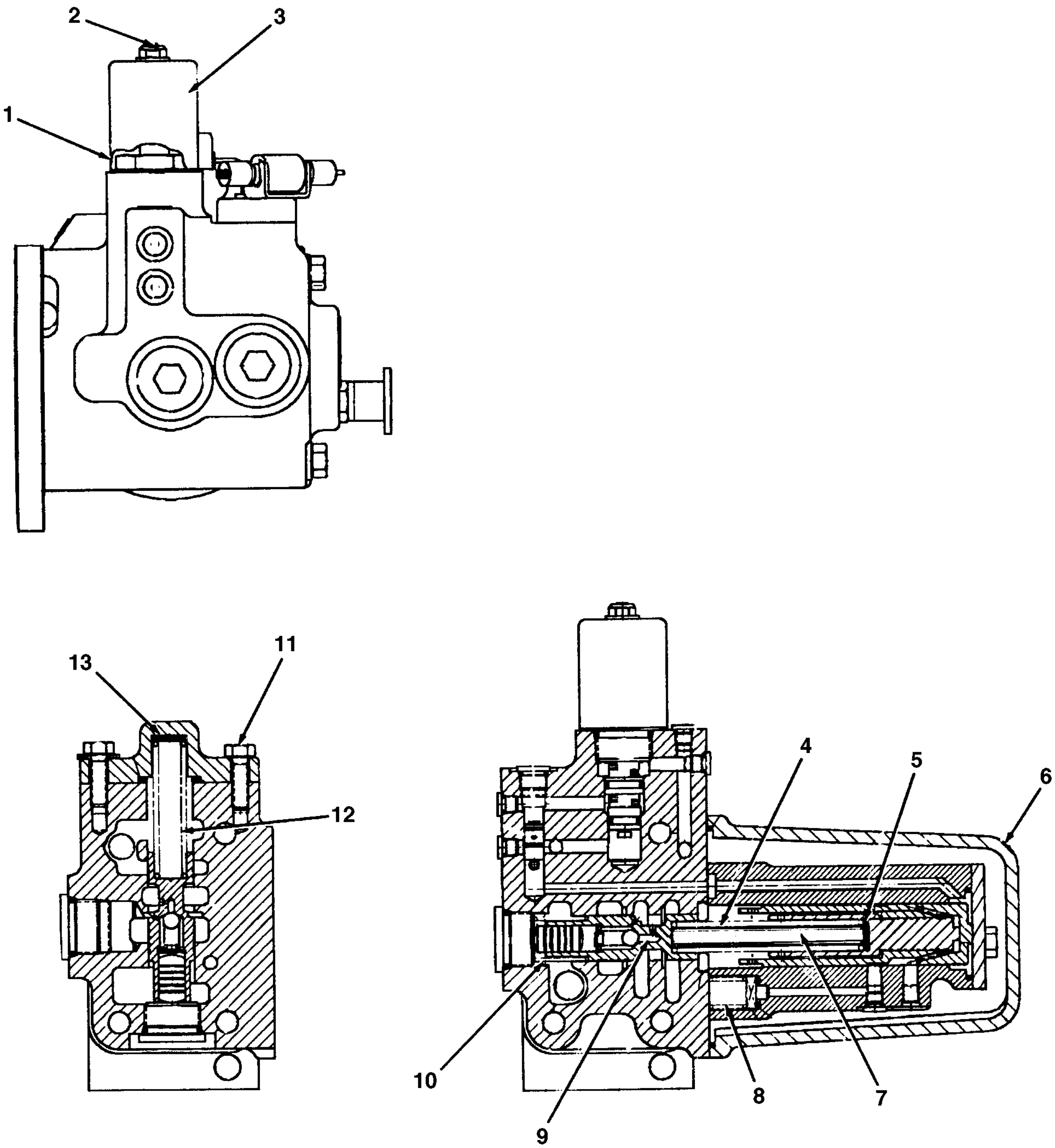
(2) 3P-4053 Spring:

Length under test force................32.3 mm (1.27 in)
Test force......................................496.9 to 566.3 N
....(111.70 to 127.31 lb)
Free length after test ....41.1 mm (1.62 in)
Outside diameter........................19.1 mm (0.752 in)

(3) 4M-2381 Spring:

Length under test force................12.2 mm (0.48 in)
Test force............2.12 to 2.48 N (0.477 to 0.558 lb)
Free length after test ....22.6 mm (0.89 in)
Outside diameter............................7.6 mm (0.30 in)

Hydraulic Lockup Clutch Valve



(1) Tighten cartridge assembly to a torque of................ ....80 ± 5 N•m (59.2 ± 3.7 lb ft)

(2) Tighten lock nut to a torque of................................. ....9 ± 0.5 N•m (6.7 ± 0.4 lb ft)

(3) Solenoid coil assembly resistance:

Nominal: 34.3 ± 1.7 OHMS at 25°C (77°F)
Minimum: 26 OHMS at -40°C (-40°F) ambient
Maximum: 56.1 OHMS at 121°C (250°F) ambient and maximum wattage

(4) 9W-7412 Spring:

Length under test force................79.5 mm (3.13 in)
Test force...........64.6 to 71.4 N (14.52 to 16.05 lb)
Free length after test ....84.07 mm (3.310 in)
Outside diameter.................14.732 mm (0.5800 in)

NOTE: Deflection to a length of 63.0 mm (2.48 in) requires an additional load of 238.4 to 253.2 N (53.59 to 56.92 lb).

(5) Use the following shim pack as needed to adjust the pressure setting of modulation reduction valve:

8J-4452 Shim thickness ....0.12 mm (0.005 in)
One shim will change pressure.....18.5 kPa (2.7 psi)
2S-0675 Shim thickness ....0.40 mm (0.016 in)
One shim will change pressure........59 kPa (8.6 psi)
9J-1330 Shim thickness............0.79 mm (0.031 in)
One shim will change pressure....114 kPa (16.6 psi)

(6) Tighten four bolts that secure cover to a torque of... ....23 to 37 N•m (17 to 27 lb ft)

(7) 7T-0569 Spring:

Length under test force...........63.93 mm (2.517 in)
Test force.....................................82.40 to 91.08 N
....(18.524 to 20.475 lb)
Free length after test ....80.4 mm (3.17 in)
Outside diameter.......................8.64 mm (0.340 in)

(8) 9D-7884 Spring:

Length under test force................18.6 mm (0.73 in)
Test force ....161.5 N (36.31 lb)
Free length after test ....23.9 mm (0.94 in)
Outside diameter..........................15.8 mm (0.62 in)

(9) 4M-2381 Spring:

Length under test force................12.2 mm (0.48 in)
Test force...........2.12 to 2.48 N (0.477 to 0.558 lb)
Free length after test ....22.6 mm (0.89 in)
Outside diameter...........................7.6 mm (0.30 in)

(10) 9P-0683 Spring:

Length under test force...........25.40 mm (1.000 in)
Test force ....32.8 to 38.4 N (7.37 to 8.63 lb)
Free length after test ....66.04 mm (2.600 in)
Outside diameter......................21.44 mm (0.844 in)

(11) Tighten six bolts to a torque of................................ ....23 to 37 N•m (17 to 27 lb ft)

(12) 9W-7410 Spring:

Color code ....three light-blue stripes

First test:

Length under test force ....79.5 mm (3.13 in)
Test force...........74.4 to 82.2 N (16.73 to 18.48 lb)

Second test:

Length under test force ....63.0 mm (2.48 in)
Test force........154.2 to 163.8 N (34.67 to 36.82 lb)
Free length after test ....87.63 mm (3.450 in)
Outside diameter.................14.732 mm (0.5800 in)

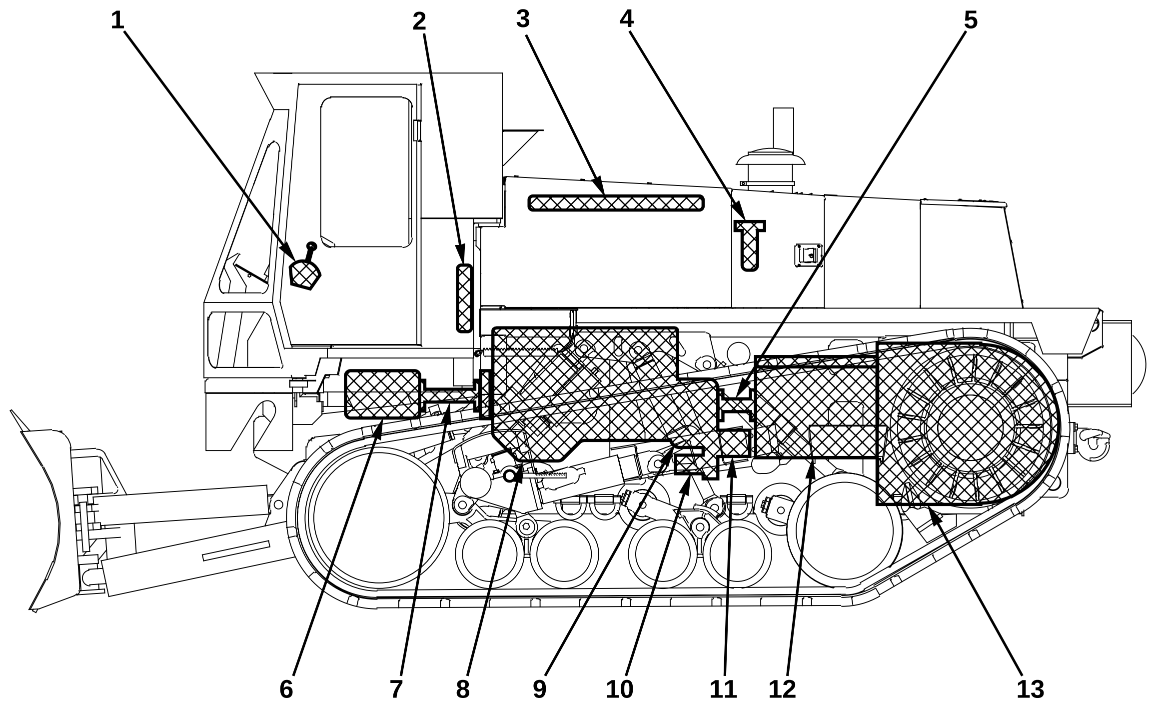
NOTE: Deflection to a length of 63.0 mm (2.48 in) requires an additional load of 154.2 to 163.8 N (34.67 to 36.82 lb).

(13) Use the following shim pack, as needed, to get correct end play of pressure reduction valve:

5J-2721 Shim thickness ....0.13 mm (0.005 in)
One shim will change pressure.......9.6 kPa (1.4 psi)
6J-3993 Shim thickness............0.25 mm (0.010 in)
One shim will change pressure.....19.3 kPa (2.8 psi)
5J-1036 Shim thickness............0.79 mm (0.031 in)
One shim will change pressure.....59.8 kPa (8.7 psi)

Systems Operation

Power Train Arrangement



Power Train Components.
(1) Transmission shift lever switch. (2) Electronic Programmable Transmission Control (EPTC II). (3) Power train oil cooler. (4) Power train oil filter. (5) Main drive shaft. (6) Steering pump. (7) Steering pump drive shaft. (8) Engine. (9) Torque converter. (10) Power train lubrication pump. (11) Implement hydraulic pump. (12) Planetary transmission. (13) Differential steering unit.

Engine (8) provides power to move the machine and control the implements. Steering pump (6) is driven by steering pump drive shaft (7), off the front of the engine. Torque converter (9) is driven directly by the flywheel at the rear of the engine.

NOTE: Refer to *Specifications Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage, Steering and Brakes* for detailed information on the steering system.

The torque converter has an integral lockup clutch which allows the machine to operate in either torque converter or direct drive. A set of gears driven by the torque converter input, which turns with the engine flywheel, drives power train lubrication pump (10) and implement hydraulic pump (11).

Power train lubrication pump (10) provides lubrication oil to the transmission, torque converter, and differential steering unit. The pump also pumps oil through power train oil cooler (3) to cool the power train lubrication oil.

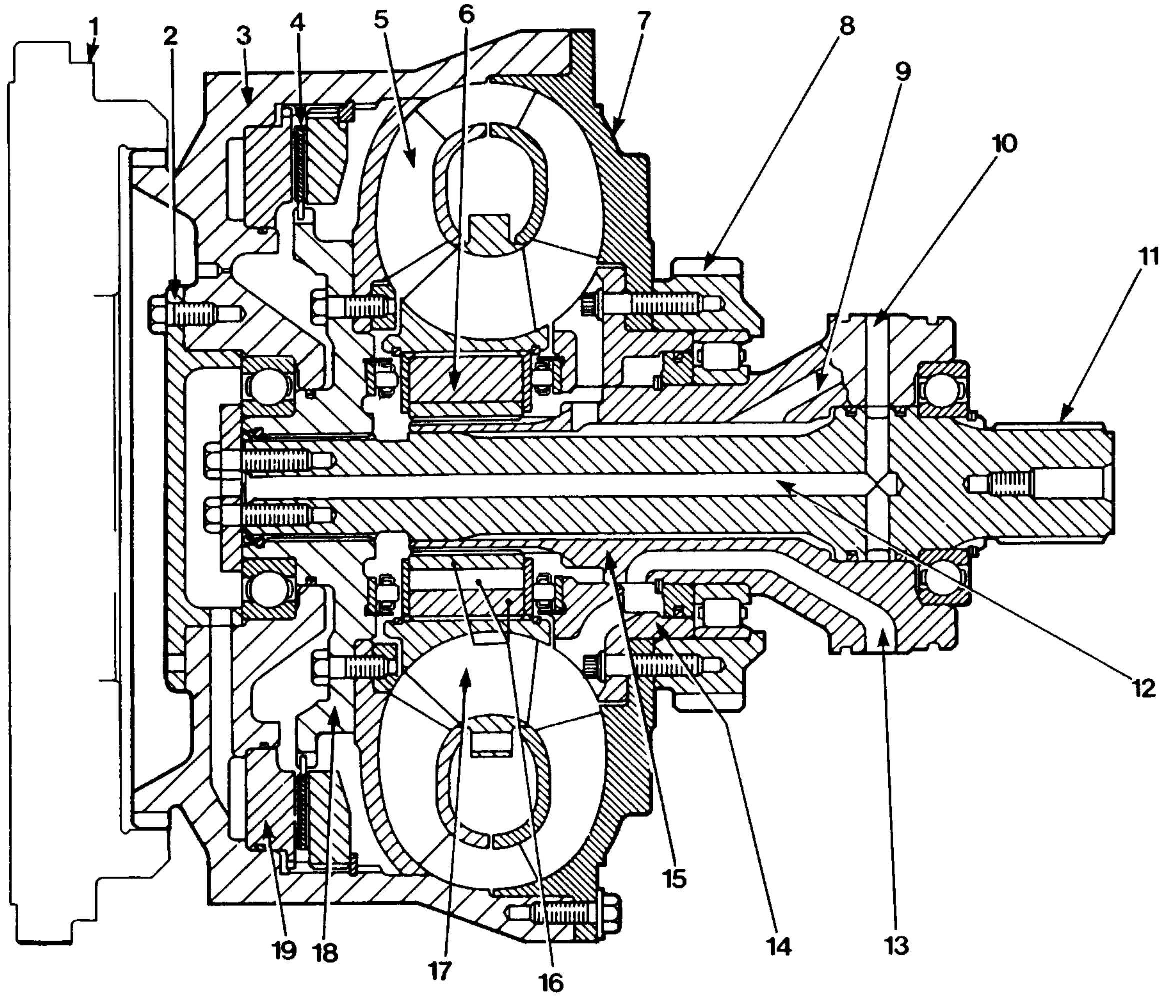
Primary output from the torque converter turns main drive shaft (5), which transmits power to planetary transmission (12). The planetary transmission drives differential steering unit (13).

The operator selects the desired transmission speed with the lever attached to transmission shift lever switch (1). The shift lever switch transmits the desired transmission speed to Electronic Programmable Transmission Control (EPTC II) (2), which signals the transmission control to select the appropriate gear.

EPTC II (2) shifts the transmission automatically between each of the six forward speeds when the machine is in SELF-DEPLOY mode. When the machine is in EARTHMOVING mode, the operator manually selects one of three forward speeds, and the EPTC II does not shift automatically between speeds. The two reverse speeds are manually controlled by the operator at all times.

NOTE: Refer to *Specifications Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* “Systems Operation, Transmission Control Circuit” for more information.

Torque Converter



Torque Converter.
(1) Engine flywheel. (2) Cover. (3) Rotating housing. (4) Clutch disk. (5) Turbine. (6) Cam. (7) Impeller. (8) Drive gear. (9) Inlet passage. (10) Passage for lockup clutch oil. (11) Output shaft. (12) Passage. (13) Outlet passage. (14) Hub. (15) Carrier. (16) Freewheel assembly. (17) Stator. (18) Clutch hub. (19) Piston.

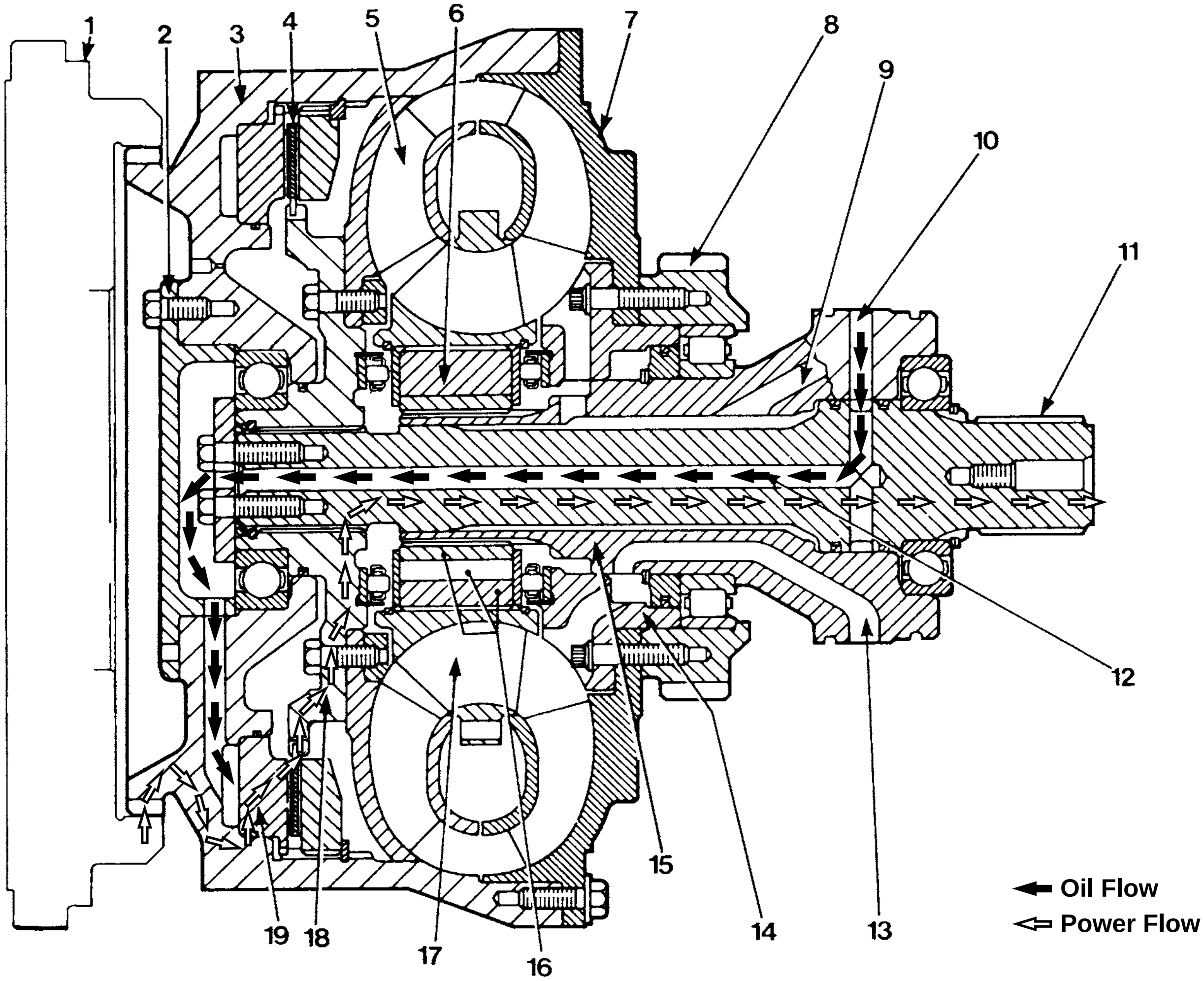
The torque converter is a remote-mount, single-stage, rotating-housing converter. The converter incorporates a lockup clutch which allows the torque converter to be operated in converter drive or in direct drive. Converter drive enables the machine to be moved from standstill, provides high output power over a broad speed range, and functions as a shock damper during each gear change.

Rotating housing (3) is driven by engine flywheel (1). The rotating housing is bolted to impeller (7). Drive gear (8) and the impeller are bolted to hub (14).

The engine flywheel, rotating housing, impeller, drive gear and hub turn as a unit at the same speed and in the same direction as the engine crankshaft.

Drive gear (8) drives the charging and lubrication pump cartridges, which are part of the transmission hydraulic pump group. The charging pump draws oil mainly from the torque converter housing and provides oil under pressure for the torque converter and transmission. The charging pump also draws oil from the differential steering unit in case oil is not available in the torque converter housing (as during cold weather starting). The lubrication pump draws oil from the differential steering unit and returns pressurized oil to the differential steering unit to lubricate its internal components.

Direct Drive



Torque Converter in Direct Drive.
(1) Engine flywheel. (2) Cover. (3) Rotating housing. (4) Clutch disk. (5) Turbine. (6) Cam. (7) Impeller. (8) Drive gear. (9) Inlet passage. (10) Passage for lockup clutch oil. (11) Output shaft. (12) Passage. (13) Outlet passage. (14) Hub. (15) Carrier. (16) Freewheel assembly. (17) Stator. (18) Clutch hub. (19) Piston.

NOTE: The torque converter will not operate in direct drive mode when the machine is in EARTHMOVING mode.

The lockup clutch assembly is situated within rotating housing (3). Internally splined clutch disk (4) is engaged with lockup clutch hub (18), which, in turn, is splined to output shaft (11); the output shaft turns at input speed. The rotating housing, turbine (5), and output shaft (11) then rotate as a unit at crankshaft rpm.

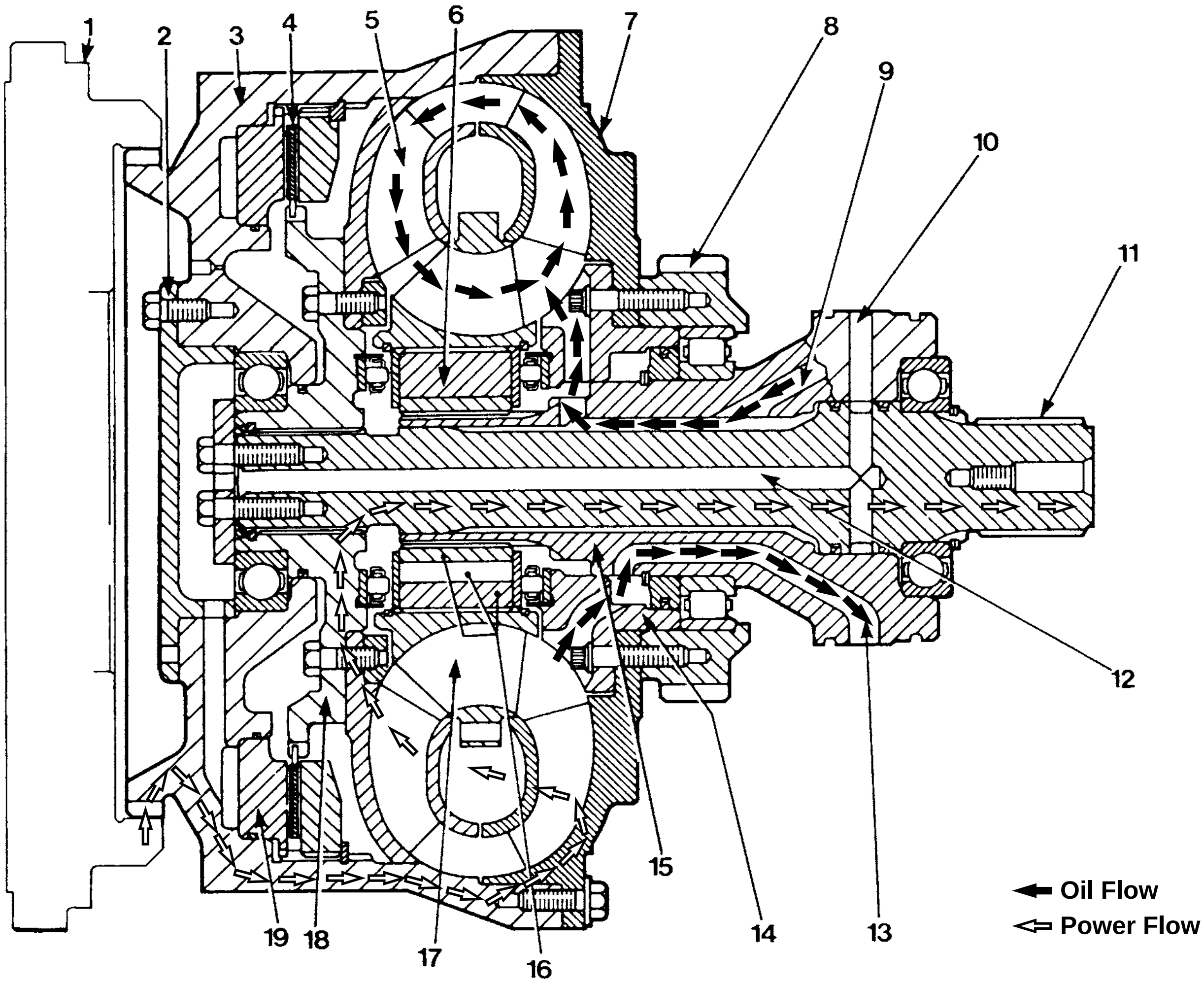
When the transmission input speed and transmission hydraulic oil pressure reach the required values, the transmission control activates the lockup solenoid on the lockup control valve. This valve directs oil to passage (10). The signal oil in passage (10) flows through passage (12) and down the middle of output shaft (11) to the cavity behind cover (2).

The oil then flows through passages in the rotating housing to piston (19), which engages the lockup clutch. With the lockup clutch engaged, the impeller, turbine and freewheel assembly rotate as a unit. Power flows through the flywheel, spider gear, input shaft, rotating housing, lockup clutch and converter output shaft. The machine is now in direct drive.

The lockup clutch remains engaged as long as the transmission input speed and transmission oil pressure are high enough.

The system reverts to converter drive during gear shifts. This prevents the transmission from being shock loaded.

Converter Drive



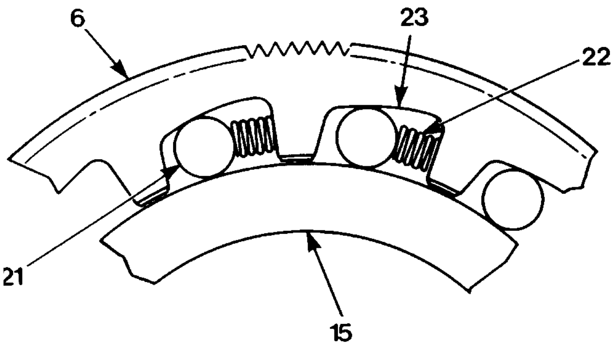
Torque Converter in Converter Drive.
(1) Engine flywheel. (2) Cover. (3) Rotating housing. (4) Clutch disk. (5) Turbine. (6) Cam. (7) Impeller. (8) Drive gear. (9) Inlet passage. (10) Passage for lockup clutch oil. (11) Output shaft. (12) Passage. (13) Outlet passage. (14) Hub. (15) Carrier. (16) Freewheel assembly. (17) Stator. (18) Clutch hub. (19) Piston.

Oil enters the torque converter through inlet passage (9) and flows along internal passages to impeller (7). The impeller blades pick up inlet oil and direct the oil against the blades of turbine (5). The turbine and clutch hub (18) are bolted together. The clutch hub assembly is splined to converter output shaft (11). The output shaft is connected to the transmission by a drive shaft and yoke arrangement.

After the oil passes through the turbine, the oil is redirected to the impeller by stator (17), to assist in torque amplification. When the torque converter is working hard (output torque requirements exceeding input torque from the engine), such as when the machine is accelerated at standstill, the impeller is turning at the same speed as the engine, but the turbine is turning relatively slowly. Oil passing through the turbine hits the stator blades so that the stator tends to turn in the opposite direction of the turbine.

The stator is prevented from turning by freewheel assembly (16), which is locked up. The stator then directs most of the oil which is passing through the turbine back to the impeller. Oil that does not pass back to the impeller flows out of the converter through outlet passage (13).

In converter drive, power flows through the flywheel, rotating housing, impeller, turbine and output shaft.

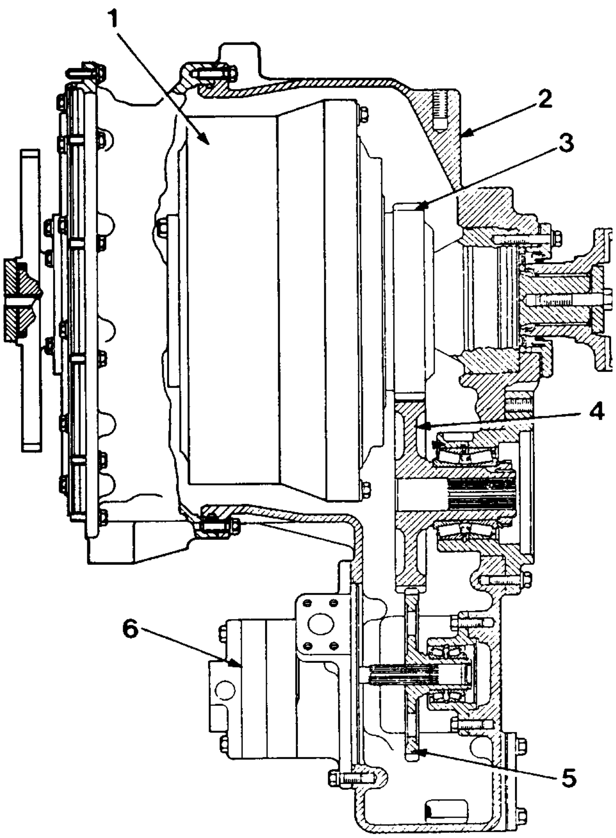


Detail of Freewheel Assembly.
(6) Cam. (15) Carrier. (21) Rollers. (22) Springs. (23) Grooves.

The freewheel assembly is a one-way clutch consisting of cam (6), rollers (21), springs (22) and carrier (15). The cam is connected by splines to stator (17), so that when the stator tries to move in the opposite direction of the turbine, the rollers are forced into the narrow end of tapered grooves (23), preventing the cam and stator assembly from rotating around the carrier. Since the carrier is held stationary, the stator cannot turn, and the freewheel assembly (one-way clutch) is locked up.

When the torque converter is not working hard (output torque requirements are equal to or less than input torque), such as when ground speed is high and resistance is low, the turbine will turn relatively quickly. Oil passing through the turbine then strikes the back of the stator blades so that the stator starts to run in the same direction as the turbine. The oil redirected from the stator multiplies the torque transfer between the impeller and the turbine. Cam (6) then rotates so that rollers (21) occupy the wide end of tapered grooves (23). The cam and stator assembly are then free to rotate around the carrier (freewheel), and oil passing through the turbine flows out of the torque converter through outlet passage (13). The result of the torque multiplication is that the output shaft rotates slower than the engine crankshaft, but with increased torque.

Transmission Pump Drive



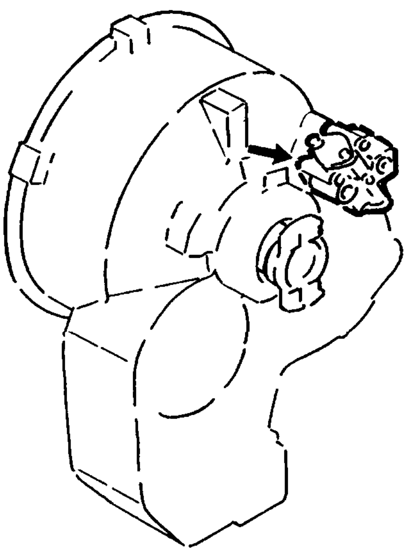
Transmission Pump Drive.
(1) Torque converter. (2) Torque converter case. (3) Drive gear. (4) Gear. (5) Gear. (6) Transmission oil pump.

Transmission oil pump (6) is a dual-section pump. One section is used to charge the transmission system; the other section is used to lubricate the differential steering assembly.

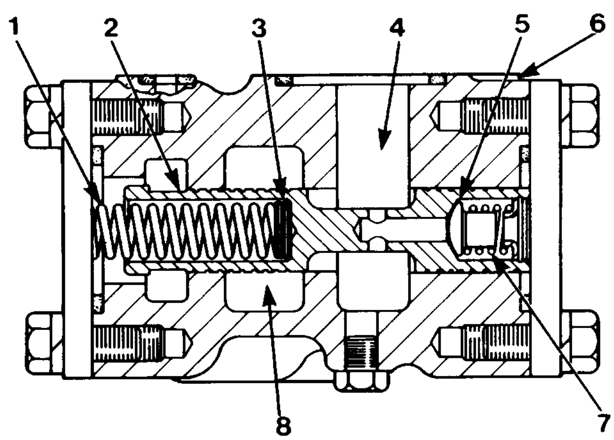
The pump is mounted on the torque converter case. Drive gear (3) turns with the torque converter impeller and transmits drive to the pump shaft through gears (4) and (5).

Torque Converter Outlet Relief Valve

The torque converter outlet relief valve is located on the back of the torque converter. The outlet relief valve controls the maximum pressure of the oil inside the torque converter.



Location of Torque Converter Outlet Relief Valve.



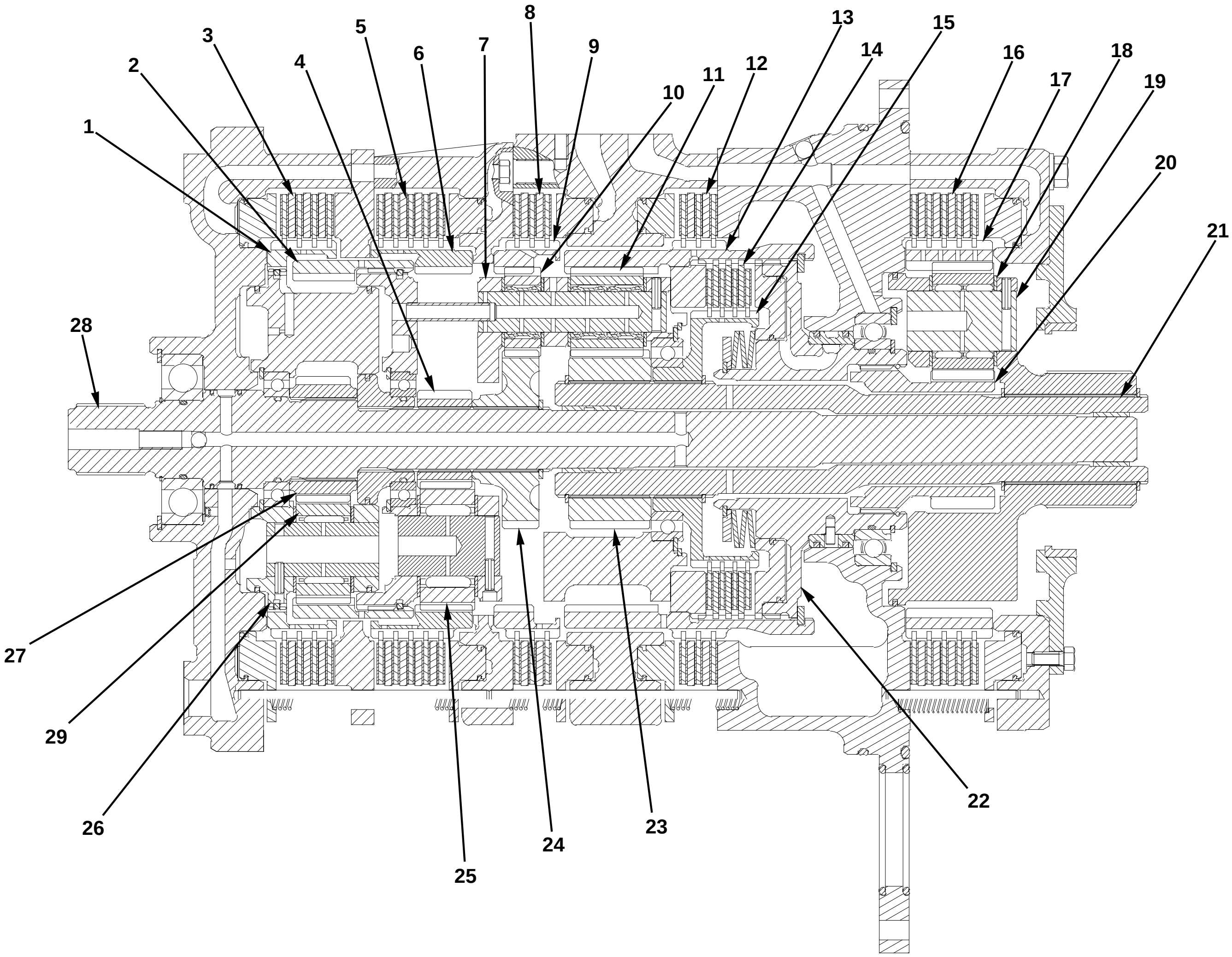
Torque Converter Outlet Relief Valve.
(1) Spring. (2) Valve spool. (3) Shims. (4) Inlet passage.
(5) Poppet valve. (6) Valve body. (7) Spring. (8) Outlet passage.

Oil which leaves the torque converter enters valve body (6) through passage (4). The oil passes through a hole in valve spool (2), unseats poppet valve (5) and acts against the end of the spool.

As the pressure of the converter outlet oil increases, the valve spool moves against the effect of spring (1). As the spool moves, outlet passage (8) is connected to inlet passage (4). Converter outlet oil flows through the oil cooler to the transmission.

Shims (3) are provided to adjust the pressure setting of the valve to 290 ± 14 kPa (42 ± 2 psi).

Planetary Transmission



Planetary Transmission.
(1) No. 1 clutch ring gear. (2) Coupling gear. (3) No. 1 clutch. (4) No. 2 sun gear. (5) No. 2 clutch. (6) No. 2 clutch ring gear. (7) No. 2, 3 and 4 carrier. (8) No. 3 clutch. (9) No. 3 clutch ring gear. (10) No. 3 planetary gears. (11) No. 4 planetary gears. (12) No. 4 clutch. (13) No. 4 clutch ring gear. (14) No. 5 clutch. (15) Rotating hub. (16) No. 6 clutch. (17) No. 6 clutch ring gear. (18) No. 6 planetary gears. (19) No. 6 carrier. (20) No. 6 sun gear. (21) Output shaft. (22) Housing assembly. (23) No. 4 sun gear. (24) No. 3 sun gear. (25) No. 2 planetary gears. (26) No. 1 carrier. (27) No. 1 sun gear. (28) Input shaft. (29) No. 1 planetary gears.

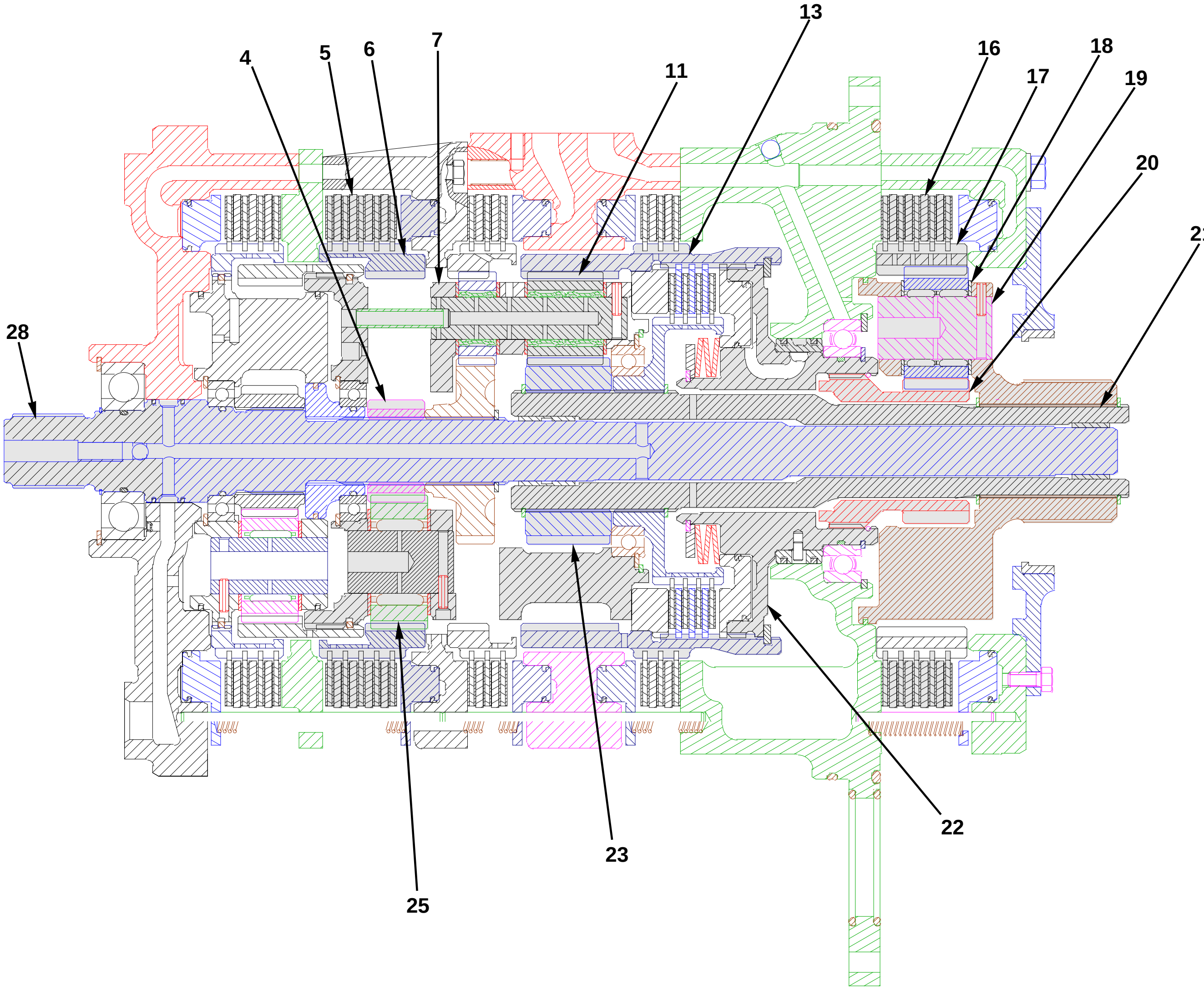
The full power shift planetary transmission contains six hydraulically activated clutches which provide six forward speeds and two reverse speeds.

Drive from the torque converter is transmitted to input shaft (28) by a drive shaft and yoke arrangement.

Number-1 clutch (3), number-2 clutch (5), and number-3 clutch (8) are all directional clutches. The number-1 clutch is the reverse directional clutch. The number-2-and-3 clutches are the forward directional clutches. Number-4 clutch (12), number-5 clutch (14), and number-6 clutch (16) are speed clutches.

Speed	Clutches Engaged
First	6 and 2
Second	6 and 3
Third	5 and 2
Fourth	5 and 3
Fifth	4 and 2
Sixth	4 and 3
Neutral	4
First Reverse	6 and 1
Second Reverse	5 and 1

First Speed Forward



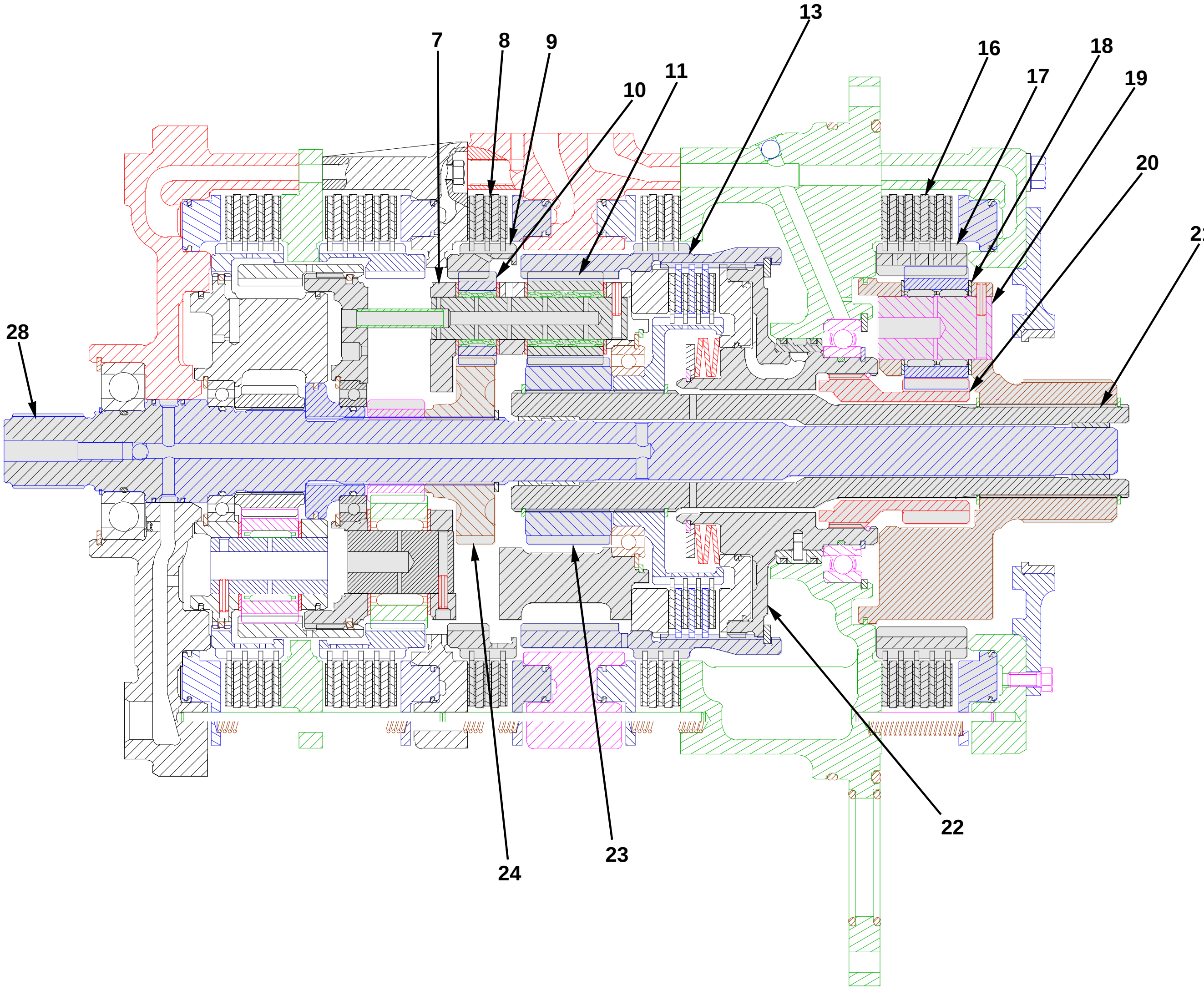
First Speed Forward.
(4) No. 2 sun gear. (5) No. 2 clutch. (6) No. 2 clutch ring gear. (7) No. 2, 3 and 4 carrier. (11) No. 4 planetary gears. (13) No. 4 clutch ring gear. (16) No. 6 clutch. (17) No. 6 clutch ring gear. (18) No. 6 planetary gears. (19) No. 6 carrier. (20) No. 6 sun gear. (21) Output shaft. (22) Housing assembly. (23) No. 4 sun gear. (25) No. 2 planetary gears. (28) Input shaft.

When first speed is selected, number-2 clutch (5) and number-6 clutch (16) are engaged.

Number-2 sun gear (4) is splined to input shaft (28). The number-2 sun gear is engaged with number-2 planetary gears (25), which are engaged with number-2 clutch ring gear (6). The engaged number-2 clutch (5) holds ring gear (6) stationary so that the number-2 planetary gears rotate within the ring gear and force number 2, 3 and 4 carrier (7) to rotate in the same direction as the input shaft.

The rotation of number 2, 3, 4 carrier (7) causes number-4 planetary gears (11), which are engaged with number-4 clutch ring gear (13), to rotate. The number-4 clutch ring gear is splined to housing assembly (22), which is splined to number-6 sun gear (20). The number-6 sun gear meshes with number-6 planetary gears (18), which also mesh with number-4 clutch ring gear (13). The rotation of number-4 planetary gears (11) is therefore transmitted to number-6 planetary gears (18) by number-4 clutch ring gear (13), housing assembly (22) and number-6 sun gear (20). Since number-6 clutch (16) is engaged, number-6 clutch ring gear (17) cannot turn, so that the rotation of number-6 planetary gears (18) causes number-6 carrier (19) to rotate. Number-6 carrier (19) is splined to output shaft (21). Number-4 planetary gears (11) are also engaged with number-4 sun gear (23), which is splined to the output shaft. Therefore, rotation of number-4 planetary gears (11) is also transmitted to the output shaft by number-4 sun gear (23). Torque is therefore transmitted to output shaft (21), partly from number-4 sun gear (23) and partly from number-6 carrier (19).

Second Speed Forward



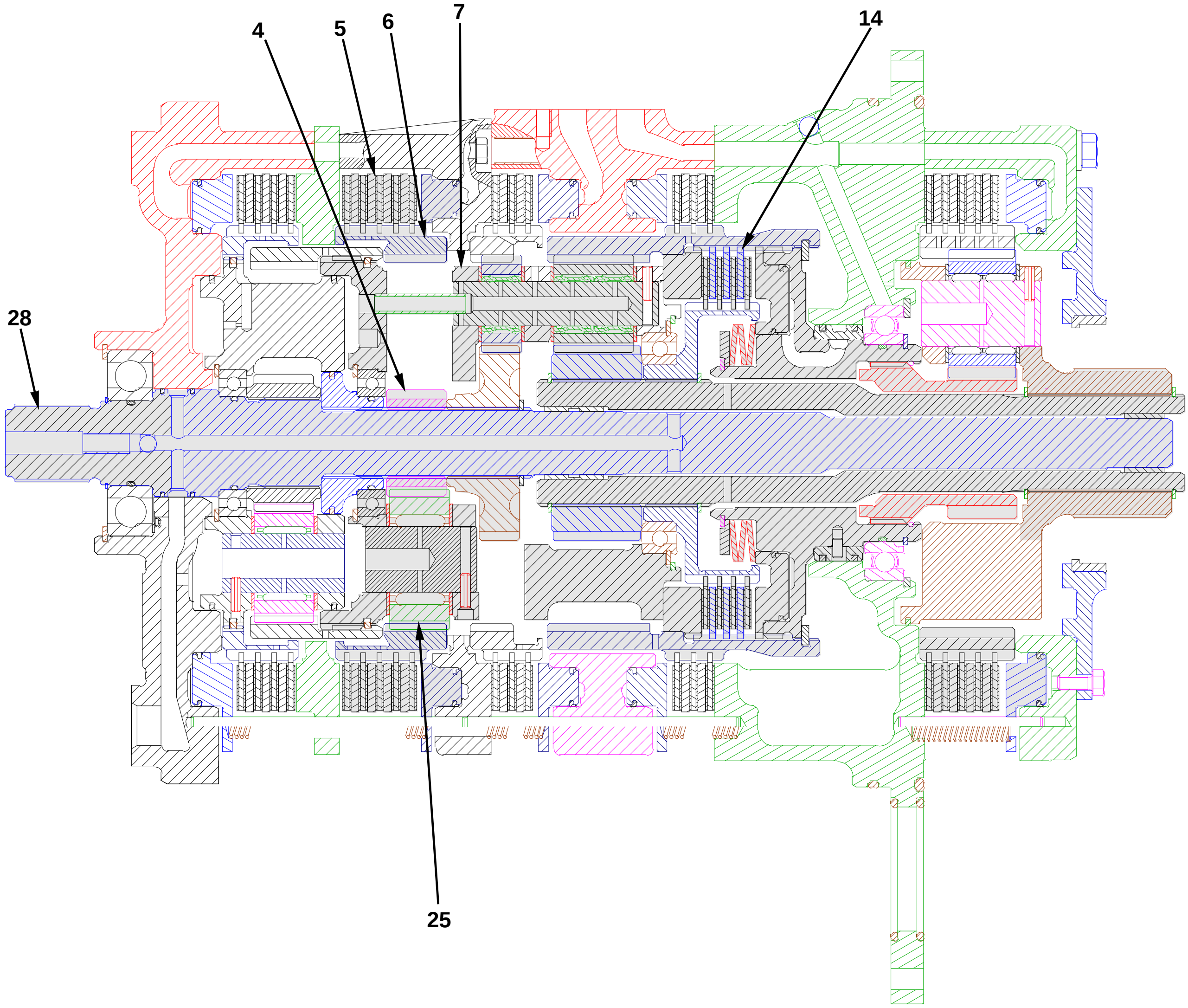
Second Speed Forward.
(7) No. 2, 3 and 4 carrier. (8) No. 3 clutch. (9) No. 3 clutch ring gear. (10) No. 3 planetary gears. (11) No. 4 planetary gears. (13) No. 4 clutch ring gear. (16) No. 6 clutch. (17) No. 6 clutch ring gear. (18) No. 6 planetary gears. (19) No. 6 carrier. (20) No. 6 sun gear. (21) Output shaft. (22) Housing assembly. (23) No. 4 sun gear. (24) No. 3 sun gear. (28) Input shaft.

When second speed is selected, number-3 clutch (8) and number-6 clutch (16) are engaged.

Number-3 sun gear (24) is splined to input shaft (28). Number-3 sun gear (24) is engaged with number-3 planetary gears (10) which are engaged with number-3 clutch ring gear (9). Engaged number-3 clutch (8) holds number-3 clutch ring gear (9) stationary so that number-3 planetary gears (10) rotate within the ring gear, and force number 2, 3 and 4 carrier (7) to rotate in the same direction as the input shaft.

The rotation of number 2, 3, and 4 carrier (7) causes number-4 planetary gears (11), which are engaged with number-4 clutch ring gear (13), to rotate. The number-4 clutch ring gear (13) is splined to housing assembly (22), which is splined to number-6 sun gear (20). The number-6 sun gear meshes with number-6 planetary gears (18), which also mesh with number-6 clutch (16) and number-4 clutch ring gear (13). The rotation of number-4 planetary gears (11) is therefore transmitted to number-6 planetary gears (18) by ring gear (13), housing assembly (22) and number-6 sun gear (20). Since number-6 clutch (16) is engaged, number-6 ring gear (17) cannot turn so that rotation of number-6 planetary gears (18) causes number-6 carrier (19) to rotate. The number-6 carrier is splined to output shaft (21). Number-4 planetary gears (11) are also engaged with number-4 sun gear (23), which is splined to the output shaft. Therefore, rotation of number-4 planetary gears (11) is also transmitted to the output shaft by number-4 sun gear (23). Torque is therefore transmitted to the output shaft, partly from number-4 sun gear (23) and partly from number-6 carrier (19).

Third Speed Forward

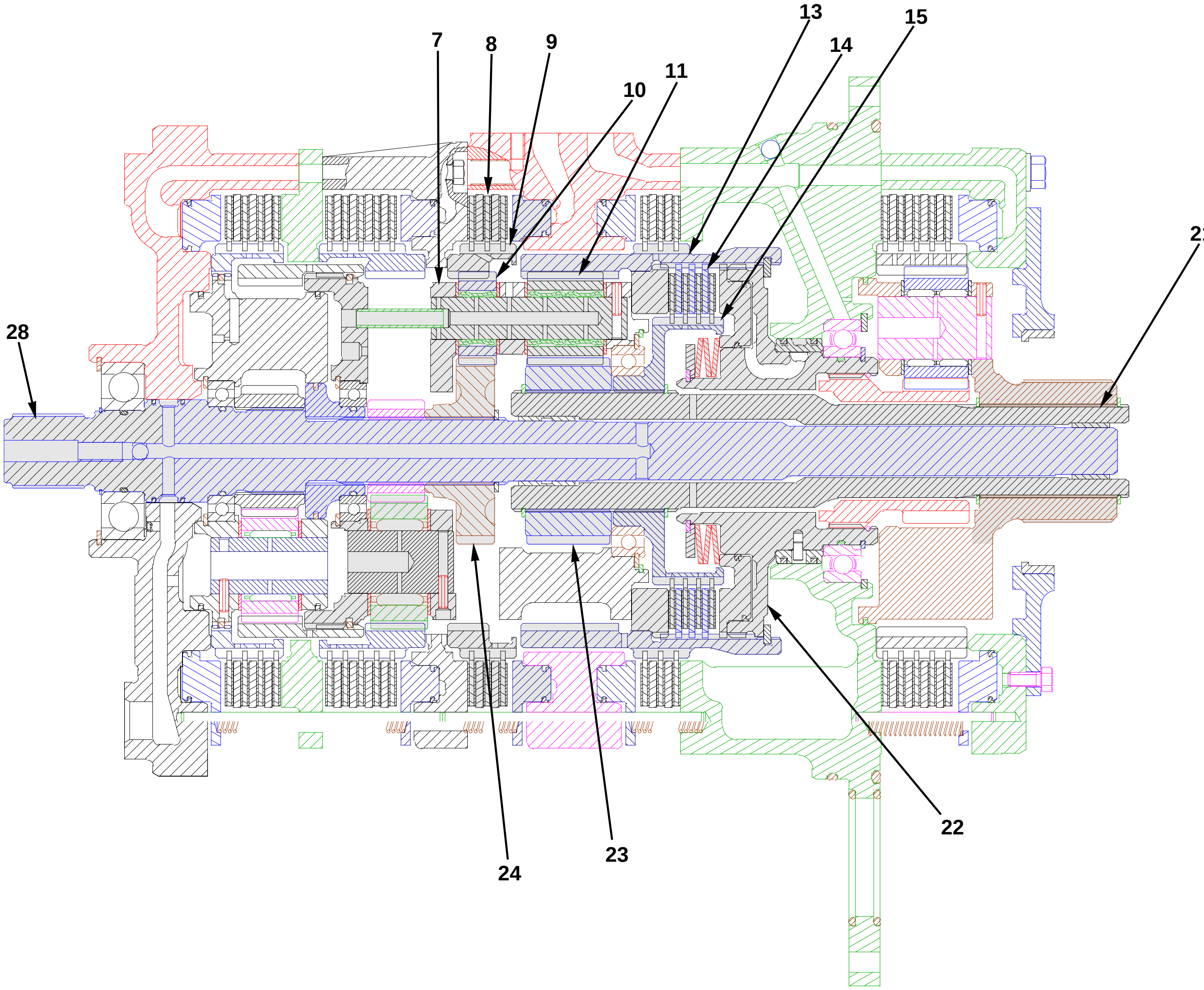


Third Speed Forward.
(4) No. 2 sun gear. (5) No. 2 clutch. (6) No. 2 clutch ring gear. (7) No. 2, 3 and 4 carrier. (14) No. 5 clutch. (25) No. 2 planetary gears. (28) Input shaft.

When third speed is selected, number-2 clutch (5) and number-5 clutch (14) are engaged.

Number-2 sun gear (4) is splined to input shaft (28). The number-2 sun gear is engaged with number-2 planetary gears (25), which are engaged with number-2 clutch ring gear (6). Engaged number-2 clutch (5) holds number-2 clutch ring gear (6) stationary so that number-2 planetary gears (25) rotate within the ring gear and force number 2, 3 and 4 carrier (7) to rotate in the same direction as the input shaft.

Fourth Speed Forward



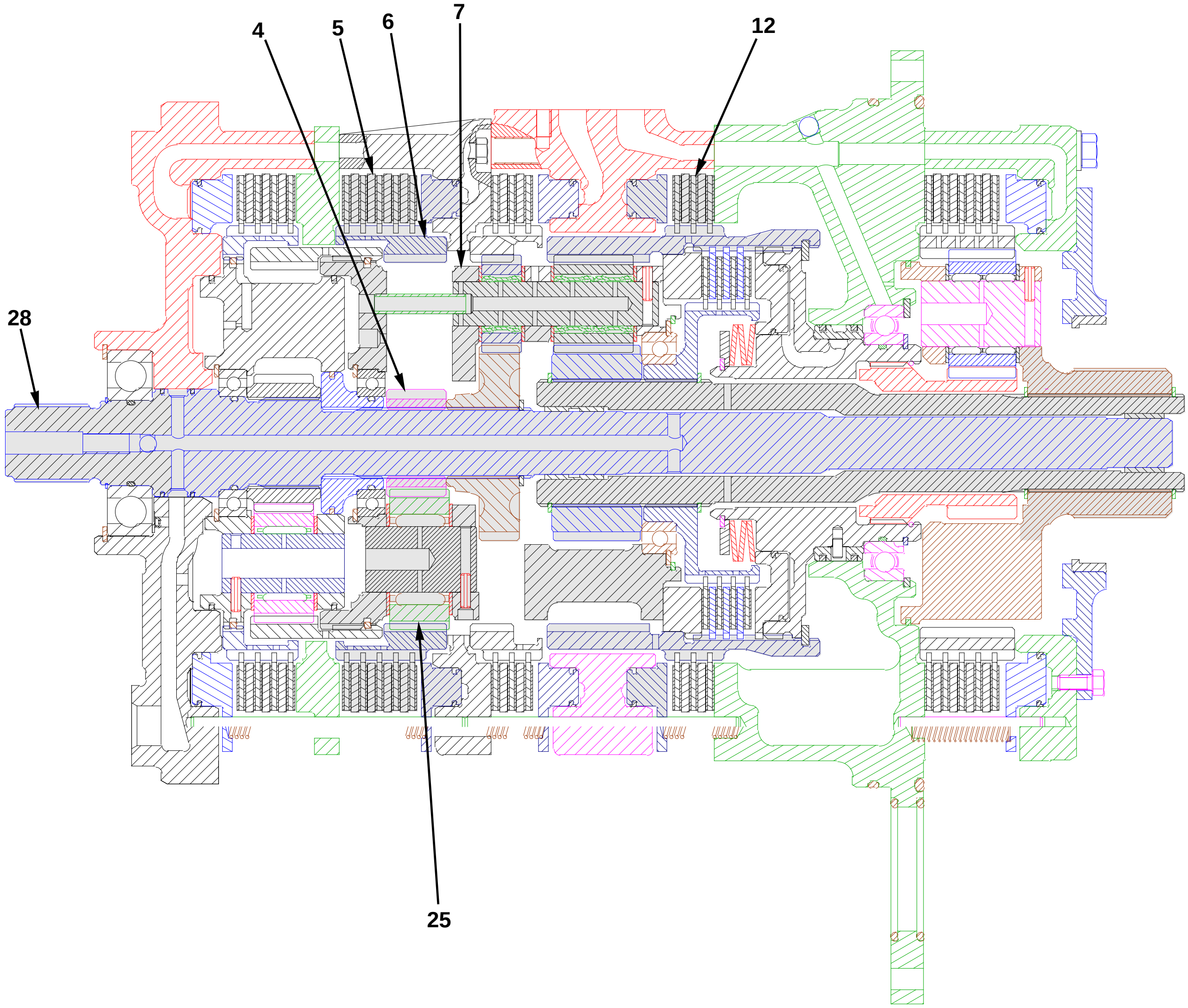
Fourth Speed Forward.
(7) No. 2, 3 and 4 carrier. (8) No. 3 clutch. (9) No. 3 clutch ring gear. (10) No. 3 planetary gears. (11) No. 4 planetary gears. (13) No. 4 clutch ring gear. (14) No. 5 clutch. (15) Rotating hub. (21) Output shaft. (22) Housing assembly. (23) No. 4 sun gear. (24) No. 3 sun gear. (28) Input shaft.

When fourth speed is selected, number-3 clutch (8) and number-5 clutch (14) are engaged.

Number-3 sun gear (24) is splined to input shaft (28). The number-3 sun gear is engaged with number-3 planetary gears (10), which are engaged with number-3 clutch ring gear (9). Engaged number-3 clutch (8) holds the number-3 clutch ring gear (9) stationary so that number-3 planetary gears (10) rotate within the ring gear and force number 2, 3 and 4 carrier (7) to rotate in the same direction as the input shaft.

In both second and third speeds, the rotation of number 2, 3, and 4 carrier (7) causes rotation of number-4 planetary gears (11). The number-4 planetary gears drive number-4 clutch ring gear (13), which is splined to housing assembly (22), and number-4 sun gear (23), which is splined to output shaft (21). Engaged number-5 clutch (14) transmits drive from the number-4 clutch ring gear (13) to rotating hub (15), which is also splined to the output shaft. Torque is therefore transmitted to the output shaft, partly from number-4 sun gear (23) and partly from rotating hub (15).

Fifth Speed Forward

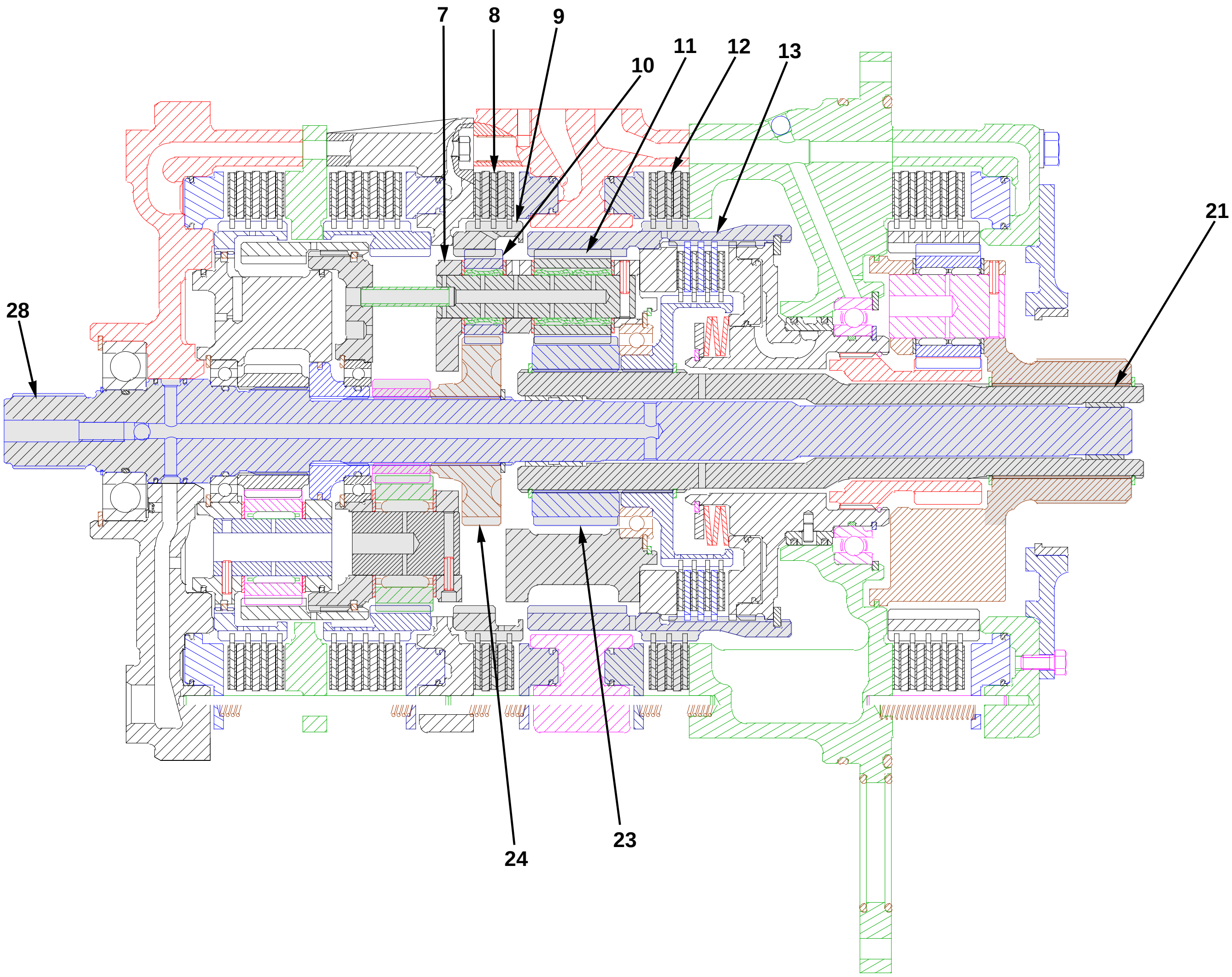


Fifth Speed Forward.
(4) No. 2 sun gear. (5) No. 2 clutch. (6) No. 2 clutch ring gear. (7) No. 2, 3 and 4 carrier. (12) No. 4 clutch. (25) No. 2 planetary gears. (28) Input shaft.

When fifth speed is selected, number-2 clutch (5) and number-4 clutch (12) are engaged.

Number-2 sun gear (4) is splined to input shaft (28). The number-2 sun gear (4) is engaged with number-2 planetary gears (25), which are engaged with number-2 clutch ring gear (6). The engaged number-2 clutch (5) holds number-2 clutch ring gear (6) stationary so that the number-2 planetary gears (25) rotate within the ring gear and force number 2, 3 and 4 carrier (7) to rotate in the same direction as the input shaft.

Sixth Speed Forward



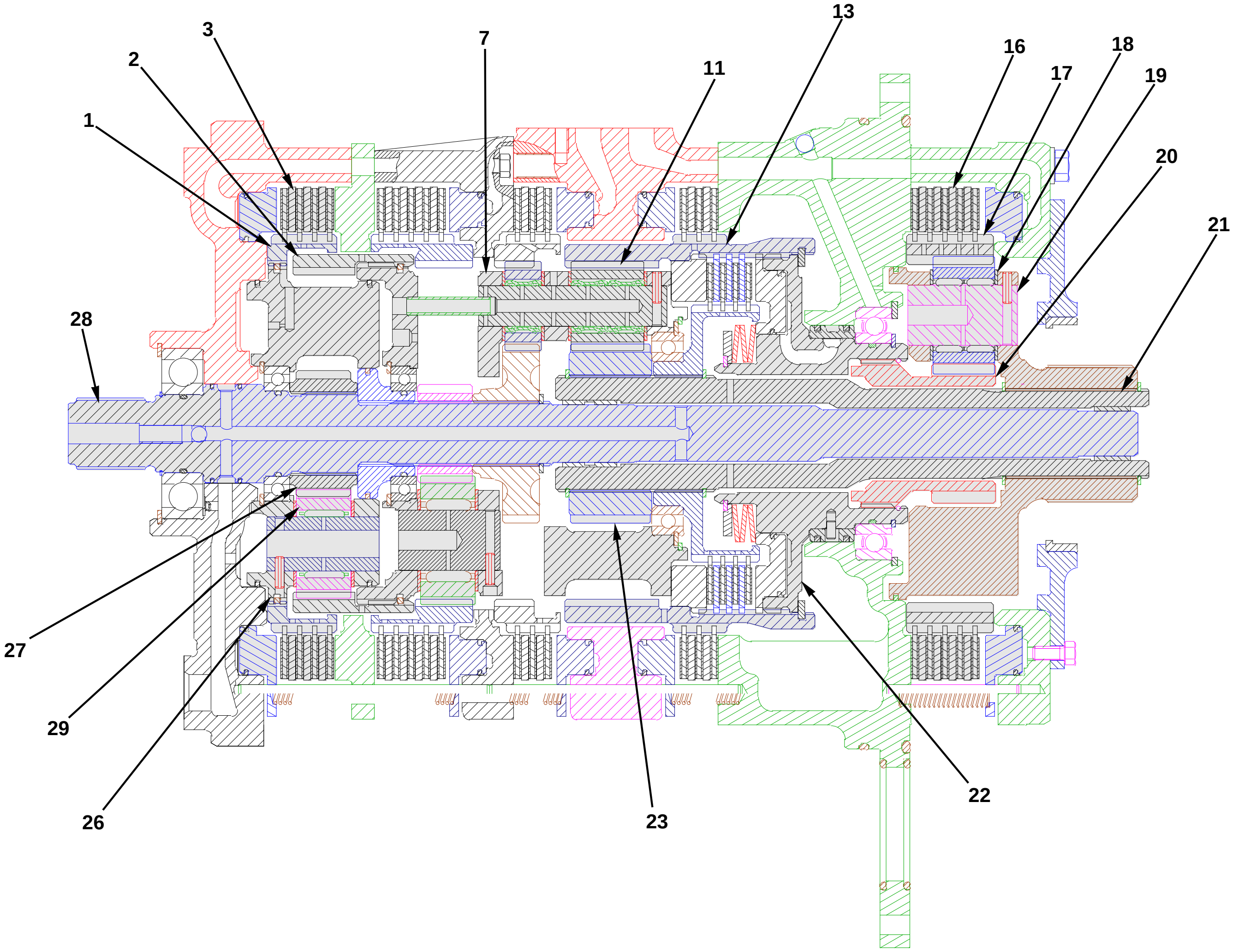
Sixth Speed Forward.
(7) No. 2, 3 and 4 carrier. (8) No. 3 clutch. (9) No. 3 clutch ring gear. (10) No. 3 planetary gears. (11) No. 4 planetary gears. (12) No. 4 clutch. (13) No. 4 clutch ring gear. (21) Output shaft. (23) No. 4 sun gear. (24) No. 3 sun gear. (28) Input shaft.

When sixth speed is selected, number-3 clutch (8) and number-4 clutch (12) are engaged.

Number-3 sun gear (24) is splined to input shaft (28). Number-3 sun gear (24) is engaged with number-3 planetary gears (10), which are engaged with number-3 clutch ring gear (9). Engaged number-3 clutch (8) holds number-3 clutch ring gear (9) stationary so that number-4 planetary gears (11) rotate within the ring gear and force number 2, 3 and 4 carrier (7) to rotate in the same direction as the input shaft.

In both fourth and fifth speeds, the rotation of number 2, 3, and 4 carrier (7) causes the rotation of number-4 planetary gears (11). Number-4 clutch ring gear (13) is held stationary by engaged number-4 clutch (12). Thus, number-4 planetary gears (11) rotate around the inside of the ring gear and drive number-4 sun gear (23). Torque is transmitted from the number-4 sun gear to output shaft (21).

First Speed Reverse



First Speed Reverse.
(1) No. 1 clutch ring gear. (2) Coupling gear. (3) No. 1 clutch. (7) No. 2, 3 and 4 carrier. (11) No. 4 planetary gears. (13) No. 4 clutch ring gear. (16) No. 6 clutch. (17) No. 6 clutch ring gear. (18) No. 6 planetary gears. (19) No. 6 carrier. (20) No. 6 sun gear. (21) Output shaft. (22) Housing assembly. (23) No. 4 sun gear. (26) No. 1 carrier. (27) No. 1 sun gear. (28) Input shaft. (29) No. 1 planetary gears.

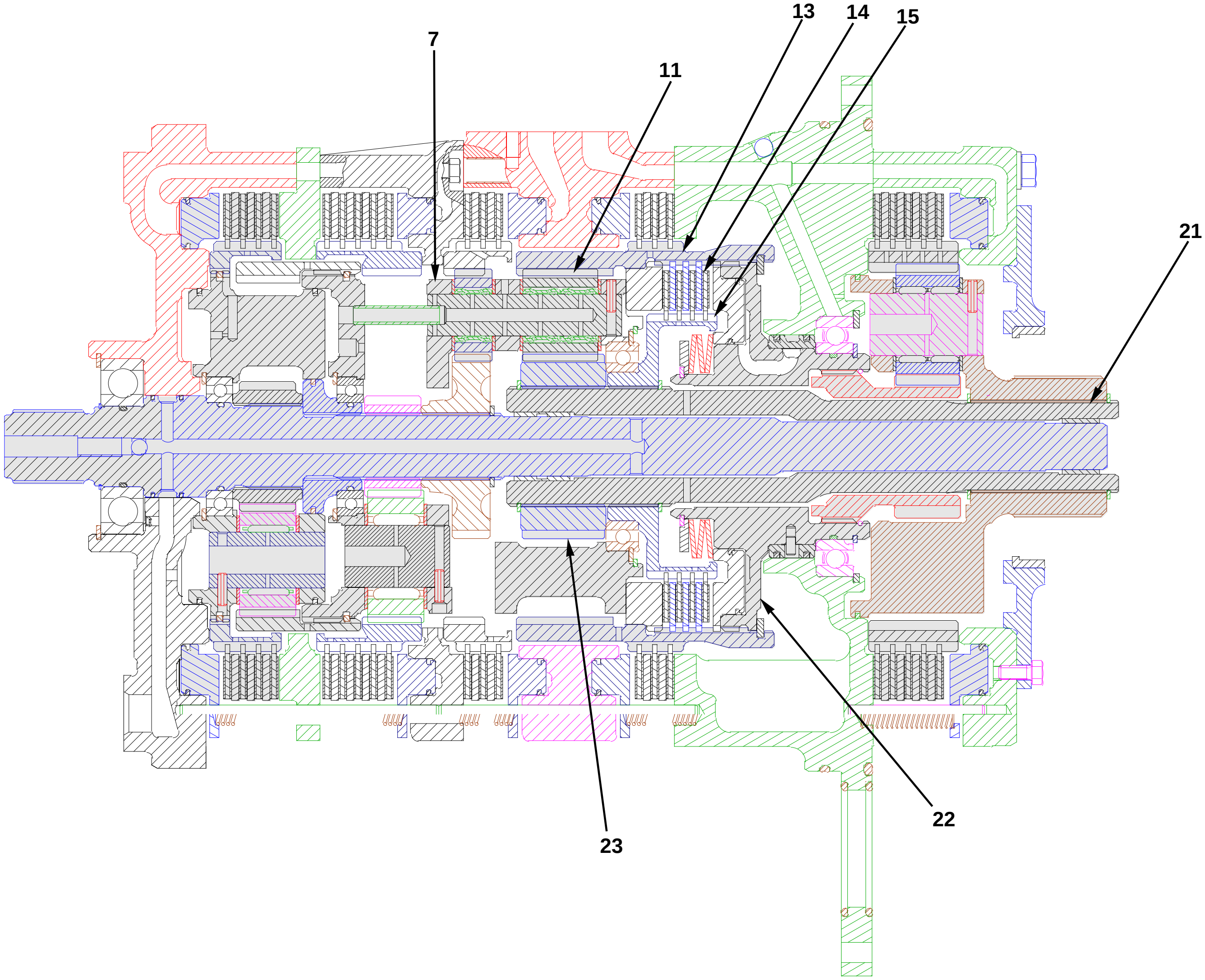
When first or second speed reverse is selected, number-1 clutch (3) is engaged.

Engaged number-1 clutch (3) holds number-1 clutch ring gear (1). The number-1 clutch ring gear is connected to number-1 carrier (26), which is also held stationary. Input shaft (28) transmits drive through number-1 sun gear (27) to number-1 planetary gears (29). The number-1 planetary gears drive coupling gear (2) in the opposite direction of the input shaft. The coupling gear is mechanically connected to number 2, 3 and 4 carrier (7), which also turns in the opposite direction of the input shaft.

When first speed reverse is selected, number-6 clutch (16) is engaged. Rotation of number 2, 3, and 4 carrier (7) causes rotation of number-4 planetary gears (11), which are engaged with number-4 clutch ring gear (13). The number-4 clutch ring gear is splined to housing assembly (22), which is splined to number-6 sun gear (20). The number-6 sun gear meshes with number-6 planetary gears (18), which also mesh with number-6 clutch ring gear (17). Rotation of number-4 planetary gears (11) is therefore transmitted to the number-6 planetary gears (18) by the number-4 clutch ring gear (13), the housing assembly (22) and the number-6 sun gear (20). Since the number-6 clutch (16) is engaged, the number-6 clutch ring gear cannot turn so that rotation of the number-6 planetary gears causes number-6 carrier (19) to rotate. The number-6 carrier (19) is splined to output shaft (21).

Number-4 planetary gears (11) are also engaged with number-4 sun gear (23), which is splined to output shaft (21). Therefore, rotation of the number-4 planetary gears (11) is also transmitted to the output shaft by the number-4 sun gear. Torque is therefore transmitted to the output shaft, partly from the number-4 sun gear (23) and partly from number-6 carrier (19).

Second Speed Reverse

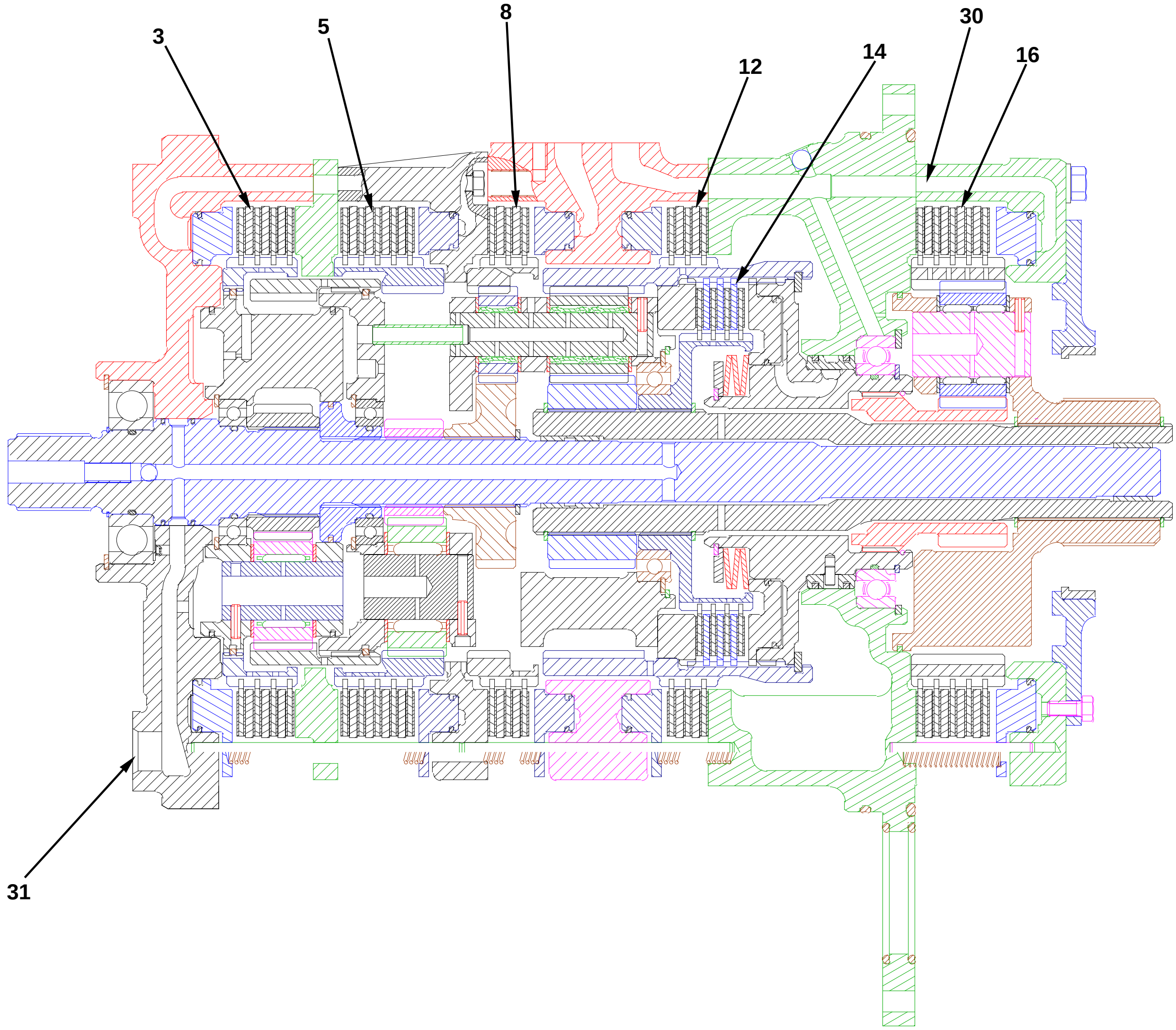


Second Speed Reverse.
(7) No. 2, 3 and 4 carrier. (11) No. 4 planetary gears. (13) No. 4 clutch ring gear. (14) No. 5 clutch. (15) Rotating hub. (21) Output shaft. (22) Housing assembly. (23) No. 4 sun gear.

When second speed reverse is selected, number-5 clutch (14) is engaged.

The rotation of number 2, 3, and 4 carrier (7) causes the rotation of number-4 planetary gears (11). Number-4 planetary gears (11) drive number-4 clutch ring gear (13), which is splined to housing assembly (22), and number-4 sun gear (23), which is splined to output shaft (21). Engaged number-5 clutch (14) transmits drive from number-4 clutch ring gear (13) to rotating hub (15). Rotating hub (15) is also splined to output shaft (21). Torque is therefore transmitted to the output shaft, partly from the number-4 sun gear (23) and partly from the rotating hub (15).

Planetary Lubrication



Planetary Lubrication.
(3) No. 1 clutch. (5) No. 2 clutch. (8) No. 3 clutch. (12) No. 4 clutch. (14) No. 5 clutch. (16) No. 6 clutch. (30) Passage. (31) Passage.

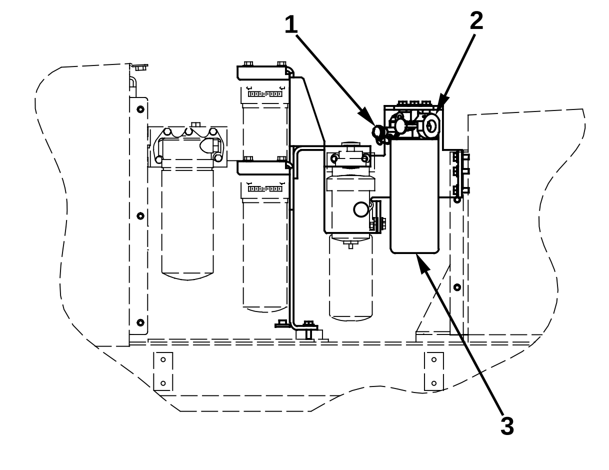
All planetary gears and bearings are pressure lubricated with oil from the transmission hydraulic control system. Transmission oil passes through the oil cooler and then enters the transmission through passages (30) and (31), and through an orifice in the transmission end plate.

Oil flowing through passage (30) lubricates and cools number-6 clutch (16) and all associated gears and bearings.

Oil flowing through passage (31) lubricates and cools number-2 clutch (5), number-3 clutch (8), number-4 clutch (12), number-5 clutch (14) and all associated gears and bearings.

Oil to lubricate and cool number-1 clutch (3) enters through the orifice in the transmission end plate.

Oil Filter



Oil Filter.
(1) Oil sampling port. (2) Filter body. (3) Filter element.

Filter body (2) contains a bypass valve which provides an oil flow path around the filter. The purpose of the bypass valve is to keep lubrication flowing to the power train, even if filter element (3) becomes plugged. The bypass valve is designed to open at 172 ± 12 kPa (25 ± 2 psi).

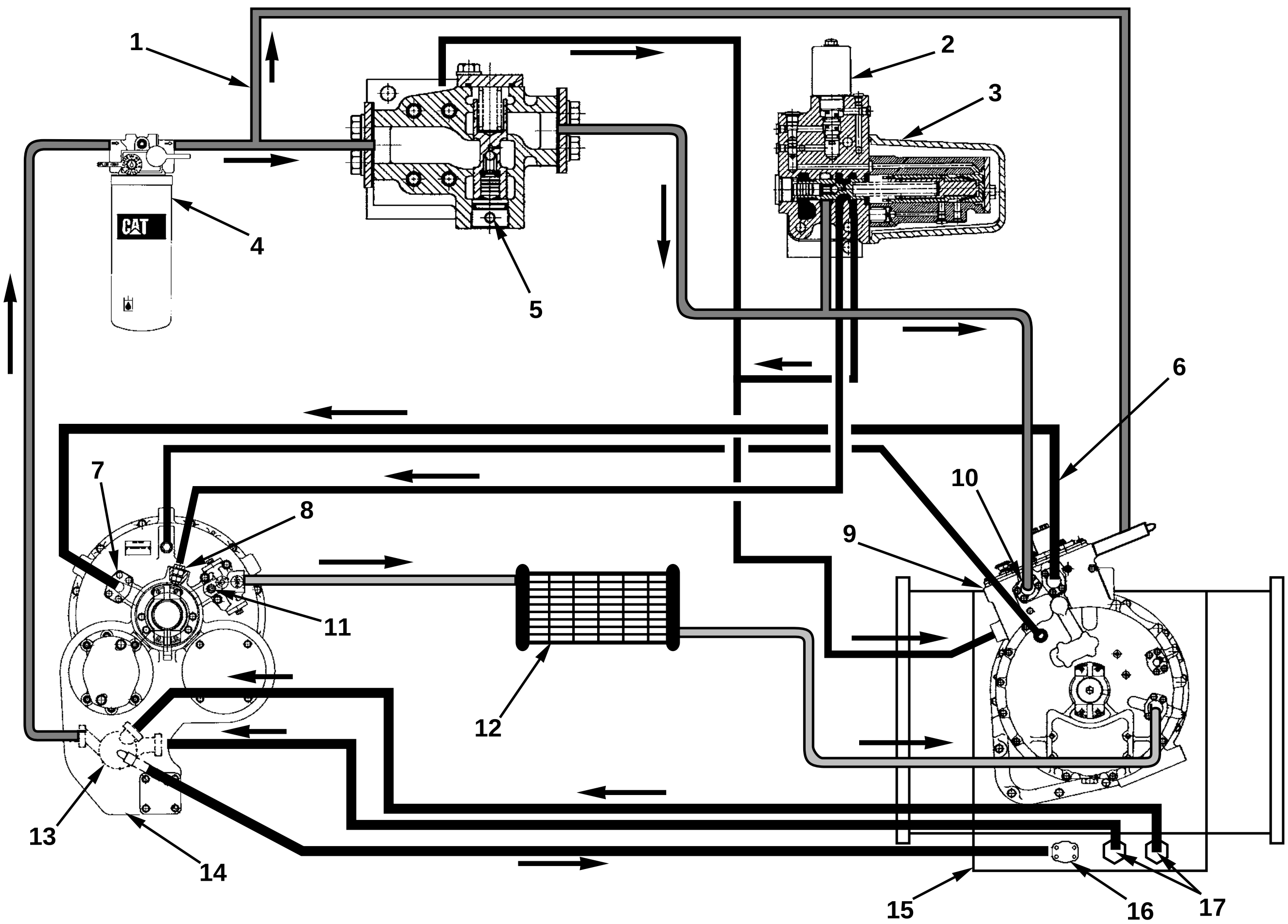
The oil filter body also contains oil sampling port (1). The oil sampling port provides a location to draw power train oil for use in oil quality analysis. The oil sampling port is designed to fit the Army Oil Analysis Program (AOAP) tooling.

Power Train Oil Cooler

Power Train Oil Cooler.
(1) Power train oil cooler.

Power train oil cooler (1) is integrated into the cooler assembly at the center of the machine. The power train oil cooler cools the power train lubrication oil to limit the operating temperature of the power train components.

Power Train Hydraulic Lines



Power Train Hydraulic Lines.
(1) Line to transmission shift solenoids. (2) Lockup solenoid. (3) Torque converter lockup control valve. (4) Power train oil filter. (5) Priority valve. (6) Line to torque converter inlet. (7) Torque converter inlet. (8) Torque converter lockup clutch signal inlet. (9) Transmission selector and control valve group. (10) Transmission hydraulic control valve inlet. (11) Torque convertor outlet relief valve. (12) Oil cooler. (13) Power train oil pump. (14) Torque converter housing. (15) Differential steering assembly. (16) Differential steering lubrication inlet. (17) Suction screens.

This schematic shows the flow of oil through the power train.

Power train oil pump (13) is a two-section gear pump mounted on the front of torque converter housing (14). One section is used to charge the transmission system; the other section is used to lubricate the differential steering assembly.

The charging section of the pump draws oil from differential steering assembly (15) through suction screen (17). Oil is then sent through power train oil filter (4) to priority valve (5). The priority valve ensures that 2206 kPa (320 psi) of oil pressure is available to the transmission shift solenoids, through line (1), before oil flows to torque converter lockup control valve (3) and transmission selector and pressure control valve group (9).

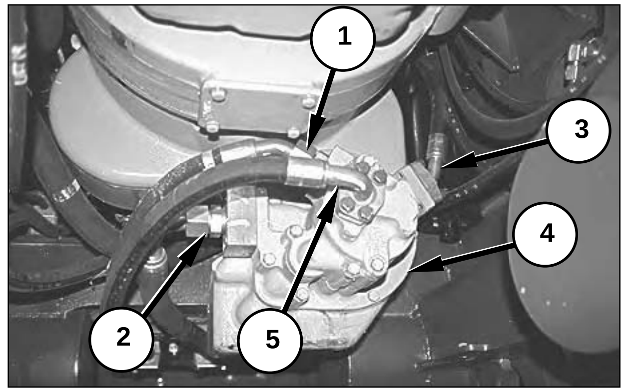
The EPTC II controls lockup solenoid (2), which is located on torque converter lockup control valve (3). When the EPTC II energizes the lockup solenoid, pressurized oil is sent to the lockup clutch through inlet (8) on the torque converter.

The lubrication section of oil pump (13) draws oil from differential steering assembly (15) through suction screens (17). Output oil from the pump is directed to inlet (16) on the differential steering case, to lubricate the differential steering components.

Transmission selector and pressure control valve group (9) directs oil at a reduced pressure to torque converter inlet (7) via line (6). A valve inside the transmission hydraulic control valve prevents the torque converter inlet pressure from rising above 930 ± 85 kPa (135 ± 12 psi) during initial cold-weather starts.

Oil that flows through the torque converter and does not drain to the bottom of the case exits the torque converter through outlet relief valve (11). After the oil exits the torque converter outlet relief valve, the oil flows through oil cooler (12) and returns to the transmission.

Power Train Hydraulic Pump



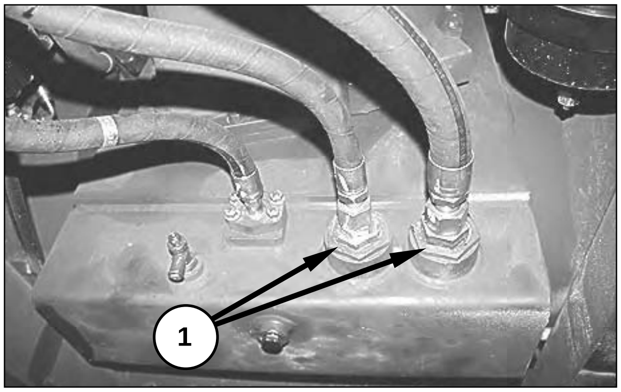
Lower Part of Oil Pump Drive.
(1) Line (from strainer). (2) Line (from strainer). (3) Charge section outlet. (4) Torque converter case. (5) Lubrication section outlet.

The power train hydraulic pump has two sections, a charge section and a lubrication section. The pump is powered by gears which are driven from the torque converter output.

The charge section of the pump draws oil from two locations. The primary oil supply is from the torque converter case (4) through an internal passage. The charge section also draws oil from the magnetic strainer through line (2). Pressurized oil from charge section outlet (3) is directed to the power train oil filter.

The lubrication section of the pump draws oil through line (1) from the magnetic strainer. Pressurized oil from lubrication section outlet (5) returns to the differential steer case to lubricate the internal components.

Suction Screen



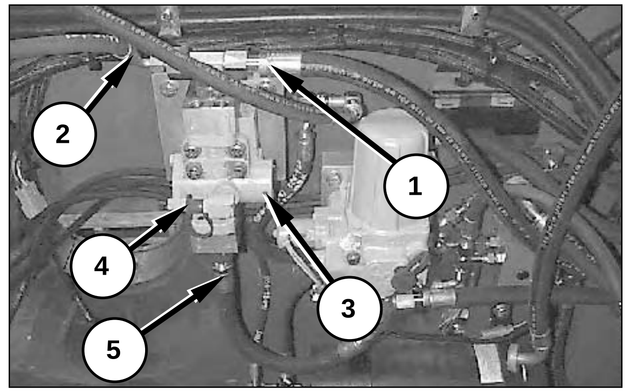
Location of Suction Screen.
(1) Suction screen assemblies.

Suction screen assemblies (1) are mounted on the bottom of the differential steer case. The screen assemblies removes larger particles of debris from the power train oil.

The suction screen has an integral bypass relief valve that opens if the restriction across the screen exceeds approximately 20 kPa (3 psi).

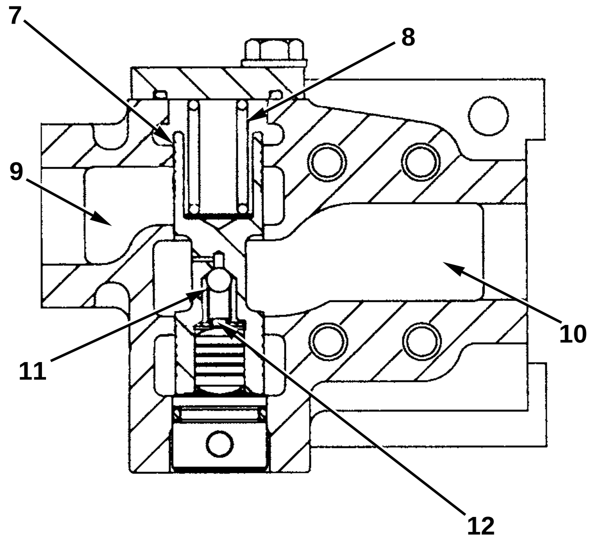
Priority Valve

The priority valve ensures that oil pressure going to the transmission shift solenoids has priority over the oil pressure in the rest of the power train hydraulic system.



Priority Valve Location.
(1) Line (from power train hydraulic pump). (2) Line (to transmission shift solenoids). (3) Priority valve. (4) Pressure tap. (5) Line (to lockup clutch solenoid valve).

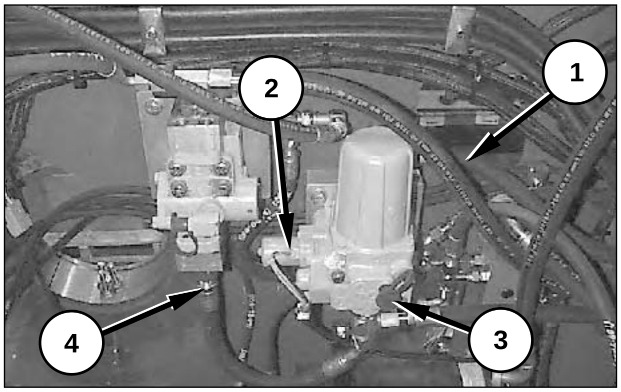
Priority valve (3) is located on the left side of the main frame, near the front of the transmission. Oil from the charge section of the power train hydraulic pump flows through line (1) to the inlet of the priority valve (3), and through line (2) to the transmission shift solenoids. Oil from the outlet of the priority valve flows through line (5) to the lockup clutch solenoid valve. Pressure tap (4) provides access to the pressure in the inlet of the priority valve, which is the transmission shift solenoid pressure.



Priority Valve.
(7) Valve. (8) Spring. (9) Outlet passage. (10) Inlet passage. (11) Check ball. (12) Slug chamber.

Oil from line (1) flows through line (2) and inlet passage (10). The pressure in the inlet passage goes through a drilled passage in valve (7) and unseats check ball (11). When the check ball unseats, the pressure in the inlet passage is present in slug chamber (12). The pressure in the slug chamber acts against the bottom end of the valve and the force of spring (8). When the pressure in the inlet passage reaches 2206 ± 36 kPa (320 ± 5 psi), the valve (7) shifts up and connects the inlet passage to outlet passage (9). The oil flows out of the outlet passage through line (5) to the lockup clutch solenoid valve. If the pressure in the inlet passage falls below 2206 ± 36 kPa (320 ± 5 psi), the valve shifts down and blocks the passage between the inlet and outlet passages. In this way, the development of oil pressure in the inlet passage and line (2) is given priority over the development of oil pressure in the outlet passage and line (5).

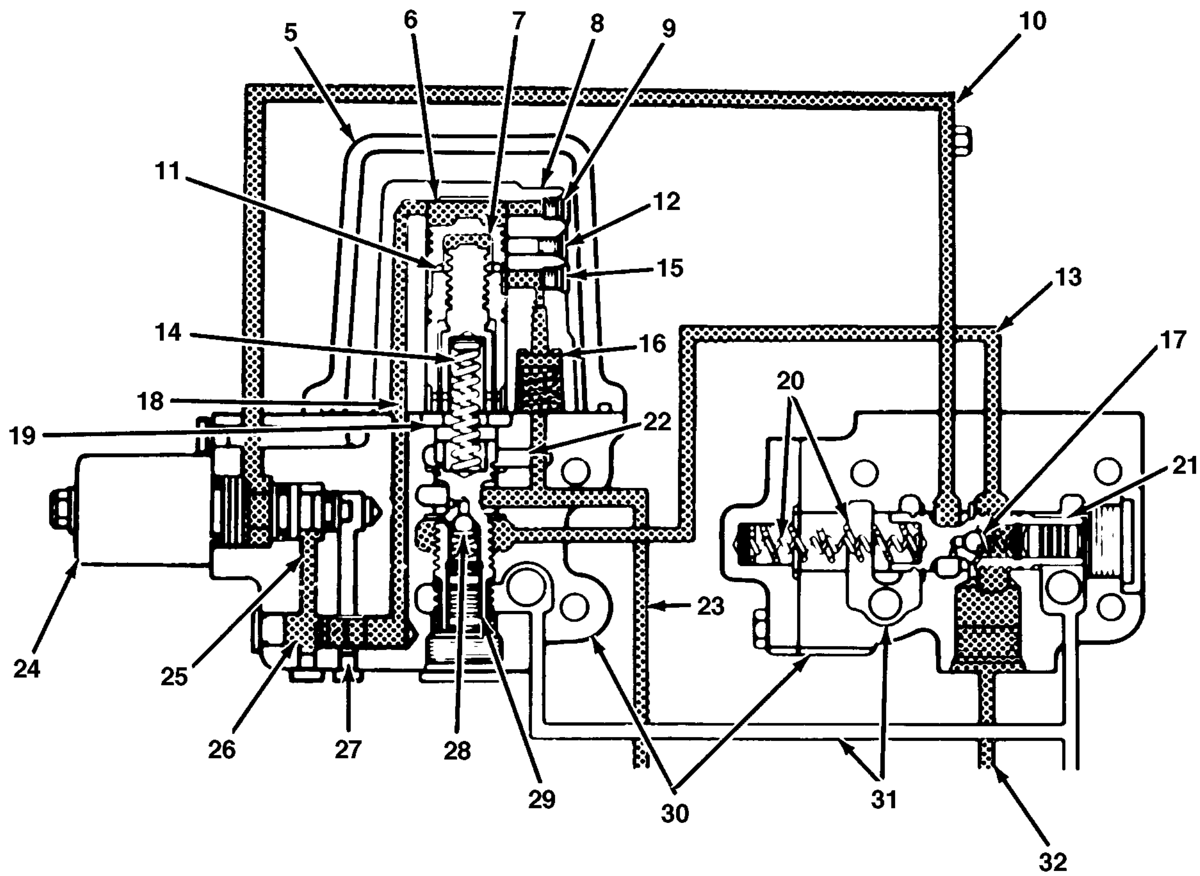
Lockup Clutch Solenoid Valve Group



Lockup Clutch Solenoid Valve.
(1) Line (to torque converter lockup clutch port). (2) Lockup clutch solenoid valve. (3) Pressure tap (lockup clutch). (4) Line (from priority valve).

Transmission Speed, Clutch Engagement, and Lockup Clutch Engagement					
Speed	Clutches Engaged	EARTHMOVING		SELF-DEPLOY	
		T.C. Drive	Direct Drive	T.C. Drive	Direct Drive
1	6 and 2	X		X*	X*
2	6 and 3	X		X*	X*
3	5 and 2	X		X*	X*
4	5 and 3				X
5	4 and 2				X
6	4 and 3				X
N	4	X		X	
1R	6 and 1	X		X	
2R	5 and 1	X		X	

*Starts in torque converter drive and shifts to direct drive within gear.



Lockup Clutch Solenoid Valve.
(5) Cover. (6) Selector piston. (7) Load piston. (8) Load piston body. (9) Selector piston plug. (10) Pilot passage. (11) Passage in selector piston. (12) Drain passage. (13) Passage for pump oil. (14) Springs. (15) Load piston plug. (16) Load piston orifice. (17) Ball check. (18) Pilot passage. (19) Modulation reduction valve. (20) Springs. (21) Pressure reduction valve. (22) Drain passage. (23) Passage to lockup clutch. (24) Lockup solenoid. (25) Pilot passage. (26) Shuttle valve. (27) Drain passage. (28) Ball check. (29) Spring. (30) Valve body. (31) Drain passages. (32) Inlet (from priority valve).

Lockup clutch solenoid valve (2) controls the operation of the lockup clutch of the torque converter. When the lockup clutch is engaged, the torque converter does not multiply torque, and the machine is in direct drive.

Pressure oil from the lockup clutch solenoid valve group engages the lockup clutch. Lockup clutch solenoid valve (2) receives oil through line (4) from the outlet of the priority valve.

Drain passages (12), (22), (27) and (31) are all connected. The drain oil goes into the drain port on the priority valve mounting block, and back to the transmission sump.

Pressure reduction valve (21) limits oil pressure to 2550 ± 100 kPa (370 ± 15 psi) in inlet (32) so the inlet can be used by lockup solenoid (24). The oil in pilot passage (10) is pilot oil and is used to activate selector piston (6). Oil pressure goes through an orifice in the pressure reduction valve, opens ball check (17) and goes into the slug chamber at the end of the valve. This pressure works against the force of springs (20).

When the pressure at inlet (32) gets too high, pressure reduction valve (21) moves against the force of springs (20). This lets some of the oil in pilot passage (10) go into drain passages (31). The pressure reduction valve moves to the right and left to keep constant pressure in pilot passage (10).

Modulation reduction valve (19) controls the pressure and time required to engage and release the lockup clutch. Pump oil goes through passage (13) to the modulation reduction valve at 3170 kPa (460 psi).

Lockup Started (Clutch Filling)

The EPTC II sends an electric signal to lockup solenoid (24). The lockup solenoid activates (opens), and directs pilot oil from pilot passage (10) to pilot passage (25). This oil pushes shuttle valve (26) over, closing drain passage (27). The oil moves the ball inside the shuttle valve and goes through pilot passage (18) to the end of selector piston (6).

Selector piston (6), along with load piston (7), moves against the force of springs (14), causing modulation reduction valve (19) to move against the force of spring (29). Flow through passage (23) to drain passage (22) is now blocked. Passage (23) is open to passage (13). Pump oil now goes to fill the lockup clutch. At the same time, oil flows through load piston orifice (16) and passage (11). This oil flows between selector piston (6) and load piston (7).

Lockup Completed (Clutch Engaged)

After the lockup clutch fills with oil, pressure increases in the clutch. This causes load piston (7) to move against the force of springs (14). Lockup clutch oil also flows through an orifice in modulation reduction valve (19), opening ball check (28) and entering the slug chamber at the end of the valve. This pressure works against the pressure at the end of the load piston. The pressure increases until the load piston moves all the way down against its stop. The pressure in the clutch is now at 1725 ± 70 kPa (250 ± 10 psi). The modulation reduction valve moves up and down to keep constant pressure in passage (23).

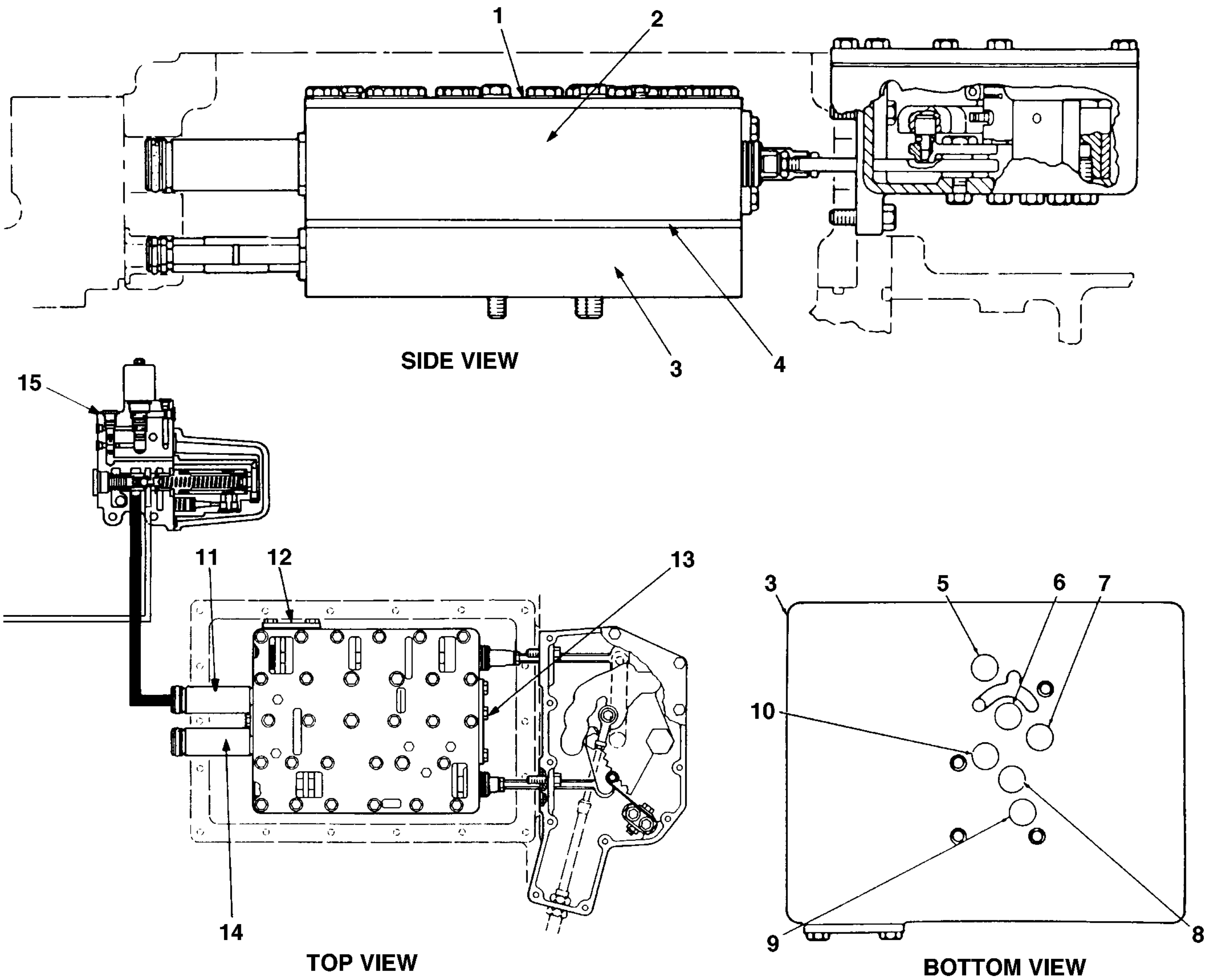
Two components control the amount of time required for the pressure in the lockup clutch to reach its maximum: the size of load piston orifice (16) and the force of springs (14). The force of springs (14) can be changed by the removal or addition of shims in load piston (7) under springs (14).

Lockup Clutch Disengaged (Released)

When the conditions are right for the machine to shift from direct drive to converter drive , the EPTC II stops the electric signal to lockup solenoid (24). The lockup solenoid deactivates (closes) and stops the flow of pilot oil into pilot passage (25), and drains the passage. The force of springs (14) moves selector piston (6) up, which causes the pressure oil in pilot passage (18) to push against shuttle valve (26). This causes the ball inside the shuttle valve to move to the left. The oil pressure causes shuttle valve (26) to also move to the left, which opens pilot passage (18) to drain passage (27). The selector piston moves up against load piston body (8).

Passage (11) is now in alignment with drain passage (12). The force of springs (14) moves load piston (7) all the way up against selector piston (6). Modulation reduction valve (19) now moves all the way up because of the force of spring (29). In this position, pump oil in passage (13) is blocked to passage (23). Passage (23) is now open to drain passage (22), and the pressure in the lockup clutch is released.

Transmission Hydraulic Controls



Transmission Hydraulic Controls.
(1) Top plate. (2) Valve group. (3) Manifold. (4) Plate. (5-10) Passages. (11) Tube. (12) Cover. (13) Cover. (14) Tube. (15) Lockup clutch solenoid valve.

The transmission hydraulic controls are located on top of the planetary group and consist of: top plate (1), valve group (2), manifold (3), and plate (4).

Clutch oil flows through passages (5), (6), (7), (8), (9) and (10); according to the speed and direction selected.

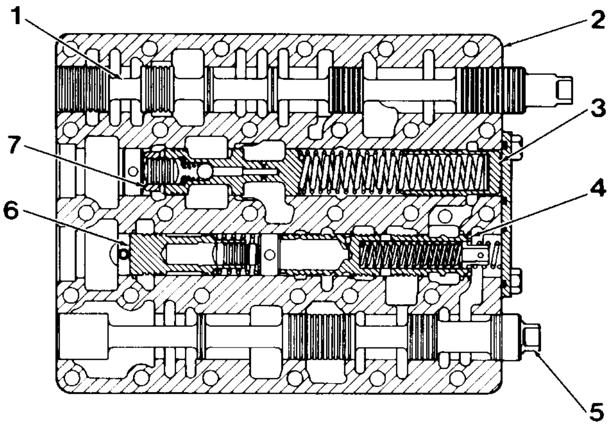
Inlet oil enters the hydraulic controls through tube (11) from lockup clutch solenoid valve (15) and flows to the pressure reducing valve and to the selector and pressure control valve. The pressure reducing valve is located under cover (12).

Oil flows out of the hydraulic control group to the torque converter through tube (14). The load piston and pressure differential valve (both part of the selector and pressure control valve group) are located under cover (13).

When the transmission is in a selected speed and direction, the pressure control valve load piston is to the left, and the passage leading from lockup clutch solenoid valve (15) to the pressure control valve load piston is blocked.

Selector and Pressure Control Valve Group

The selector and pressure control valve is located under the top cover of the transmission. The valve controls speed and directional clutch pressures in the transmission.



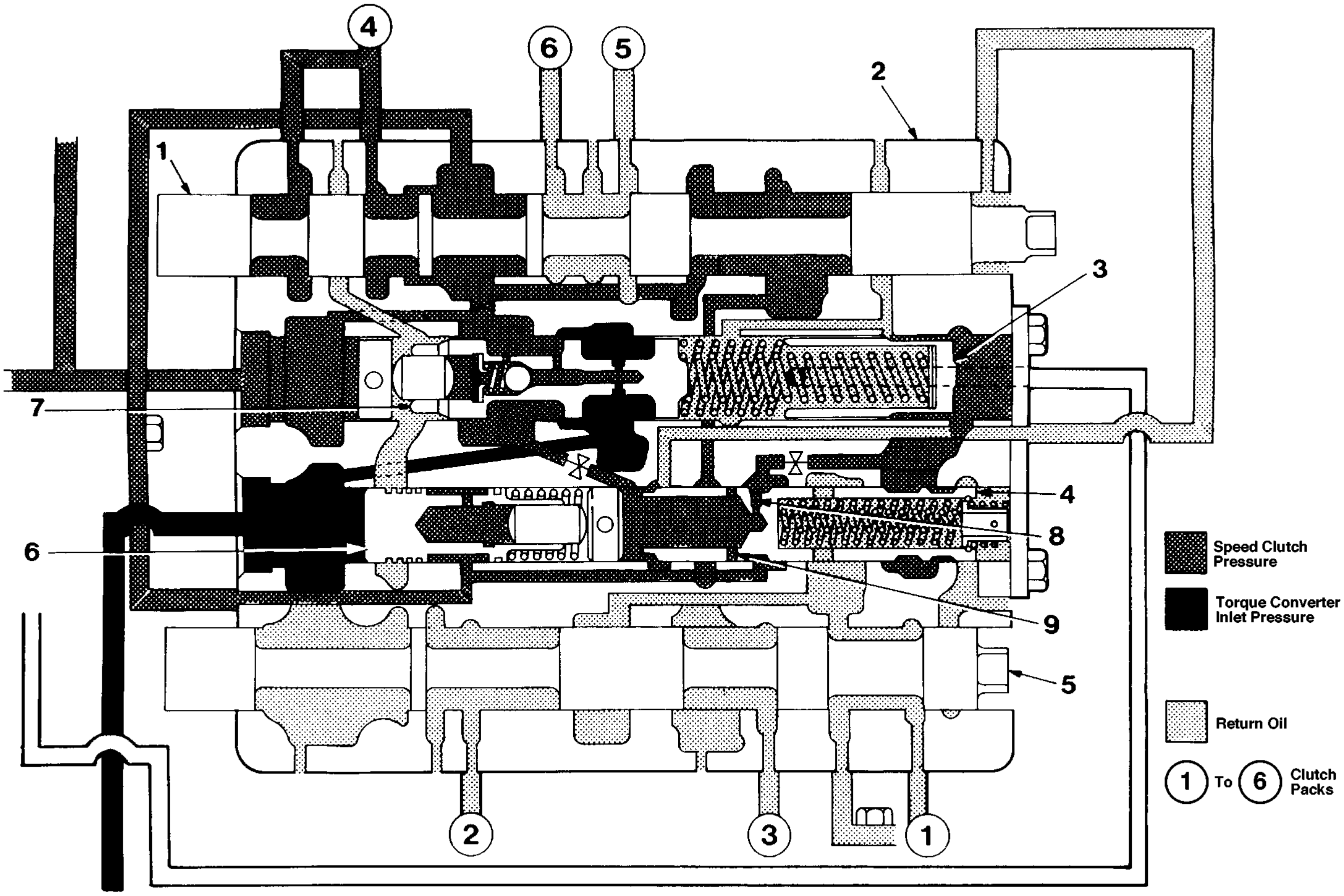
Selector and Pressure Control Valve.
(1) Speed selector spool. (2) Valve body. (3) Load piston. (4) Pressure differential valve. (5) Directional selector spool. (6) Torque converter inlet pressure valve. (7) Modulation relief valve.

The main components of the valve group are:

- Speed selector spool (1)—controls the flow of oil to and from the number-4, number-5 and number-6 clutches, which are the main speed clutches.
- Modulation relief valve (7)—controls the maximum pressure in the system and works in conjunction with load piston (3) to control the rate of pressure increase in the clutches.
- Load piston (3)—controls the rate of pressure increase in the clutches in conjunction with the modulation relief valve (7).
- Torque converter inlet pressure valve (6)—controls the maximum pressure of the torque converter inlet oil.
- Pressure differential valve (4)—maintains a pressure differential between the speed and directional clutches and prevents a directional clutch from filling (if the machine is started with the gear level in any position except NEUTRAL).
- Directional selector spool (5)—controls the flow of oil to and from the number-1, number-2 and number-3 clutches. Number 1 is the reverse directional clutch. Number 2 and number 3 are the forward directional clutches.

Speed and directional selector spools (1) and (5) are connected to the control linkage, which is operated by the shift valve.

Engine Running, Transmission in NEUTRAL



Engine Running, Transmission in NEUTRAL.
(1) Speed selector spool. (2) Valve body. (3) Load piston. (4) Pressure differential valve. (5) Directional selector spool. (6) Torque converter inlet pressure valve. (7) Modulation relief valve. (8) Orifice. (9) Orifice.

When the transmission is in NEUTRAL, speed selector spool (1) and directional selector spool (5) are in the positions shown in the illustration above.

Oil from the outlet of the priority valve enters the valve group and flows to the number-4 clutch. The positions of the speed and directional spools (1 and 5) open number-1, number-2, number-3, number-5 and number-6 clutches to the sump. Pump oil also flows to modulation relief valve (7), torque converter inlet pressure relief valve (6), pressure differential valve (4) and load piston (3). Oil flowing to the pressure differential valve passes through orifice (8) to the load piston.

With the gear lever in NEUTRAL, orifice (9) cannot allow oil to flow to the sump because of the position of speed selector spool (1). When pressure differential valve (4) has moved a small amount, orifice (9) is blocked by the valve body, and the left end of the spool starts to uncover a drain passage. This prevents the spool from moving any further. This is termed the “set” position.

Oil flowing to modulation relief valve (7) flows around the valve spool and through an orifice, to act against the integral poppet valve. The poppet valve unseats, allowing oil to fill the slug chamber in the spool. At the same time, oil flows through an orifice to the right end of load piston (3). The position of pressure differential valve (4) blocks the tank passage, allowing pressure to build against the face of the load piston.

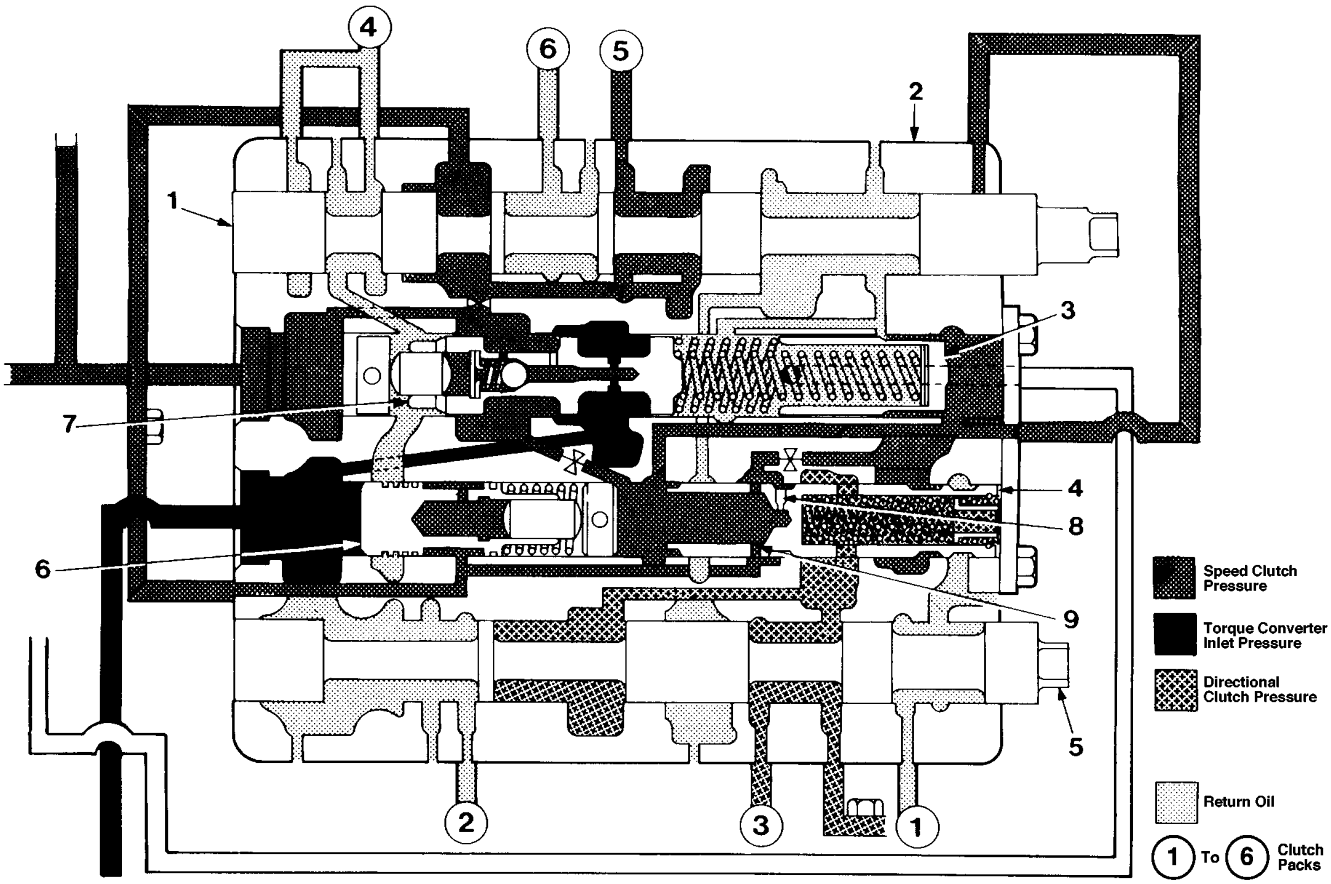
When the number-4 clutch is full of oil, the speed clutch pressure starts to rise. The increasing pressure is transmitted to the slug chamber of modulation relief valve (7). This moves the modulation relief valve to the right, allowing excess flow to pass into the torque converter line. Increasing speed clutch pressure is also transmitted to the right end of load piston (3), which moves the load piston to the left. The orifice in the passage leading to the load piston causes a short delay between the pressure rise at the modulation relief valve and at the load piston.

As load piston (3) moves to the left, the resistance to motion of modulation relief valve (7) increases. This allows pressure in the number-4 clutch to increase further. This gradual increase in pressure is known as “modulation” and prevents shock loading of the transmission by allowing the clutches to pick up the load gradually. Eventually, the load piston moves so far to the left that the chamber at the right end is opened to the tank. Movement of the load piston then stops, and the piston is held in a balanced position. The modulation relief valve also takes up a balanced position, with excess oil flowing to the torque converter circuit. At this point, the speed clutch pressure has reached its correct value.

Torque converter inlet pressure valve (6) controls the maximum pressure to the torque converter. Its main purpose is to prevent damage to the torque converter components when the oil is cold.

Oil flows through an orifice in the spool of torque converter inlet pressure valve (6) and fills the slug chamber at the right end of the spool. Torque converter inlet pressure acts against the left end of the spool. Converter inlet pressure acts against the full area of the spool, whereas speed clutch pressure acts only against the area of the slug. Thus, the converter pressure required to move the spool to the right is less than the speed clutch pressure. When the converter inlet pressure is high enough, the spool moves to the right, allowing oil to return to sump. This limits the converter inlet pressure to an acceptable level.

Engine Running, NEUTRAL to FOURTH Speed



Engine Running, NEUTRAL to FOURTH Speed.
(1) Speed selector spool. (2) Valve body. (3) Load piston. (4) Pressure differential valve. (5) Directional selector spool. (6) Torque converter inlet pressure valve. (7) Modulation relief valve. (8) Orifice. (9) Orifice.

When the gear shift lever is moved from NEUTRAL to FOURTH speed, the speed and directional selector spools (1) and (5) move to the positions shown. The directional selector spool opens the number-3 clutch to oil flow, and opens the number-1 and number-2 clutches to the sump. The speed selector spool opens the number-5 clutch to oil flow and opens the number-4 and number-6 clutches to the sump.

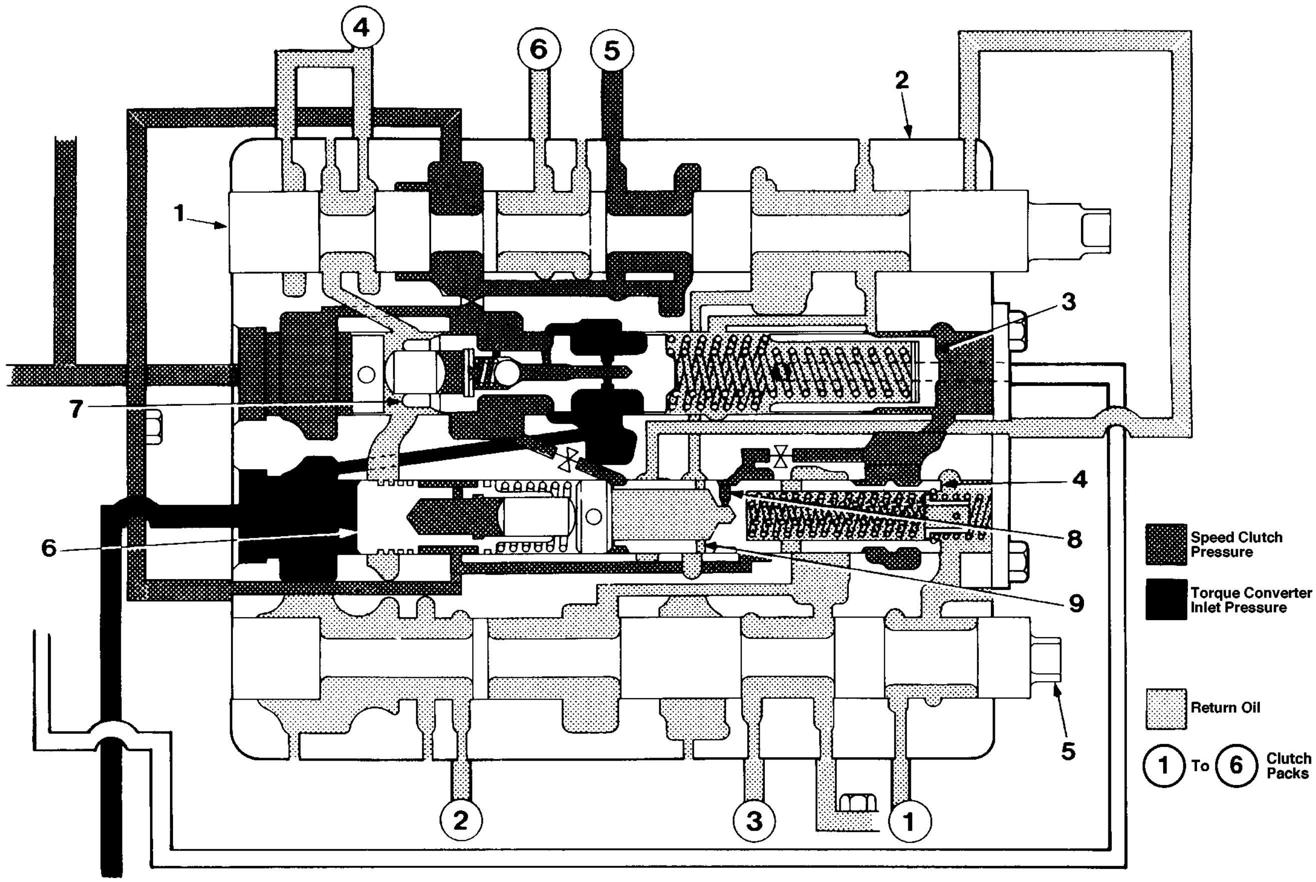
When the gear shift is made, the speed clutch pressure decreases as oil in the number-4 clutch flows to the sump. Springs move modulation relief valve (7) to the left. Pressure differential valve (4) moves to the left, allowing oil to flow from the right end of the load piston to the sump. The load piston then moves to the right.

The action of the load piston causes the torque converter to revert to converter drive if a gear shift is made while the lockup clutch is engaged. This happens because the movement of the load piston to the right connects the line from the reducing valve to the sump.

The number-5 clutch fills with oil, and system pressure rises again. This pressure increase acts against the left end of pressure differential valve (4) and is transmitted to the right end of the load piston through orifice (8). The pressure differential valve moves right to block the sump passage from the right end of the load piston. As the pressure rises, the modulation relief valve moves right and is opposed by the load piston moving left (as described previously). This allows the speed clutch pressure to rise.

The pressure differential valve (4) also allows oil to flow past directional selector spool (5) to fill the number-3 clutch. This occurs when speed clutch pressure is 380 kPa (55 psi). When the number-3 clutch is full, the directional clutch pressure continues to rise. Thus, speed clutch pressure is always 380 kPa (55 psi) higher than directional clutch pressure to ensure that the speed clutch engages first. This allows the directional clutch to pick up the high loads associated with a speed change.

Engine Started With Transmission in a Speed and Direction



Engine Started With Transmission in a Speed and Direction.
(1) Speed selector spool. (2) Valve body. (3) Load piston. (4) Pressure differential valve. (5) Directional selector spool. (6) Torque converter inlet pressure valve. (7) Modulation relief valve. (8) Orifice. (9) Orifice.

NOTE: This function supplements the neutral start function of the EPTC II. The EPTC II puts the transmission into NEUTRAL by default when power is first applied to the EPTC II.

If the engine is started with speed selector spool (1) in any position other than NEUTRAL, pressure differential valve (4) prevents movement of the machine by preventing a directional clutch from filling. If the engine is started with the transmission in THIRD speed, the pump directs oil to modulation relief valve (7), torque converter inlet pressure valve (6) and pressure differential valve (4). Oil also flows to the number-5 clutch.

Oil flowing to pressure differential valve (4) passes through orifice (8) and fills the chamber at the left end of the spool. However, due to the position of speed selector spool (1), the chamber is open to sump through orifice (9). Thus the pressure differential valve cannot move to the right to initiate the filling of a directional clutch. Orifice (9) connects the chamber at the left end of the spool to the sump in all gear selector positions except NEUTRAL. The operator must make a deliberate shift to NEUTRAL before a gear can be engaged.

Testing and Adjusting

Troubleshooting

Visual checks are the first steps to be taken when troubleshooting a problem. If the visual checks do not show any problems, the operational checks are next. The operational checks will permit the identification of possible problems while the machine is in operation.

For the location of components and electrical connectors, see the *Schematic, Deployable Universal Combat Earthmover (DEUCE), Electrical Schematic*. For hydraulic components or pressure tap locations, refer to the “Torque Converter Hydraulic System” and “Transmission Hydraulic System” sections in this module.

The following troubleshooting procedures should be used in conjunction with the troubleshooting procedures in the “Testing and Adjusting” section of *Systems Operation, Testing and Adjusting, Electronic Programmable Transmission Control (EPTC II)*.

Setup Procedure

WARNING

Some of the tests that follow must be done with the machine in operation. A trained machine operator will be needed. Whenever the engine is in operation, the machine operator must be in the cab with the parking and service brakes APPLIED, unless told differently.

Sudden movement of the machine can cause injury to persons on or near the machine. To prevent possible injury, do the procedure that follows before troubleshooting the power train.

With the engine running, this machine will spot turn when the steering wheel is turned, even if the transmission is in NEUTRAL.

To avoid personal injury due to unexpected movement, engage the parking brake and make sure the area is free of personnel before starting the engine.

1. Move the machine to a smooth, horizontal location. Move away from other working machines and personnel. Put the transmission shift lever into the NEUTRAL position. Engage the parking brake. Stop the engine.

2. Permit only two people in the cab (one operator and one service person). Keep all other personnel either away from the machine or in view of the operator. The machine operator must only operate the machine, as directed by the service person. The service person will look at all lights (light emitting diodes [LEDs]) or gauges.

3. The transmission must be in the NEUTRAL position.

Visual Checks

Perform visual checks first when troubleshooting a problem. Make the checks while the engine is stopped. Place the shift lever into NEUTRAL. Engage the parking brake.

Check A

Inspect the oil level in the power train system.

NOTE: Many problems in the power train are caused by low oil level or air in the oil. If the engine has not been running for several minutes, this oil-level check will ensure that there is oil in the transmission and that the engine can be started. If the machine has sat overnight, or longer, with the engine off, the oil level will be high. An accurate oil level check can be made after the oil becomes hot.

Check B

Lower or remove the bottom guards and inspect all oil lines, hoses and connections for damage or leaks. Look for oil on the bottom guards or under the machine.

NOTE: If oil can leak out of a fitting or connection, air can leak in. Air in the system can be as damaging as low oil level.

Check C

Inspect the EPTC II circuit breaker, harnesses and electrical connectors (refer to *Schematic, Deployable Universal Combat Earthmover [DEUCE], Electrical Schematic* and *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System*).

With the start switch and electrical disconnect switch OFF, check the EPTC II breaker. If the circuit breaker is open, press the reset button.

Inspect the electrical harnesses for damaged or broken wires. Disconnect each connector and look for bent, broken or pulled out (removed) pins and sockets. Also look for any foreign material inside the connectors. The connectors must be tightened with normal force. They must also disconnect with the same amount of force.

Check D

Check the batteries. Turn the disconnect switch ON.

Check E

Inspect the power train oil filter and suction screen.

Clues about the nature of a transmission problem or failure can often be found during a visual inspection of the filter and suction screen.

Shiny steel particles in the filter or screen indicate pump wear or failure. However, the absence of such particles is no guarantee that the pumps are performing correctly; a pump problem may still exist.

Aluminum particles in the filter or screen indicate a torque converter failure.

Rubber particles in the filter screen indicate a seal or hose failure.

Iron or steel chips in the screen indicate broken parts in the transmission, torque converter or differential steering unit.

The pressure setting of the bypass valves in the transmission oil filter is approximately 172 ± 12 kPa (25 ± 2 psi). The pressure setting of the bypass valve in the suction screen is approximately 20 kPa (3 psi). If any contamination is found in the filter element or screen, all components of the power train hydraulic system must be cleaned. Do not reuse any damaged parts. Any damaged parts must be removed and new parts installed.

Check F

Check the transmission control (electrical system) for fault codes. Refer to "Detected Fault Troubleshooting" in *Systems Operation Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electronic Programmable Transmission Control II (EPTC II)*.

Operational Checks

The operational checks that follow are set in a sequence to find most problems and/or probable causes quickly. These operational checks must be done in order, starting with Check 1. Do not go to the next check until either the problem in the previous check has been corrected, or you are instructed to do so. If the correct result is found, as instructed in the procedure, go directly to the next check or procedure.

Take note of all WARNINGS and NOTICES in these checks. Never start the next check until you have read and understand the WARNINGS or NOTICES.

The checks that follow can be used to find many of the problems that may occur during the operation of the machine. These checks will also give an indication of the system in which the problems can be found.

Machine Preparation for Checks

1. Engage the parking brake. The shift lever must be in NEUTRAL.

2. Check all fluid levels on the machine.

NOTE: The oil levels can be above the full mark at this time. With the engine running, power train oil must be at the normal temperature for operation.

3. The engine must be stopped. Do not start the engine until instructed to do so.

Troubleshooting Problem List

Troubleshooting Problems

Problem 1: Transmission Overheating

Probable Cause(s):

- Incorrect power train oil level
- Hydraulic oil cooler externally plugged
- Suction screen dirty
- Restriction in power train oil cooler or lines
- Cooling fan system failure
- Power train hydraulic pump worn or damaged
- Internal damage to transmission
- Excessive internal leakage in torque converter

1. Incorrect power train oil level:

Check the power train oil level. Add or remove oil as necessary. Refer to the *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE)*.

2. Hydraulic oil cooler externally plugged:

Raise the radiator grill and clean any accumulated debris from the cooler cores.

NOTE: The air-conditioning condenser may need to be removed to clean the hydraulic oil cooler core.

3. Suction screen dirty:

Clean the suction screen.

4. Restriction in power train oil cooler or lines:

a. Check the power train oil cooler for restrictions.

b. Check the power train oil cooler lines for restrictions.

5. Cooling fan system failure:

a. Perform the procedure shown in “Testing and Adjusting, Cooling Fan System, Fan Speed Test” in *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Implement and Fan Hydraulic System*.

b. If necessary, repair the cooling fan system.

6. Power train hydraulic pump worn or damaged:

Perform the priority valve setting check. Refer to “Transmission Hydraulic System, Priority Valve Setting Check” in this section. If the the pressure cannot be brought within specification, remove the power train hydraulic pump and check for wear or damage. Refer to “Specifications, Power Train Lubrication Pump” in this module and *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* “Power Train Hydraulic Pump.”

7. Internal damage to transmission:

a. Low speed or directional clutch pressures can cause slippage and result in excessive temperatures. Check the directional (P2) and speed (P1) clutch pressures. Refer to “Transmission Hydraulic System, Speed and Directional Clutch Pressures” in this module.

b. Internal damage to the transmission can cause the clutches to slip or drag. Remove and disassemble the transmission and inspect for internal damage. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* “Transmission.”

8. Excessive internal leakage in torque converter:

Remove and disassemble the torque converter and check for internal wear or damage. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* “Torque Converter.”

Problem 2: Transmission Will Not Shift From Speed to Speed

Probable Cause(s):

- Air in power train hydraulic oil
- Fault in EPTC II electrical system
- Transmission shift control linkage out of adjustment.

1. Air in power train hydraulic oil:

Check for air in the power train hydraulic oil; check for leaks in the power train oil lines.

2. Fault in EPTC II electrical system:

Check for fault codes stored in the EPTC II. Refer to *Systems Operation Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electronic Programmable Torque Converter (EPTC II),* "Testing and Adjusting."

3. Transmission shift control linkage out of adjustment:

Check the transmission shift control linkage adjustment. Refer to "Transmission Hydraulic System, Transmission Shift Control Linkage Adjustment" in this module.

Problem 3: Transmission Shifts Slowly

Probable Cause(s):

- Fault in EPTC II electrical system
- Low oil pressure
- Air in power train hydraulic oil
- Transmission shift control linkage damaged, or out of adjustment
- Failure in transmission pressure control valve

1. Fault in EPTC II electrical system:

Check for fault codes stored in the EPTC II. *Refer to Systems Operation Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electronic Programmable Torque Converter (EPTC II),* "Testing and Adjusting."

2. Low oil pressure:

a. Check the transmission shift solenoid pressure at the priority valve. Refer to "Transmission Hydraulic System, Priority Valve Setting Check" in this module.

b. Check the lockup clutch pressure. Refer to "Torque Converter Hydraulic System, Lockup Clutch Tests" in this module.

3. Air in power train hydraulic oil:

Check for air in the power train hydraulic oil; check for leaks in the power train oil lines.

4. Transmission shift control linkage damaged, or out of adjustment:

Check the transmission shift control linkage adjustment. Refer to "Transmission Hydraulic System, Transmission Shift Control Linkage" in this module. Make sure the linkage operates smoothly through all gears.

5. Failure in transmission pressure control valve:

a. Check the speed clutch pressure (P1) and the shift clutch pressure (P2). Refer to "Transmission Hydraulic System, Speed and Directional Clutch Pressures" in this module.

b. Disassemble the transmission pressure control valve and look for debris or damage which may cause the interval valves to malfunction. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Transmission Control Valve."

Problem 4: Transmission Clutches Engage Very Suddenly (Rough Shifts)

Probable Cause(s):

- Fault in EPTC II electrical system
- Initial pressure setting of modulation relief valve incorrect
- Operation of pressure differential and safety valve incorrect
- Load piston in pressure control valve stuck

1. Fault in EPTC II electrical system:

Check for fault codes stored in the EPTC II. Refer to *Systems Operation Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electronic Programmable Torque Converter (EPTC II),* "Testing and Adjusting."

2. Initial pressure setting of modulation relief valve incorrect:

Check the speed clutch pressure. Refer to "Transmission Hydraulic System, Speed and Directional Clutch Pressures" in this module.

3. Operation of pressure differential and safety valve incorrect:

Check the directional clutch pressure. Refer to "Transmission Hydraulic System, Speed and Directional Clutch Pressures" in this manual.

4. Load piston in pressure control valve stuck:

Remove and disassemble the transmission pressure control valve. The load piston should move smoothly in the bore. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Transmission Control Valve."

Problem 5: Machine Does Not Move in Any Speed

Probable Cause(s):

- Low oil level
- Fault in EPTC II electrical system
- Low oil pressure
- Failure in transmission pressure control valve
- Excessive leakage in transmission
- Damage to torque converter
- Damage to differential steering unit

1. Low oil level:

Check the power train hydraulic oil level.

2. Fault in EPTC II electrical system:

Check for fault codes stored in the EPTC II. Refer to *Systems Operation Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electronic Programmable Torque Converter (EPTC II),* "Testing and Adjusting."

3. Low oil pressure:

a. Check the transmission shift solenoid pressure at the priority valve. Refer to "Transmission Hydraulic System, Priority Valve Setting Check" in this module.

b. Check the lockup clutch pressure, which is the same as the inlet pressure to the transmission pressure control valve. Refer to "Torque Converter Hydraulic System, Lockup Clutch Tests" in this module.

c. Remove and disassemble the power train hydraulic pump. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Power Train Lubrication Pump."

4. Failure in transmission pressure control valve:

a. Check the transmission shift control linkage adjustment. Refer to "Transmission Hydraulic System, Transmission Shift Control Linkage Adjustment" in this module.

b. Remove and disassemble the transmission pressure control valve. Look for debris or damage that may cause a valve to stick. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Transmission Pressure Control Valve."

5. Excessive leakage in transmission:

Remove and disassemble the transmission. Look for damage that may cause excessive internal leakage. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Transmission."

6. Damage to torque converter:

Remove and disassemble the torque converter to look for internal damage. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Torque Converter."

7. Damage to differential steering unit:

Remove and disassemble the differential steering unit and look for internal damage. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Differential Steering Unit."

Problem 6: Clutches Slip in All Speeds

Probable Cause(s):

- Air in power train hydraulic oil
- Failure in transmission pressure control valve
- Excessive leakage in transmission

1. Air in power train hydraulic oil:

Check for air in the power train hydraulic oil, and check for leaks in the power train oil lines.

2. Failure in transmission pressure control valve:

a. Check the speed clutch pressure (P1). Refer to "Transmission Hydraulic System, Speed and Directional Clutch Pressures" in this module.

b. Check the transmission shift control linkage adjustment. Refer to "Transmission Hydraulic System, Transmission Shift Control Linkage Adjustment" in this module.

c. Remove and disassemble the transmission pressure control valve. Look for debris or damage that may cause a valve to stick. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Transmission Control Valve."

3. Excessive leakage in transmission:

Remove and disassemble the transmission. Look for damage that may cause excessive internal leakage. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Planetary Transmission."

Problem 7: Machine Moves When Selector Lever is in Neutral

Probable Cause(s):

- Transmission shift control linkage out of adjustment
- Directional clutch not releasing

1. Transmission shift control linkage out of adjustment:

Check the transmission shift control linkage adjustment. Refer to "Transmission Hydraulic System, Transmission Shift Control Linkage Adjustment" in this module.

2. Directional clutch not releasing:

Remove and disassemble the transmission. Look for debris or damage which may cause the directional clutches to stick. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Planetary Transmission."

Problem 8: Transmission Does Not Operate in REVERSE, but Does Operate in All Forward Speeds

Probable Cause(s):

- Transmission shift control linkage out of adjustment
- Number-1 clutch not engaging correctly due to failed seals, worn disks and plates or damaged components

1. Transmission shift control linkage out of adjustment:

Check the transmission shift control linkage adjustment. Refer to "Transmission Hydraulic System, Transmission Shift Control Linkage Adjustment" in this manual.

2. Number-1 clutch not engaging correctly due to failed seals, worn disks and plates or damaged components:

Remove and disassemble the transmission. Replace any damaged components. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Planetary Transmission."

Problem 9: Transmission Does Not Operate in First Forward or Reverse, but Does Operate in Second, Third, Fourth and Fifth Speeds

Probable Cause(s):

- Transmission shift control linkage out of adjustment
- Number-6 clutch not engaging correctly due to failed seals, worn disks and plates or damaged components

1. Transmission shift control linkage out of adjustment:

Check the transmission shift control linkage adjustment. Refer to "Transmission Hydraulic System, Transmission Shift Control Linkage Adjustment" in this module.

2. Number-6 clutch not engaging correctly due to failed seals, worn disks and plates or damaged components:

Remove and disassemble the transmission. Replace any damaged components. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Planetary Transmission."

Problem 10: Transmission Does Not Operate in Third, Fourth, or Second Reverse Speeds, but Does Operate in First, Fifth and Sixth Speeds

Probable Cause(s):

- Transmission shift control linkage out of adjustment
- Number-5 clutch not engaging correctly due to failed seals, worn disks and plates or damaged components

1. Transmission shift control linkage out of adjustment:

Check the transmission shift control linkage adjustment. Refer to "Transmission Hydraulic System, Transmission Shift Control Linkage Adjustment" in this module.

2. Number-5 clutch not engaging correctly due to failed seals, worn disks and plates, or damaged components:

Remove and disassemble the transmission. Replace any damaged components. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Planetary Transmission."

Problem 11: Transmission Does Not Operate in Fifth or Sixth Speed, but Does Operate in First, Second, Third, and Fourth Speeds

Probable Cause(s):

- Transmission shift control linkage out of adjustment
- Number-4 clutch not engaging correctly due to failed seals, worn disks and plates or damaged components

1. Transmission shift control linkage out of adjustment:

Check the transmission shift control linkage adjustment. Refer to "Transmission Hydraulic System, Transmission Shift Control Linkage Adjustment" in this module.

2. Number-4 clutch not engaging correctly due to failed seals, worn disks and plates or damaged components:

Remove and disassemble the transmission. Replace any damaged components. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Planetary Transmission."

Problem 12: Transmission Does Not Operate in First, Third or Fifth Speeds, but Does Operate in Second, Fourth and Sixth Speeds

Probable Cause(s):

- Transmission shift control linkage out of adjustment
- Number-2 clutch not engaging correctly due to failed seals, worn disks and plates or damaged components

1. Transmission shift control linkage out of adjustment:

Check the transmission shift control linkage adjustment. Refer to "Transmission Hydraulic System, Transmission Shift Control Linkage Adjustment" in this module.

2. Number-2 clutch not engaging correctly due to failed seals, worn disks and plates, or damaged components:

Remove and disassemble the transmission. Replace any damaged components. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Planetary Transmission."

Problem 13: Transmission Does Not Operate in Second, Fourth or Sixth Speeds, but Does Operate in First, Third and Fifth Speeds

Probable Cause(s):

- Transmission shift control linkage out of adjustment
- Number-3 clutch not engaging correctly due to failed seals, worn disks and plates or damaged components

1. Transmission shift control linkage out of adjustment:

Check the transmission shift control linkage adjustment. Refer to "Transmission Hydraulic System, Transmission Shift Control Linkage Adjustment" in this module.

2. Number-3 clutch not engaging correctly due to failed seals, worn disks and plates or damaged components:

Remove and disassemble the transmission. Replace any damaged components. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Planetary Transmission."

Problem 14: Transmission Does Not Shift Above Certain Gear in SELF-DEPLOY Mode

Probable Cause(s):

- Low engine power
- Fault in EPTC II electrical system
- Torque converter lockup clutch not engaging

1. Low engine power:

For low engine power due to fuel leaks, or leaks in the aftercooler lines, refer to *Specifications Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE) 3100 HEUI DEUCE Engine,* "Troubleshooting, Troubleshooting Problems, Problem 7."

2. Fault in EPTC II electrical system:

Check for fault codes stored in the EPTC II. Refer to *Systems Operation Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electronic Programmable Torque Converter (EPTC II),* "Testing and Adjusting."

3. Torque converter lockup clutch not engaging:

Refer to "Problem 15: Torque converter lockup clutch not engaging."

Problem 15: Torque Converter Lockup Clutch Not Engaging

Probable Cause(s):

- Fault in EPTC II electrical system
- Lockup clutch solenoid valve failure
- Internal failure in torque converter

1. Fault in EPTC II electrical system:

Check for fault codes stored in the EPTC II. Refer to *Systems Operation Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electronic Programmable Torque Converter (EPTC II),* "Diagnostic Operation."

2. Lockup clutch solenoid valve failure:

Check the operation of the lockup clutch solenoid valve. Refer to "Torque Converter Hydraulic System, Lockup Clutch Tests" in this module.

3. Internal failure in torque converter:

Remove and disassemble the torque converter. Look for debris or damage which may cause the lockup clutch to fail. Refer to *Disassembly and Assembly, Power Train,* "Torque Converter Group."

Transmission Hydraulic System

Make reference to the following warning and pressure tap locations for all the checks and tests of the transmission hydraulic system. If the problem area is not known, do the checks and tests in the order in which they are given.

Setup Procedures

WARNING

Sudden movements of the machine can cause injury to persons on or near the machine. To prevent possible injury, perform the setup procedures, shown below, before troubleshooting the power train.

While the engine is running, this machine will spot turn when the steering wheel is turned, even if the transmission is in NEUTRAL.

To avoid personal injury due to unexpected movement, engage the parking brake and make sure the area is free of personnel before the engine is started.

1. Move the machine to a smooth, horizontal location, away from other working machines and personnel.

2. Place the transmission shift lever into the NEUTRAL position. Stop the engine.

3. Permit only one operator on the machine. Keep all other personnel either away from the machine or in view of the operator.

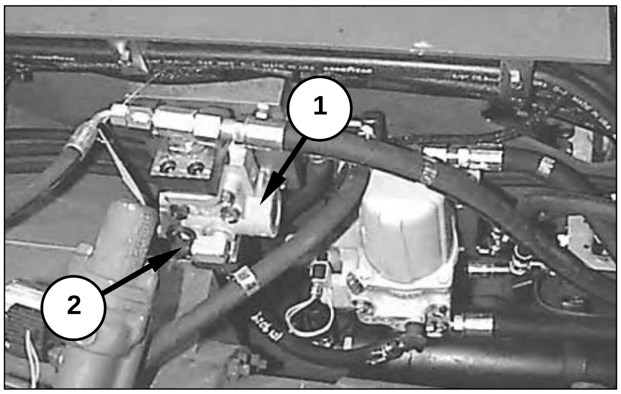
4. Make sure the transmission is in the NEUTRAL position.

5. Make sure all hydraulic pressure is released before any fitting, hose or component is loosened, tightened, removed or adjusted.

Priority Valve Setting Check

Tools Needed		
177-7861	Hose Assembly	1
6V-4143	Coupler	1
8T-0855	Pressure Gauge	1
8T-4188	Adapter	1

NOTE: This procedure requires that the machine be operated. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE)* for information about machine operation.



Left Wall of Main Frame, Beneath Fuel Tank.
(1) Priority valve. (2) Pressure tap.

1. Connect an extension hose and a 4000 kPa (580 psi) pressure gauge to pressure tap (2).

2. Start the engine and operate the hydraulic system until the oil in the power train system reaches the normal operating temperature.

3. Make sure the parking brake is released, and apply the service brake.

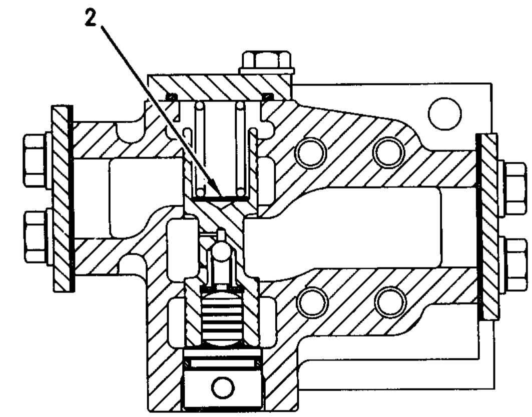
4. Move the shift lever from NEUTRAL into FIRST gear with the engine at low idle.

5. The pressure reading at pressure tap (2) will drop to the setting of the priority valve, pause, and then increase back to full pump pressure.

NOTE: The pause occurs while oil is flowing to fill the new clutches which were selected by shifting to FIRST gear.

6. The setting of the priority valve is shown in the following chart.

Specification Chart Priority Valve	
Condition	**Setting kPa (psi)**
Bench test	2206 ± 36 (320 ± 5)
On machine, engine idling	2200 min (320 min)



Priority Valve.
(2) Shim pack.

Shim Chart Priority Valve[1]		
Part Number For Shims	**Thickness**	**Change In Pressure**
5M-9624	0.25 mm (.010 in)	79.0 kPa (11.4 psi)

[1] **Before an adjustment is made, make sure that the springs are not weak or broken. Refer to "Priority Valve Group" in the "Specifications" section of this manual.**

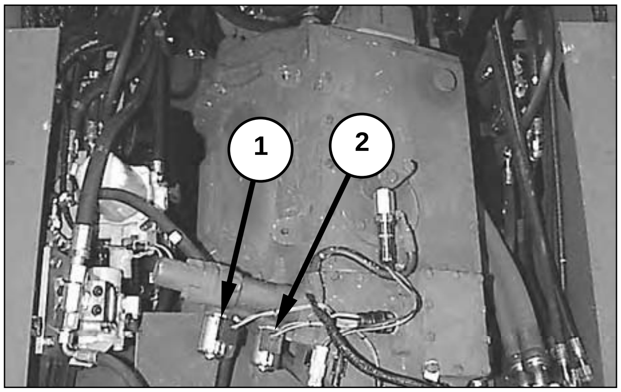
7. If the setting of the priority valve is not within specification, add or subtract shims until the setting is within specifications: add shims to increase the pressure setting, or subtract shims to decrease the pressure setting.

8. Once the correct pressure setting has been achieved, remove all tooling and check for leaks.

Transmission Shift Solenoid Checks

Electrical Check

1. Remove the winch bracket and winch assembly. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Hydraulic System,* “Winch Bracket With Winch Assembly.”



Power Train Solenoids (Fuel Tank Shown Removed). (1) Upshift solenoid. (2) Downshift solenoid.

2. Disconnect upshift solenoid (1) and downshift solenoid (2) from their respective receptacles on the main harness.

3. Move the engine start switch to ON, but do not start the engine. Refer to *Operator’s Manual, Deployable Universal Combat Earthmover (DEUCE),* “Operation Section, Monitoring Systems and Cab Features, Switches.”

NOTE: When the start switch is ON and the transmission is in NEUTRAL, the EPTC II transfers power to energize downshift solenoid (2).

4. Reconnect downshift solenoid (2) to its receptacle on the main harness. At the moment the downshift solenoid is reconnected, a “click” and/or “buzz” should be heard coming from the downshift solenoid.

5. Disconnect downshift solenoid (2) from the main harness receptacle. Connect upshift solenoid (1) to the receptacle on the main harness which is for the downshift solenoid. At the moment the upshift solenoid is connected to the downshift harness receptacle, a “click” and/or “buzz” should be heard coming from the upshift solenoid.

6. If the solenoids do not make a sound, check for fault codes in the EPTC II. Refer to *Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electronic Programmable Torque Converter (EPTC II),* “Testing and Adjusting.”

7. Reconnect upshift solenoid (1) and downshift solenoid (2) to their correct receptacles on the main harness.

8. Reinstall the winch bracket and winch assembly.

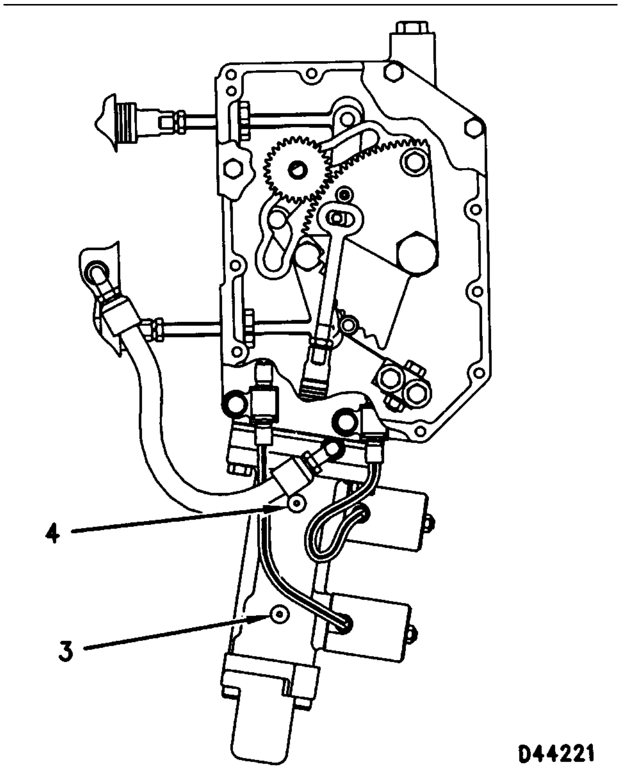
Pressure Check

Tools Needed		
177-7861	Hose Assembly	2
3J-1907	O-ring Seal	4
3J-7354	O-ring Seal	2
6V-3965	Adapter	2
6V-4143	Coupler	2
6V-8397	O-ring Seal	2
7J-0204	O-ring Seal	2
8T-2353	ORB–ORB Connector	2
8T-0855	Gauge	2
8T-2362	Adapter	2
8T-4188	Adapter	2

NOTE: This procedure requires that the machine be operated. Refer to *Operator’s Manual, Deployable Universal Combat Earthmover (DEUCE)* for information about machine operation.

1. Park the machine on a hard, level surface and block the belts.

2. Remove the winch bracket and winch assembly. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Hydraulic System,* “Winch Bracket With Winch Assembly.”



(3) Plug (for the upshift solenoid pressure port).
(4) Plug (for the downshift solenoid pressure port).

3. Remove plugs (3) and (4) from the shift cylinder body. Install pressure taps into both ports.

4. Connect a 4000 kPa (580 psi) gauge and a suitable length of extension hose to each pressure tap. Position the gauge so it can be read inside the cab.

5. Move the engine start switch to ON, and start the engine. The transmission downshift solenoid should activate. The pressure reading on the gauge should be 2206 kPa (320 psi) or greater.

6. Apply the service brake and release the parking brake.

WARNING

The machine will move during Step 6 if the service brake is released. Sudden movement of the machine can cause injury to persons on or near the machine.

While the engine is running, this machine will spot turn when the steering wheel is turned, even if the transmission is in NEUTRAL.

Make sure the area is free of personnel before starting the engine.

7. With the engine idling, move the shift lever to one of the forward gear positions. The transmission upshift solenoid should activate. The pressure reading on the gauge should be 2206 kPa (320 psi) or greater.

8. If the pressure is incorrect, refer to "Priority Valve Setting Check" in this section.

   If the priority valve is set correctly, check the pilot line between the priority valve and the shift solenoids for plugs or leaks.

   If the line between the priority valve and shift solenoid is not plugged or leaking, stop the engine, and then remove and disassemble the shift solenoid, and check for internal damage.

9. Turn off the engine. Remove the tooling.

10. Reinstall the winch bracket and winch assembly.

Speed and Directional Clutch Pressures

Tools Needed		
177-7861	Hose Assembly	2
6V-4143	Coupler	2
8T-0856	Pressure Gauge	2
8T-4188	Adapter	2
8T-5200	Signal Generator	1

NOTE: This procedure requires that the machine be operated. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE)* for information about machine operation.

1. Park the machine on a hard, level surface and block the belts.

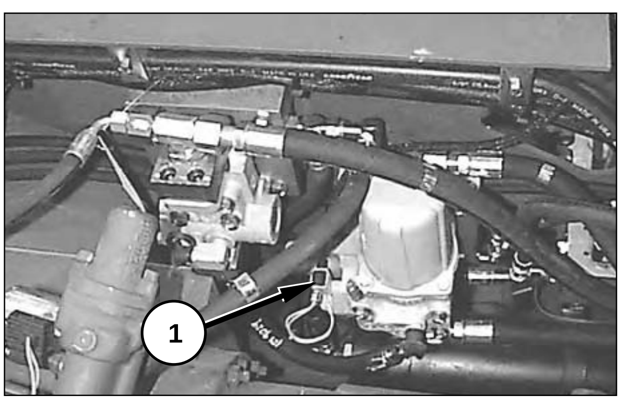
2. Remove the winch bracket and winch assembly. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Hydraulic System,* "Winch Bracket With Winch Assembly."

3. Remove the drive axles and adapters from both sides of the machine. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Towing Information, Preparation for Towing a Disabled Machine."

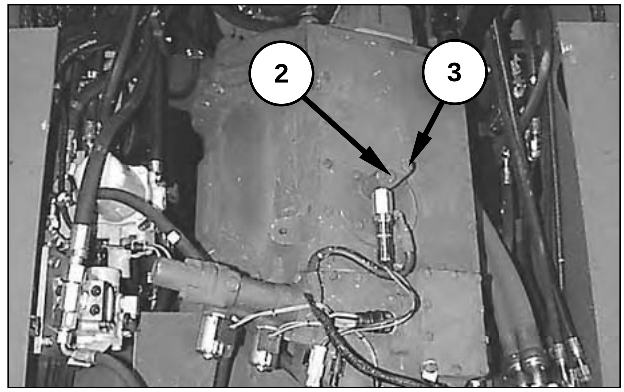
WARNING

Sudden movement of the machine can cause injury to persons on or near the machine.

Make sure the area is free of personnel before starting the engine.

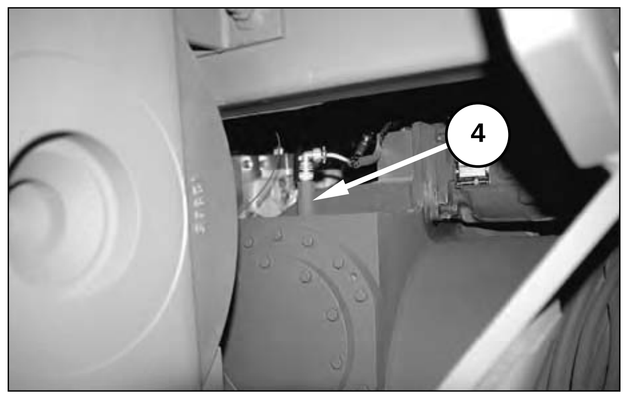


4. Disconnect lockup clutch solenoid wiring harness connector (1).



Transmission Pressure Test Taps.
(2) Directional clutch pressure (P2) port. (3) Speed clutch pressure (P1) port.

5. Install a hose with a 6000 kPa (870 psi) pressure gauge in test ports (2) and (3).



Transmission Speed Sensor.
(4) Transmission speed sensor.

6. Cut the lock wire and disconnect transmission speed sensor (4), and connect the 8T-5200 Signal Generator Group to the connector side of the harness.

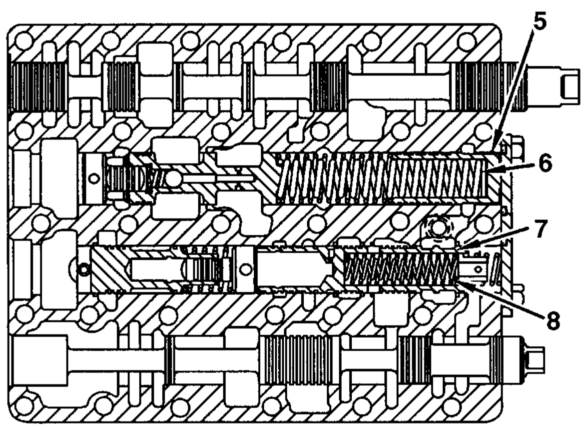
NOTE: When the transmission speed sensor is reconnected, install lock wire. Refer to "Installation of Lock Wire on Transmission Gear Switch and Transmission Speed Sensor Connectors" in this section.

7. Start the engine and operate at low idle.

8. Place the transmission selector lever into NEUTRAL. The pressure gauge in speed clutch pressure (P1) port (3) should register the initial pressure of 585 ± 35 kPa (85 ± 5 psi).

9. Put the machine in SELF-DEPLOY, and move the transmission selector to SIXTH speed. With the engine at low idle, the gauge in speed clutch pressure (P1) port (3) should register less than 3100 kPa (450 psi). The pressure gauge in directional clutch pressure (P2) port (2) should register 380 kPa (55 psi) less than the reading on speed clutch pressure (P1) port (3).

10. Gradually increase the signal speed on the 8T-5200 Signal Generator. Observe the gauges as the transmission shifts through the gears. The pressures should be similar after each shift. After all shifts have been observed, stop the engine.



Transmission Control Valve.
(5) Load piston. (6) Shims. (7) Differential valve. (8) Differential valve spring.

Shim Chart Load Piston		
Part Number For Shims	**Thickness**	**Change In Pressure**
5M-9624	0.25 mm (.010 in)	15.8 kPa (2.3 psi)
5M-9623	0.91 mm (.036 in)	56.5 kPa (8.2 psi)
5M-9622	1.57 mm (.062 in)	97.9 kPa (14.2 psi)

11. If the low idle pressure on the pressure gauge in speed clutch pressure (P1) port (3) is too low, check the priority valve and power train hydraulic pump for damage. If both components are undamaged, add shims (6) to load piston (5). See “Shim Chart, Load Piston” on this page, for the part number of the shims and the corresponding change in pressure.

12. If the low idle pressure on the pressure gauge in speed clutch pressure (P1) port (3) is too high, remove shims (6) from load piston (5). See “Shim Chart, Load Piston” on this page, for the part number of the shims and the corresponding change in pressure.

13. If the low idle pressure on the pressure gauge in speed clutch pressure (P1) port (3) is correct, but the pressure on the gauge in directional clutch pressure (P2) port (2) is too low, check for the following problems:
- Differential valve (7) stuck in bore.
- Differential valve spring (8) damaged. Refer to “Specifications, Transmission Selector and Pressure Control Valve” in this module.
- Orifice(s) to pressure differential valve blocked.
- Directional clutch piston seal leaking.

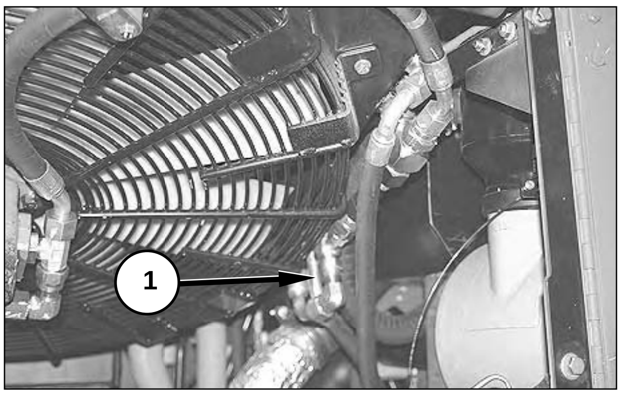
14. If the pressures are within specification, remove the tooling.

15. Reinstall the winch and the axles and adapters on both sides of the machine.

Transmission Lubrication Pressure

Tools Needed		
177-7861	Hose Assembly	1
3K-0360	O-ring Seal	1
6V-3966	Nipple	1
6V-4143	Coupler	2
6V-9746	Seal	1
7X-0873	T-fitting	1
8T-0855	Gauge	1
8T-4188	Adapter	1

NOTE: This procedure requires that the machine be operated. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE)* for information about machine operation.



1. Raise the radiator. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE)*, "Radiator Tilt."

2. Install a 7X-0873 T-fitting, using a 6V-9746 Seal, and a 6V-3965 Nipple and a 3K-0360 O-ring Seal, to power train oil cooler outlet (1).

3. Connect an extension hose and a 1000 kPa (145 psi) pressure gauge to the nipple which was installed in Step 2.

4. Start the engine and operate the machine until the power train oil temperature is in the normal operating range.

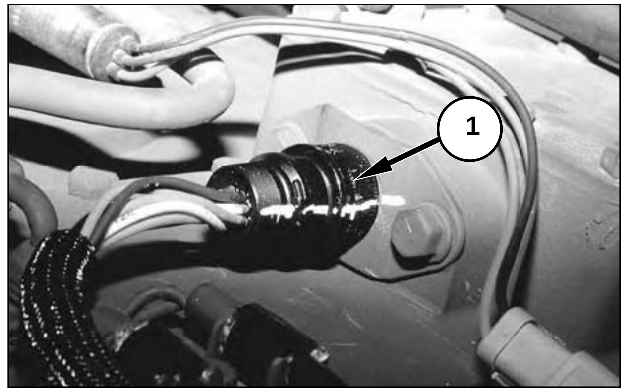
5. With the engine speed at high idle, the lubrication pressure should be at a minimum of 140 kPa (20) psi. With the engine speed at low idle, lubrication pressure should be 104 ± 48 kPa (15 ± 7 psi).

6. If the pressure is too low, check the torque converter outlet pressure.

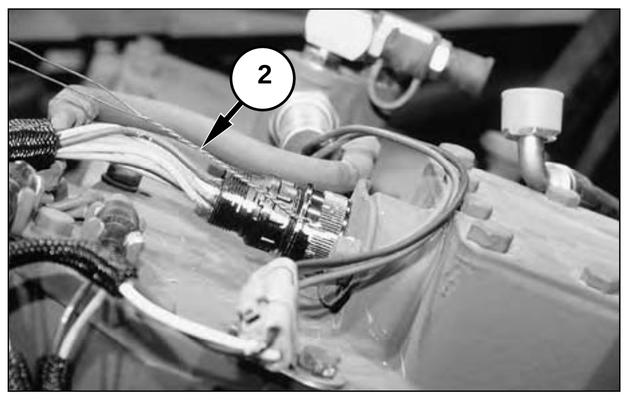
7. If the pressure is within specification, remove all tooling, and lower the radiator.

Installation of Lock Wire on Transmission Gear Switch and Transmission Speed Sensor Connectors

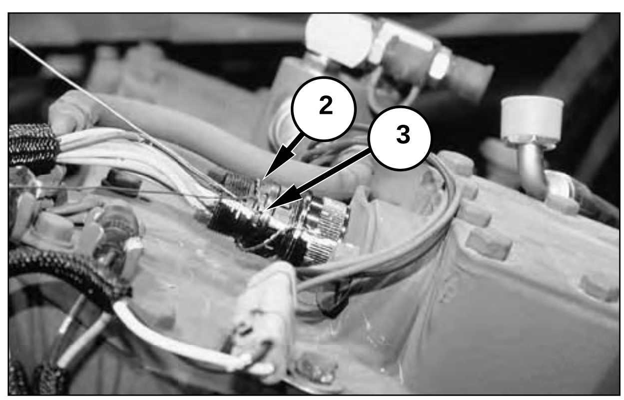
NOTE: This procedure shows the transmission gear switch connector. The procedure for the transmission speed sensor is the same.



1. Thread one end of the lock wire through tab (1) on the switch side of the connector.

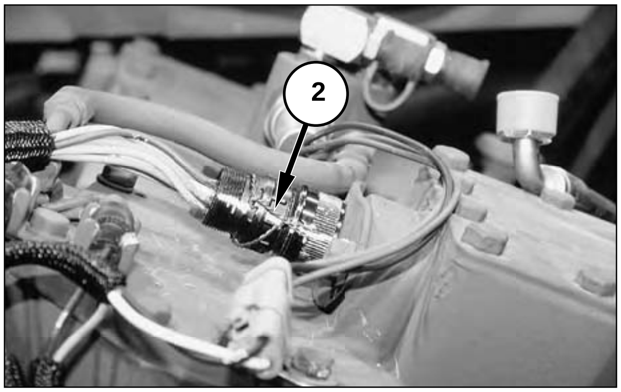


2. Twist lock wire (2).



3. Wrap lock wire (2) clockwise around the harness side of the connector.

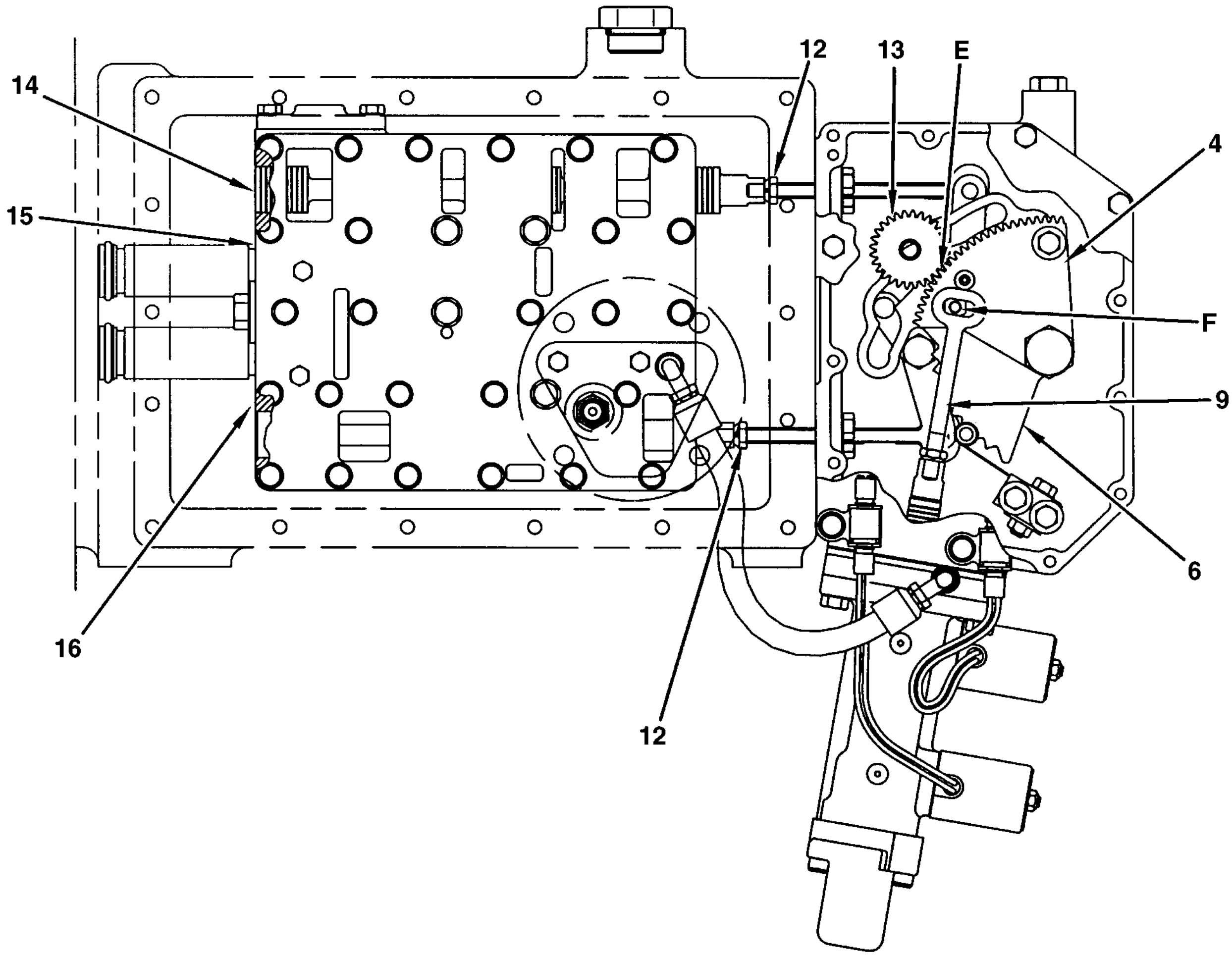
4. Thread one end of lock wire (2) through tab (3) on the harness side of the connector.



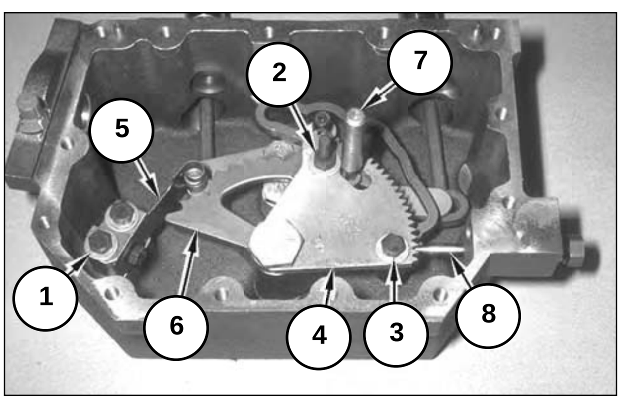
5. Twist lock wire (2) an additional 10 times.

NOTE: Trim off the excess lock wire (the wire beyond the final twists), and bend the wire out of the way, as shown.

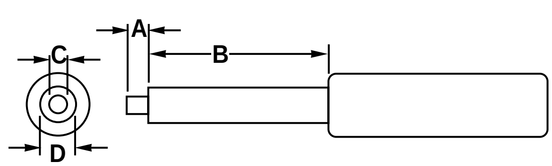
Transmission Shift Control Linkage Adjustment



Shift Control Linkage With Speed Control Spool and Directional Control Spool.
(4) Sector gear. (6) Cam. (9) Shift control spool rod. (12) Jam nut. (13) Drive gear. (14) Speed control spool. (15) Valve body. (16) Directional control spool. (E) Location. (F) Location.



Shift Control Linkage (Shown Removed from Machine).
(1) Bolts. (2) Bolt. (3) Bolt. (4) Sector gear. (5) Spring. (6) Cam. (7) Alignment tool. (8) Plug assembly.



Alignment Tool (7).
(A) 3.81 mm (0.15 in). (B) 31.75 mm (1.25 in).
(C) Diameter 3.09-3.14 mm (0.122-0.124 in).
(D) 6.27-6.32 mm (0.247-0.249 in).

1. Remove the fuel tank. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Machine Systems,* “Fuel Tank.”

2. Remove the covers from the shift control linkage assembly and the transmission control valve. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Transmission Control Valve."

3. Loosen two bolts (1) on the block, and then hand tighten the bolts so the block and spring (5) can slide freely.

4. Loosen bolts (2) and (3) on sector gear (4), then hand tighten the two bolts so the sector gear can rotate freely.

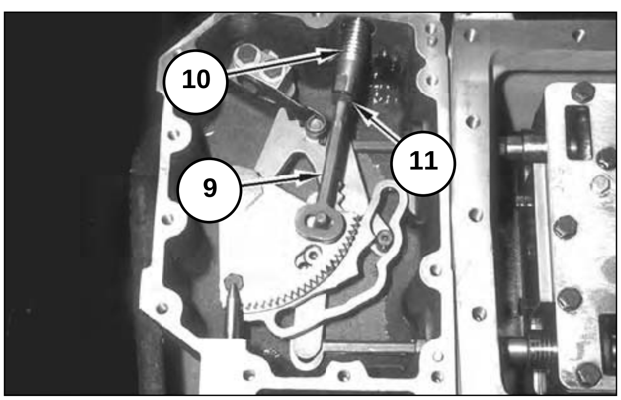
5. Rotate cam (6) until spring (5) engages the cam in the THIRD gear, detent position. The THIRD gear, detent position is identified with the number "3" stamped on the cam at location (E).

6. Equalize the hole in cam (6), with the smaller hole in the follower located below the cam. Alignment tool (7) can be fabricated to keep the holes aligned during the adjustment.

7. Tighten two bolts (1).

8. Engage the tip of plug assembly (8) in the tooth space between the adjacent teeth which are marked with a "V" on sector gear (4).

9. Tighten bolts (2) and (3) on sector gear (4). After tightening the sector gear, return plug assembly (8) to the storage position above the sector gear.



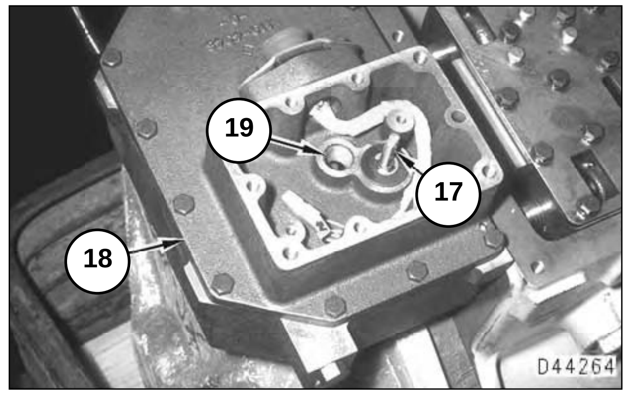
Transmission Control Linkage With Shift Control Spool and Rod.
(9) Rod. (10) Shift cylinder. (11) Jam nut.

10. Thread rod (9) into the spool in shift cylinder (10) until the dimension from the outside face of jam nut (11) to the center of the rod eye is 96.0 ± 2 mm (3.78 ± .08 in). Tighten the jam nut to 25 ± 4 N•m (18 ± 3 lb ft).

11. With the cam still in the THIRD gear, detent position, adjust speed control spool (14) and directional control spool (16) until the ends of the spools are flush with the face of valve body (15).

12. When speed control spool (14) and directional control spool (16) are flush with the face of valve body (15), tighten two jam nuts (12) to 25 ± 4 N•m (18 ± 3 lb ft).

13. Rotate cam (6) through all gear detent positions to make sure that shift control spool rod (9) does not bind on the bolt at location (F). After the shift control spool rod is checked and found free from binding, return the cam to the THIRD gear, detent position.

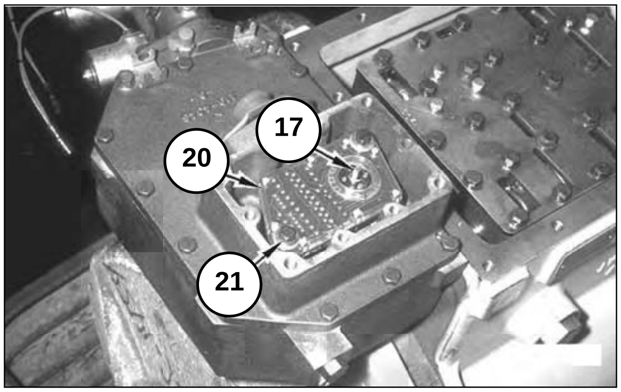


Actual Gear Switch Alignment.
(17) Coupling assembly. (18) Shift linkage cover. (19) Alignment sighting port.

14. Remove the plug in alignment sighting port (19).

15. Coupling assembly (17) that drives the EPTC II actual gear switch is installed in the drive gear. The drive gear and coupling assembly are installed in shift linkage cover (18). When the shift linkage cover is installed, look through alignment sighting port (19). The "V" on the gear segment must align with the tooth space between the adjacent teeth, which are each marked with a "V" on the drive gear.

16. Install the plug in alignment sighting port (19) after the alignment is completed.



Actual Gear Switch Location.
(17) Coupling assembly. (20) Actual gear switch. (21) Mounting bolts.

17. Install actual gear switch (20) over coupling assembly (17). Tighten two mounting bolts (21) to 12 ± 4 N•m (106 ± 36 lb in).

18. After the actual gear switch is installed, the contact fingers must be centered over the switch pad. If the contact fingers are not centered, the cover must be removed and the adjustment procedure repeated.

19. Install the covers, and install the fuel tank.

Torque Converter Hydraulic System

Make reference to the following warning and pressure tap locations for all checks and test. If the problem area (torque converter, lockup clutch, hoist or brake cooling) is not known, do the checks and tests in the order in which they are given. For all tests, the oil must be at normal operating temperature.

Setup Procedures

WARNING

Sudden movement of the machine can cause injury to persons on or near the machine. To prevent possible injury, perform the setup procedures, shown below, before troubleshooting the torque converter.

While the engine is running, this machine will spot turn when the steering wheel is turned, even if the transmission is in NEUTRAL.

To avoid personal injury due to unexpected movement, engage the parking brake and make sure the area is free of personnel before the engine is started.

1. Move the machine to a smooth, horizontal location, away from other working machines and people.

2. Put the transmission shift lever into NEUTRAL. Stop the engine.

3. Permit only one operator on the machine. Keep all other personnel either away from the machine, or in view of the operator.

4. Engage the parking brake.

5. Make sure the transmission is in the NEUTRAL position.

⚠ WARNING

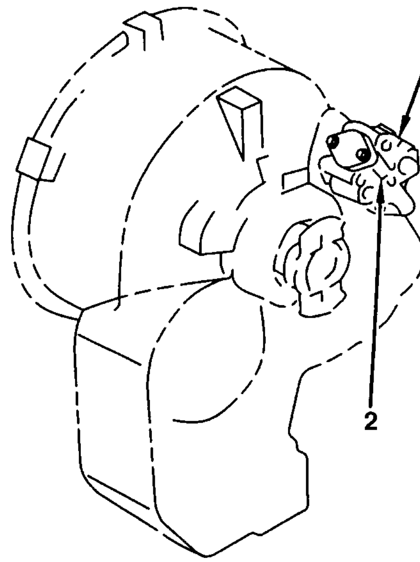
Make reference to the warning on the first page of "Troubleshooting the Torque Converter Hydraulic System."

Outlet Pressure Test

Tools Needed		
177-7861	Hose Assembly	1
3J-1907	O-ring Seal	2
3J-7354	O-ring Seal	1
6V-3965	Adapter	1
6V-4143	Coupler	1
7J-0204	O-ring Seal	1
8T-0854	Pressure Gauge	1
8T-2353	Adapter	1
8T-2362	Adapter	1
8T-4188	Adapter	1

NOTE: This procedure requires that the machine be operated. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE)* for information about machine operation.

1. Prepare to measure the engine speed. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Testing and Adjusting, Fuel System, Engine Speed Measurement."



Torque Converter Outlet Relief Valve.
(1) Outlet relief valve for the torque converter. (2) Pressure tap.

2. Connect a hose to pressure tap (2). Connect a 1000 kPa (145 psi) pressure gauge to the hose.

3. Block the front and rear of the belts to prevent the machine from moving forward or backwards during the test.

4. Start and run the engine at low idle with the transmission shift lever in NEUTRAL.

5. Warm up the power train oil to normal operating temperature. Verify that the engine high idle speed is 2590 ± 50 rpm, and low idle speed is 850 ± 50 rpm.

6. Engage the service brakes and release the parking brake. The drive wheels must not turn during the test.

NOTE: If the brakes do not prevent machine movement, put the machine against a solid object that will not move.

7. Move the transmission shift lever to the SECOND REVERSE position.

8. Slowly depress the throttle pedal against the high idle stop. The machine will try to move.

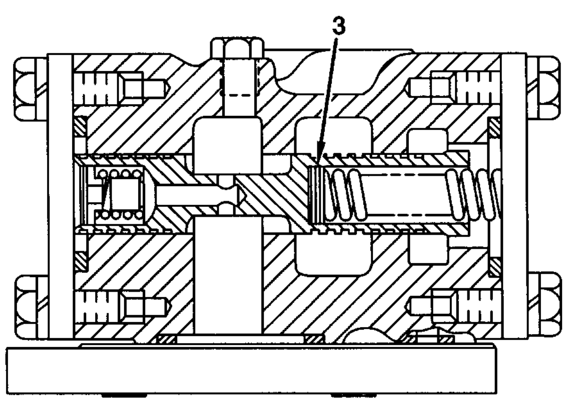
9. The engine rpm should be 1970 ± 30 rpm, with the torque converter in a stalled condition.

10. The pressure on the gauge should be 414 ± 104 kPa (60 ± 15 psi).

NOTICE

Overheating can cause damage to the torque converter, engine and brakes. To avoid overheating, do not operate the torque converter at stall for more than one minute. Allow the systems to cool down to normal operating temperatures before repeating the test.

Test Results Chart Torque Converter Outlet Pressure Test	
Condition	**Cause/Action**
High idle speed correct; Stall speed too high; Outlet pressure correct	• Torque converter worn • Excessive engine power
Outlet pressure too high; Powertrain oil overheats during normal operation	• Internal leakage in torque converter, check inlet pressure • Inlet pressure setting low
Outlet pressure is too low; All other values normal	• Internal leakage in torque converter, check inlet pressure. • Inlet pressure setting low
Outlet pressure too high; Powertrain oil temperature is normal	• Torque converter inlet pressure is too high, check inlet pressure • Outlet relief valve setting is too high, adjust valve using shims (3)
High idle speed correct; Stall speed too low; Outlet pressure correct	• Engine low power • Oil is cold • Oil viscosity not right for conditions



Outlet Relief Valve.
(3) Shims.

Shim Chart Torque Converter Outlet Relief Valve[1]		
Part Number For Shims	**Thickness**	**Change In Pressure**
4M-1751	0.41 mm (.016 in)	19 kPa (2.7 psi)
5S-7001	0.91 mm (.036 in)	40 kPa (6.0 psi)

[1] Before an adjustment is made, make sure that the valve spring is not weak or broken. Refer to “Specifications, Torque Converter Outlet Relief Valve” in this module.

11. When the test is complete, put the transmission shift lever into NEUTRAL, engage the parking brake, and stop the engine.

12. If the pressure reading on the gauge is too high, remove shims (3). If the pressure on the gauge is too low, add shims. Refer to “Shim Chart, Torque Converter Outlet Relief Valve” on this page for the correct thickness of shims to add or subtract.

13. When the correct pressure is reached, remove the test equipment and check for leaks. Reinstall all parts which were removed during the test.

Lockup Clutch Tests

WARNING

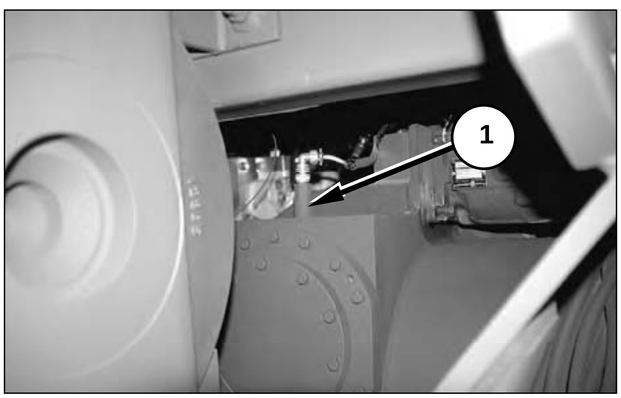
Make reference to the warning on the first page of "Troubleshooting the Torque Converter Hydraulic System."

Lockup Clutch Solenoid Valve Pilot Pressure (Pressure Reduction Valve Setting)

Tools Needed		
177-7861	Hose Assembly	1
3B-6552	90° Elbow	1
6V-4143	Coupler	2
8T-0855	Pressure Gauge	1
8T-4188	Adapter	1
8T-5200	Signal Generator Group	1

NOTE: This procedure requires that the machine be operated. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE)* for information about machine operation.

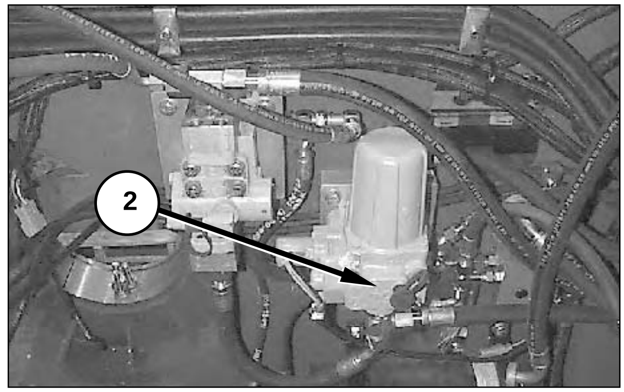
1. Park the machine on a hard, level surface and block the belts.



Transmission Speed Sensor.
(1) Transmission speed sensor.

2. Cut the lock wire and disconnect transmission speed sensor (1), and connect the 8T-5200 Signal Generator Group to the connector side of the harness.

NOTE: When the transmission speed sensor is reconnected, install lock wire. Refer to "Installation of Lock Wire on Transmission Gear Switch and Transmission Speed Sensor Connectors" in this section.



Lockup Clutch Solenoid Valve.
(2) Port (marked "RV").

3. Connect a 4000 kPa (580 psi) pressure gauge, with an extension hose, to the pressure tap in port (2).

NOTE: Port (2) can be accessed through the upper rear access hole in the left side of the frame.

4. Remove the drive axles and adapters from both sides of the machine. After the axles have been removed, replace the covers. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Towing Information, Preparation for Towing a Disabled Machine."

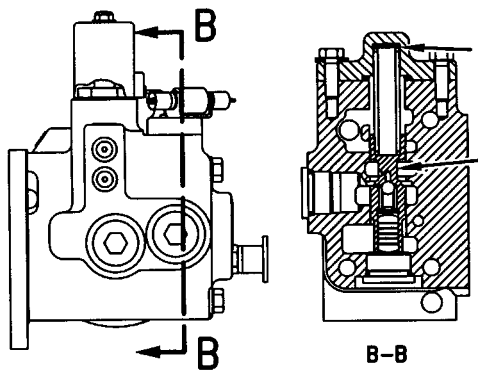
5. Start and run the engine at low idle with the transmission control in NEUTRAL.

6. Place the machine in SELF-DEPLOY.

7. The pressure on the gauge should read "zero."

8. Move the transmission control lever to SIXTH speed, and use the signal generator to slowly increase the transmission input signal to the EPTC II.

9. When the signal from the signal generator reaches the lockup speed in FIRST gear, the pressure on the gauge should be 1967 ± 104 kPa (285 ± 15 psi). When the signal reaches the THIRD gear shift point, the pressure in the gauge should return to zero. When the signal strength reaches the lockup speed in THIRD gear, the pressure on the gauge should be 1967 ± 104 kPa (285 ± 15 psi). When the signal strength passes through the shift points for FOURTH, FIFTH, and SIXTH speed, the pressure should momentarily drop and then return to 1967 ± 104 kPa (285 ± 15 psi).



Lockup Clutch and Solenoid Valve Group.
(3) Pressure reduction valve. (4) Shims.

Shim Chart Pressure Reduction Valve[1]		
Part Number Of Shims	Thickness	Change In Pressure
5J-2721	0.13 mm (.005 in)	9.6 kPa (1.4 psi)
6J-3993	0.25 mm (.010 in)	19.3 kPa (2.8 psi)
5J-1036	0.79 mm (.031 in)	59.8 kPa (8.7 psi)

[1] Before an adjustment is made, make sure that the valve spring is not weak or broken. Refer to "Specifications, Hydraulic Lockup Clutch Valve" in this module.

10. If an adjustment is necessary, stop the engine. If the pressure is too high, remove shims (4) from pressure reduction valve (3). If the pressure is too low, remove the shims from the pressure reduction valve. Recheck the pressure setting.

11. Stop the engine.

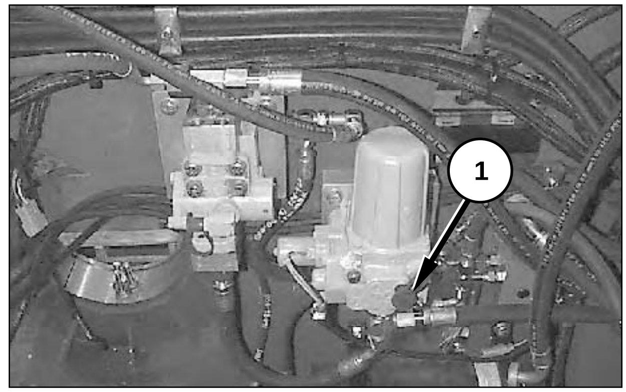
12. Remove the test equipment.

13. Install the drive axles and adapters on both sides of the machine.

Lockup Clutch Leakage

Tools Needed		
177-7861	Hose Assembly	1
6V-4143	Coupler	1

NOTE: This procedure requires that the machine be operated. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE)* for information about machine operation.



Lockup Clutch and Solenoid Valve Group.
(1) Pressure tap (for torque converter lockup clutch [port LU]).

1. Start the engine and operate the machine until the power train oil reaches normal operating temperature.

2. Install a line on pressure tap (1), which is installed in the port marked "LU." The line should have one end open to allow oil to flow out. Place the open end of the line in a suitable calibrated container (at least 18.9 liters [5 U.S. gal]) to collect the oil.

3. Start and run the engine at low idle, in NEUTRAL.

4. Measure the amount of oil that comes out of pressure tap (1) in one minute.

NOTE: Another acceptable method of measurement is to determine the amount of time required to collect 7.57 liters (2 U.S. gal). Divide 7.57 liters (2 U.S. gal) by the time required (in minutes), to calculate the liters (gallons) per minute.

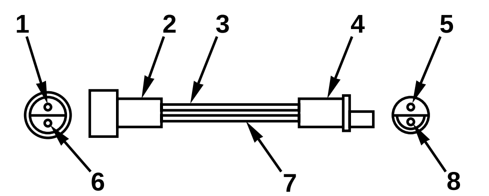
5. There should be less than 3.8 liters/min (1 gpm) of oil flowing from the port. If there is more than this amount, remove and disassemble the torque converter, and inspect the lockup clutch seals for damage.

6. Stop the engine and remove the test equipment.

7. Refill the hydraulic tank with clean hydraulic oil of the appropriate grade.

Lockup Clutch Maximum Pressure

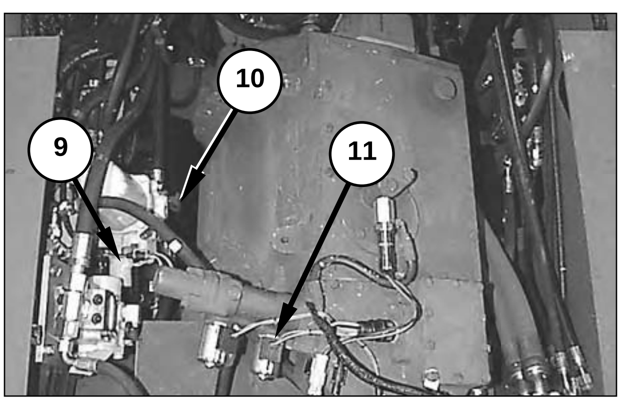
Tools Needed		
177-7861	Hose Assembly	1
3B-6552	90° Elbow	1
5P-4515	AWG 16 Wire (Pink)	6 m (260 in)
5P-5623	AWG 16 Wire (Black)	6 m (260 in)
6V-4143	Coupler	2
7N-7779	Socket	4
7N-7780	Pin	4
7N-9737	Plug (Sure-Seal)	2
7N-9738	Recepticle (Sure-Seal)	2
8T-0855	Pressure Gauge	1
8T-4188	Adapter	1



Fabricated Test Harness.
(1) 7N-7780 Pin. (2) 7N-9736 Receptacle. (3) 5P-4515 Wire. (4) 7N-9737 Plug. (5) 7N-7779 Socket. (6) 7N-7779 Socket. (7) 5P-5623 Wire. (8) 7N-7780 Pin.

NOTE: This procedure requires that the machine be operated. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE)* for information about machine operation.

1. Remove the winch bracket and winch assembly. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Hydraulic System,* "Winch Bracket With Winch Assembly."



Lockup Clutch and Solenoid Valve Group, Fuel Tank Removed. (9) Lockup solenoid. (10) Pressure tap (for torque converter lockup clutch [port LU]). (11) Downshift solenoid.

2. Disconnect lockup solenoid (9) and downshift solenoid (11) from their respective receptacles on the main harness.

3. Connect the plug end of one of the fabricated test harnesses to the main harness receptacle for downshift solenoid (11). Connect the receptacle end of the other fabricated test harness to the plug on lockup clutch solenoid (9).

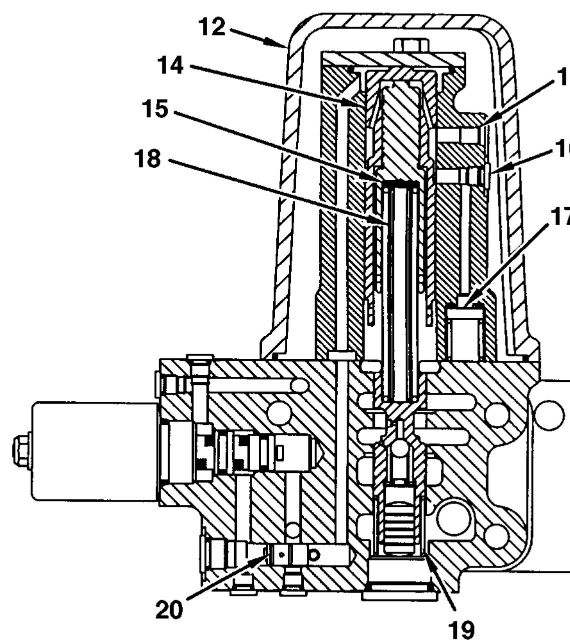
4. Connect a 4000 kPa (580 psi) pressure gauge, with extension hose, to pressure tap (10) on the lockup solenoid valve.

5. With the parking brakes engaged, start and operate the engine at low idle with the transmission control lever in NEUTRAL. The pressure on the gauge should be 0 kPa (0 psi).

6. Connect the loose ends of the fabricated harnesses together. The pressure on the gauge should be 1967 ± 104 kPa (285 ± 15 psi).

NOTE: When the engine is ON and the transmission is in NEUTRAL, the EPTC II transfers power to energize the downshift solenoid. With the fabricated harnesses connected together, the power from the EPTC II energizes the lockup solenoid.

7. Disconnect the two ends of the fabricated harnesses. The pressure on the gauge should go back to 0 kPa (0 psi).



Lockup Clutch and Solenoid Valve Group.
(12) Cover. (13) Selector piston plug. (14) Selector piston. (15) Shims. (16) Load piston plug. (17) Load piston orifice. (18) Spring. (19) Spring. (20) Shuttle valve.

Test Results Chart	
Lockup Clutch Maximum Pressure	
Condition	**Cause/Action**
• Pressure in Step 5 is not 0 kPa (0 psi)	• Selector piston (14) is stuck in the bore • Spring (18) is weak or broken • Lockup solenoid is leaking internally
• Pressure in Step 6 is 0 kPa (0 psi)	• Pilot pressure is low • Shuttle valve (20) is damaged • Spring (19) is weak or broken
• Pressure in Step 6 does not increase above 1967 ± 104 kPa (285 ± 15 psi)	• Load piston plug (16) is not installed • Load piston orifice (17) is plugged • Selector piston (14) is stuck in bore
• Pressure in Step 7 decreases slowly, or does not decrease to zero	• Shuttle valve (20) is damaged • Selector piston (14) is stuck in bore
• Pressure in Step 6 is too low (not zero) or too high	• Lockup clutch primary pressure incorrect

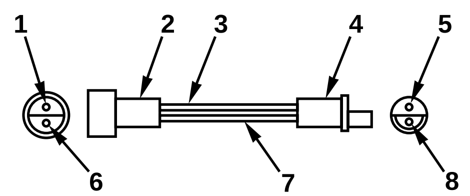
8. Stop the engine.

9. Remove the tooling.

10. Install the winch bracket and winch assembly.

Lockup Clutch Primary Pressure

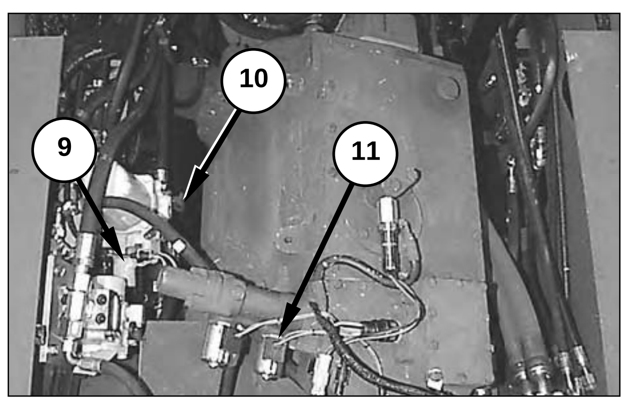
Tools Needed		
177-7861	Hose Assembly	1
3B-6552	90° Elbow	1
5P-4515	AWG 16 Wire (Pink)	6 m (260 in)
5P-5623	AWG 16 Wire (Black)	6 m (260 in)
6V-4143	Coupler	2
7N-7779	Socket	4
7N-7780	Pin	4
7N-9737	Plug (Sure-Seal)	2
7N-9738	Recepticle (Sure-Seal)	2
8T-0855	Pressure Gauge	1
8T-4188	Adapter	1



Fabricated Test Harness.
(1) 7N-7780 Pin. (2) 7N-9736 Receptacle. (3) 5P-4515 Wire. (4) 7N-9737 Plug. (5) 7N-7779 Socket. (6) 7N-7779 Socket. (7) 5P-5623 Wire. (8) 7N-7780 Pin.

NOTE: This procedure requires that the machine be operated. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE)* for information about machine operation.

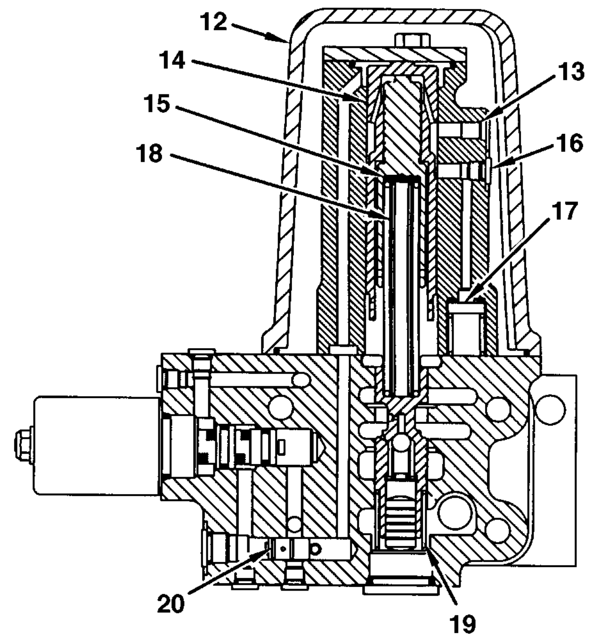
1. Remove the fuel tank to gain access to the top of the transmission. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Machine Systems,* "Fuel Tank."



Lockup Clutch and Solenoid Valve Group, Fuel Tank Removed. (9) Lockup solenoid. (10) Pressure tap (for torque converter lockup clutch [port LU]). (11) Downshift solenoid.

2. Disconnect lockup solenoid (9) and downshift solenoid (11) from their respective receptacles on the main harness.

3. Connect the plug end of one of the fabricated test harnesses to the main harness receptacle for downshift solenoid (11). Connect the receptacle end of the other fabricated test harness to the plug on lockup clutch solenoid (9).



Lockup Clutch and Solenoid Valve Group.
(12) Cover. (13) Selector piston plug. (14) Selector piston.
(15) Shims. (16) Load piston plug. (17) Load piston orifice.
(18) Spring. (19) Spring. (20) Shuttle valve.

4. Remove the four bolts and washers from cover (12), and remove the cover from the lockup clutch and solenoid valve group.

5. Remove load piston plug (16), and use the four bolts and washers to install cover (12).

NOTE: Tighten the four bolts to a torque of 30 ± 7 N•m (23 ± 5 lb ft).

6. Connect a 4000 kPa (580 psi) pressure gauge, with an extension hose, to pressure tap (10).

7. Reinstall the fuel tank.

8. Connect the loose ends of the fabricated harnesses together.

NOTE: When the engine is ON and the transmission is in NEUTRAL, the EPTC II transfers power to energize the downshift solenoid. With the fabricated harnesses connected together, the power from the EPTC II energizes the lockup solenoid.

9. With the parking brakes engaged, start and run the engine at low idle with the transmission control lever in NEUTRAL. The initial pressure on the gauge must be 585 ± 35 kPa (85 ± 5 psi).

10. Stop the engine.

Shim Chart Modulation Reduction Valve[1]		
Part Number for Shims	**Thickness**	**Change in Pressure**
8J-4452	0.12 mm (0.005 in)	18.5 kPa (2.7 psi)
2S-0675	0.40 mm (0.016 in)	59 kPa (8.6 psi)
9J-1330	0.79 mm (0.031 in)	114 kPa (16.6 psi)

[1] **Before an adjustment is made, make sure that the springs are not weak or broken.**

NOTE: If the pressure is 0 kPa (0 psi), check to be sure selector piston plug (13) is installed.

11. If the pressure is too low (but not zero), add shims (15). If the pressure is too high, remove shims (15). Refer to the “Shim Chart for Modulation Reduction Valve,” above.

NOTE: It may be necessary to add or remove shims and retest the pressure several times before the machine operates within specification. Each time shims are added or removed, the fuel tank must be removed and installed.

12. Remove the tooling, replace load piston plug (16) and reassemble the lockup clutch and solenoid valve group, reconnect lockup solenoid (9) and downshift solenoid (11) to their respective receptacles on the main harness.

TM5-2430-200-24

Specifications
Systems Operation
Testing & Adjusting

Deployable Universal Combat Earthmover (DEUCE)

Undercarriage, Steering and Brakes

PIN: 7RR00003-Up

Important Safety Information

Most accidents involving product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “WARNING” as shown below.

The meaning of this safety alert symbol is as follows:

WARNING

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning, explaining the hazard, can be either written or pictorially presented.

Operations that may cause product damage are identified by NOTICE labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are therefore not all inclusive. If a tool, procedure, work method or operating technique not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and others. You should also ensure that the product will not be damaged or made unsafe by the operation, lubrication, maintenance or repair procedures you choose.

The information, specifications, and illustrations in this publication are on the basis of information available at the time it was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service given to the product. Obtain the complete and most current information before starting any job. Caterpillar dealers have the most current information available. For a list of the most current publication form numbers available, see the Service Manual Contents Microfiche, REG1139F.

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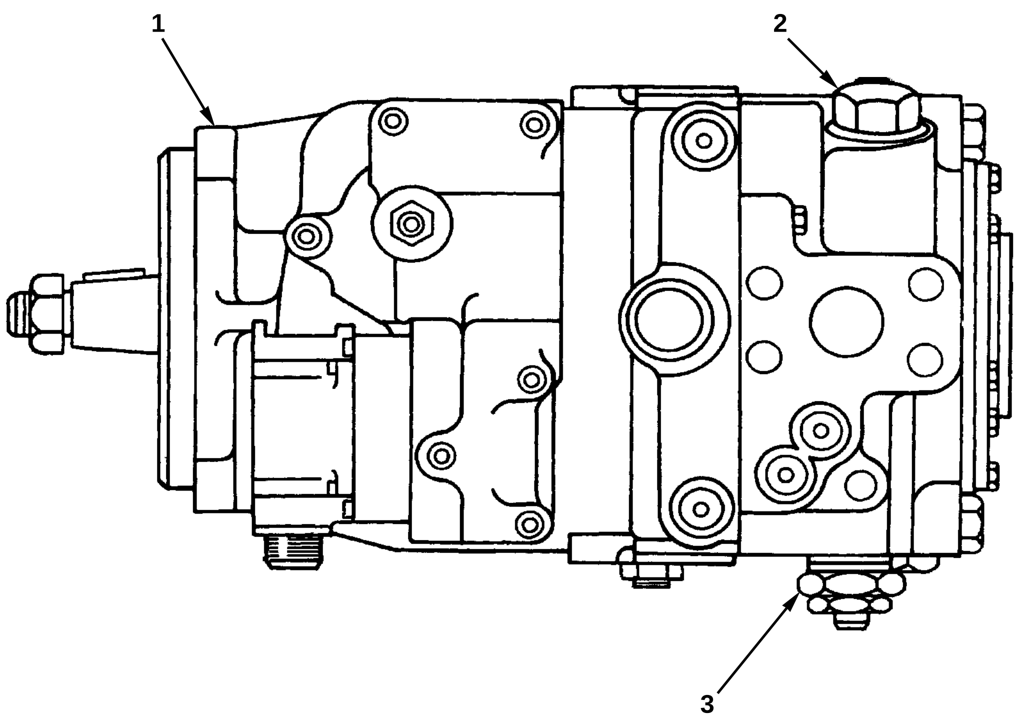
Specifications

Steering System

Pump Group



(1) Steering pump

Torque to rotate shaft, after assembly:
Minimum..7 N•m (5 lb ft)
Maximum......................................14 N•m (10 lb ft)

Rotation is counterclockwise when seen from drive end.

Type of pump: piston.

(2) Charge pressure relief valve pressure setting (above pump case pressure)......................2415 ± 345 kPa ....(350 ± 50 psi)

(3) Crossover relief valve pressure setting (above pressure limiter)..........................3450 kPa (500 psi)

Pressure limiter valve pressure setting (above pump case pressure plus charge relief pressure)............... ....41 340 ± 690 kPa (6000 ± 100 psi)

NOTE: The crossover relief valve pressure setting is not adjustable. The pressure limiter valve must be adjusted on the machine, or on a bench that simulates the machine steering hydraulic system.

NOTE: For test, use SAE 10W oil at 65°C (150°F).

Test at Full Speed

Output ....239 L/min (62 U.S. gpm)

At a pressure of..................................690 kPa (100 psi)
With engine at ....2016 rpm

Output ....233 L/min (61 U.S. gpm)

At a pressure of ....6900 kPa (1000 psi)
With engine at ....2016 rpm

Test at Half Speed

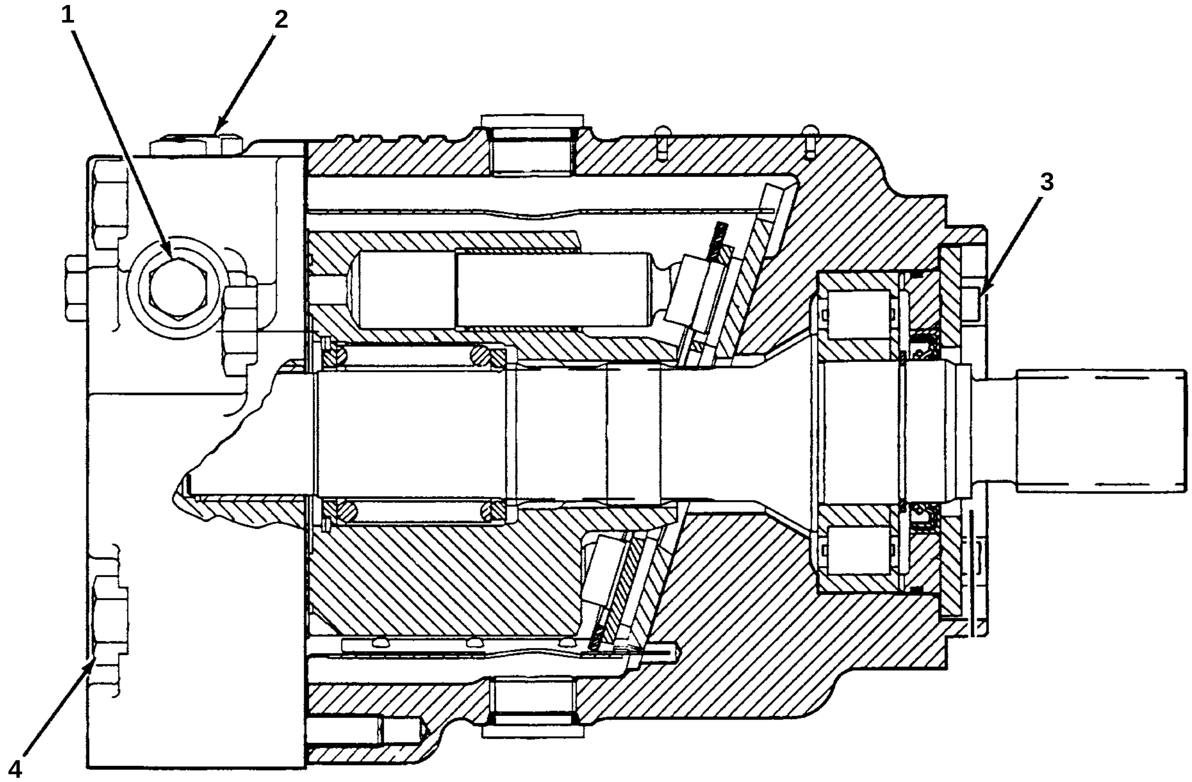
Output ....119.5 L/min (31 U.S. gpm)

At a pressure of..................................690 kPa (100 psi)
With engine at ....1008 rpm

Output ....116.5 L/min (30 U.S. gpm)

At a pressure of ....6900 kPa (1000 psi)
With engine at ....1008 rpm

Motor Group



Motor displacement.................75 cm^3/rev (4.75 in^3/rev)

Type of motor–Parallel axis piston, fixed displacement

(1) Tighten plugs to a torque of...........40 N•m (30 lb ft)

(2) Tighten locknut to a torque of........52 N•m (38 lb ft)

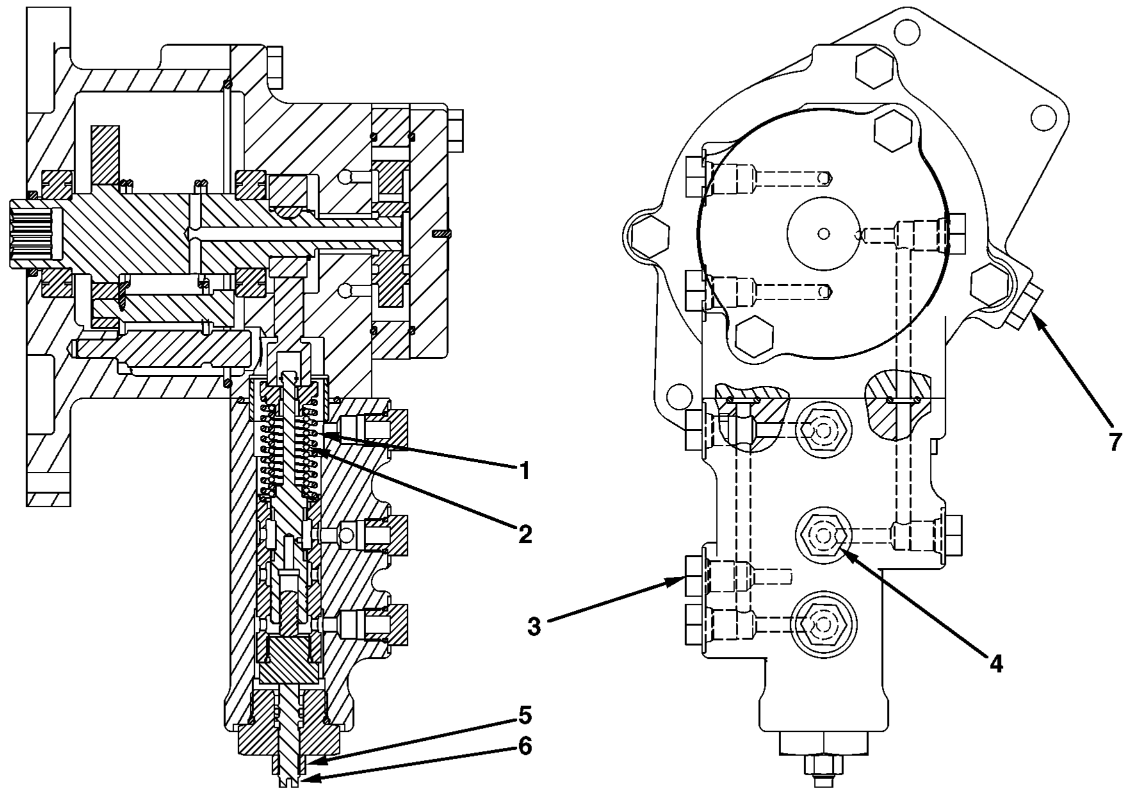
Cooling relief valve setting ....242 ± 69 kPa ....(35 ± 10 psi) less than charge pressure

(3) Tighten three retainer bolts to a torque of ....14 N•m (10 lb ft)

(4) Tighten seven cap bolts to a torque of:

17 mm type ....52 N•m (38 lb ft)
19 mm type ....95 N•m (70 lb ft)

Steering Control Valve Group



(1) 8N-9000 Spring:

Length under test force..............54.61 mm (1.44 in)
Test force......................44.5 ± 2.2 N (10.3 ± 1.0 lb)
Free length after test ....75.2 mm (2.96 in)
Outside diameter........................24.51 mm (0.96 in)

(2) 7B-3557 Spring:

Length under test force................33.3 mm (1.31 in)
Test force......................90.3 ± 7.1 N (20.3 ± 1.6 lb)
Free length after test ....41.4 mm (1.69 in)
Inside diameter...............................12.3 mm (0.5 in)

(3) Pressure supply port.

(4) Output pressure port.

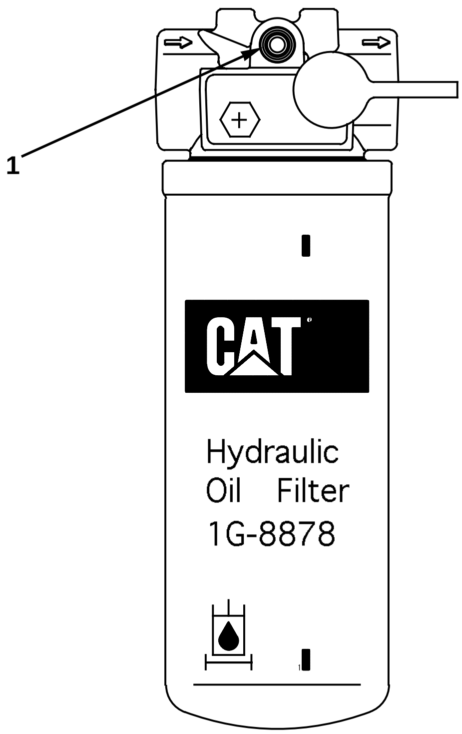
(5) Locknut.

(6) Adjustment screw:

Supply input pressure of 2500 ± 100 kPa (362 ± 14.5 psi) and flow of 10 ± 1 L/min (2.6 ± 0.24 gpm) to pressure supply port (3). Connect port (7) to tank pressure. Adjust screw (6) to achieve output pressure of 400 ± 20 kPa (58 ± 3 psi) at port (4).

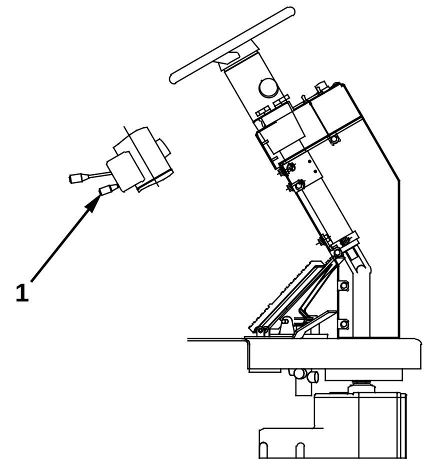
(7) Tank pressure port.

Charge Filter Group



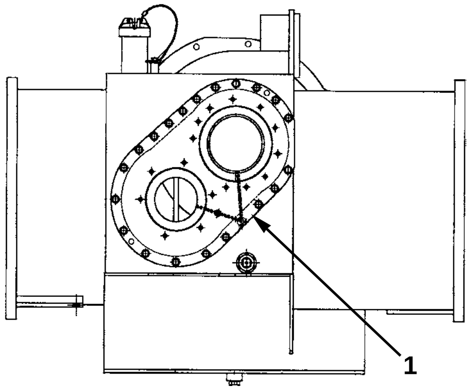
(1) Bypass valve pressure setting ....172 ± 12 kPa
....(25 ± 2 psi)

Steering Control Group



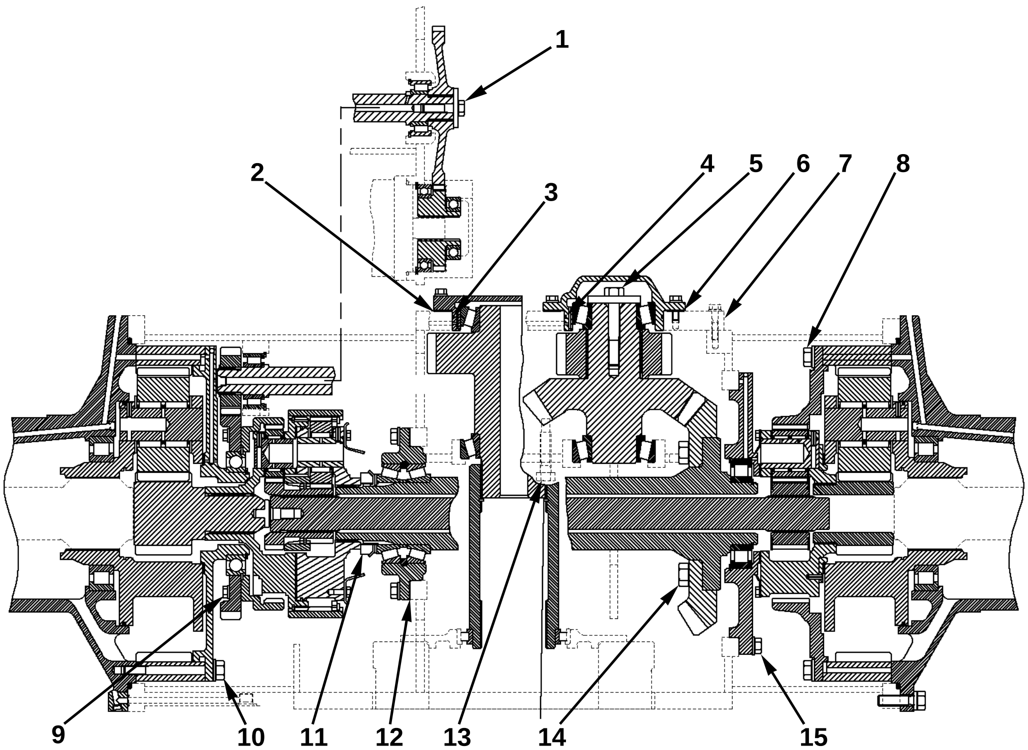
(1) Tighten lever to a torque of ....3.4 ± 0.6 N•m
....(30.3 ± 5 lb in)

Steering Case Group



(1) Apply 4C-9505 Gasket Sealant to cover, prior to assembly.

Differential Steering Unit



(1) Tighten bolt to a torque of................135 ± 20 N•m ....(99 ± 15 lb ft)

(2) 126-8178 Shim Pack (refer to the bearing adjustment procedure in *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Differential Steering Unit."):

Thickness of six shims.......0.30 mm (0.012 in) each
Thickness of six shims.......0.05 mm (0.002 in) each

(3) Coat bore lightly with lubricant that is to be sealed.

(4) Coat bore lightly with lubricant that is to be sealed.

(5) Tighten bolt to a torque of.................270 ± 40 N•m ....(199 ± 29 lb ft)

(6) 134-1343 Shim Pack (refer to the bearing adjustment procedure in *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Differential Steering Unit."):

Thickness of six shims ....0.05 mm (0.002 in)
Thickness of seven shims ....0.12 mm (0.005 in)
Thickness of one shim ....0.80 mm (0.031 in)

(7) Remove all grease and dirt from mating surfaces and apply 4C-5300 Liquid Gasket to cover prior to assembly.

(8) Tighten bolts to a torque of...............270 ± 40 N•m ....(199 ± 29 lb ft)

(9) Tighten bolts to a torque of.................55 ± 10 N•m ....(40 ± 7.4 lb ft)

(10) Tighten bolts to a torque of...............270 ± 40 N•m ....(199 ± 29 lb ft)

(11) Apply 4C-5598 Antiseize Compound to face and threads of nut.

Tighten to a torque of........................612 ± 68 N•m
....(451 ± 50 lb ft)

(12) 9P-1478 Shim Pack (refer to the bearing adjustment procedure in *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* “Differential Steering Unit,” and item [13], below):

Six shims.......................0.008 mm (0.0003 in) each
Six shims.......................0.021 mm (0.0008 in) each
Two shims.......................0.405 mm (0.016 in) each

(13) Install the bolt to a torque of 7 N•m (62 lb in) between gear teeth. Use shims (12), as required, to achieve a backlash value of 0.36 ± 0.12 mm (0.014 ± 0.005 in) after removing the end clearance in bearing assembly. Measure the backlash on three equally spaced teeth around the gear, and the average results to determine the backlash value.

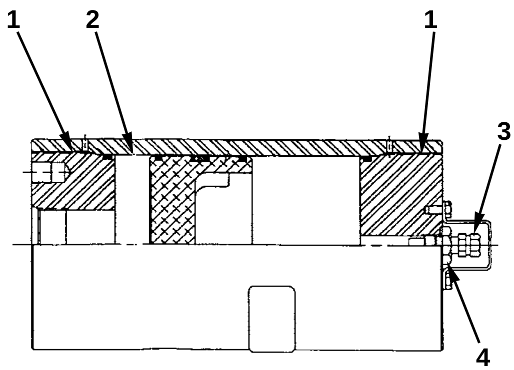
(14) Tighten bolts to a torque of ....475 ± 60 N•m
....(350 ± 44 lb in)

(15) Tighten bolts to a torque of ....135 ± 20 N•m
....(99 ± 15 lb ft)

Suspension and Undercarriage

Accumulators

Front Suspension Cylinder, Bottom Middle Cylinder Accumulator



(1) Tighten end cap until face of end cap is 1.6 ± 1.6 mm (0.0625 ± 0.0625 in) above face of accumulator housing.

(2) Bore of new cylinder...................102.36 ± 0.02 mm
....(4.030 ± 0.001 in)

Nominal oil capacity..................1.5 L (0.38 U.S. gal)

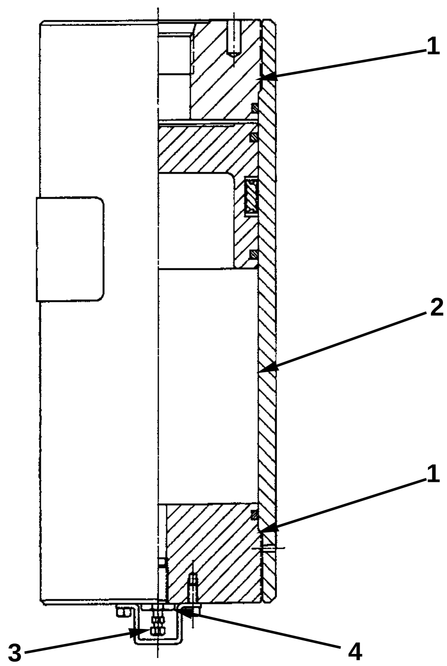
Nominal gas capacity ....1.6 L (0.43 U.S. gal)

Precharge pressure (dry nitrogen only):
Front bottom cylinder ....2756 kPa (400 psi)
Middle cylinder ....4483 kPa (650 psi)

(3) Tighten gas valve to a torque of ....1.4 ± 0.3 N•m
....(12.5 ± 2.5 lb in)

(4) Tighten nut to a torque of ....35 N•m (26 lb ft)

Front Cylinder Accumulator, Top



(1) Tighten end cap until face of end cap is 1.6 ± 1.6 mm (0.0625 ± 0.0625 in) above face of accumulator housing.

(2) Bore of new cylinder...................102.38 ± 0.02 mm ....(4.030 ± 0.001 in)

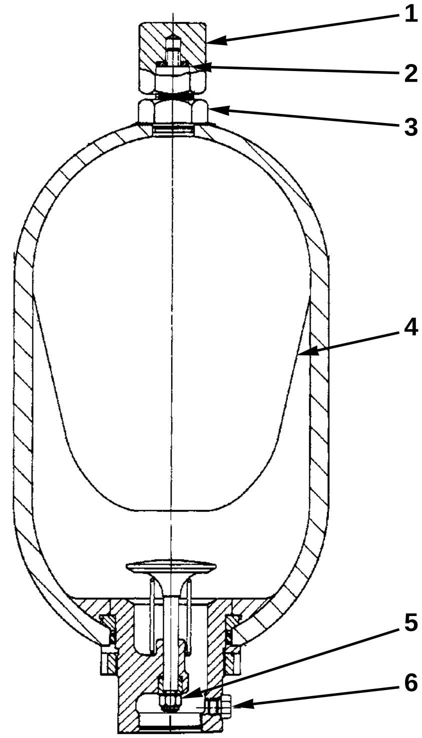
(3) Tighten gas valve to a torque of ....1.4 ± 0.3 N•m ....(12.5 ± 2.5 lb in)

Nominal gas capacity ....3788 mL (231 cu in)

Precharge pressure (dry nitrogen only)......2756 kPa ....(400 psi)

(4) Tighten nut to a torque of ....35 N•m (26 lb ft)

Recoil Cylinder Accumulator



(1) Tighten cap to a torque of ....19 N•m (14 lb ft)

(2) Tighten valve core to a torque of ....0.4 N•m ....(3.5 lb in)

(3) Tighten nut to a torque of ....76 N•m (56 lb ft)

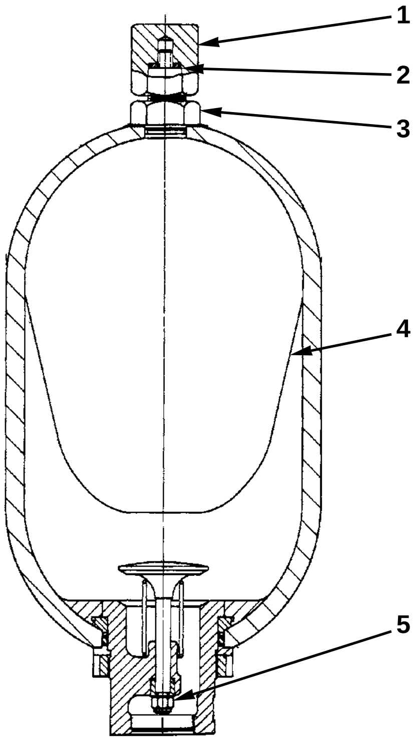
(4) Nominal gas capacity ....9500 mL (580 cu in)

Precharge pressure (dry nitrogen only)...11 730 kPa ....(1700 psi)

(5) Tighten locknut to a torque of....372 N•m (275 lb ft)

(6) Tighten bleed plug to a torque of ....13.6 N•m ....(10 lb ft).

Midroller Bogie Cylinder Accumulator



(1) Tighten cap to a torque of ....19 N•m (14 lb ft)

(2) Tighten valve core to a torque of ....0.4 N•m ....(3.5 lb in)

(3) Tighten nut to a torque of ....76 N•m (56 lb ft)

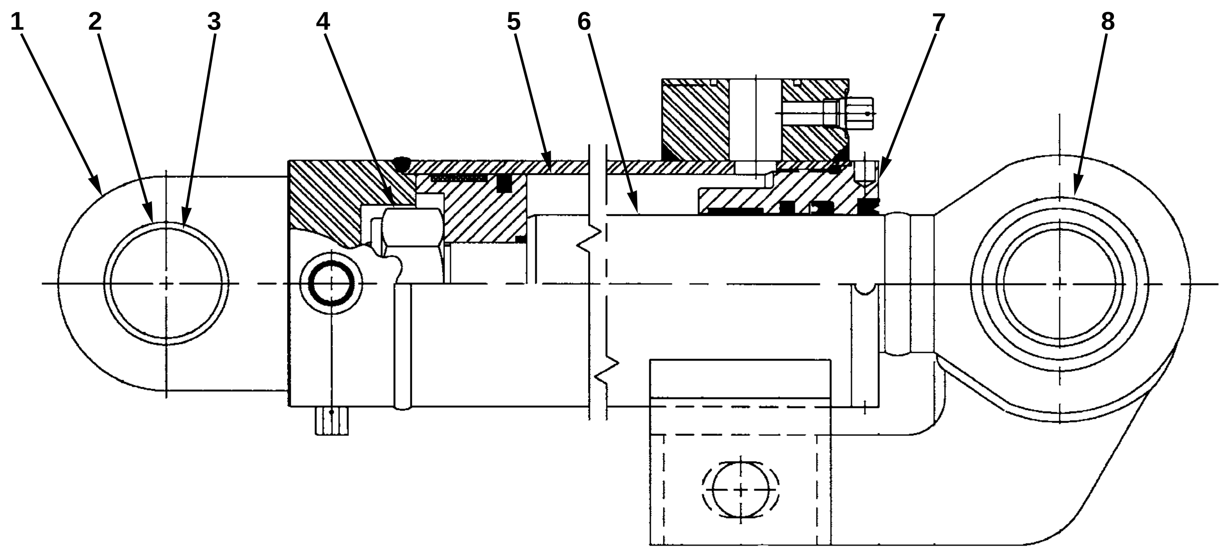
(4) Nominal gas capacity ....492 mL (30 cu in)

Precharge pressure (dry nitrogen only)......6890 kPa ....(1000 psi)

(5) Tighten locknut to a torque of....372 N•m (275 lb ft)

Hydraulic Cylinders

Front Suspension Cylinder



(1) Bore in head-end eye for bushing ..50.8 mm (2.0 in)

(2) 6S-3463 Bushing:

Outer diameter ....63.563 ± 0.013 mm
....(2.5025 ± 0.0005 in)
Inner diameter ....50.960 ± 0.020 mm
....(2.0063 ± 0.0008 in)

(3) Coat seal lightly with lubricant that is to be sealed.

(4) Tighten piston nut to a torque of ....456 N•m
....(335 lb ft)

(5) Diameter of bore in new cylinder..............101.6 mm
....(4.0 in)

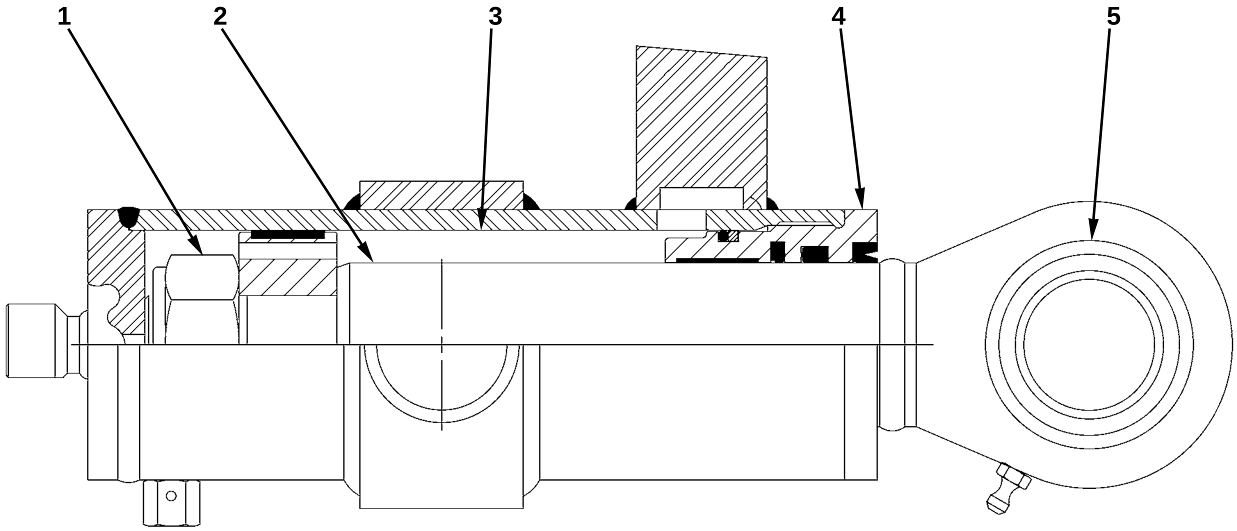
(6) Cylinder rod:

Outer diameter after plating..........63.5 mm (2.50 in)
Chrome plating thickness...........0.015 ± 0.003 mm
....(0.0006 ± 0.0001 in)

(7) Tighten end cap to a torque of ..408 N•m (300 lb ft)

(8) Bore of rod eye for bushing (spherical).....50.80 mm
....(2.000 in)

Minor Bogie Cylinder



(1) Tighten piston nut to a torque of ....388 N•m ....(285 lb ft)

(2) Cylinder rod:

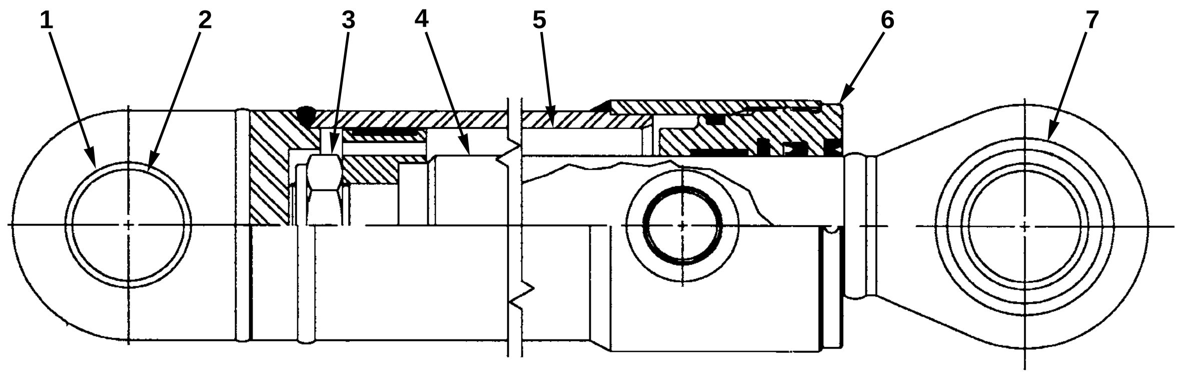
Outer diameter after plating........63.5 mm (2.500 in)
Chrome plating thickness.........0.0015 ± 0.003 mm ....(0.0006 ± 0.0001 in)

(3) Diameter of bore in new cylinder................88.9 mm ....(3.500 in)

(4) Tighten end cap to a torque of ..340 N•m (250 lb ft)

(5) Diameter of bore in rod eye for bushing.....50.8 mm ....(2.0 in)

Middle Suspension Cylinder



(1) 6S-3463 Bushing:

Outer diameter ....63.563 ± 0.013 mm
....(2.5025 ± 0.0005 in)
Inner diameter ....50.960 ± 0.020 mm
....(2.0063 ± 0.0008 in)

(2) Coat lightly with lubricant that is to be sealed.

(3) Tighten piston nut to a torque of ....386 N•m
....(285 lb ft)

(4) Piston rod:

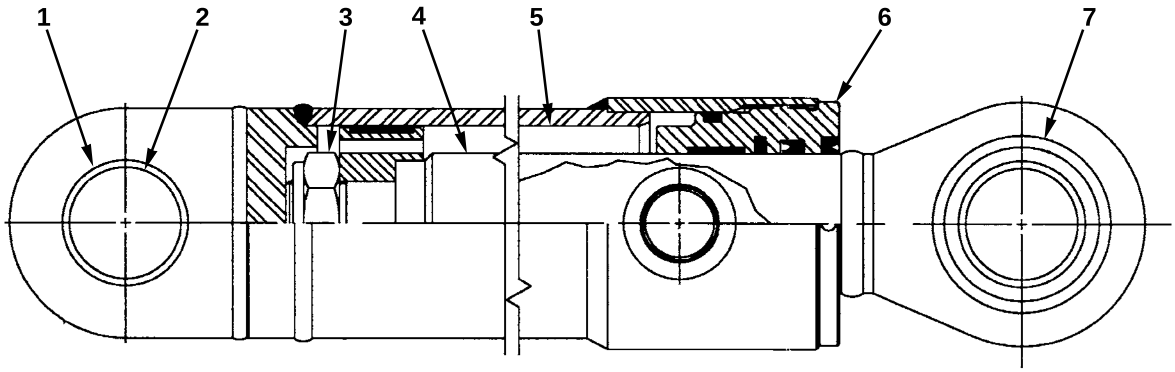
Outer diameter after plating....66.675 mm (2.628 in)
Chrome plating thickness.........0.0015 ± 0.003 mm
....(0.0006 ± 0.0001 in)

(5) Diameter of bore in new cylinder..............88.90 mm
....(3.500 in)

(6) Tighten end cap to a torque of ..340 N•m (250 lb ft)

(7) Diameter of bore in rod eye for bushing...50.80 mm
....(2.000 in)

Rear Suspension Cylinder



(1) 6S-3463 Bushing:

Outer diameter ....63.563 ± 0.013 mm
....(2.5025 ± 0.0005 in)
Inner diameter ....50.960 ± 0.020 mm
....(2.0063 ± 0.0008 in)

(2) Coat lightly with lubricant that is to be sealed.

(3) Tighten piston nut to a torque of ....386 N•m
....(285 lb ft)

(4) Piston rod:

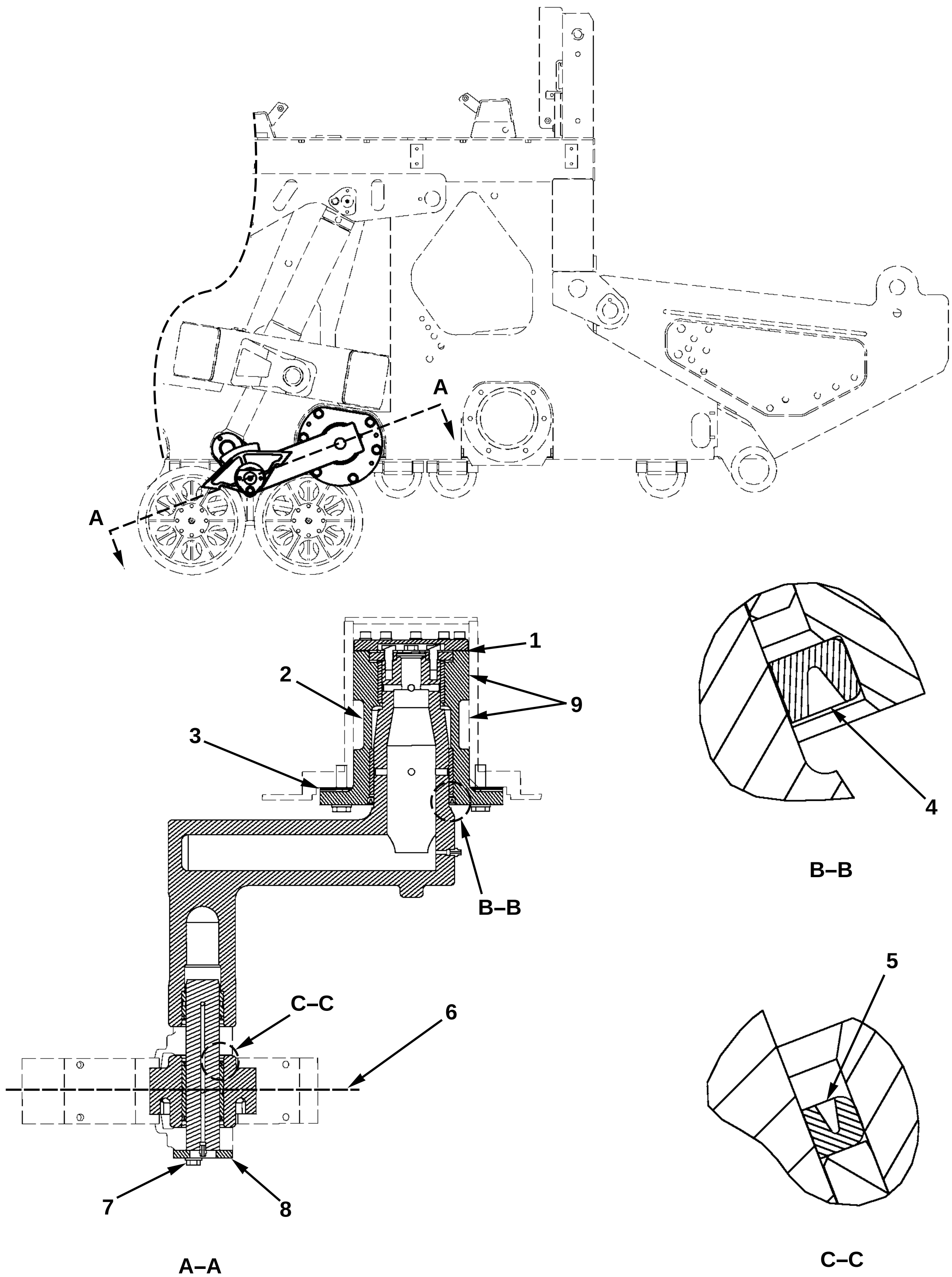
Outer diameter after plating....66.675 mm (2.628 in)
Chrome plating thickness.........0.0015 ± 0.003 mm
....(0.0006 ± 0.0001 in)

(5) Diameter of bore in new cylinder..............88.90 mm
....(3.500 in)

(6) Tighten end cap to a torque of ..340 N•m (250 lb ft)

(7) Diameter of bore in rod eye for bushing...50.80 mm
....(2.000 in)

Suspension Support Group



NOTE: The right hand suspension support group is shown, but the specifications given apply to both sides.

(1) Shims:

143-7932 ....0.06 mm (0.0024 in)
143-7933 ....0.10 mm (0.004 in)
143-7934 ....0.25 mm (0.010 in)

(2) Use shims (1) to adjust the rolling resistance of swing arm socket to ....
................................204 ± 68 N•m (150 ± 50 lb ft)

(3) Shims:

143-7045 ....3.0 mm (0.12 in)
143-7046 ....1.6 mm (0.06 in)
143-7047 ....0.8 mm (0.03 in)

(4) Coat sealing lips with lubricant that is to be sealed.

(5) Install seal with lips facing away from bearing.

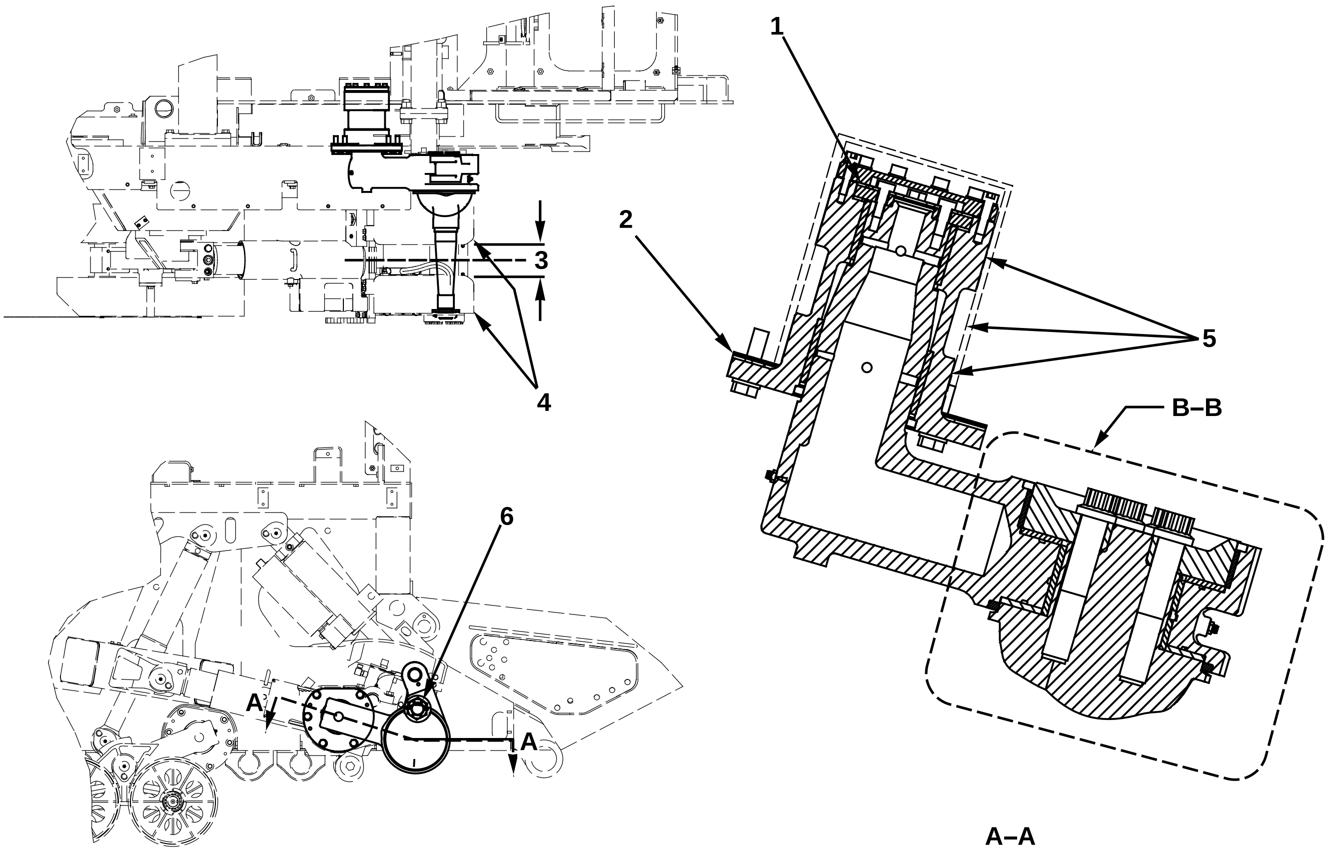
(6) Add or subtract shims (3) to align centerline of midroller assembly within 1.5 mm (0.06 in) of centerline of drive wheel.

(7) Apply 9S-3263 Sealant to threads, prior to assembly.

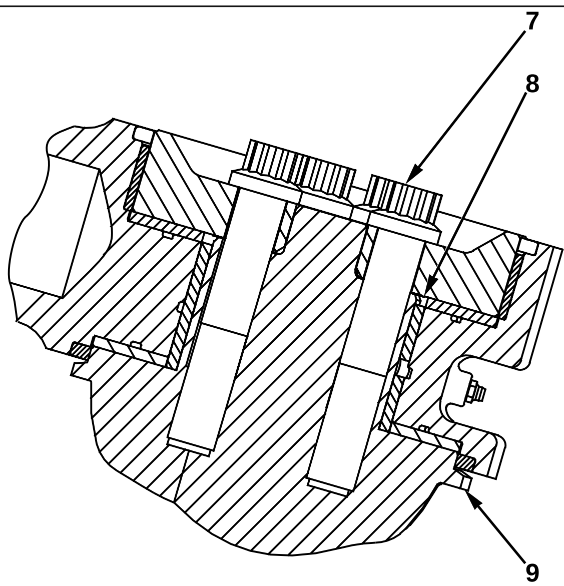
(8) Lubricate pin with oil, prior to installation.

(9) Apply 4C-5598 Antiseize Compound to socket and socket bore prior to installation.

Recoil Group



A–A



View B–B.

NOTE: The right hand recoil group is shown, but the specifications given apply to both sides.

(1) Shims:

143-7932 ....0.06 mm (0.0024 in)
143-7933 ....0.10 mm (0.004 in)
143-7934 ....0.25 mm (0.010 in)

(2) Shims:

143-7045 ....3.0 mm (0.12 in)
143-7046 ....1.6 mm (0.06 in)
143-7047 ....0.8 mm (0.03 in)

(3) Add or subtract shims (2) to align centerline of track guides (4), on belt tension group, within 1.5 mm (0.06 in) of centerline of drive wheel.

(4) Track guides (part of belt tension group).

(5) Apply 4C-5598 Antiseize Compound to socket and socket bore, prior to installation.

Using shims (1), adjust the socket rotation resistance to 204 ± 68 N•m (150 ± 50 lb ft).

(6) Tighten nut to a torque of..................136 ± 40 N•m ....(100 ± 30 lb ft)

Then, install wire.

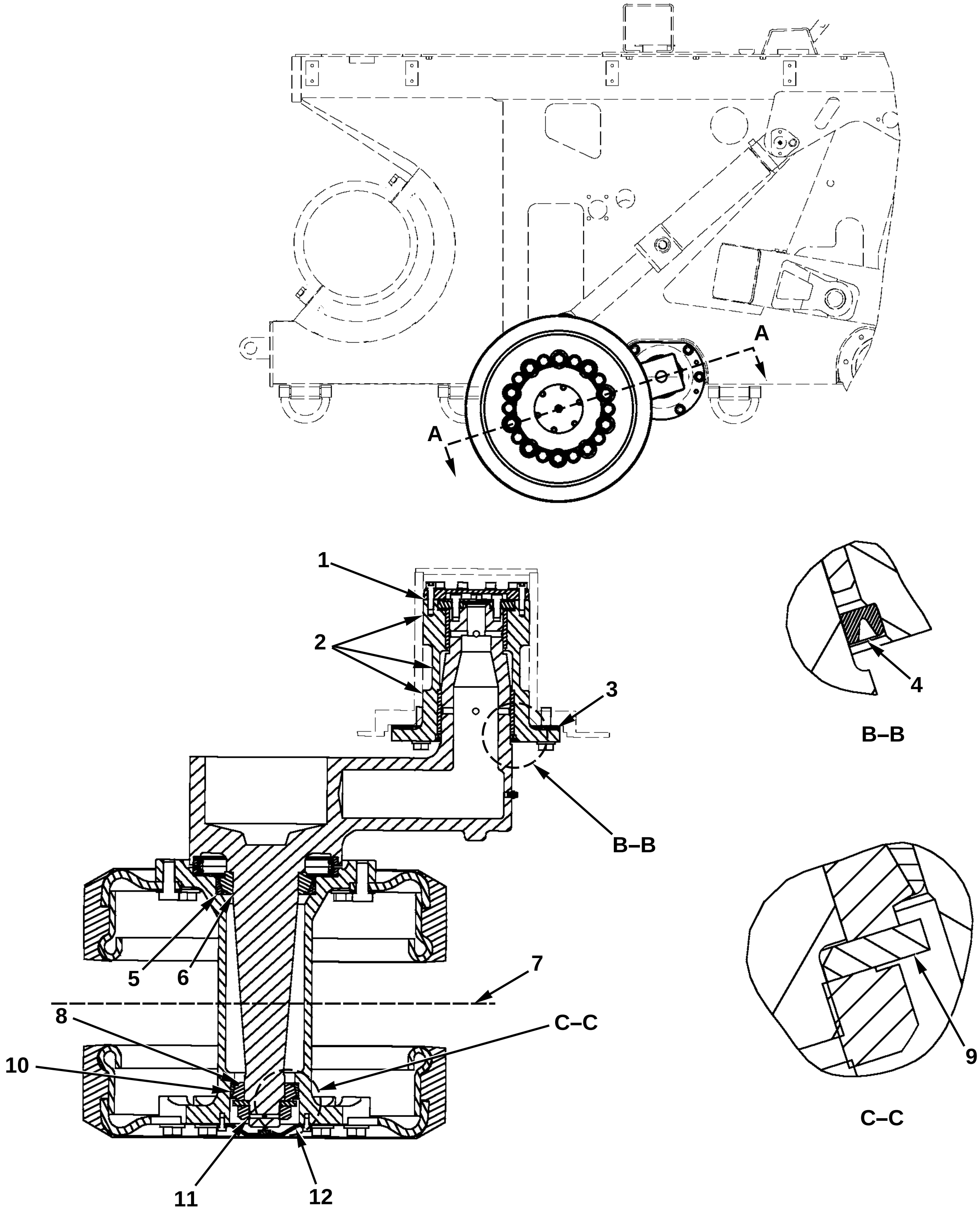
(7) Apply 9S-3263 Sealant to bolt threads and tighten to a torque of ....700 ± 90 N•m (516 ± 66 lb ft)

(8) Shims:

130-9164 ....0.25 mm (0.0035 in)
131-2803 ....0.10 mm (0.0014 in)
131-2804 ....0.05 mm (0.0007 in)

(9) Using shims (8), adjust pivot arm rotational resistance to ....204 ± 68 N•m (150 ± 50 lb ft)

Rear Idler Group



(1) Shims:

143-7932 ....0.06 mm (0.0024 in)
143-7933 ....0.10 mm (0.004 in)
143-7934 ....0.25 mm (0.010 in)

(2) Apply 4C-5598 Antiseize Compound to swing arm socket and socket bore, prior to installation.

Use shims (1) to adjust rolling resistance of swing arm socket to ....204 ± 68 N•m (150 ± 50 lb ft)

(3) Shims:

143-7045 .... 3.0 mm (0.12 in)
143-7046 .... 1.6 mm (0.06 in)
143-7047 .... 0.8 mm (0.03 in)

(4) Coat sealing lips with lubricant that is to be sealed.

(5) Lubricate bearing cup with oil prior to installation.

(6) Lubricate bearing cone with oil prior to installation.

(7) Add or subtract shims (3) to align centerline of midroller assembly within ± 1.5 mm (0.06 in) of centerline of drive wheel.

(8) Lubricate bearing cup with oil prior to installation.

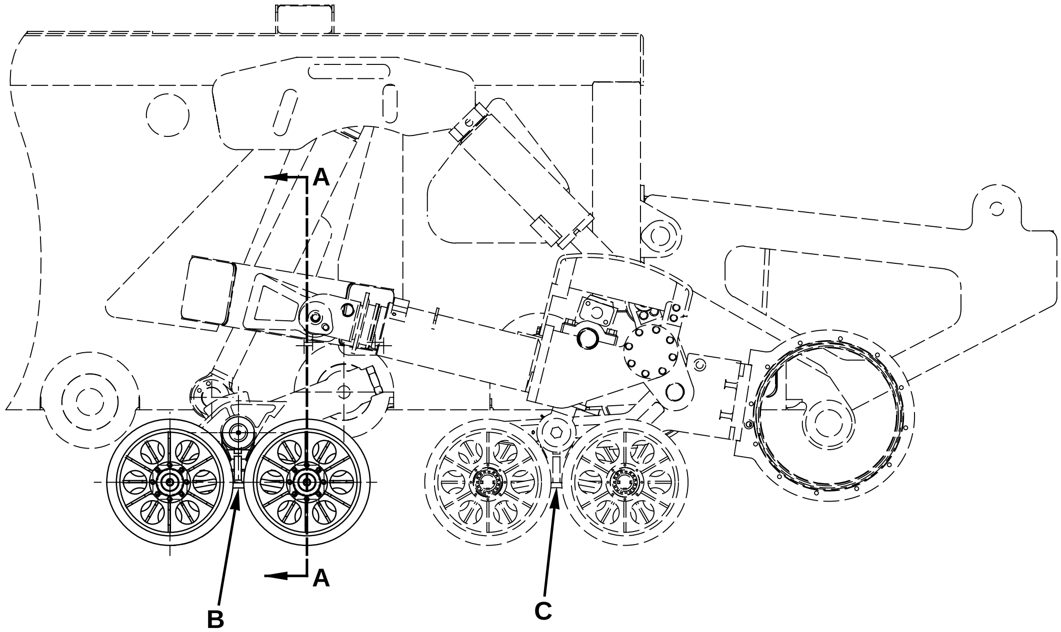
(9) Install thrust plate with chamfer facing towards bearing.

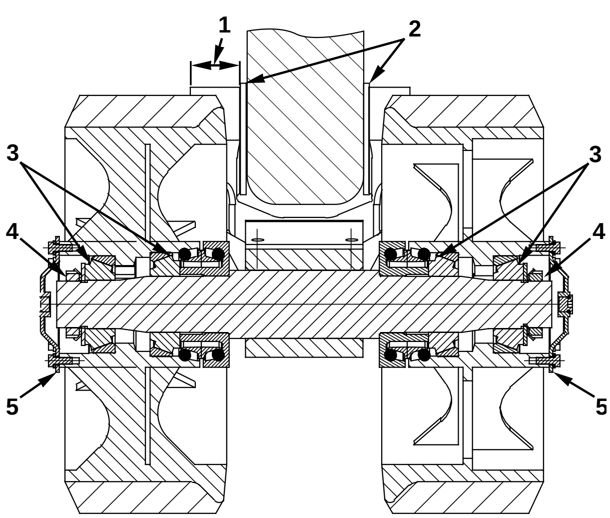
(10) Lubricate bearing cone with oil prior to installation.

(11) Tighten nut to achieve a bearing preload of .... 0.105 ± 0.025 mm (0.0041 ± 0.001 in)

(12) Apply V-5765 Sealant to end of hub to form seal between hub and cover.

Middle Roller Group





View A–A.

(1) Thick flange of minor bogie clevis:

To be located towards main tractor frame when installing front minor bogie group (C).

To be located away from main tractor frame when installing rear minor bogie group (B).

(2) Shim as required to minimize gap:

131-2805 Shim thickness ....0.1 mm (0.004 in)
130-9165 Shim thickness ....0.25 mm (0.001 in)
131-2806 Shim thickness ....0.05 mm (0.0002 in)

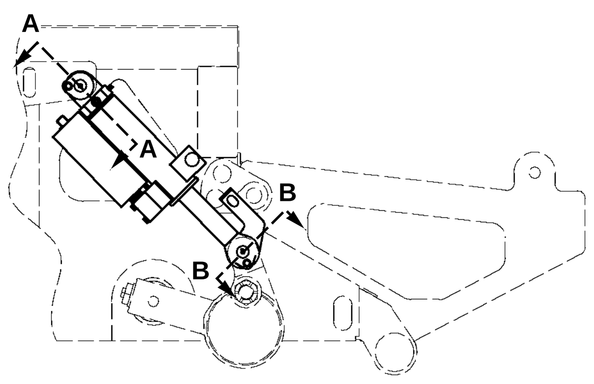
(3) Coat bearing lightly with oil that is to be sealed.

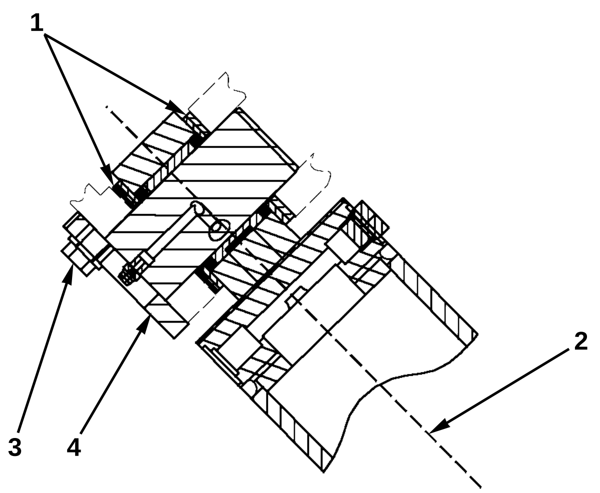
(4) Make sure that outer bearing cones slide easily on axle, and nut rotates freely on axle threads.

Tighten nut (4) to a torque of 34 ± 7 N•m (25 ± 5 lb ft) while rotating the midroller assembly. Bend lock washer tab into any locking slot on nut (4). If no tabs line up with any slots, tighten nut until closest tab and slot align, then bend tab into slot.

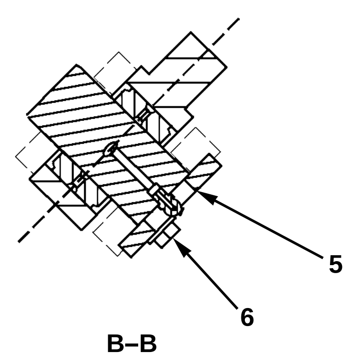
(5) Apply 6V-5765 Sealant in continuous bead between hub and cover.

Front Cylinder Mounting Group





Section A-A.



Section B–B.

(1) Shims:

144-8001 .... 3 mm (0.12 in)
144-8002 .... 1.6 mm (0.06 in)
144-8003 .... 0.8 mm (0.03 in)

(2) Use shims (1) to align upper mounting lug within ±1.5 mm (0.06 in) of lower mounting lug.

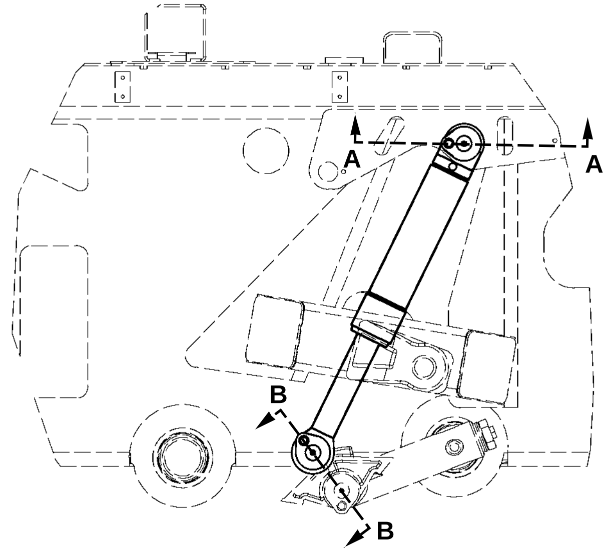
(3) Apply 9S-3263 Sealant to threads prior to assembly.

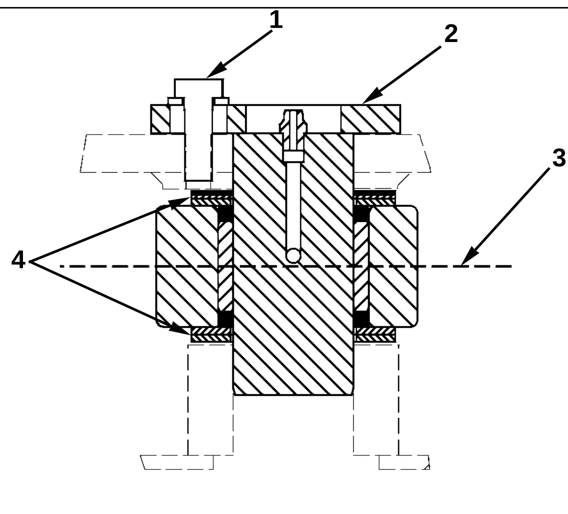
(4) Apply lubricant to pins with grease prior to installation.

(5) Lubricate pins with grease prior to installation.

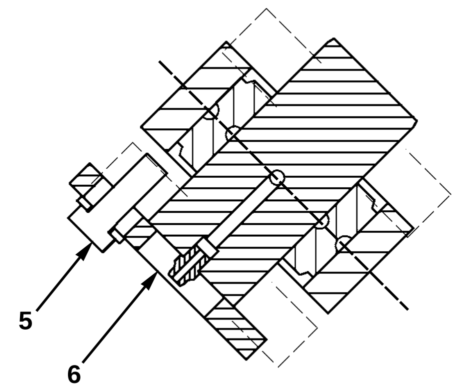
(6) Apply 9S-3263 Sealant to threads prior to assembly.

Middle Cylinder Mounting Group





Section A–A.



Section B–B.

(1) Apply 9S-3263 Sealant to threads prior to assembly, and tighten bolt to a torque of...120 ± 20 N•m (88 ± 15 lb ft)

(2) Lubricate pins with grease prior to installation.

(3) Use shims (3) to align upper mounting lug within ±1.5 mm (0.06 in) of lower mounting lug.

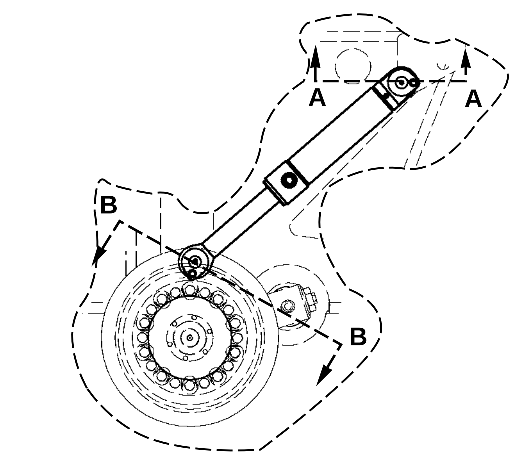
(4) Shims:

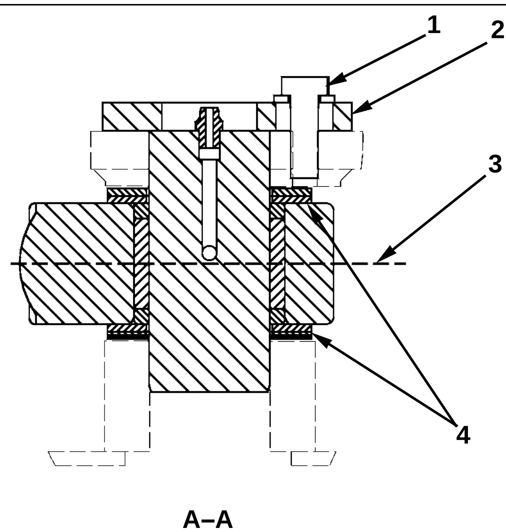
144-8001 ....3 mm (0.12 in)
144-8002 ....1.6 mm (0.06 in)
144-8003 ....0.8 mm (0.03 in)

(5) Apply 9S-3263 Sealant to threads prior to assembly, and tighten bolt to a torque of...120 ± 20 N•m (88 ± 15 lb ft)

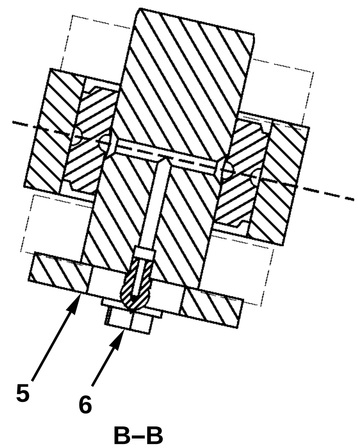
(6) Lubricate pins with grease prior to installation.

Rear Cylinder Mounting Group





Section A–A.



Section B–B.

(1) Apply 9S-3263 Sealant to threads prior to assembly, and tighten bolt to a torque of................. ....120 ± 20 N•m (88 ± 15 lb ft)

(2) Lubricate pins with grease prior to installation.

(3) Use shims (3) to align upper mounting lug within ±1.5 mm (0.06 in) of lower mounting lug.

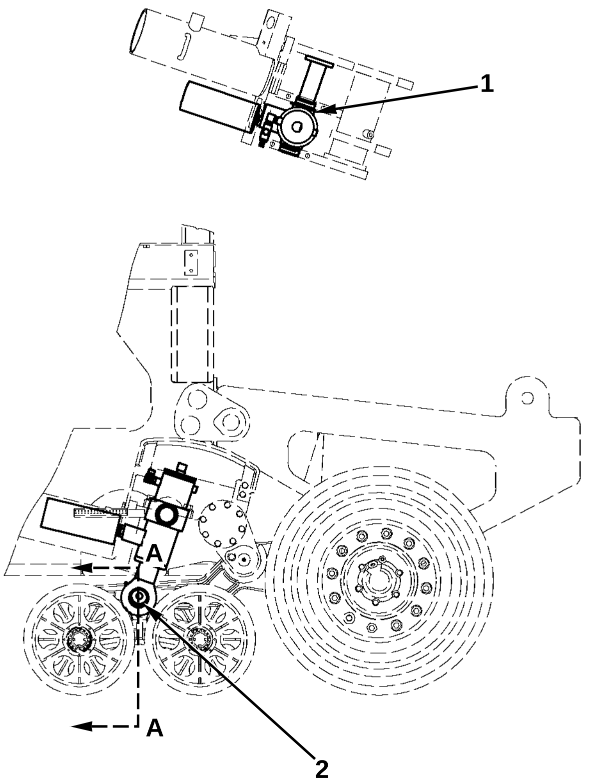
(4) Shims:

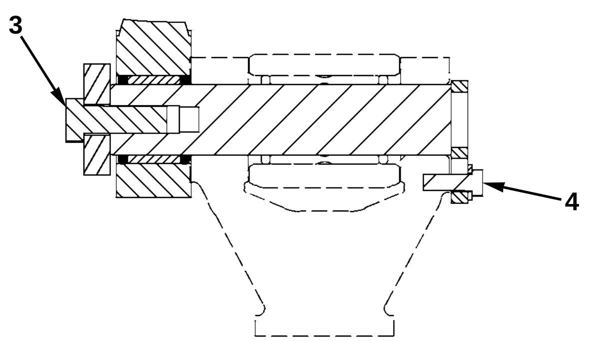
144-8001 ....3 mm (0.12 in)
144-8002 ....1.6 mm (0.06 in)
144-8003 ....0.8 mm (0.03 in)

(5) Lubricate pins with grease prior to installation.

(6) Apply 9S-3263 Sealant to threads prior to assembly, and tighten bolt to a torque of................. ....120 ± 20 N•m (88 ± 15 lb ft)

Midroller Bogie Cylinder Mounting Group





(1) Add or subtract shims to remove any gap between cylinder.

Shims:

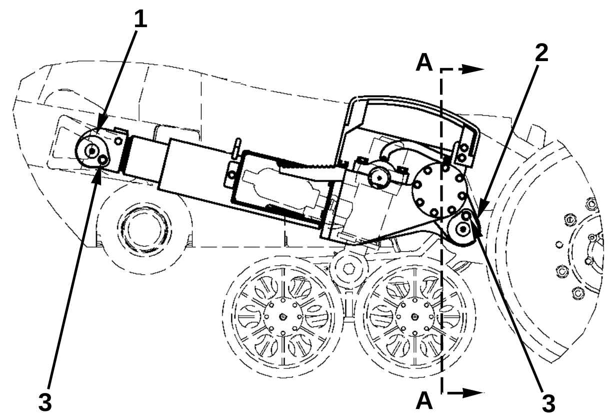
117-7777 .... 1.9 mm (0.07 in)
117-7778 .... 1.2 mm (0.05 in)
121-3033 .... 0.6 mm (0.02 in)

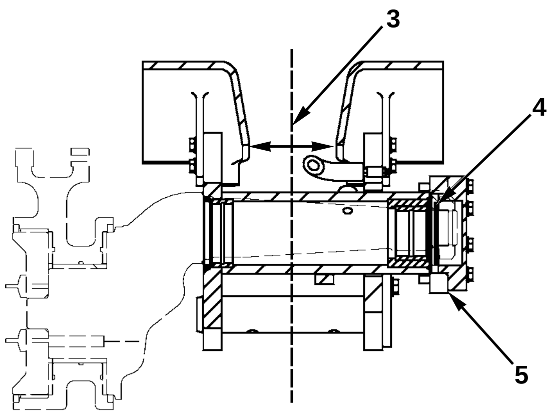
(2) Lubricate pin with grease prior to installation.

(3) Apply 9S-3263 Sealant to threads prior to assembly, and tighten bolt to a torque of................. ....570 ± 80 N•m (420 ± 59 lb ft)

(4) Apply 9S-3263 Sealant to threads prior to assembly, and tighten bolt to a torque of................. ....300 ± 40 N•m (222 ± 30 lb ft)

Belt Tension Group





A–A

Section A–A.

(1) Lubricate pins with grease prior to installation.

(2) Lubricate pins with grease prior to installation.

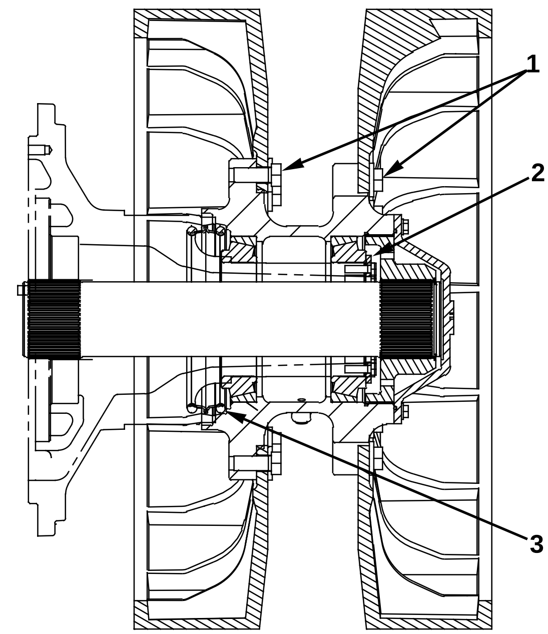
(3) Apply 9S-3263 Sealant to threads prior to assembly, and tighten to a torque of..300 ± 40 N•m (222 ± 30 lb ft)

(4) Add or subtract shims (4) as necessary to achieve an end play of..............0.0 ± 0.4 mm (0 ± 0.005 in)

Shims:
144-8001 ....3 mm (0.12 in)
144-8002 ....1.6 mm (0.06 in)
144-8003 ....0.8 mm (0.03 in)

(5) Apply 4C-9613 Sealant in continuous bead between mating parts.

Wheel Mounting Group



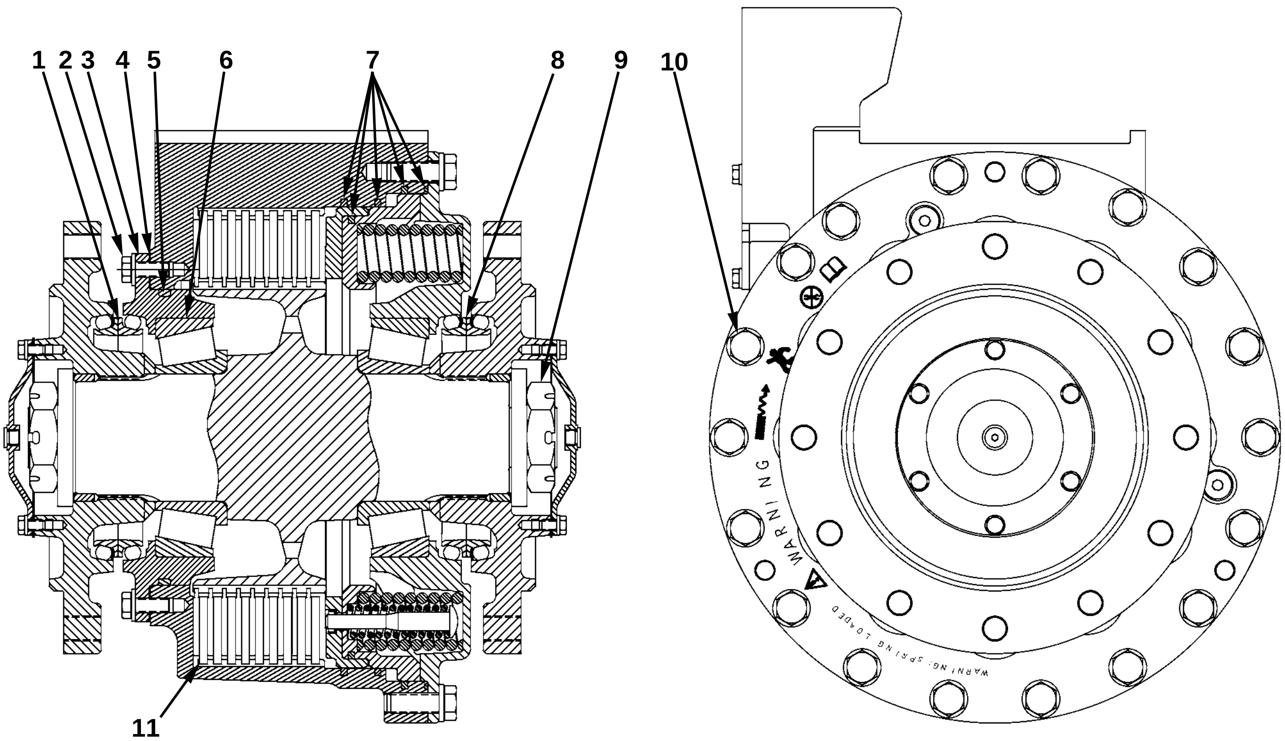
(1) Apply 154-9731 Thread Compound to threads, and tighten 24 bolts to a torque of...530 ± 70 N•m (391 ± 52 lb ft)

(2) 125-0990 Shim Pack. Add or subtract shims to achieve bearing preload of .....0.0254 mm (0.001 in)

(3) The rubber toric rings and all surfaces contacting them must be clean and dry at assembly. Apply a thin film of oil to the contacting surfaces of the metal seal rings just prior to assembly. The seal rings must be assembled square with the bore and toric, and must not bulge or twist. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Duo-Cone Seals."

Brake System

Brake Group



(1) The rubber toric rings and all surfaces contacting them must be clean and dry at assembly. Apply a thin film of oil to the contacting surfaces of the metal seal rings just prior to assembly. The seal rings must be assembled square with the bore and toric, and must not bulge or twist. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Duo-Cone Seals."

(2) Bolts.

(3) Bearing cage.

(4) Shims:

142-6123.................................0.076 mm (0.003 in)
142-6124.................................0.127 mm (0.005 in)
142-6125.................................0.178 mm (0.007 in)

(5) Coat seal with oil that is to be sealed.

(6) Bearing preload .0.10 ± 0.05 mm (0.004 ± 0.002 in)

(7) Coat seals with oil that is to be sealed.

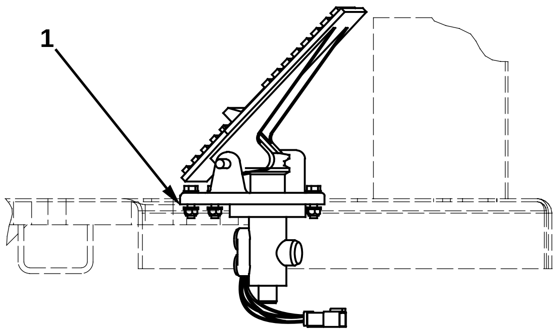
(8) The rubber toric rings and all surfaces contacting them must be clean and dry at assembly. Apply a thin film of oil to the contacting surfaces of the metal seal rings just prior to assembly. The seal rings must be assembled square with the bore and toric, and must not bulge or twist. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Duo-Cone Seals."

(9) After shim thickness has been determined, tighten nut to a torque of 740 ± 10 N•m (548 ± 7 lb ft), and install wire. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Brake Group."

(10) Tighten each of 18 cover bolts, one turn at a time, to draw cover down evenly. After cover is tight against brake housing, tighten bolts to standard torque value, in a criss-cross pattern.

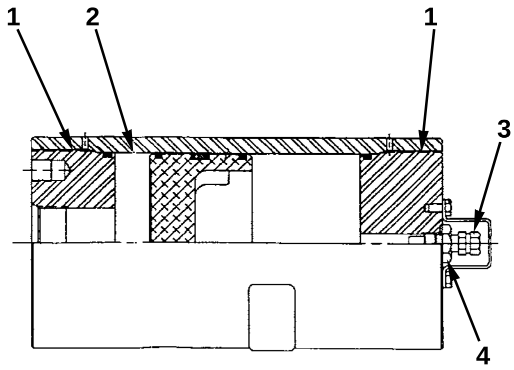
(11) Minimum plate and disk thickness ....
............................4.33 ± 0.08 mm (0.17 ± 0.003 in)

Pedal Group



(1) Apply 4C-9613 Sealant in continuous bead between mating parts.

Accumulator



(1) Tighten end cap until face of end cap is 1.6 ± 1.6 mm (0.0625 ± 0.0625 in) above face of accumulator housing.

(2) Bore of new cylinder.................102.36 ± 0.025 mm ....(4.030 ± 0.001 in)

Nominal oil capacity........................1.9 L (116 cu in)

Nominal gas capacity ....2.1 L (126 cu in)

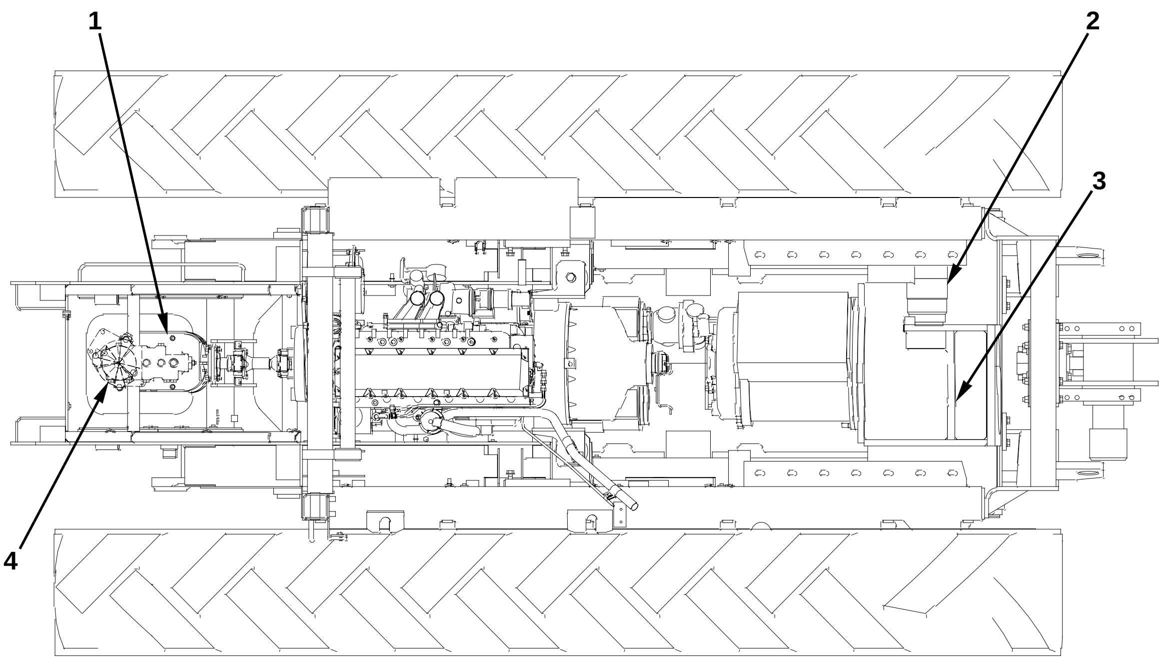
Precharge pressure (dry nitrogen only)......5855 kPa ....(850 psi)

(3) Tighten charging valve to a torque of...........35 N•m ....(26 lb ft)

(4) Tighten cap to a torque of.................1.4 ± 0.3 N•m ....(12.5 ± 2.5 lb in)

Systems Operation

Steering System



Steering System Major Components.
(1) Steering pump. (2) Steering motor. (3) Differential steering unit. (4) Steering control valve.

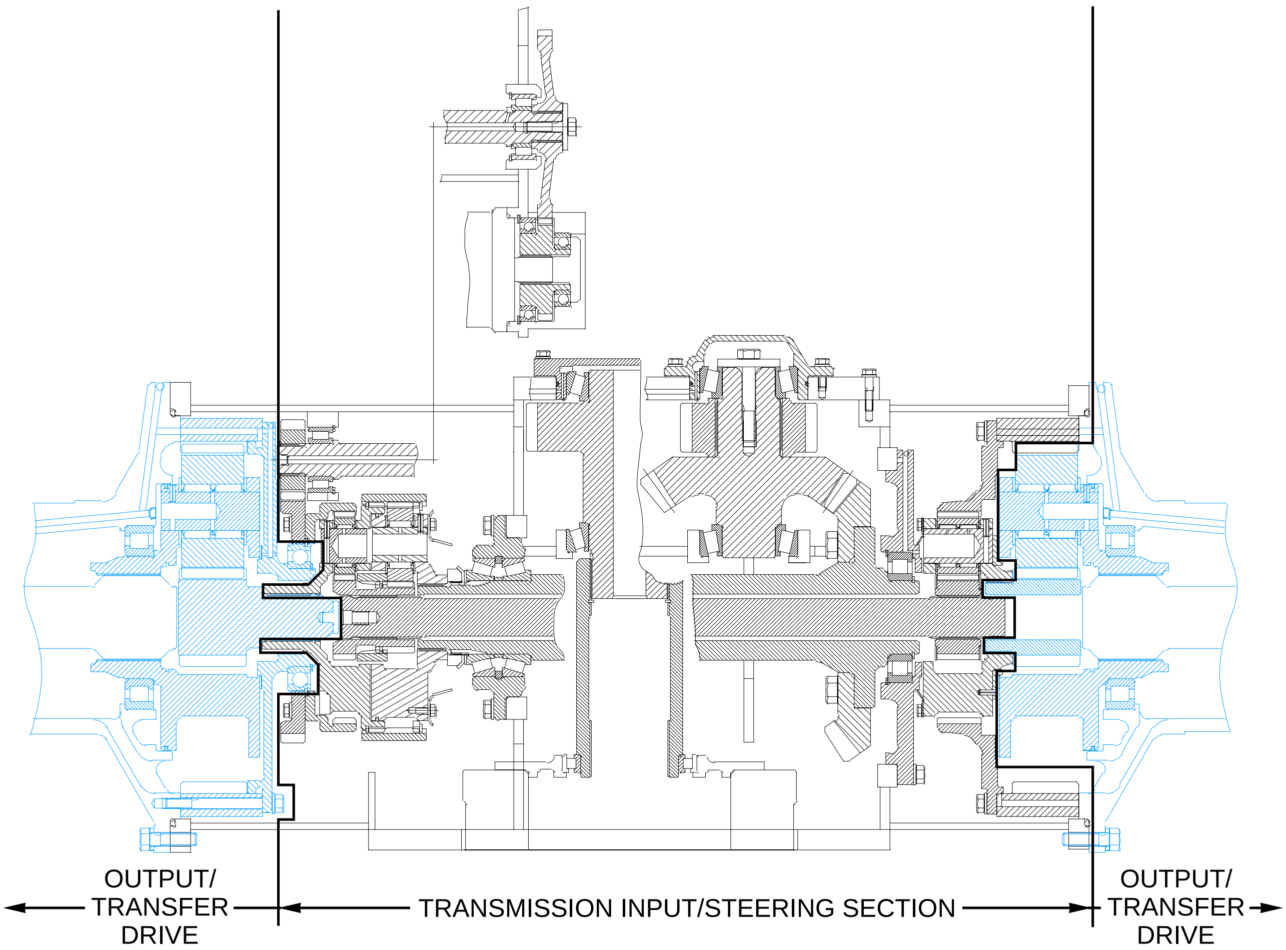
The machine is steered by means of a hydraulic pump and motor. Oil flow from steering pump (1) turns steering motor (2), which turns a ring gear in a set of planetary gears, inside differential steering unit (3). The machine turns right or left, depending on the rotational direction of the steering motor. The machine travels straight when the steering motor is not turning.

The major components of the steering system are: steering pump (1), steering motor (2), differential steering unit (3), and steering control valve (4).

Steering pump (1) and steering control valve (4) are located beneath the cab. The steering pump is mounted to the machine frame. The steering control valve is mounted to the bottom of the cab floor.

Steering motor (2) and differential steering unit (3) are located at the rear of the machine, beneath the fuel tank. The steering motor is mounted to the top of the differential steering unit. The differential steering unit is mounted to the machine frame.

Differential Steering Unit



Section View of Differential Steering Unit Showing Functional Sections.

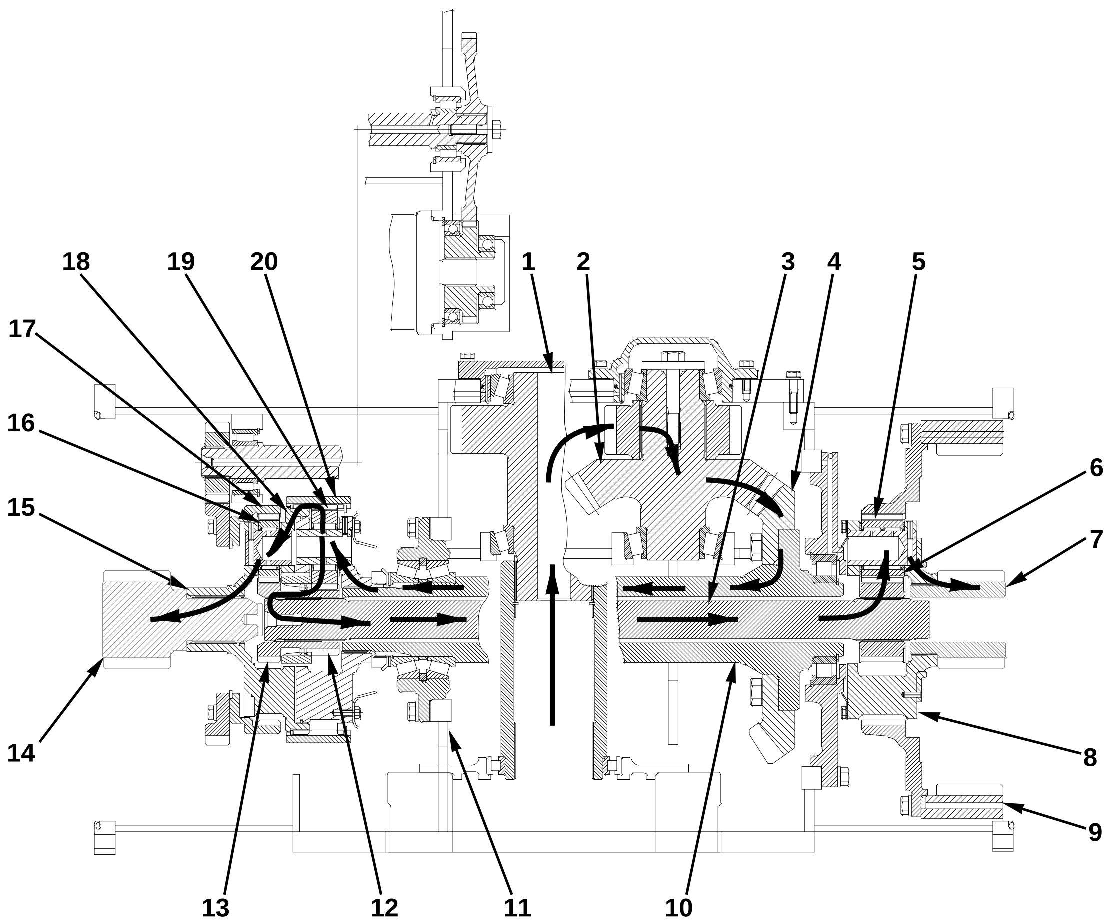
The differential steering unit has three functional sections. The center of the unit is the transmission input/steering section. The left and right sides are the output/transfer drive sections.

The transmission input/steering section receives input from the transmission and the steering motor. The input from the transmission provides the power to propel the machine. The input from the steering motor determines whether the machine will move straight or turn right or left.

NOTE: The word “power” in the following power flow explanations can be defined in terms of torque and speed. The input torque from the transmission and steering motor is followed through the steering system to the final drives.

Transmission Input/Steering Operation

Transmission Power Flow



Transmission Input/Steering Section, Power Flow During Straight Line Operation (Forward, No Steering).
(1) Transmission input gear. (2) Pinion. (3) Center axle shaft. (4) Bevel gear. (5) Planetary equalizing gears. (6) Sun gear. (7) Right output sun gear. (8) Carrier. (9) Ring gear. (10) Bevel gear shaft. (11) Support. (12) Sun gear. (13) Sun gear. (14) Left output sun gear. (15) Carrier. (16) Planetary steering gears. (17) Ring gear. (18) Carrier. (19) Planetary drive gears. (20) Ring gear.

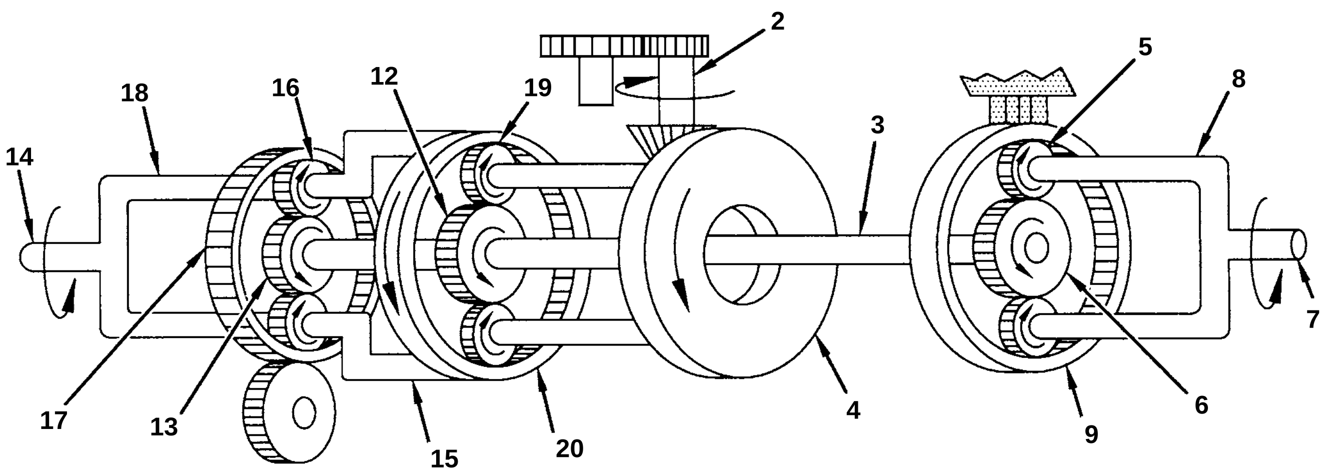
Power from the transmission flows through transmission input gear (1) to pinion (2) and bevel gear (4).

Bevel gear (4) sends the power through bevel gear shaft (10) to carrier (18). Power through the carrier flows in two directions. Half of the power (lower speed, higher torque) flows through planetary drive gears (19) to ring gear (20). The other half of the power (higher speed, lower torque) flows through the planetary drive gears to sun gear (12).

Ring gear (20) sends the power through carrier (15) to left output sun gear (14). Sun gear (12) sends the power through center axle shaft (3) to sun gear (6).

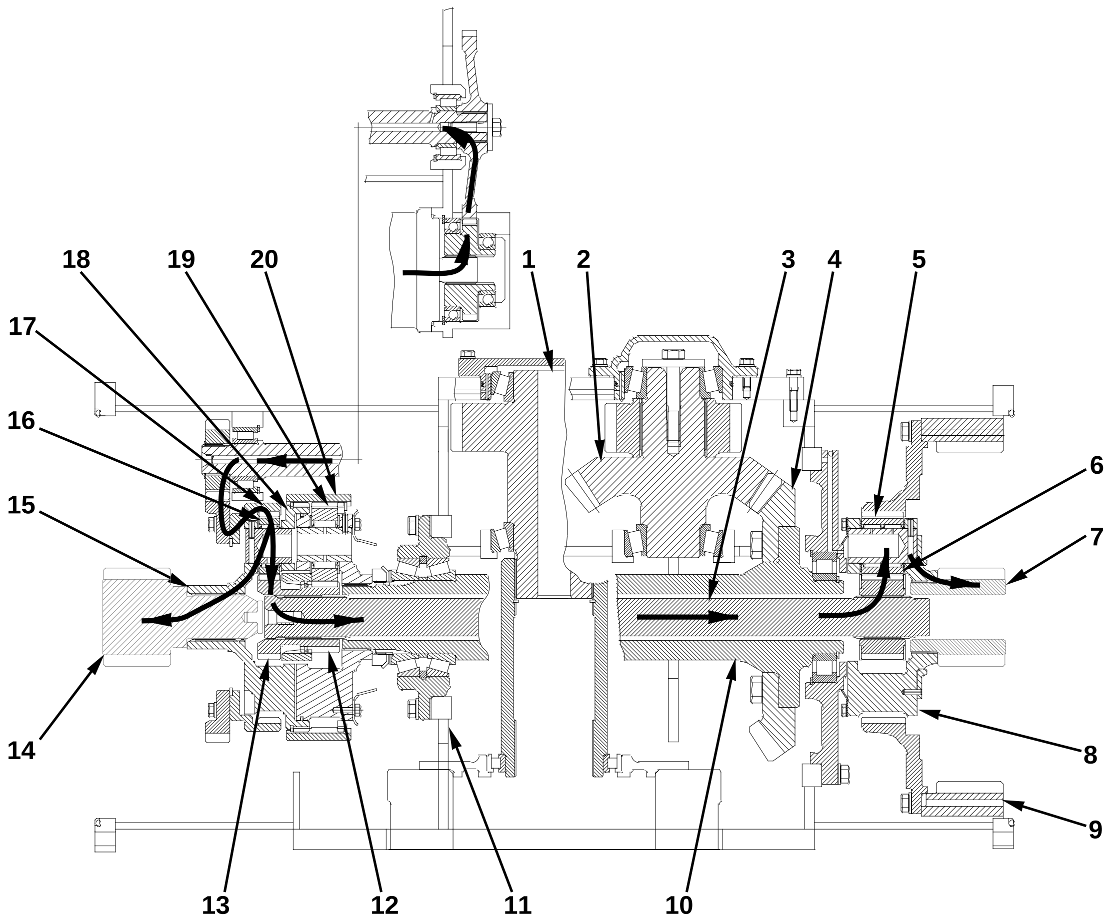
Sun gear (6), along with planet equalizing gears (5), carrier (8), and ring gear (9) converts the higher speed, lower torque input from sun gear (6) into a lower speed, higher torque output to right output sun gear (7).

The amount of power to both outer sun gears is the same and the direction of gear rotation is the same, moving the machine straight ahead or straight backward.



Rotation of Components During Straight Line Operation (Forward).
(2) Pinion. (3) Center axle shaft. (4) Bevel gear. (5) Planetary equalizing gears. (6) Sun gear. (7) Right output sun gear. (8) Carrier. (9) Ring gear. (12) Sun gear. (13) Sun gear. (14) Left output sun gear. (15) Carrier. (16) Planetary steering gears. (17) Ring gear. (18) Carrier. (19) Planetary drive gears. (20) Ring gear.

Steering Power Flow

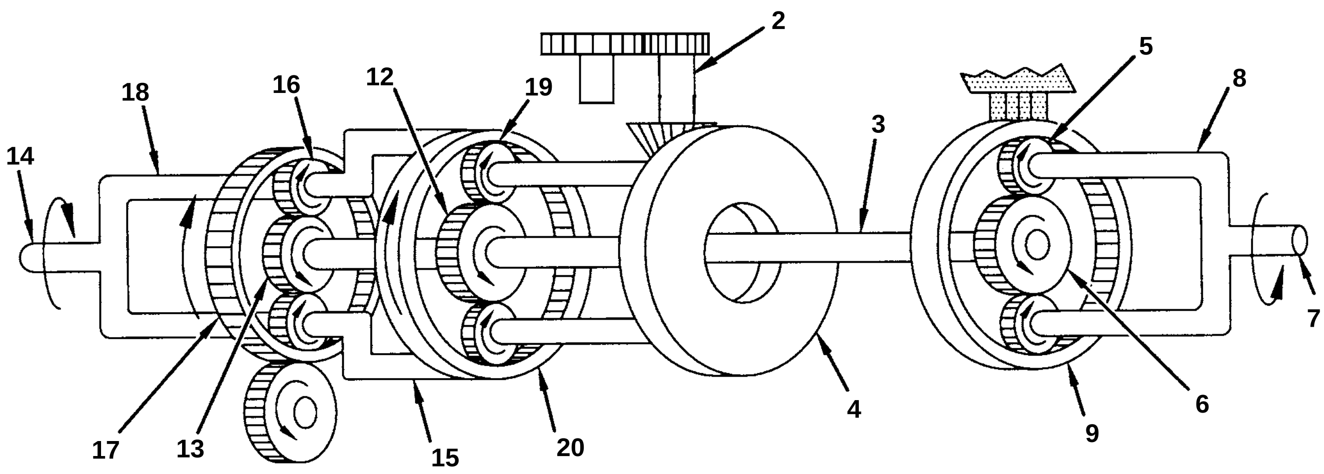


Transmission Input/Steering Section, Power Flow During Straight Line Operation (Steering Only, Counterrotating).
(1) Transmission input gear. (2) Pinion. (3) Center axle shaft. (4) Bevel gear. (5) Planetary equalizing gears. (6) Sun gear. (7) Right output sun gear. (8) Carrier. (9) Ring gear. (10) Bevel gear shaft. (11) Support. (12) Sun gear. (13) Sun gear. (14) Left output sun gear. (15) Carrier. (16) Planetary steering gears. (17) Ring gear. (18) Carrier. (19) Planetary drive gears. (20) Ring gear.

When the transmission is in NEUTRAL, power from the steering motor flows through ring gear (17). Power from ring gear (17) divides in two directions. Half of the power (lower speed, higher torque) flow is sent through planetary steering gears (16) to carrier (15). Power through carrier (15) flows to left output sun gear (14).

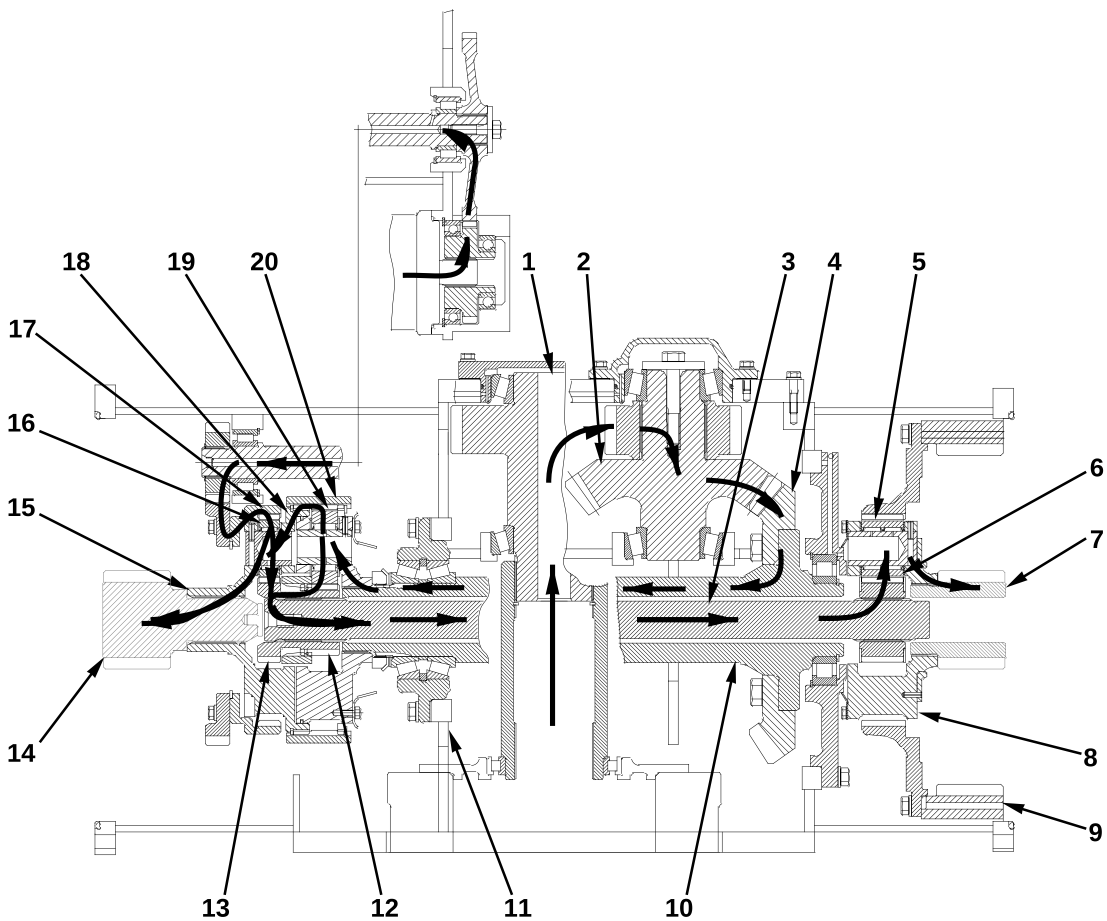
The other half of the power (higher speed, lower torque) flows through planetary steering gears (16) to sun gear (13). Sun gear (13) sends the power through center axle shaft (3) to sun gear (6). Sun gear (6), along with planetary equalizing gears (5), carrier (8), and ring gear (9) converts the higher speed, lower torque input from sun gear (6) into a lower speed, higher torque output to right output sun gear (7).

Power to both output sun gears is the same, but the direction of shaft rotation is opposite. The result is that the machine rotates about its own center (counterrotating).



Rotation of Components During Straight Line Operation (Steering Only, Counterrotating).
(2) Pinion. (3) Center axle shaft. (4) Bevel gear. (5) Planetary equalizing gears. (6) Sun gear. (7) Right output sun gear. (8) Carrier. (9) Ring gear. (12) Sun gear. (13) Sun gear. (14) Left output sun gear. (15) Carrier. (16) Planetary steering gears. (17) Ring gear. (18) Carrier. (19) Planetary drive gears. (20) Ring gear.

Steering and Transmission Power Flow Combined



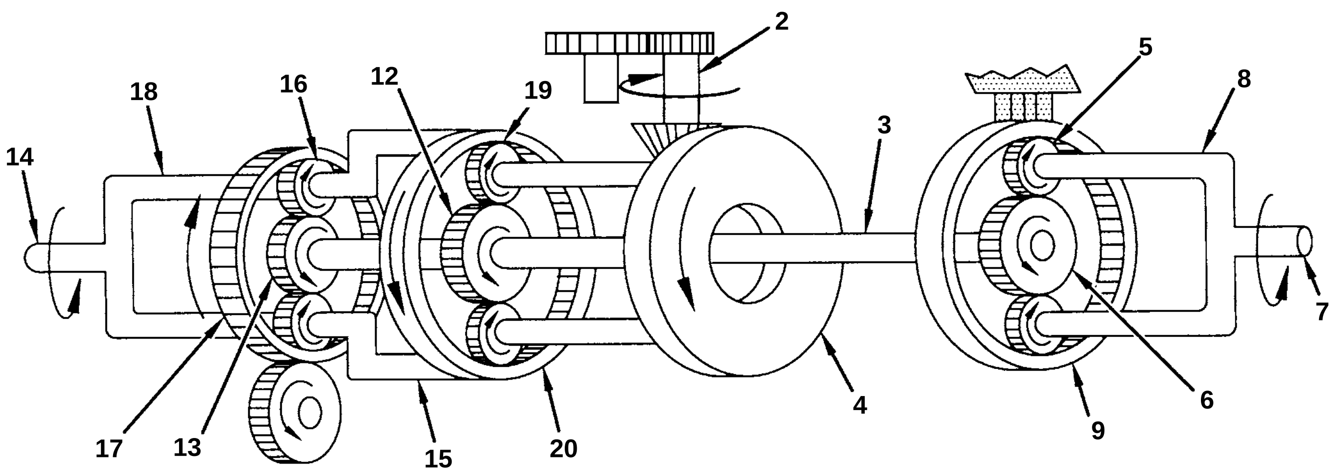
Transmission Input/Steering Section, Power Flow During Straight Line Operation (Combined Forward and Steering).
(1) Transmission input gear. (2) Pinion. (3) Center axle shaft. (4) Bevel gear. (5) Planetary equalizing gears. (6) Sun gear. (7) Right output sun gear. (8) Carrier. (9) Ring gear. (10) Bevel gear shaft. (11) Support. (12) Sun gear. (13) Sun gear. (14) Left output sun gear. (15) Carrier. (16) Planetary steering gears. (17) Ring gear. (18) Carrier. (19) Planetary drive gears. (20) Ring gear.

When both the steering motor and the transmission are working together in the differential steering system, transmission power flows through the differential steering system in the same that it does when the steering motor is not operating.

The power from the steering motor still divides, with half of the power going in one direction and the other half going in the opposite direction.

The transmission controls the amount of power going to the axle shafts, and their rotation. The steering motor controls the difference in the speed of the axle shafts and the direction of the turn.

As a result, power to one outer axle shaft is greater, causing the speed of that shaft to increase and the speed of the other outer axle shaft to decrease.



Rotation of Components During Turn (Forward).
(2) Pinion. (3) Center axle shaft. (4) Bevel gear. (5) Planetary equalizing gears. (6) Sun gear. (7) Right output sun gear. (8) Carrier. (9) Ring gear. (12) Sun gear. (13) Sun gear. (14) Left output sun gear. (15) Carrier. (16) Planetary steering gears. (17) Ring gear. (18) Carrier. (19) Planetary drive gears. (20) Ring gear.

The direction of rotation of the steering motor and ring gear (17) controls which way the machine turns. The speed of the motor and pinion determines how sharp or gradual the machine turns: the faster the motor speed, the sharper the turn.

When the machine makes a left turn, ring gear (17) and pinion (2) rotate in the same direction. Power to ring gear (17) flows to planetary drive gears (19). Planetary drive gears (19) send the power through sun gear (12) to center axle shaft (3) and add to the power from sun gear (13).

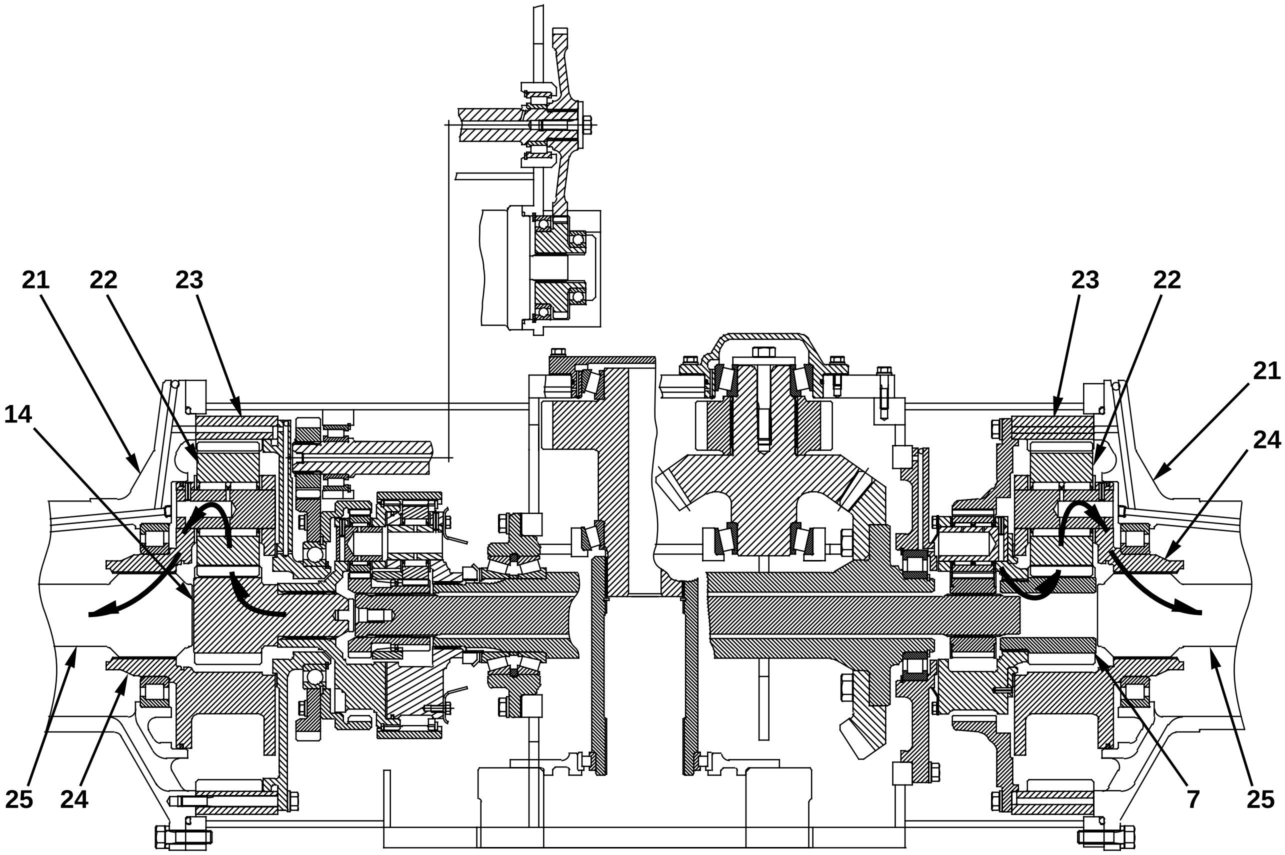
The combined power flows through center axle shaft (3) to sun gear (6). Sun gear (6), along with planetary equalizing gears (5), carrier (8), and ring gear (9) converts the higher speed, lower torque input from sun gear (6) into a lower speed, higher torque output to right output sun gear (7). As a result of the lower speed and higher torque, the axle shaft increases speed.

The speed of center axle shaft (3) increases when the power to sun gear (13) joins the power at sun gear (12). The increase in power causes the speed of sun gear (12) to increase. When the speed of sun gear (12) increases, the speed of ring gear (17) decreases. The reduction in the speed of ring gear (17) causes carrier (15) and left output sun gear (14) to reduce speed also. The resulting speed difference between output sun gears (14) (faster) and (7) (slower) causes the machine to turn left.

To turn the machine to the right, ring gear (20) and pinion (2) rotate in opposite directions. Power to ring gear (20) flows through planetary steering gears (16). Power through planetary steering gears (16) flows to carrier (15) and joins the power flowing through ring gear (17) to carrier (15). The combined power flows through carrier (15) to left output sun gear (14) and causes the input shaft to increase speed, along with carrier (15) and ring gear (17). When the speed of ring gear (17) increases, the speed of sun gear (12) decreases.

A decrease in the speed of sun gear (12) causes center axle shaft (3), sun gear (6), carrier (8), and right output sun gear (7) to decrease speed also. The resulting speed differential between output sun gears (7) and (14) causes the machine to turn to the right.

Transfer Output Drive Operation

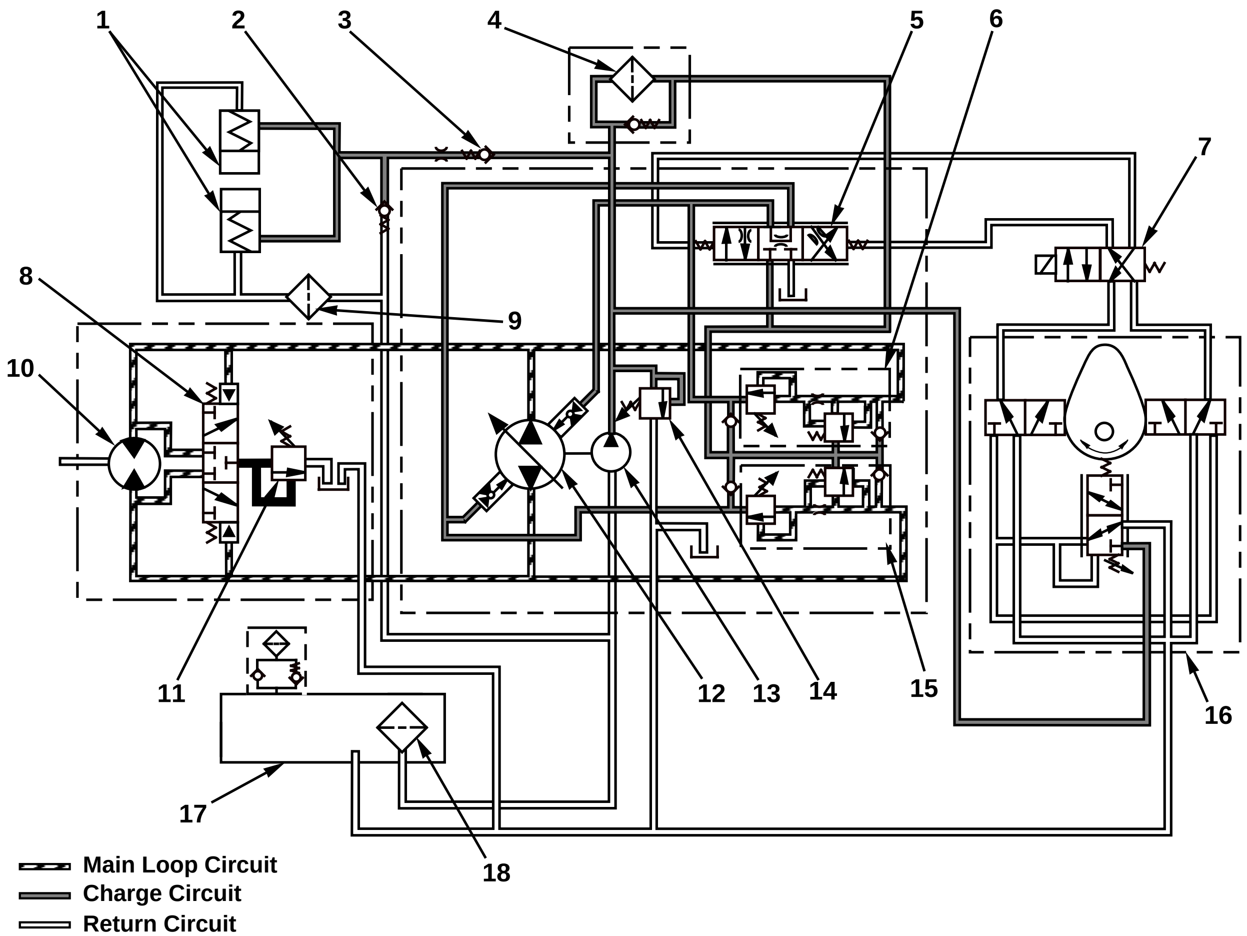


Transfer Output Drive.
(7) Right output sun gear. (14) Left output sun gear. (21) Spindles. (22) Planet gears. (23) Ring gears. (24) Planet carriers. (25) Axles.

The right and left output transfer drives provide the final speed reduction and torque increase between the transmission input steering section and the drive wheels.

The torque from output sun gears (7) and (14) is transmitted to planet gears (22). The torque is increased as planet gears (22) turn around inside ring gears (23). The torque is transmitted to axles (25) by planet carriers (24).

Steering Hydraulic System

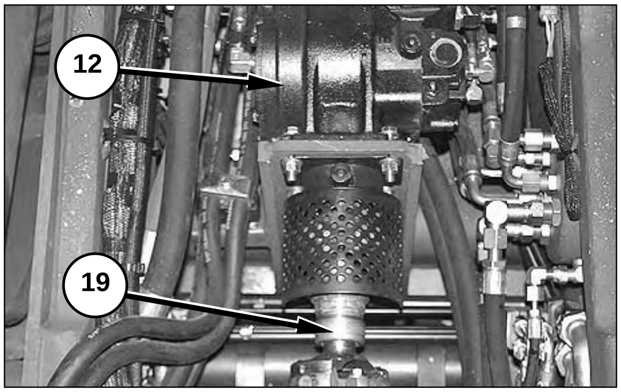


Steering Hydraulic System Schematic.

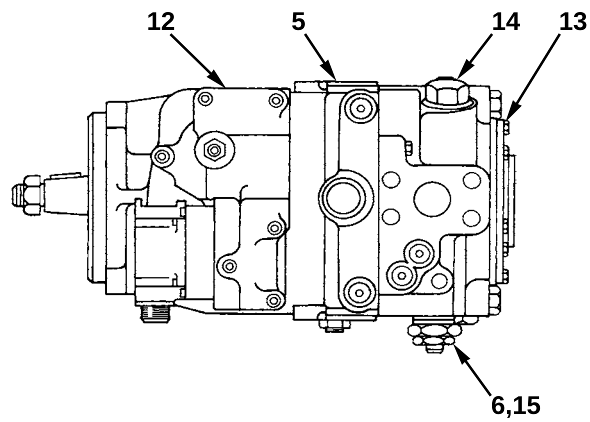
(1) Brakes. (2) Check and relief valve. (3) Check and relief valve. (4) Charge filter. (5) Hydraulic displacement control. (6) Multifunction valve. (7) Steering solenoid valve. (8) Cooling valve. (9) Screen. (10) Steering motor. (11) Cooling relief valve. (12) Steering pump. (13) Charge pump. (14) Charge relief valve. (15) Multifunction valve. (16) Steering control valve. (17) Hydraulic oil tank. (18) Screen.

The steering hydraulic system draws oil from hydraulic oil tank (17), which is mounted on the right side of the machine.

The steering hydraulic system is a high pressure, closed loop system. The main components of the system are: steering pump (12), steering motor (10), charge pump (13), steering control valve (16), charge filter (4), and steering solenoid valve (7).



Underneath Cab (Cab Tilted Up).
(12) Steering pump. (19) Drive shaft.



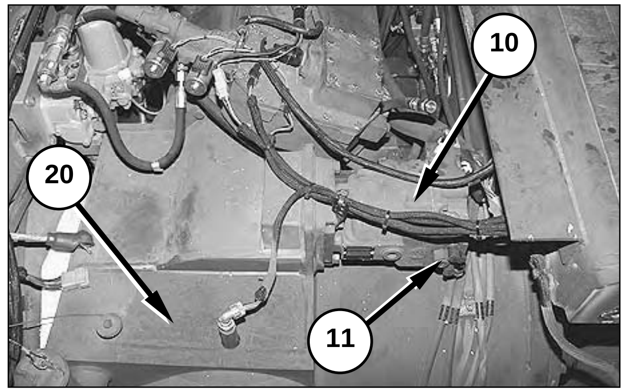
Right Side View of Steering Pump.
(5) Hydraulic displacement control. (6) Multifunction valve.
(12) Steering pump. (13) Charge pump. (14) Charge relief valve.
(15) Multifunction valve.

Steering pump (12) is located beneath the cab and is driven by drive shaft (19), off the front of the engine. The steering pump provides the high pressure oil used to turn the steering motor. The steering pump contains charge pump (13), charge relief valve (14), and multifunction valves (6) and (15).

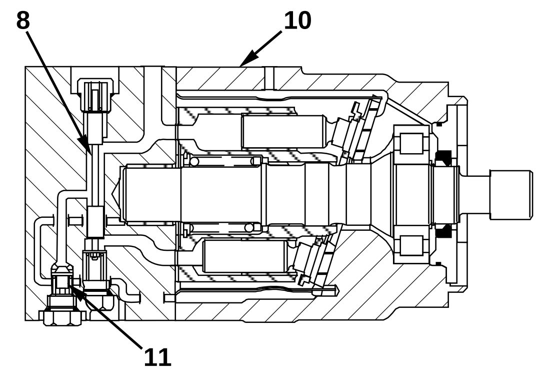
Charge pump (13) supplies charging and cooling oil to the steering system, and cooling oil to the machine braking system. When charge pump pressure exceeds 1310 kPa (190 psi), check and relief valve (3) opens and allows oil to flow through the brakes to cool them.

The suction side of charge pump (13) draws oil from the brakes through screen (9) and from hydraulic oil tank (17). If pressure in the brake cooling circuit exceeds 172.5 kPa (25 psi), check and relief valve (2) opens and drains oil to the suction side of charge pump (13). This protects the seals inside the brakes during cold weather starts.

Multifunction valves (6) and (15) limit the maximum operating pressure of the high pressure loop in the steering system, and provide makeup oil for the low pressure loop.

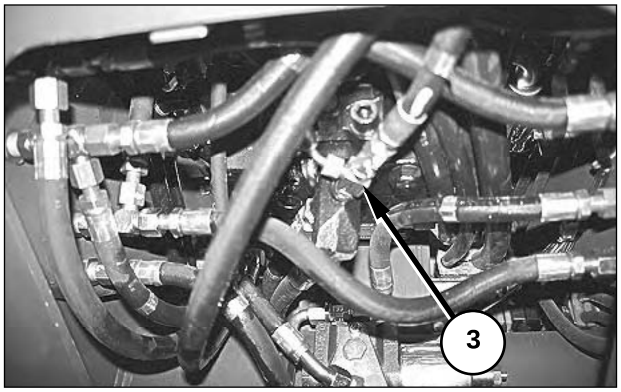


Steering Motor Location (Fuel Tank Shown Removed).
(10) Steering motor. (11) Cooling relief valve. (20) Differential steering unit.



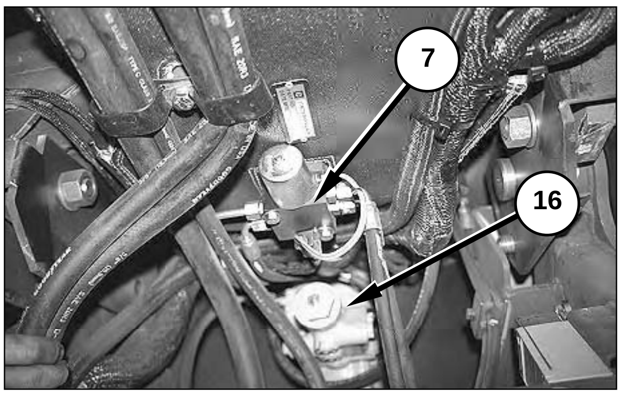
Steering Motor.
(8) Cooling valve. (10) Steering motor. (11) Cooling relief valve.

Steering motor (10) is mounted directly on differential steering unit (20), at the rear of the machine. The steering motor receives high pressure oil from the steering pump and turns a ring gear in a planetary gear which is set inside the differential steering unit, to turn the machine. The steering motor contains cooling valve (8) and cooling relief valve (11). The cooling valve and the cooling relief valve provide a return path to hydraulic oil tank (17), to cool and clean the steering system oil.



Bottom View of Steering Pump.
(3) Check and relief valve.

Check and relief valve (3) is located on the bottom of the steering pump. The check and relief valve controls the amount of steering charge oil that flows to the brakes for cooling.

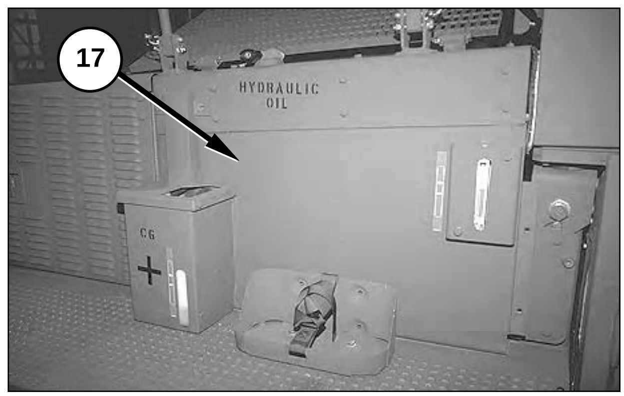


Location of Diverter Valve and Steering Pilot Valve.
(7) Steering solenoid valve. (16) Steering control valve.

Steering control valve (16) and steering solenoid valve (7) work together to control the direction of the flow of the steering pump, which controls the steering direction of the machine. When the steering wheel is turned, the steering control valve directs charge pressure oil to the hydraulic displacement control on the steering pump, through the steering solenoid valve. The steering solenoid valve switches the effect of the pilot valve to cause the machine to steer in the same direction in forward and reverse operation (C-turn logic).

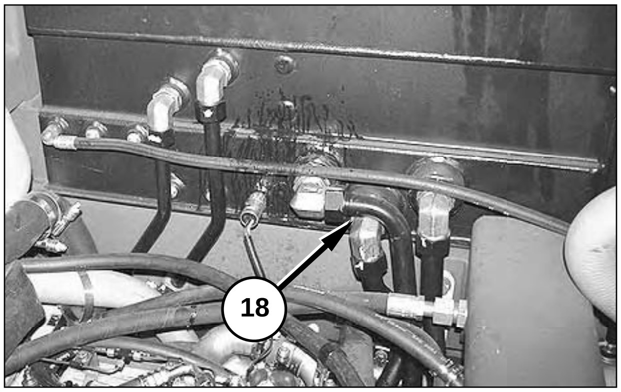
Location of Charge Filter.
(4) Charge filter.

Charge filter (4) is located in the oil filter compartment, on the right side of the machine. The filter bases of the charge filter and the return filter contain a differential pressure gauge which indicates the degree to which the filter is plugged, when the engine is running at high idle. Replace the filter if the indicator moves into the red zone, when the engine is running at high idle.



Right Side of Machine.
(17) Hydraulic oil tank.

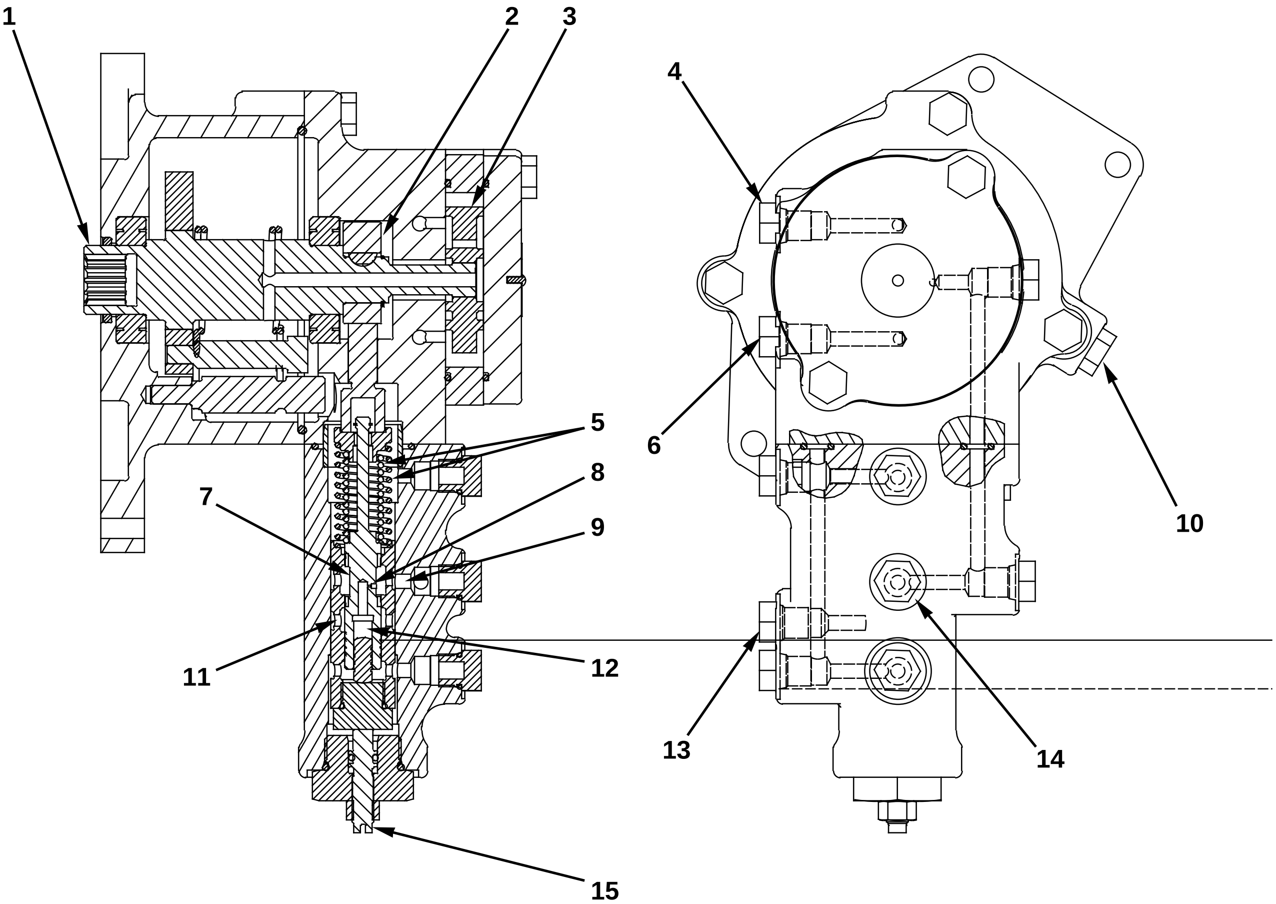
Hydraulic oil tank (17) is located on the right side of the machine. The hydraulic oil tank supplies hydraulic oil to the steering circuit.



Left Side of Hydraulic Tank (Radiator Shown Removed).
(18) Screen.

Screen (18) is part of a fitting that is threaded into the hydraulic tank. Screen (18) removes any large particles from the suction oil flowing to charge pump (13).

Steering Control Valve Operation



Steering Control Valve.
(1) Input shaft. (2) Pressure cam. (3) Valve plate. (4) “AR” port. (5) Springs. (6) “AL” port. (7) Valve spool. (8) Orifice. (9) Chamber. (10) Tank port. (11) Chamber. (12) Slug chamber. (13) Pressure port. (14) Test port. (15) Adjusting screw.

The steering wheel in the cab is connected to the steering control valve by input shaft (1). Pressure cam (2) and valve plate (3) are splined to the input shaft. When the input shaft turns, the pressure cam and valve plate also turn. The pressure cam determines the timing and level of steering actuation pressure, based on the amount the pressure cam is rotated. The valve plate directs steering actuation pressure to "AR" port (4), or "AL" port (6), depending on the direction the valve plate is rotated.

Pressure oil from the steering charge pump comes from pressure port (13) and is present in chamber (11). Steering actuation pressure is fed from chamber (9) to valve plate (3) by internal passages, and is measurable at test port (14).

When the steering wheel is turned, pressure cam (2) compresses springs (5) and forces valve spool (7) down. When the valve spool moves down, a passage between chambers (11) and (9) opens. Pressure oil from the charge pump flows through this passage into chamber (9).

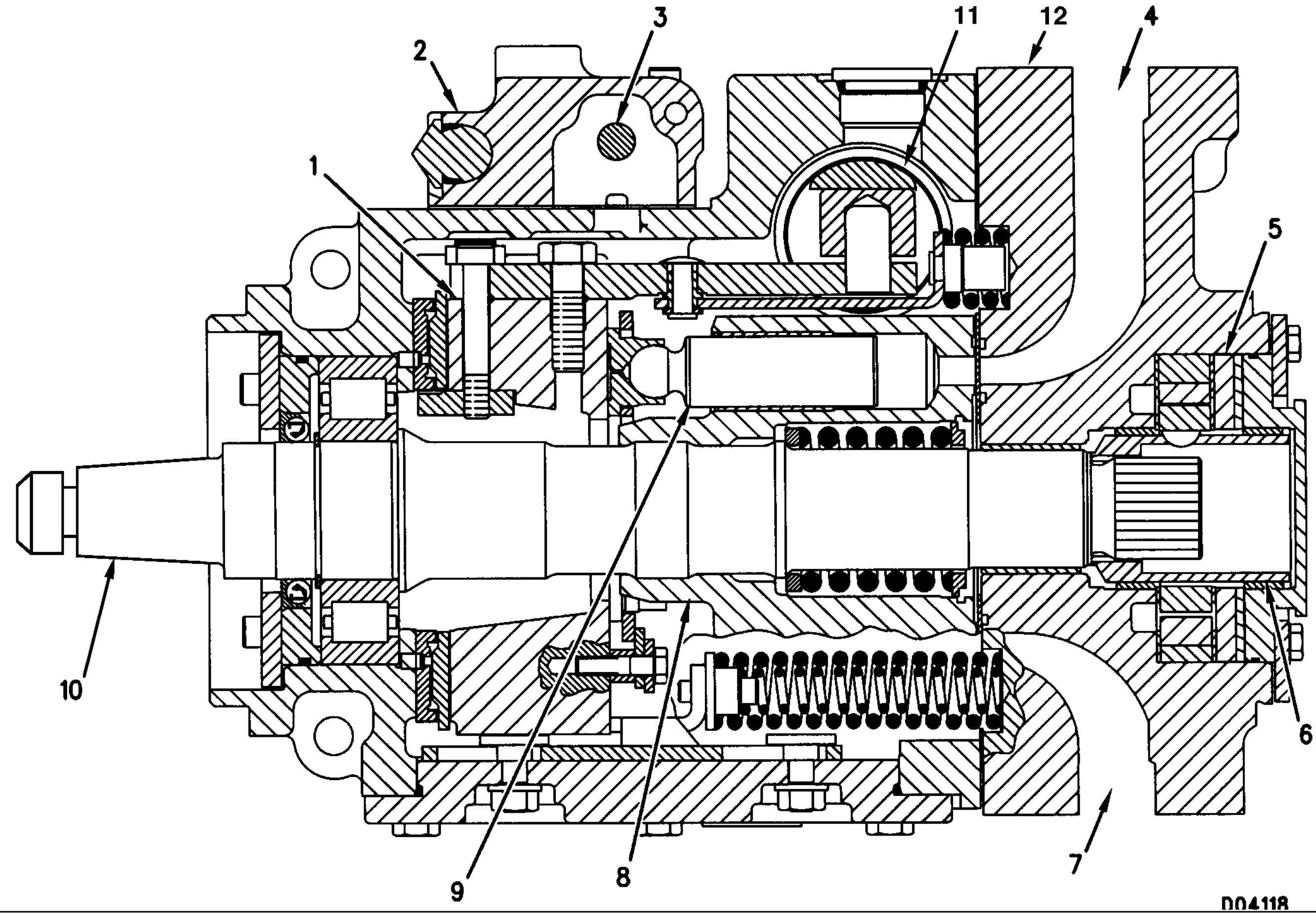
The pressurized oil in chamber (9) flows through orifice (8) in valve spool (7) into slug chamber (12). As the pressure in the slug chamber increases, the valve spool moves up against the force of springs (5). When the valve spool moves up, the passage between chambers (11) and (9) closes. In this way, the valve spool moves up and down against the force of the springs to maintain constant pressure in chamber (9).

Increased rotation of the steering wheel causes increased rotation of pressure cam (2), which increases the force on springs (5). The increased force on the springs causes valve spool (7) to modulate around an increased pressure in chamber (9). In this way, increased steering wheel rotation is converted into increased steering actuation pressure. The steering actuation pressure is directed to either "AR" port (4) or "AL" port (6) by the rotation of valve plate (3).

Adjusting screw (15) is used to change the maximum steering actuation pressure.

Port (10) is open to the tank.

Steering Pump Operation



Steering Pump.
(1) Swashplate. (2) Hydraulic displacement controls. (3) Signal oil port. (4) Pump oil port. (5) Charge pump. (6) Coupling. (7) Pump oil port. (8) Barrel. (9) Pistons. (10) Input shaft. (11) Servo piston. (12) End cap.

The steering pump is a variable-displacement, over-center, bidirectional piston pump. The steering pump is driven from the front side of the pump drive (left hand pump rotation).

Input shaft (10) turns barrel (8), pistons (9), and coupling (6). The coupling turns the shaft of charge pump (5). The charge pump provides makeup oil for the closed loop and pressure oil for the steering pump controls. The charge pump also sends oil to the steering control valve.

Hydraulic displacement controls (2) and the steering control valve work together to control the amount and direction of oil flow from the pump. This is controlled by the direction and degree to which swashplate (1) is tilted.

When charge oil is sent to either end of servo piston (11), swashplate (1) tilts. The tilted swashplate causes pistons (9) to move in and out of barrel (8). The movement of the pistons as the barrel turns causes oil to flow from either pump oil port (4) or (7). Signal pressure oil at port (3) causes oil to flow from pump oil port (7), and signal pressure oil at the opposite port causes oil to flow from port (4).

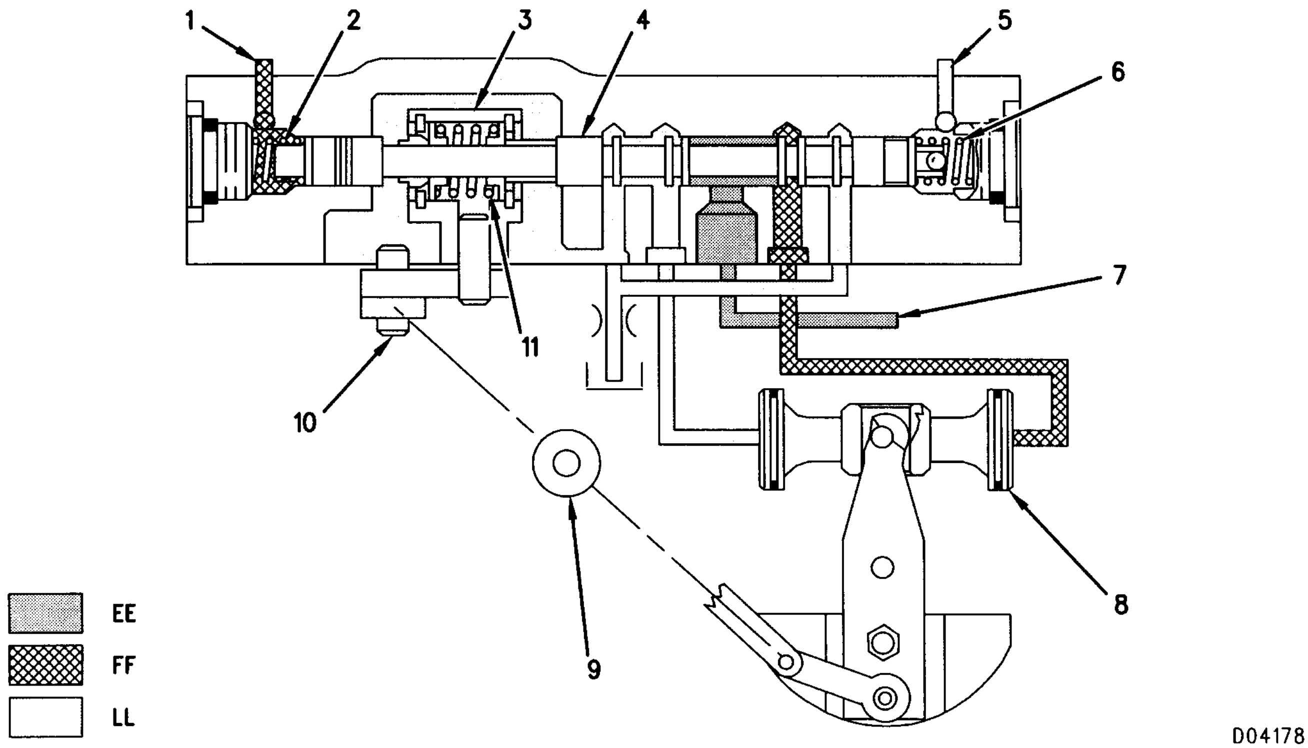
Charge pump (5) produces approximately 53.6 L/min (14.1 U.S. gpm) at high idle. The charge pump provides charge oil for the steering control, pump servo system, and makeup oil to keep the closed loop circuit full.

Charge pump (5) pressure is controlled by a relief valve. The relief valve maintains a pressure of 2415 ± 345 kPa (350 ± 50 psi) above case drain pressure in the charge oil circuit.

Servo pressure relief valves are located in the pump’s end cap (12). One relief valve is located in the circuit to each side of servo piston (11). The servo relief valves limit the oil pressure to destroke the pump to 2500 kPa (750 psi) over charge pressure.

Hydraulic Displacement Control Valve

Steering Operation (Right Shown)



Hydraulic Displacement Control Valve (Right Shown).
(1) Signal passage. (2) Centering spring. (3) Barrel. (4) Spool. (5) Signal passage. (6) Spring. (7) From charge pump. (8) Servo cylinder. (9) Pivot point. (10) Feedback linkage. (11) Feedback spring. (EE) Charge oil. (FF) Reduced charge oil. (LL) Return oil.

Feedback linkage (10) connects the steering pump's swashplate and spool (4). As the swashplate moves (upstrokes and/or destrokes), the feedback linkage follows. The feedback linkage moves barrel (3) in the opposite direction of the control spool.

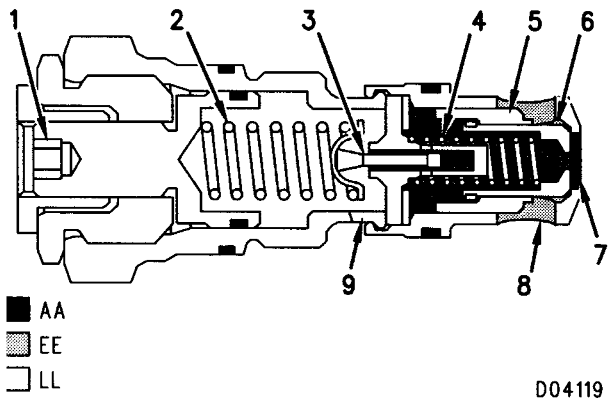
Barrel (3) movement allows feedback spring (11) to re-center spool (4), shutting off the metered pilot pressure oil to servo cylinder (8).

If input pilot oil signal pressure in signal passage (1) has not resolved (balanced) itself against the force of spring (6), at the opposite end of spool (4), pilot oil signal pressure in signal passage (1) will again shift the control spool.

The shifting of spool (4) allows metered pilot oil pressure to servo cylinder (8), upstroking the steering pump. Because of feedback linkage (10), spool (4) shifts back and forth with barrel (3) and feedback spring (11), until the pressure and spring forces balance.

Multifunction Valve

High Pressure Cutoff Operation



High Pressure Cutoff Operation.
(1) High pressure cutoff adjustment. (2) Spring. (3) High pressure cutoff valve. (4) Spring. (5) Makeup valve. (6) Relief valve. (7) High pressure side of main loop. (8) Charge pressure. (9) Outlet to steering pump servo piston. (AA) High pressure oil. (EE) Charge oil. (LL) Return oil.

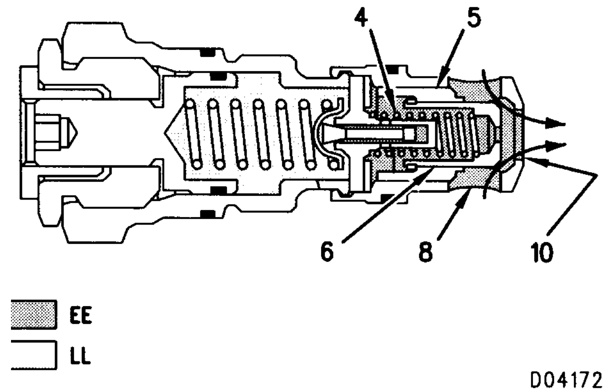
The steering pump contains a multifunction valve in each output circuit of the pump. The multifunction valve contains makeup valve (5), high pressure cutoff valve (3), and relief valve (6). The multifunction valve also contains high pressure cutoff adjustment (1), and springs (2) and (4). The operation of the multifunction valve depends upon the conditions in the closed-loop circuit.

When operating in the high pressure side of loop (7), high pressure cutoff valve (3) destrokes the steering pump as drive pressure increases to the maximum setting of the valve. The pressure increases when high resistance loads are felt during a turn.

When high pressure that is 41 340 ± 690 kPa (6000 ± 100 psi) above charge pressure (8) is felt at the end of the multifunction valve, high pressure cutoff valve (3) moves off its seat and against the force of spring (2). Outlet (9) directs high pressure oil to the opposite servo cylinder to destroke the pump. The pump will destroke so the high resistance load pressure can be maintained.

High pressure cutoff valve (3) is adjustable with high pressure cutoff adjustment (1) and spring (2).

Makeup Valve Operation

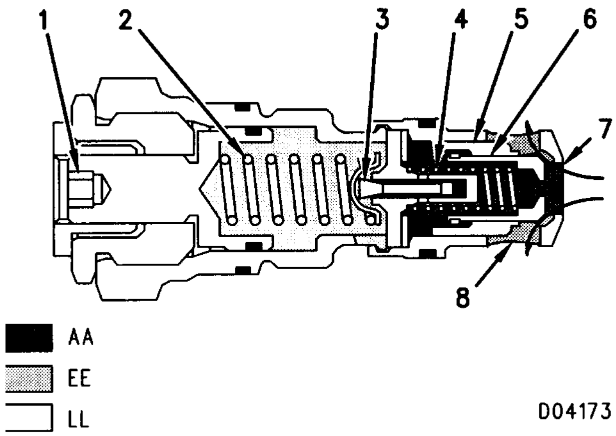


Makeup Valve Operation.
(4) Spring. (5) Makeup valve. (6) Relief valve. (8) Charge pressure. (10) Low pressure side of main loop. (EE) Charge oil. (LL) Return oil.

When makeup valve (5) is on the low pressure side of main loop (10), the makeup valve operates. When pressure in the loop is lower than charge pressure (8), the charge pressure moves the makeup valve to the left.

Makeup valve (5) moves relief valve (6) left against spring (4), and off its seat. This permits charge oil to flow into loop (10), replenishing flow losses. Flow losses are created by normal leakage through the pump components and the cooling valve in the steering motor.

Relief Valve Operation

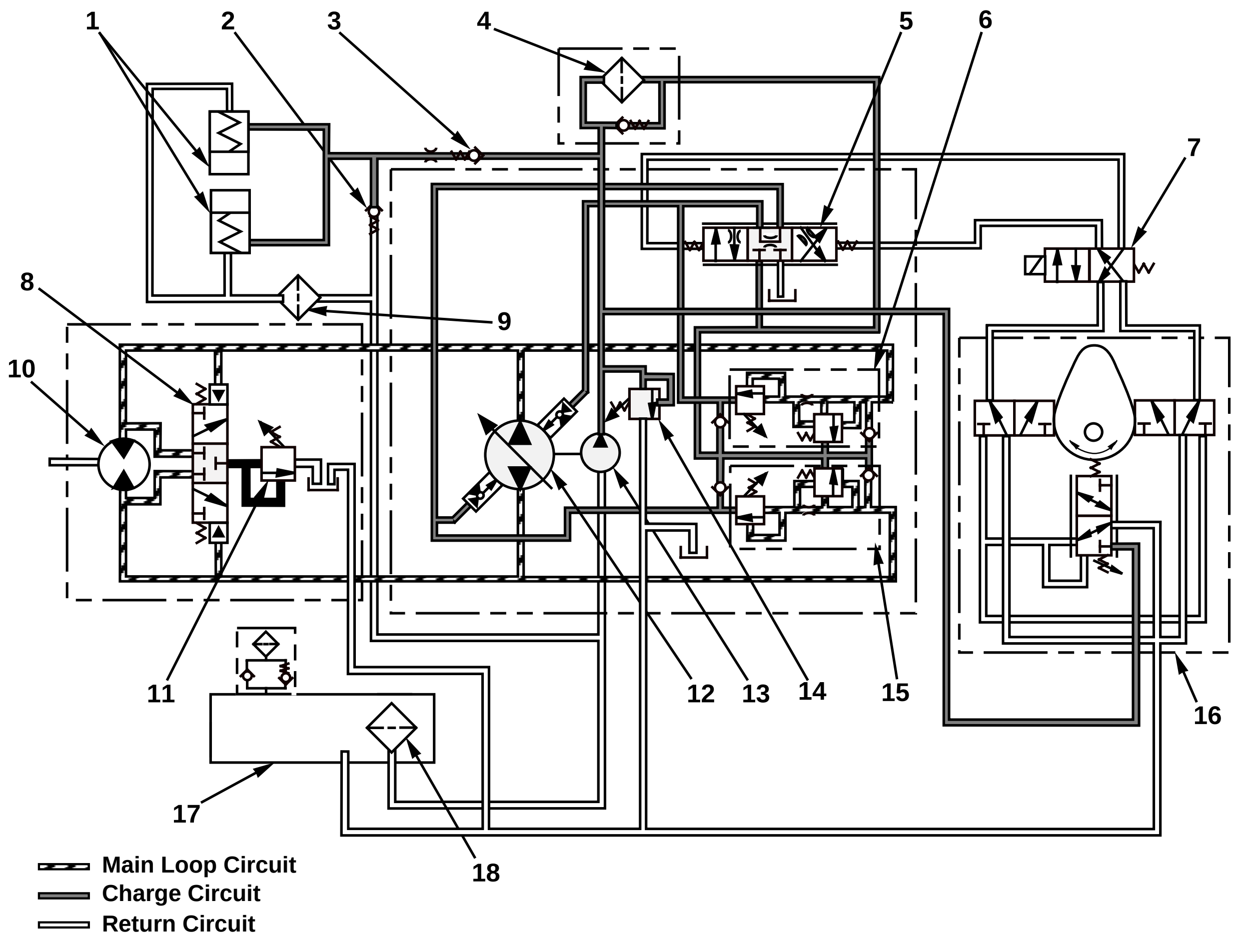


Relief Valve Operation.
(1) High pressure cutoff adjustment. (2) Spring. (3) High pressure cutoff valve. (4) Spring. (5) Makeup valve. (6) Relief valve. (7) High pressure side of main loop. (8) Charge pressure. (AA) High pressure oil. (EE) Charge oil. (LL) Return oil.

When operating on the high pressure side of loop (7), relief valve (6) protects the system from high pressure spikes. High pressure spikes occur when the machine encounters a large external force.

When high pressure that is 3450 kPa (500 psi) above the high pressure cutoff is felt at the end of the multifunction valve, relief valve (6) moves left against spring (4). The movement of the relief valve allows the high pressure oil to flow into the lower charge pressure (8) oil circuit.

Straight Line Operation



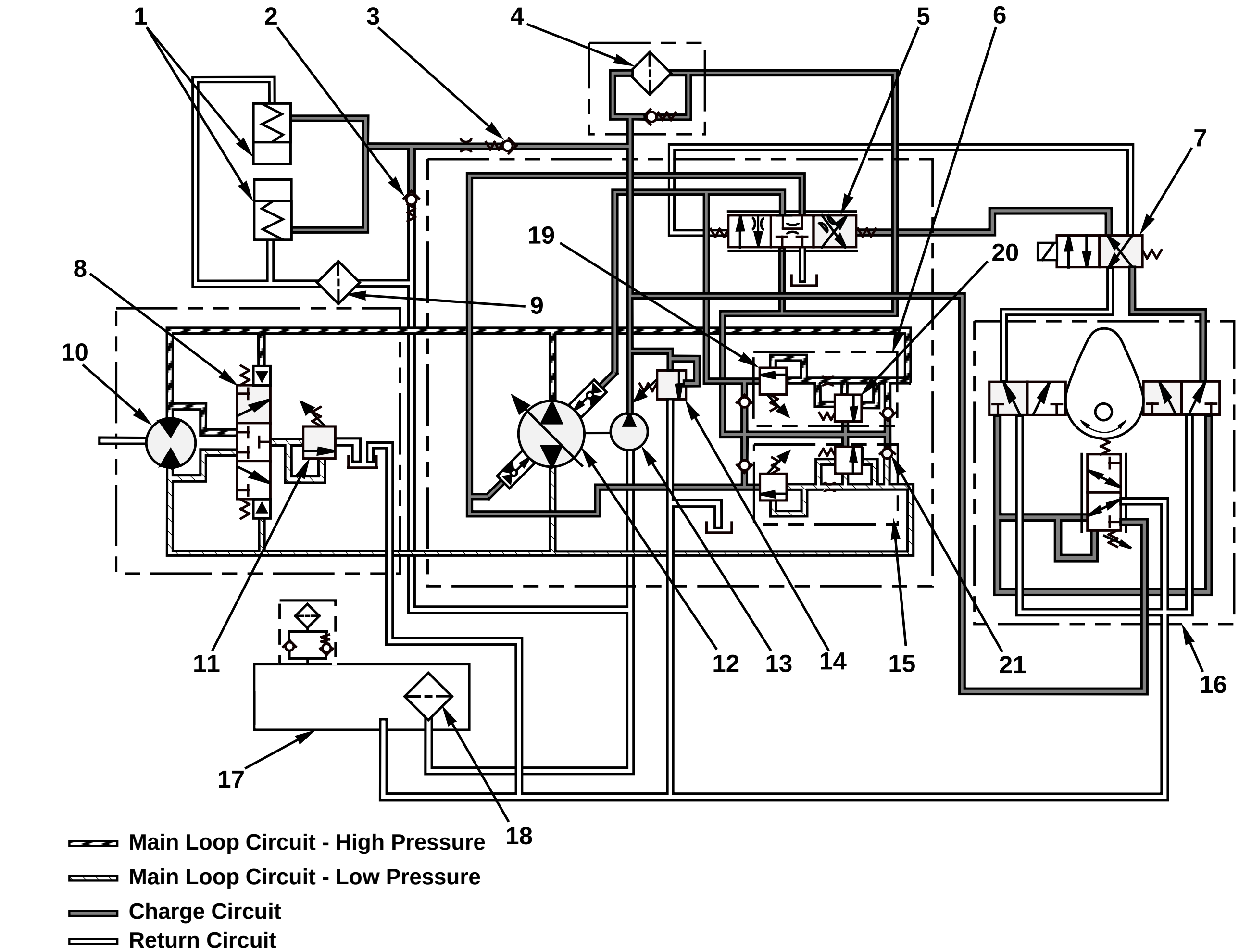
Steering Hydraulic System Schematic, Straight Line Operation.
(1) Brakes. (2) Check and relief valve. (3) Check and relief valve. (4) Charge filter. (5) Hydraulic displacement control. (6) Multifunction valve. (7) Steering solenoid valve. (8) Cooling valve. (9) Screen. (10) Steering motor. (11) Cooling relief valve. (12) Steering pump. (13) Charge pump. (14) Charge relief valve. (15) Multifunction valve. (16) Steering control valve. (17) Hydraulic oil tank. (18) Screen.

This schematic shows the steering circuit during straight line operation.

When the steering wheel is not turned, the spools inside steering control valve (16) remain in the neutral position. With the spools in the neutral position, both sides of hydraulic displacement control (5) are connected to the tank, and the hydraulic displacement control remains in the center position. In the neutral position, the hydraulic displacement control connects both sides of the steering pump servo to return oil. The steering pump swashplate remains fixed at zero angle, producing no steering flow.

Charge pump (13) fills the entire circuit with charge oil to compensate for any leakage which may occur.

Turning Operation



Steering Hydraulic System Schematic, Turning Operation.
(1) Brakes. (2) Check and relief valve. (3) Check and relief valve. (4) Charge filter. (5) Hydraulic displacement control. (6) Multifunction valve. (7) Steering solenoid valve. (8) Cooling valve. (9) Screen. (10) Steering motor. (11) Cooling relief valve. (12) Steering pump. (13) Charge pump. (14) Charge relief valve. (15) Multifunction valve. (16) Steering control valve. (17) Hydraulic oil tank. (18) Screen. (19) High pressure cutoff valve. (20) Relief valve. (21) Makeup valve.

This schematic shows the steering hydraulic circuit when the steering wheel is turned right, with the machine moving forward.

When the steering wheel is turned right, the right spool in steering control valve (16) shifts down, directing charge pressure oil to steering solenoid valve (7). When the machine is in a forward gear, the steering solenoid valve is not energized, and the charge pressure oil from the steering control valve is directed to the right end of hydraulic displacement control (5).

Hydraulic displacement control (5) shifts left and meters charge pressure oil to the swashplate control servo inside steering pump (12). The steering pump upstrokes and pumps oil to steering motor (10).

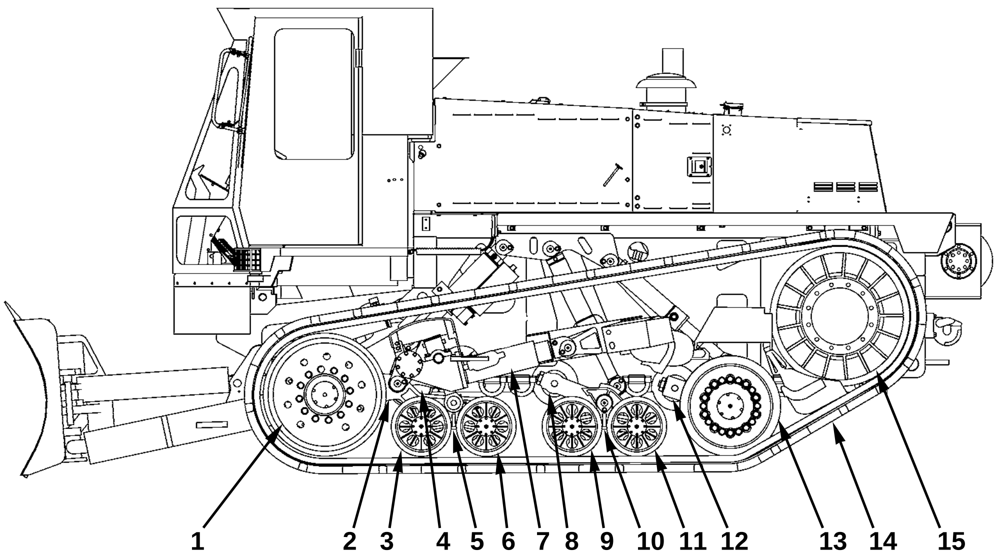
Pressure in the high pressure side of the main loop circuit shifts cooling valve (8) down, and directs oil from the low pressure side of the main loop to hydraulic oil tank (17), across cooling relief valve (11). Charge oil flowing across makeup valve (21) in multifunction valve (15) replenishes the oil in the low pressure side of the main loop, which is then returned to the tank across the cooling relief valve.

If the pressure in the high pressure side of the main loop circuit increases to 41 340 ± 690 kPa (6000 ±100 psi), high pressure cutoff valve (19) opens and begins to destroke the pump. If the pressure in the circuit continues to increase and reaches approximately 47 265 kPa (6850 psi), relief valve (20) opens and vents the high pressure oil to the charge circuit.

If the transmission is placed in a reverse gear, steering solenoid valve (7) is activated by the Electronic Programmable Transmission Control (EPTC II). When activated, the steering solenoid valve switches the charge pressure signal sent by steering control valve (16) to hydraulic displacement control (5), and causes steering pump (12) to reverse the steering direction. This causes the machine to steer in the same direction, whether in forward or reverse (C-turn logic).

Undercarriage System

Undercarriage System Components



Undercarriage Components.
(1) Front idler. (2) Major bogie. (3) Midroller. (4) Offset arm. (5) Front minor bogie. (6) Midroller. (7) Recoil cylinder. (8) Middle swing arm. (9) Midroller. (10) Rear minor bogie. (11) Midroller. (12) Rear swing arm. (13) Rear idler. (14) Drive belt. (15) Drive wheel.

The machine undercarriage supports the weight of the machine and transfers power from the drive train to the ground. The undercarriage is fully suspended, to absorbs shocks during travel at high speed and to give increased traction over rough terrain.

The major components of the undercarriage are: front idler (1), major bogie (2), offset arm (4), midrollers (3), (6), (9) and (11), minor bogies (5) and (10), recoil cylinder (7), swing arms (8) and (12), rear idler (13), drive belt (14) and drive wheel (15).

Power from the output transfer drive flows through drive wheel (15), which drives belt (14). The drive wheel drives the belt through friction. The friction between the drive wheel and the belt is maintained by recoil cylinder (7). The recoil cylinder forces major bogie (2) and front idler (1) forward, to apply 157.6 kN (35,400 lb) of tension to the track. The track tension can be set using the on-board hydraulic system and the undercarriage hydraulic charging ports at the rear of the machine.

NOTE: To tighten or loosen the track tension, refer to "Testing and Adjusting, Suspension System Procedures, Suspension Hydraulic Charging Procedure."

Front idler (1) also supplies the braking force to stop the machine.The front idlers are mounted on a brake assembly.

NOTE: The braking system is discussed in the "Systems Operation, Brake Section, and "Testing and Adjusting, Brake System Procedures" sections of this module.

Drive Belts

Drive belt (14) is made of flexible rubber with rubber grousers (tread bars). The 96 grousers are 43 mm (1.7 in) high and are arranged in a chevron pattern at 30-degree angles. Forty-eight guide blocks along the center of the inside of the belt keep the belt aligned with drive wheel (15), and with the idlers and midrollers.

Drive Wheels

Drive wheel (15) is mounted to the spindle group on each side of the machine. The drive wheels are of a single piece, cast of ductile iron. Each drive wheel has 34 drive slats arranged horizontally across the wheel. The drive slats grip the drive belt to transfer torque to the drive belt. Air gaps between each of the drive slats allow material caught between the drive wheels and the drive belt to fall through.

Midrollers

Midrollers (3), (6), (9) and (11) are mounted to the minor bogies. Four pairs of midrollers are mounted on each side of the machine. The midrollers, together with the idlers, evenly distribute the weight of the machine over the length of drive belt (14). The midrollers are 356 mm (14 in) in diameter and are coated (bonded) with molded rubber 10 mm (0.4 in) thick. The rubber absorbs impact and also serves as the wear surface. The midrollers are filled with oil which is retained by duo-cone seals. A sight gauge is installed in the center of the midroller for viewing of the oil level. The oil in the midrollers does not have to be changed for maintenance.

Front Idlers

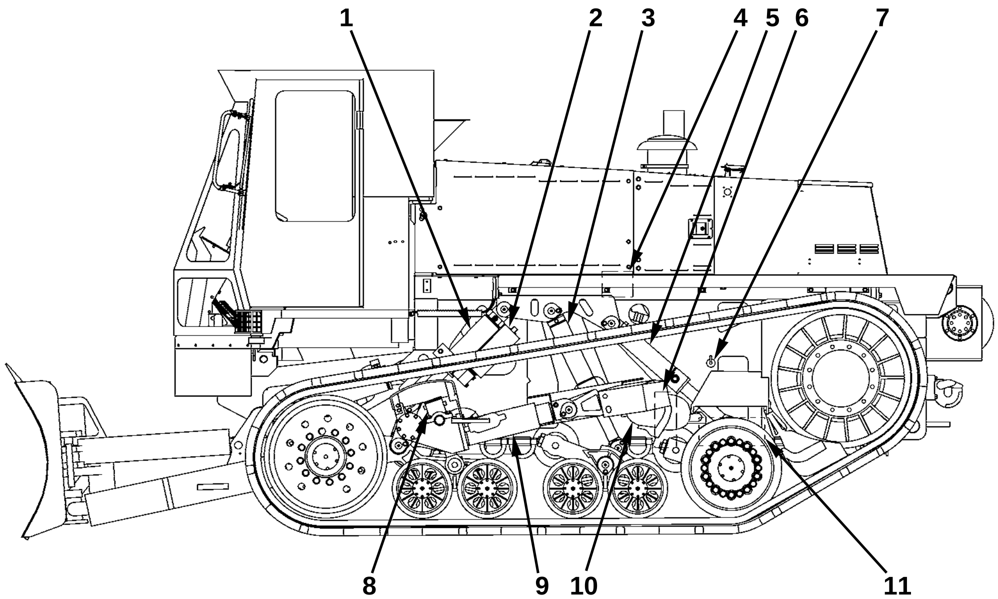
Front idler (1) is mounted to the brake assembly on major bogie (2), on each side of the machine. The front idlers are 730 mm (29 in) in diameter and are coated (bonded) with molded rubber 44 mm (1.7 in) thick. The rubber absorbs impact and also serves as the wear surface. There is a total of 60, 12 mm (0.5 in) deep, alternating grooves molded into the rubber wear surface. These grooves make the front idlers self-cleaning and assure good contact with the inside of drive belt (14) for stopping the machine.

Rear Idlers

Rear idler (13) is mounted to rear swing arm (12), on each side of the machine. The rear idlers are 583 mm (30 in) in diameter and are coated (bonded) with molded rubber 19 mm (0.75 in) thick. The rubber absorbs impact and also serves as the wear surface. A sight gauge is installed in the center of the rear idler for viewing of the oil level.

Suspension Hydraulic System

Suspension Hydraulic Components



Suspension and Undercarriage Components.
(1) Front suspension cylinder. (2) Accumulator. (3) Middle suspension cylinder. (4) Multifunction control valve. (5) Rear suspension cylinder. (6) Accumulator. (7) Manual suspension lockout valve. (8) Bogie suspension cylinder. (9) Recoil cylinder. (10) Accumulator. (11) Accumulator.

The suspension hydraulic system supports the machine weight, tensions the track, and absorbs shock while the machine is travelling at high speed over rough terrain.

The major components of the suspension system are: front suspension cylinder (1), accumulators (2), (6), (10), and (11), middle suspension cylinder (3), multifunction control valve (4), rear suspension cylinder (5), bogie suspension cylinder (8), suspension lockout valve (7), recoil cylinder (9), and accumulator (10).

The suspension hydraulic system must be precharged with hydraulic oil after assembly. The suspension is precharged through remote charging valves, as well as charging valves which are mounted directly on some of the cylinders and accumulators.

The suspension has three modes of operation.

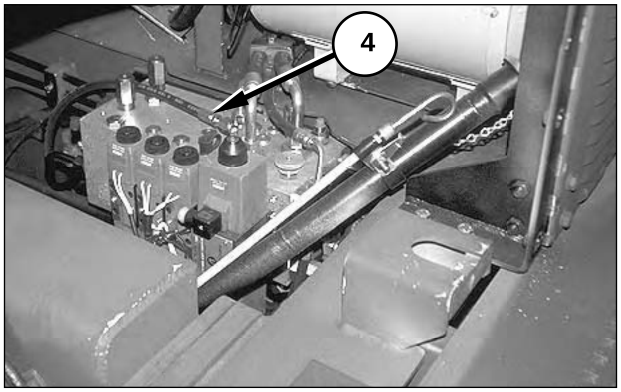
In SELF-DEPLOY mode, the suspension is active so that recoil cylinder (9), front suspension cylinder (1) and rear suspension cylinder (5) extend and retract to absorb shock as the machine travels. SELF-DEPLOY is the default mode of operation for the suspension.

In EARTHMOVING mode, recoil cylinder (9), front suspension cylinder (1) and rear suspension cylinder (5) are locked when the machine is traveling FORWARD. This gives a stable base to allow fine control of the blade in earthmoving applications. The suspension is put in EARTHMOVING mode when the earthmoving/self-deploy switch is moved into the EARTHMOVING position. The switch activates a solenoid valve which blocks the flow of oil in and out of the recoil, front and rear suspension cylinders. If the solenoid valve fails, the suspension may be manually put into EARTHMOVING mode. Turning manual suspension lockout valve (7) on both sides of the machine puts the suspension into EARTHMOVING mode.

The third mode of suspension operation is the KNEELING mode. Front suspension cylinder (1) can be retracted with the KNEELING switch in the cab. The purpose of the KNEELING mode is to lower the front of the machine in order to drive the machine on and off transport aircraft, such as the C-130.

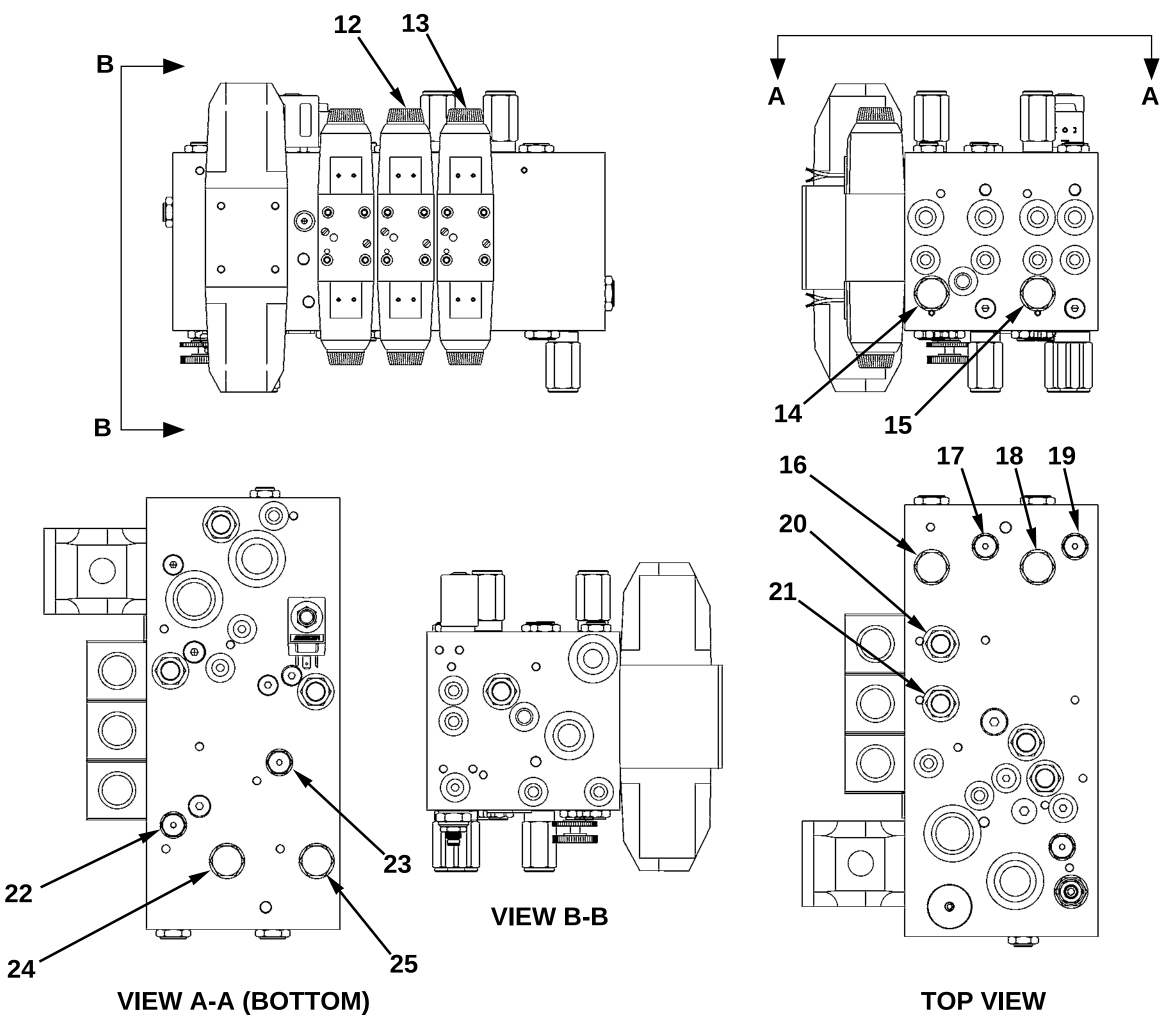
NOTE: Middle suspension cylinder (3) and bogie suspension cylinder (8) extend and retract in all modes of operation.

Multifunction Control Valve

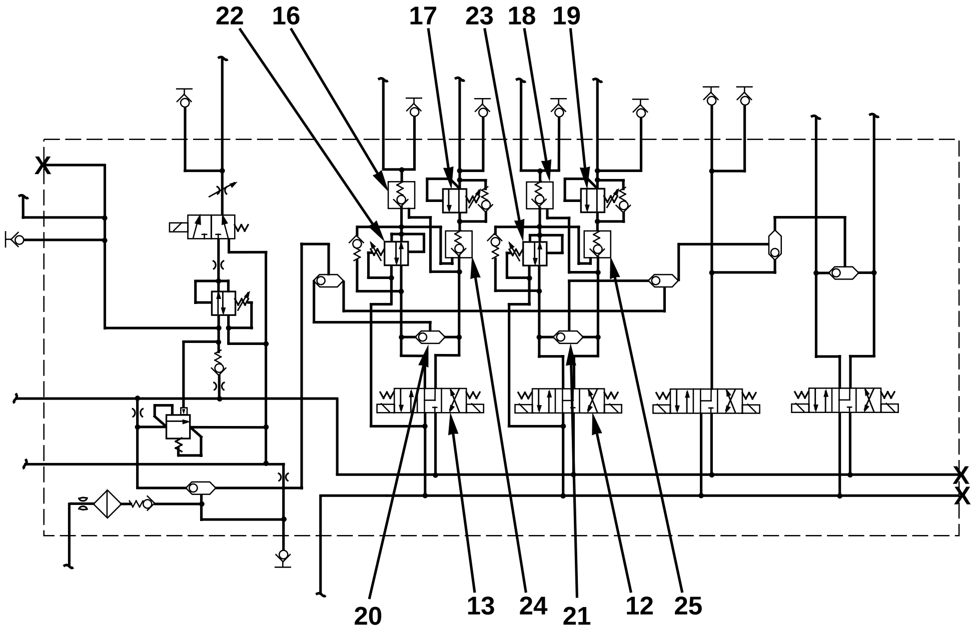


Location of Kneeling Solenoid Valves.
(4) Multifunction control valve.

Multifunction control valve (4) is mounted to the machine frame. The multifunction control valve contains a number of valves that are used in the suspension hydraulic system.



Multifunction Control Valve Group, Suspension Hydraulic Components.
(12) Right kneeling solenoid valve. (13) Left kneeling solenoid valve. (14) Check valve. (15) Check valve. (16) Check valve. (17) Relief valve. (18) Check valve. (19) Relief valve. (20) Resolver. (21) Resolver. (22) Pressure reduction valve. (23) Pressure reduction valve. (24) Check valve. (25) Check valve.



Multifunction Control Valve Schematic, Suspension Hydraulic Components.
(12) Right kneeling solenoid valve. (13) Left kneeling solenoid valve. (16) Check valve. (17) Relief valve. (18) Check valve. (19) Relief valve. (20) Resolver. (21) Resolver. (22) Pressure reduction valve. (23) Pressure reduction valve. (24) Check valve. (25) Check valve.

Right and left kneeling solenoid valves (12) and (13) control the kneeling function. When the valves are actuated in one direction, the machine kneels. When the valves are actuated in the other direction, the machine raises from the kneeled position.

Relief valves (17) and (19) maintain 6210 kPa (900 psi) of back pressure in the rod end of front suspension cylinder (1), when the machine is being raised from the kneeled position. The relief valves contain an integral check valve to allow oil to flow freely around the valves and into the rod end of the cylinders.

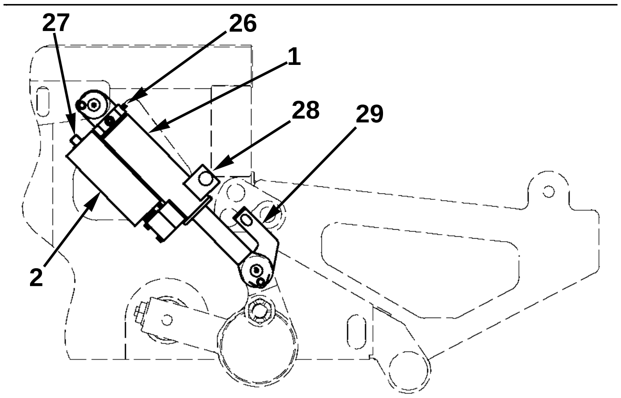
Check valves (16), (18), (24), and (25) prevent front suspension cylinder (1) from drifting down when kneeling solenoid valves (12) and (13) are in the neutral position. The check valves are pilot operated. When pressure is applied to the rod end circuit (kneeling - down) the check valves are held open to allow oil to flow out of the head end of the front suspension cylinders. The check valves are pilot operated. When pressure is applied to the head end circuit (machine rising), the check valves are held open to allow oil to flow out of the rod end of the front suspension cylinders.

Check valves (14) and (!5) prevent oil in the front suspension cylinder accumulator from bleeding through multifunction control valve (4) during normal operation. These check valves also allow pump supply oil to flow into the rod end of the kneeling cylinder when the machine is being lowered.

Resolvers (20) and (21) compare the head end and rod end pressure in the front cylinder when the machine is being raised or lowered. The highest pressure is directed into the resolver network.

Pressure reduction valves (22) and (23) maintain 6205 kPa (900 psi) of pressure in the head end of front suspension cylinder (1) when the cylinders are being extended (machine rising).

Front Suspension Cylinder and Accumulator



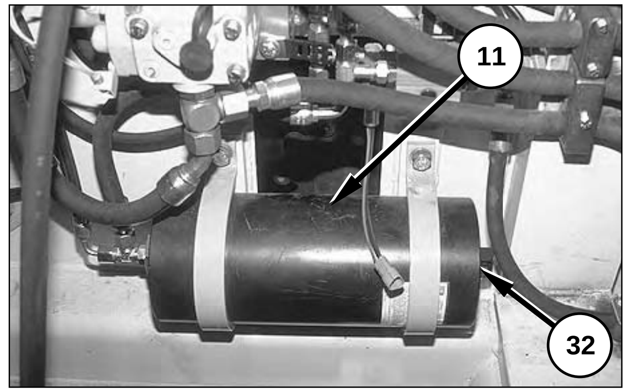
Left Front Suspension Cylinder and Accumulator.
(1) Front suspension cylinder. (2) Accumulator. (26) Bleed valve. (27) Charging valve. (28) Boss. (29) Bar.

Front suspension cylinder (1) is mounted between the machine frame and the front swing arm, on both sides of the machine. The front suspension cylinder extends and retracts to raise and lower the front of the machine during KNEELING mode operation. Boss (28) and bar (29) are mounted on the cylinder so that a locking pin can be inserted to mechanically lock the cylinder into the retracted position (machine kneeled).

Accumulator (2) is mounted directly to front suspension cylinder (1). The accumulator is connected to the rod (lower) end of the front suspension cylinder. The accumulator is precharged with nitrogen to a pressure of 2756 kPa (400 psi) through charging valve (27). Air is bled from the front suspension cylinder through bleed valve (26).

Remote Charging Valves (Left Side Shown, Right Side Symmetrical).
(30) Charging valve. (31) Charging valve.

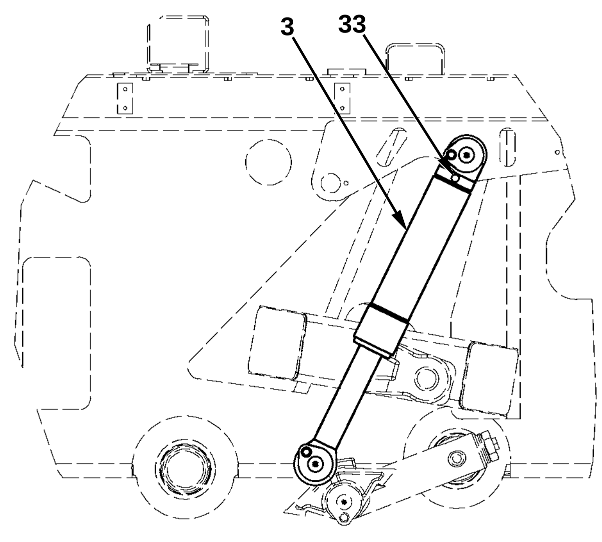
Charging valve (30) can be used to supply oil to the top (head) end of front suspension cylinder (1). Charging valve (31) can be used to supply oil to the bottom (rod) end of front suspension cylinder (1).



View of Left Main Frame Wall (Right Side Similar, Machine Shown Partially Assembled).
(11) Accumulator. (32) Charging valve.

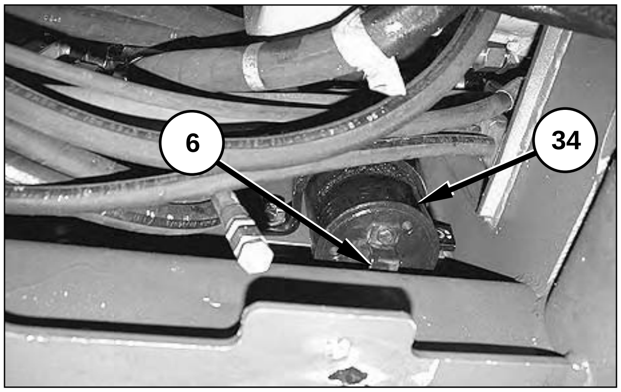
Accumulator (11) is mounted on the inside wall of both sides of the machine frame, next to the transmission. The accumulator is connected to the head end of each front suspension cylinder (1). The accumulator is precharged with nitrogen to a pressure of 2760 kPa (400 psi) through charging valve (32).

Middle Suspension Cylinder and Accumulator



Location of Left Middle Suspension Cylinder (Right Side Similar).
(3) Middle suspension cylinder. (33) Bleed valve.

Middle suspension cylinder (3) is mounted between the machine frame and the middle swing arm on both sides of the machine. The piston inside the middle suspension cylinder has a hole which internally connects the head and rod ends of the cylinder. This hole allows oil to transfer between the head and rod ends, allowing the cylinder to extend and retract. Air is bled from the middle suspension cylinder through bleed valve (33).



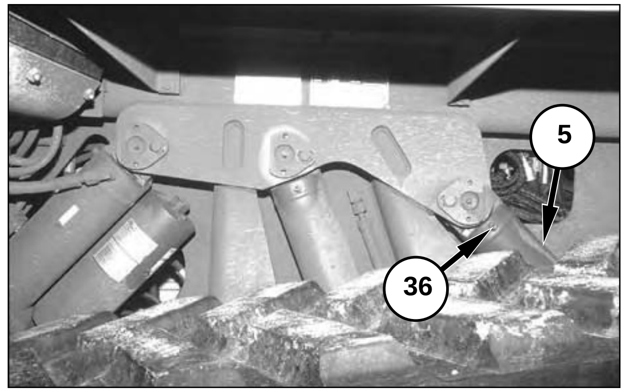
View of Right Frame Side Wall (Left Side Similar, Bottom Cover Removed).
(6) Accumulator. (34) Charging valve.

Accumulator (6) is mounted to the inside of each side of the machine frame, to the rear of the engine. The accumulator is connected to right middle suspension cylinder (3). The accumulator is precharged with nitrogen to a pressure of 2755 kPa (400 psi) through charging valve (34).

Remote Charging Valves (Left Side Shown, Right Side Symmetrical).
(35) Charging valve.

Oil is supplied to middle suspension cylinder (3) through charging valve (35). The middle suspension cylinder system is charged to a pressure of 6210 kPa (900 psi).

Rear Suspension Cylinder



Rear Suspension Cylinder.
(5) Rear suspension cylinder. (36) Bleed valve.

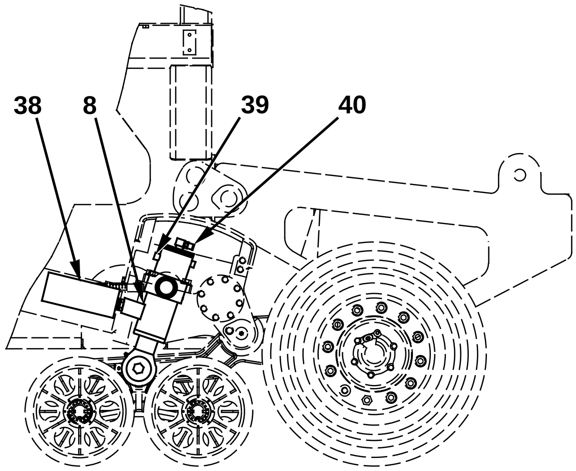
Rear suspension cylinder (5) is mounted between the machine frame and the rear swing arm on both sides of the machine. The piston inside the rear suspension cylinder has a hole which internally connects the head and rod ends of the cylinder. Oil transfers through the hole and between the head and rod ends, allowing the cylinder to extend and retract as necessary. The rear suspension cylinder is connected to the recoil cylinder through suspension lockout valve (7). Air is bled from the rear suspension cylinder through bleed valve (36).

Remote Charging Valves (Left Side Shown, Right Side Symmetrical).
(37) Charging valve.

Oil is supplied to rear suspension cylinder (5) through charging valve (37), which is marked “RECOIL” on the decal.

NOTE: Rear suspension cylinder (5) is hydraulically coupled with recoil cylinder (9).

Midroller Bogie Cylinder and Accumulator



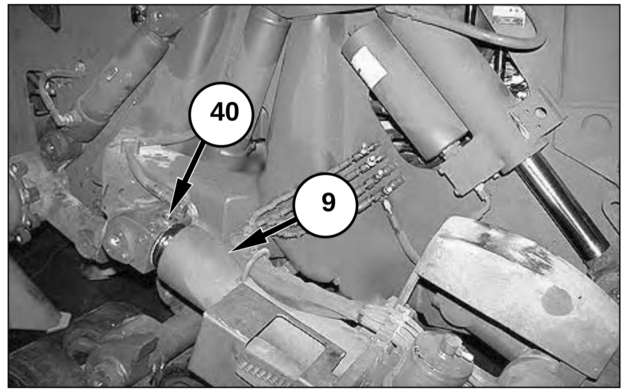
Location of Right Midroller Bogie Cylinder and Accumulator (Left Side Similar).
(8) Bogie cylinder. (38) Accumulator. (39) Bleed valve.
(40) Charging valve.

Bogie cylinder (8) is mounted between the major bogie and the front minor bogie. The piston inside the bogie cylinder has a hole which internally connects the head and rod ends of the cylinder. Oil transfers through the hole and between the head and rod ends, allowing the cylinder to extend and retract as necessary. Air is bled from the midroller bogie cylinder through bleed valve (39).

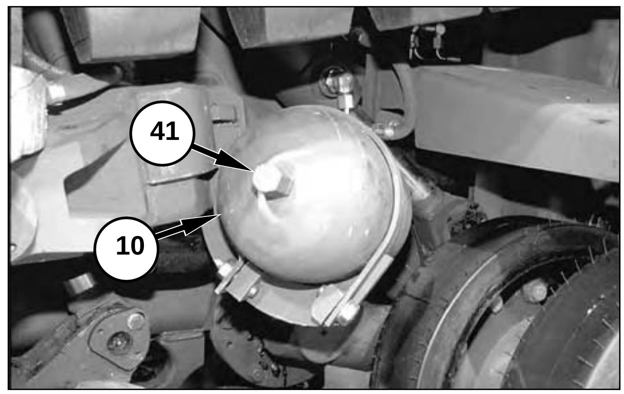
Accumulator (38) is mounted directly to bogie cylinder (8). The accumulator is connected to the rod end of the bogie cylinders. The accumulator is precharged with nitrogen to a pressure of 6890 kPa (1000 psi), through a charging valve on the end of the accumulator.

Bogie suspension cylinder (8) is charged with hydraulic oil to a pressure of 11 790 kPa (1710 psi), through charging valve (40).

Recoil Cylinder and Accumulator



Location of Right Recoil Cylinder, Machine Partially Disassembled (Left Side Similar).
(9) Recoil cylinder. (40) Bleed valve.



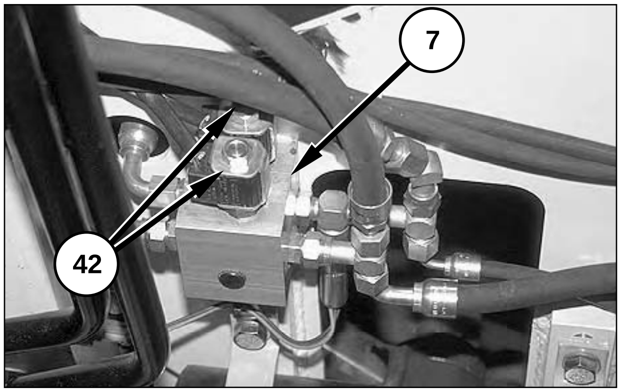
Location of Right Recoil Accumulator, Cover Removed (Left Side Similar).
(10) Accumulator. (41) Charging valve.

Recoil cylinder (9) is mounted between the machine frame and the major bogie on both sides of the machine. Bleed valve (40) is located on the end of the cylinder rod and is used to bleed air from the recoil cylinder.

Accumulator (10) is mounted in front of the rear idlers. The accumulator is connected to the head end of the recoil cylinders. The accumulator is precharged with nitrogen to a pressure of 11 720 kPa (1700 psi), through charging valve (41).

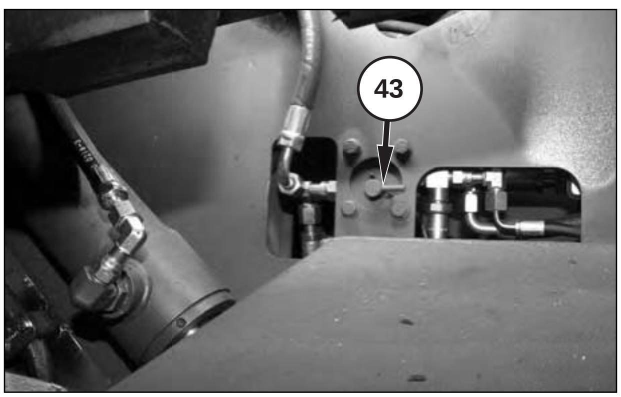
Recoil cylinder (9) is precharged with hydraulic oil to a pressure of 15 170 kPa (2200 psi), through charging valve (37).

Lockout Valve



Location of Right Lockout Valve (Left Side Similar).
(7) Lockout valve. (42) Solenoid.

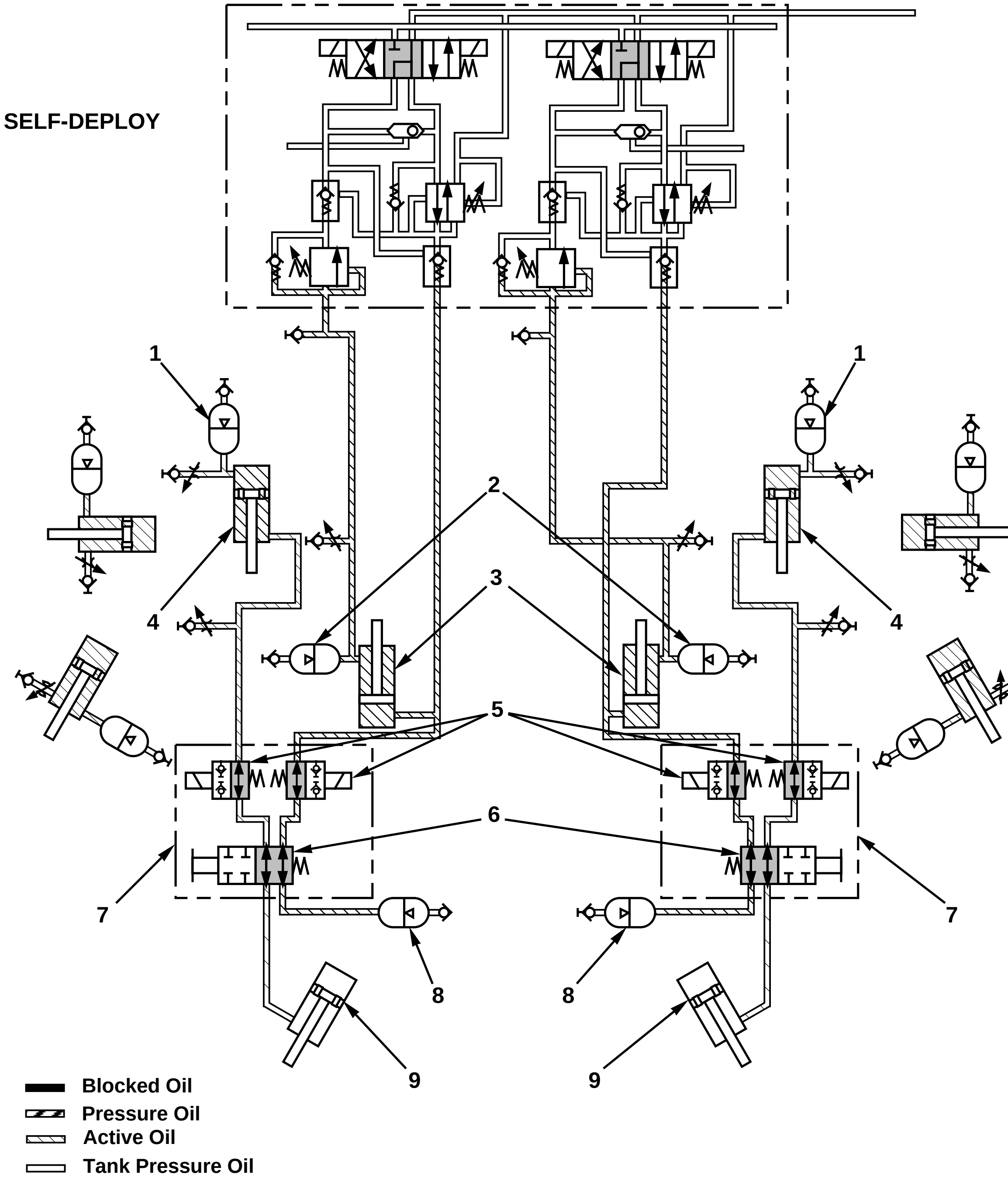
Lockout valve (7) is mounted on the inside walls of both sides of the machine main frame, in front of the transmission. The lockout valve is a combination of a solenoid-operated valve and a manually operated valve. Both the manual and solenoid valves can block the flow of oil between front suspension cylinder (1), accumulator (10), recoil cylinder (9) and rear suspension cylinder (5) when the machine is put into EARTHMOVING mode. The solenoid valve is activated by the self-deploy/earthmoving switch located on the instrument panel in the cab.



Location of Left Lockout Valve Manual Control, Suspension Cover Removed (Right Side Similar).
(43) Turning lever.

The manual valve is activated by turning lever (43), which is located in front of the drive wheels on both sides of the machine. Turning the lever clockwise closes the valve.

Suspension Hydraulic System
SELF-DEPLOY Mode



Suspension Hydraulic Schematic—SELF-DEPLOY Mode.
(1) Accumulators. (2) Accumulators. (3) Front suspension cylinders. (4) Recoil cylinders. (5) Lockout solenoid valves. (6) Manual lockout valves. (7) Lockout valves. (8) Accumulators. (9) Rear suspension cylinders.

When the machine is in SELF-DEPLOY mode, the suspension is active and will absorb shocks when being driven over uneven terrain. Before the machine is placed in SELF-DEPLOY mode, the bulldozer blade must be fully raised and manual lockout valves (6) must be in the OPEN position on both sides of the machine.

The EPTC II monitors the self-deploy/earthmoving switch, located on the instrument panel, and controls lockout solenoid valves (5). When the switch is in the SELF-DEPLOY position, the EPTC II deactivates the lockout solenoid valves. When the lockout solenoid valves are deactivated (and manual lockout valves [6] are OPEN), oil is free to flow through lockout valves (7).

When the rear idler encounters a large object, the piston inside rear suspension cylinders (9) moves up, and the cylinders retract. When the cylinders retract, oil from the head end of the cylinders is displaced into the rod end. Since the volume of the head end of the cylinders is greater than the volume of the rod end of the cylinders, oil flows out of the rod end of the cylinders.

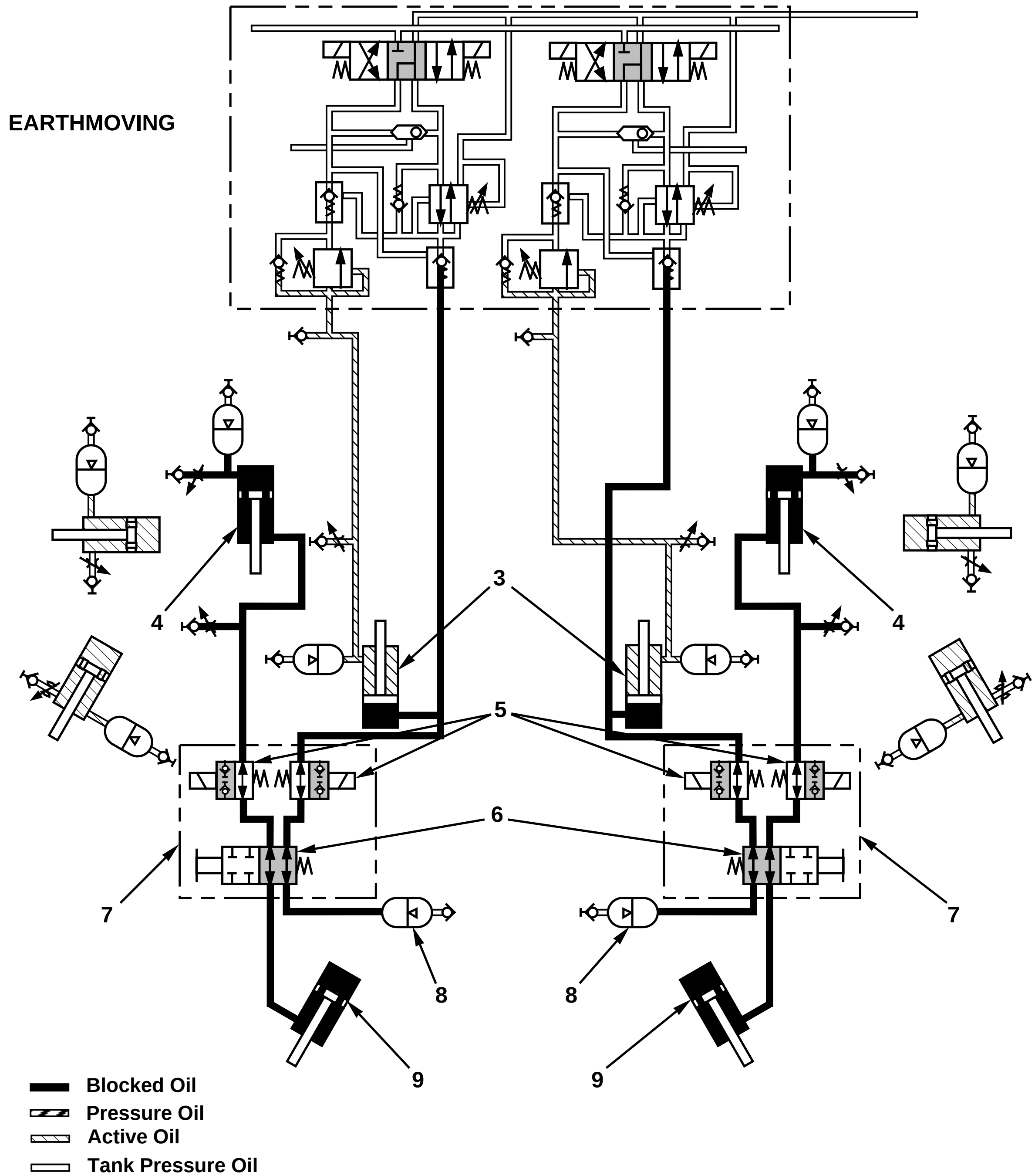
Oil flowing out of the rod end of rear suspension cylinders (9) flows through lockout valves (7) to the rod end of recoil cylinders (4). Oil flowing into the rod end of the recoil cylinders increases the pressure in the rod end of the cylinders. This causes the recoil cylinders to extend and the pressure in accumulators (1) to increase. The recoil cylinders must extend when the rear suspension cylinder retracts, in order to maintain the correct tension on the drive belt.

When the rear idler moves down off the object, the increased pressure in accumulators (1) causes the oil to flow out of recoil cylinders (4) and back into rear suspension cylinders (9), causing the rear suspension cylinders to return to the normal position.

If the front idler encounters a large object, the piston in front suspension cylinders (3) moves up and the cylinders retract. Oil displaced from the head end of the cylinders flows through lockout valves (7) to accumulators (8), which increases the pressure in the accumulators. Oil flows into the rod end of the front suspension cylinders from accumulators (2), which drops in pressure.

When the front idler rolls down off the object, the increased pressure in accumulators (8) causes oil to flow back into the head end of front suspension cylinders (3). Oil also flows out of the rod end of the suspension cylinders and back into accumulators (2). This oil flow causes the suspension cylinders to return to their normal length.

Suspension Hydraulic System
EARTHMOVING Mode



Suspension Hydraulic Schematic—EARTHMOVING Mode.
(3) Front suspension cylinders. (4) Recoil cylinders. (5) Lockout solenoid valves. (6) Manual lockout valves. (7) Lockout valves. (8) Accumulators. (9) Rear suspension cylinders.

When the switch in the cab is put into the EARTHMOVING position, lockout solenoid valves (5) are activated. When the lockout solenoid valves are activated, an internal spool shifts and blocks oil from flowing through lockout valves (7).

If the rear idler encounters a large object, the piston inside rear suspension cylinders (9) will try to move up and retract the cylinders. This will start to increase the pressure in the head end of the cylinders, which will cause oil to flow through the hole in the piston and into the rod end of the cylinders. However, since the volume of the rod end of the cylinders is lower than the volume in the head end of the cylinders, and lockout valves (7) are preventing oil from flowing out, the piston cannot move and is locked in position.

If the front idler encounters a large object, the piston inside front suspension cylinders (3) will try to move up and retract the cylinders. This will increase the pressure in the head end of the cylinders. Oil is blocked from flowing out the head end of the cylinders and into accumulator (8) by lockout valves (7). The cylinders are locked in position.

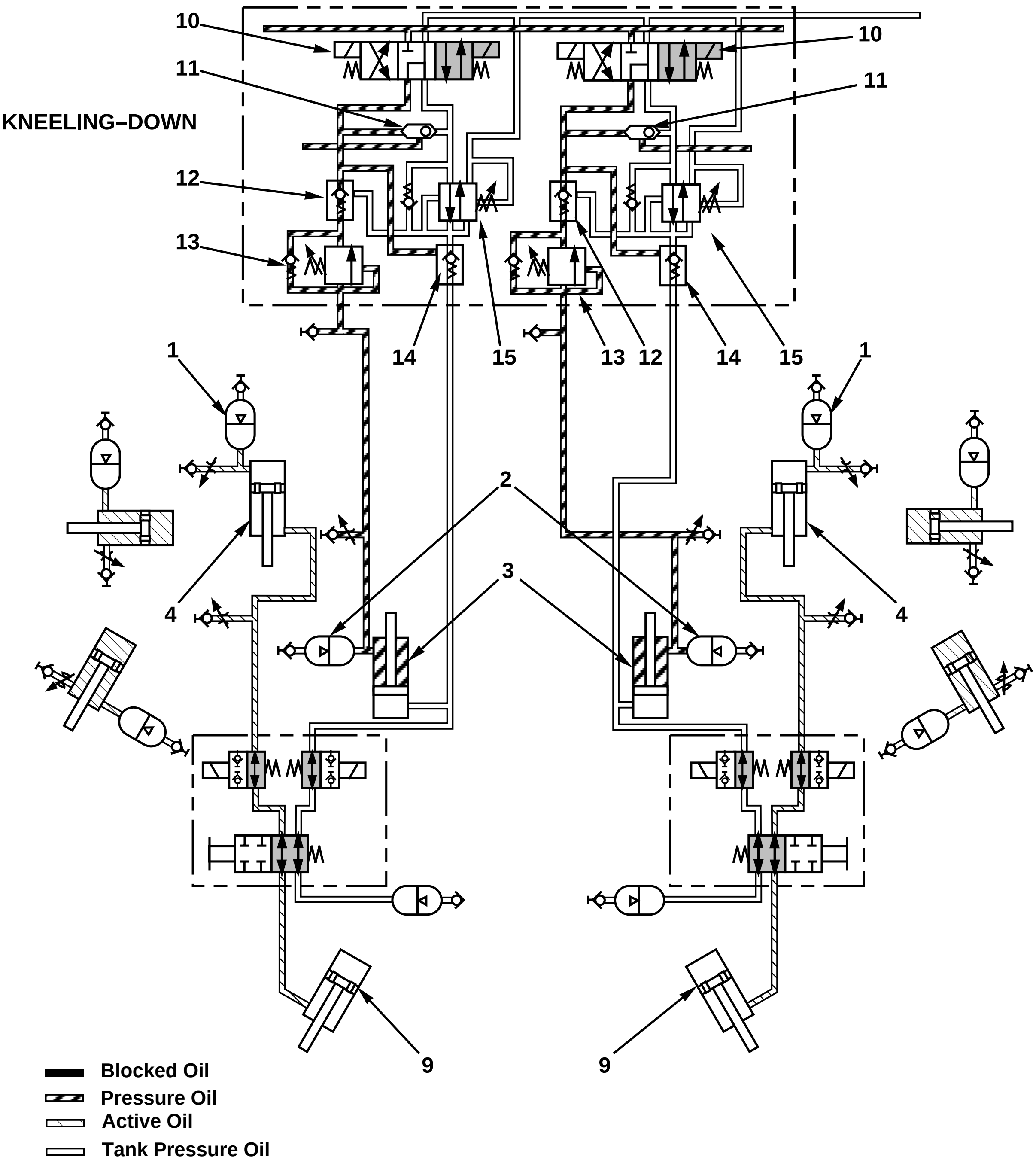
Moving manual lockout valves (6) to the locked position has the same effect as activating lockout solenoid valves (5).

NOTE: Lockout solenoid valves (5) will deactivate when the machine is put into a reverse gear, even if the machine is in EARTHMOVING mode. This feature allows the machine to operate at higher speeds in reverse, in order to reduce cycle times.

Recoil cylinder (4), the bogie suspension cylinder, and the middle suspension cylinder are active even when the suspension is locked. These suspension cylinders keep the drive belt tight force the midrollers to follow the terrain, keeping as much of the drive belt as possible in contact with the ground at all times.

Suspension Hydraulic System
Kneeling Operation

DOWN



Suspension Hydraulic Schematic—Kneeling Down.
(1) Accumulators. (2) Accumulators. (3) Front suspension cylinders. (4) Recoil cylinders. (6) Manual lockout valves. (9) Rear suspension cylinders. (10) Solenoid valves. (11) Resolvers. (12) Pilot check valves. (13) Relief valves. (14) Pilot check valves. (15) Pressure reduction valves.

When the machine is in the SELF-DEPLOY mode and the kneeling switch in the cab is moved into the DOWN position, solenoid valves (10) activate and shift.

Pressure oil from the implement hydraulic pump is directed through pilot check valves (12) and the check valve section of relief valves (13), to the rod end of front suspension cylinders (3) and accumulators (2). The pressure oil in the rod end of the front suspension cylinders cause the cylinders to retract, lowering the machine.

Pressure oil flows through resolvers (11) and into the implement load sensing signal circuit. The load sensing circuit signals the implement hydraulic pump to provide flow according to the demands of the circuit.

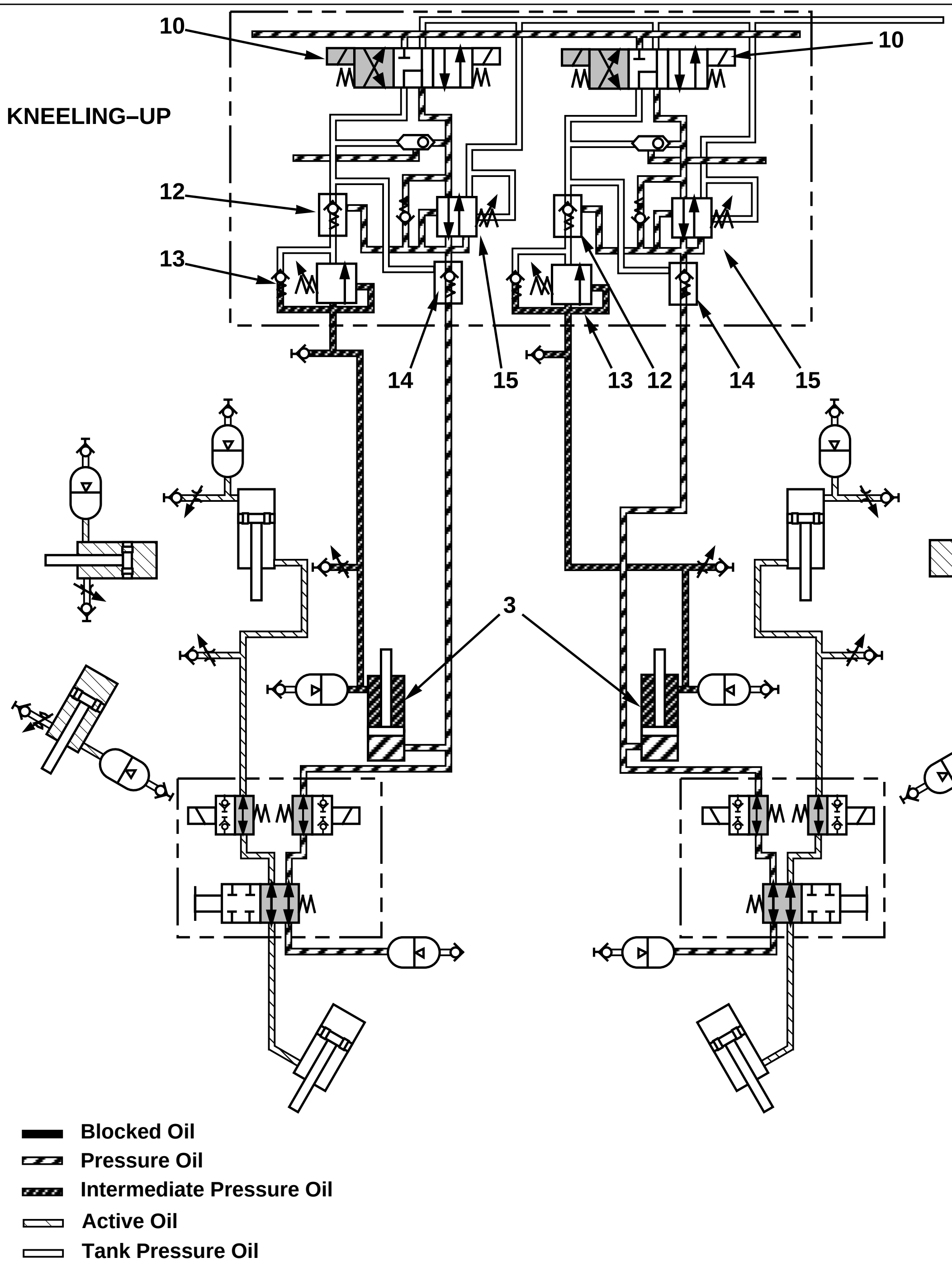
NOTE: Refer to *Specifications Systems Operation, Deployable Universal Combat Earthmover (DEUCE), Implement and Fan Hydraulic System,* “Systems Operation, Blade Hydraulic System” for a complete description of the implement pump load sensing circuit.

Oil is forced out of the head end of the front suspension cylinders. The pressure in the rod end circuit causes pilot check valves (14) to open and allow oil to flow through the check valve portion of pressure reduction valves (15), and back to the tank through solenoid valves (10).

The geometry of the undercarriage components causes the belt tension to increase when the machine is kneeled down. The increased belt tension causes increased pressure in recoil cylinders (4). The increased pressure in the recoil cylinders forces them to retract, which forces rear suspension cylinders (9) to extend. The increased pressure in the recoil circuit is also present in accumulators (1).

NOTE: If the machine is in EARTHMOVING mode, or the manual lockout valves are in the CLOSED position, the machine will not be able to kneel down since the recoil system is not able to adjust for the increased belt tension.

UP



Suspension Hydraulic Schematic—Kneeling Up.
(3) Front suspension cylinders. (10) Solenoid valves. (12) Pilot check valves. (13) Relief valves. (14) Pilot check valves. (15) Pressure reduction valves.

When the machine is in SELF-DEPLOY mode and the kneeling switch is moved to the UP position, solenoid valves (10) shift. When the solenoid valves shift, pressure oil from the implement hydraulic pump is directed to pressure reduction valves (15). Pressure oil flows through the pressure reduction valves, pilot check valves (14) and into the head end of front suspension cylinders (3).

Pressure reduction valves (15) allow oil to continue flowing into the head end of the front suspension cylinders until the pressure in the circuit reaches 6205 kPa (900 psi). When this pressure is exceeded, the pressure reduction valves begin to close and restrict oil flow to maintain the pressure.

Pressure in the head end of front suspension cylinders (3) causes the cylinders to extend, forcing oil out of the rod end of the cylinders.

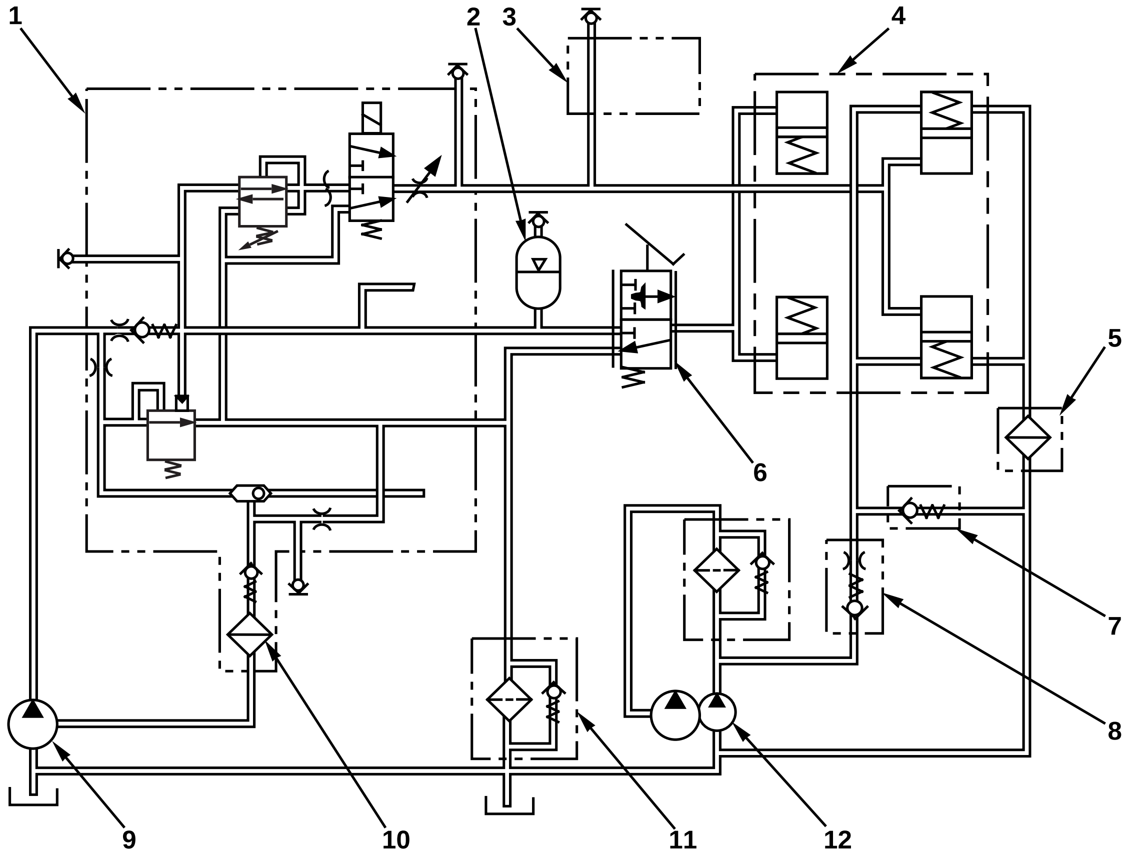
Oil from the rod end of the cylinders flows into relief valves (13). When the pressure in the rod end circuit reaches 3690 kPa (535 psi), the relief valves open.

Pilot check valves (12), which are held open by pressure in the head end circuit, allow oil to flow through the check valves and back to the tank through solenoid valves (10).

The operation of relief valves (13) and pressure reduction valves (15) cause a constant pressure difference across front suspension cylinders (3). This constant pressure difference raises the machine at a controlled speed.

Brake System

Brake System Components

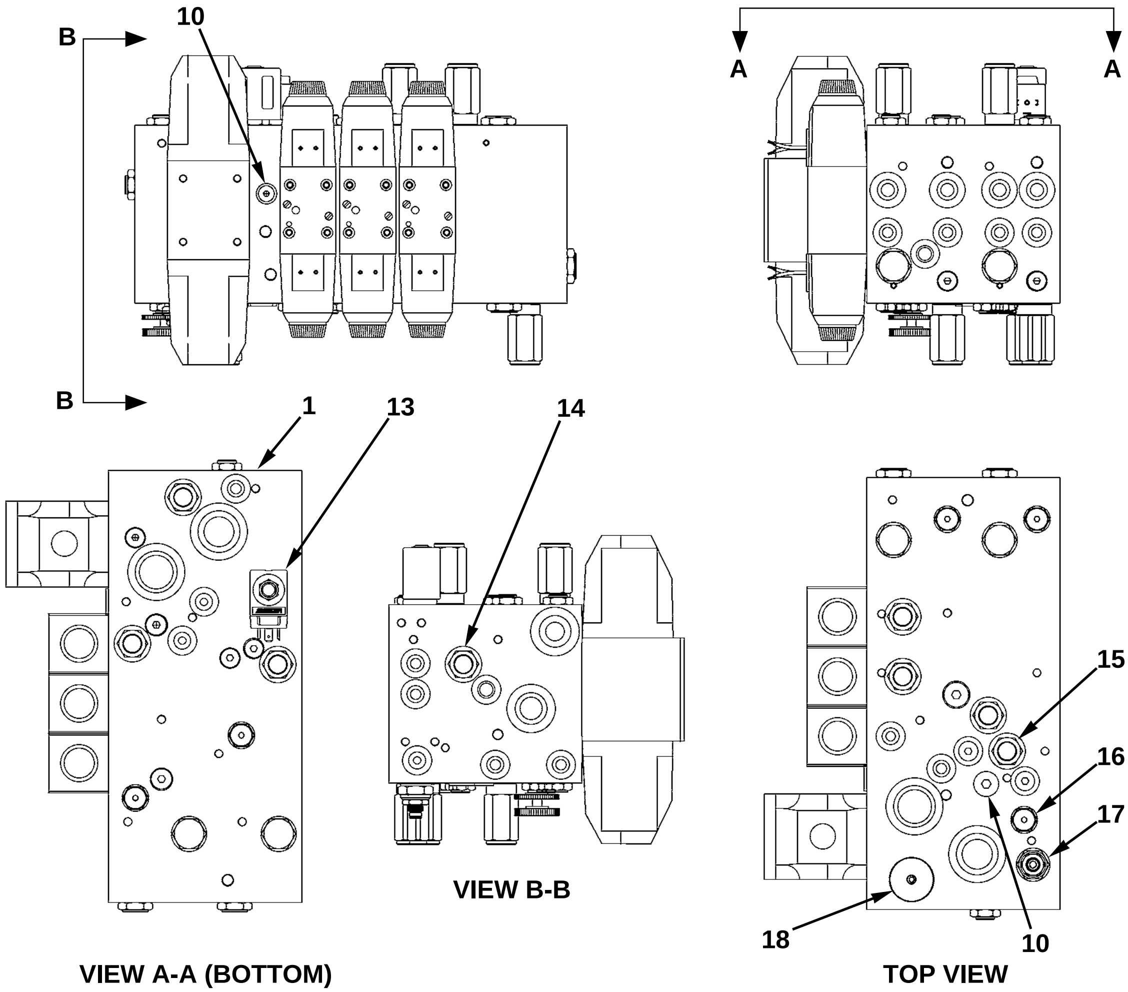


Brake System Components.
(1) Multifunction control valve. (2) Accumulator. (3) Remote hydraulic tool manifold. (4) Brake groups. (5) Strainer. (6) Brake Valve. (7) Check relief valve. (8) Check relief valve. (9) Implement pump. (10) Check valve and strainer. (11) Hydraulic return filter. (12) Steering charge pump.

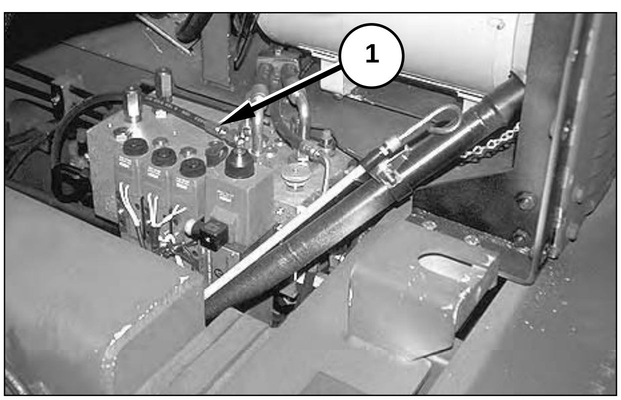
The machine has wet disk brakes for stopping and holding the machine. The parking brakes are spring applied and hydraulically released. The service brakes are hydraulically applied and spring released. The brake system draws oil from the implement hydraulic system to charge the brake accumulator and release the brakes. The charge oil from the steering charge pump flows through the brakes to cool them.

The major components of the brake system are: multifunction control valve (1), accumulator (2), remote hydraulic tool manifold (3), brake groups (4), strainer (5), brake valve (6), check relief valve (7), check relief valve (8), implement pump (9), check valve and strainer (10), hydraulic return filter (11), and steering charge pump (12).

Multifunction Valve



Multifunction Control Valve—Brake System Components.
(1) Multifunction control valve. (10) Check valve and strainer. (13) Parking brake solenoid valve. (14) Orifice check valve. (15) Resolver. (16) Relief valve. (17) Pilot unloading valve. (18) Manual parking brake release valve.



Location of Multifunction Control Valve.
(1) Multifunction control valve.

Multifunction control valve (1), which is mounted to the machine frame, contains several valves that are used in the brake system. The brake system components in the multifunction control valve are: parking brake solenoid valve (13), orifice check valve (14), resolver (15), relief valve (16), pilot unloading valve (17), and manual parking brake release valve (18).

Check valve and strainer (10) keeps higher pressures in the implement pump signal relief circuit from feeding back into the resolver network in multifunction valve (1). The strainer portion blocks any large debris from flowing to the load-sensing signal portion of the implement pump.

Parking brake solenoid valve (13) applies and releases the parking brakes. The parking brakes are released when the parking brake solenoid valve is energized. The parking brakes are applied when the parking brake solenoid valve is de-energized.

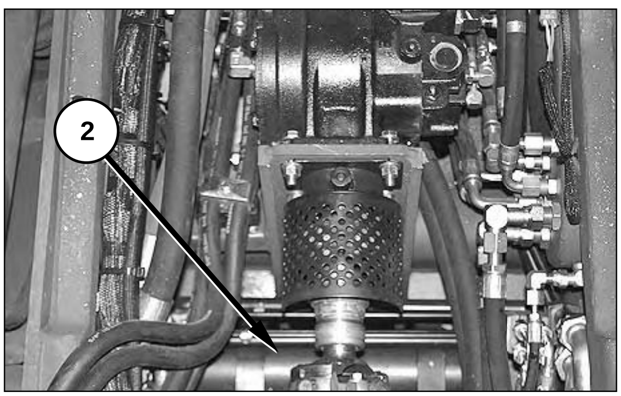
Relief valve (16) limits the pressure going to the parking brake system. When the pressure in the parking brake system exceeds 5515 kPa (800 psi), the relief valve shifts and directs a portion of the oil to the hydraulic tank.

Pilot unloading valve (17) produces the load sensing signal pressure for the brake system. The load sensing signal pressure is used to match the implement pump output to demands of the different hydraulic circuits.

NOTE: Refer to *Specifications Systems Operation, Deployable Universal Combat Earthmover (DEUCE), Implement and Fan Hydraulic System,* "Systems Operation, Blade Hydraulic System" for a description of how the load sensing signal is used by the implement pump.

Manual parking brake release valve (18) allows the parking brake to be manually released. The manual parking brake release valve must be open (fully counterclockwise) during normal operation. The manual parking brake release valve must be closed (fully clockwise) when the parking brake is manually released.

Accumulator

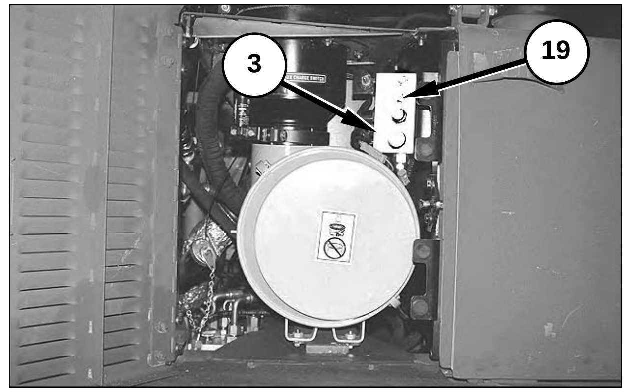


Location of Accumulator.
(2) Accumulator.

Accumulator (2) stores hydraulic pressure in the brake system. The accumulator is precharged with nitrogen gas to a pressure of 5855 kPa (850 psi). The accumulator maintains hydraulic pressure for braking system use, when the engine stops running. There is enough capacity in the accumulator to operate the service brake five times after the machine stops running.

NOTE: Five service brake applications will not completely exhaust the oil pressure stored in the accumulator. The service brake pedal may need to be depressed 120 or more times before the oil pressure is fully vented.

Remote Hydraulic Tool Manifold

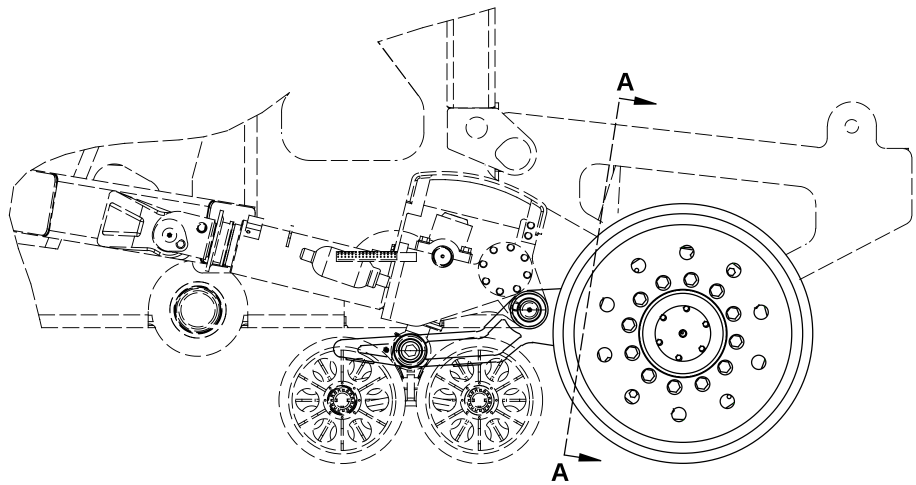


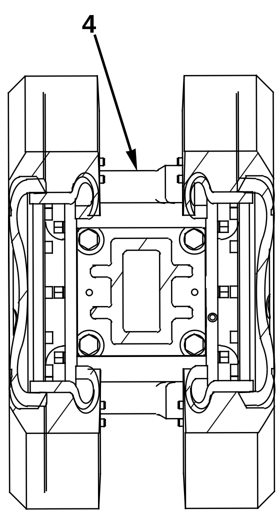
Location of Remote Hydraulic Tool Manifold.
(3) Remote hydraulic tool manifold. (19) Port.

Remote hydraulic tool manifold (3) contains ports and a signal relief valve. Port (19) provides an input location for hydraulic pressure used to manually release the parking brakes.

NOTE: The signal relief valve and the other ports in remote hydraulic tool manifold (3) are used with the remote hydraulic tools.

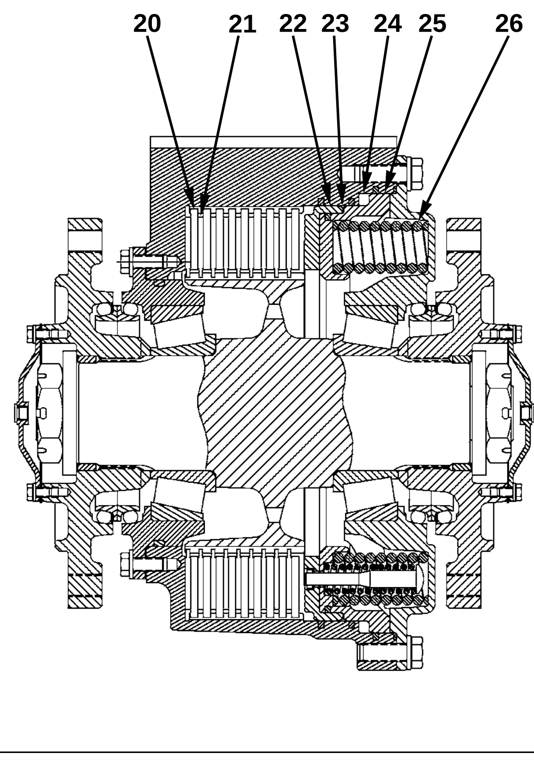
Brake Group





Location of Brake Group (View A–A).
(4) Brake groups.

Brake groups (4) are mounted to the front of the major bogie, between the front idlers. The brake groups contain both a parking brake and a service brake. The parking brakes are spring applied and hydraulically released. The service brakes are hydraulically applied and spring released.



Section View of Brake Group.
(20) Plates. (21) Disks. (22) Service brake piston. (23) Chamber. (24) Chamber. (25) Parking brake piston. (26) Springs.

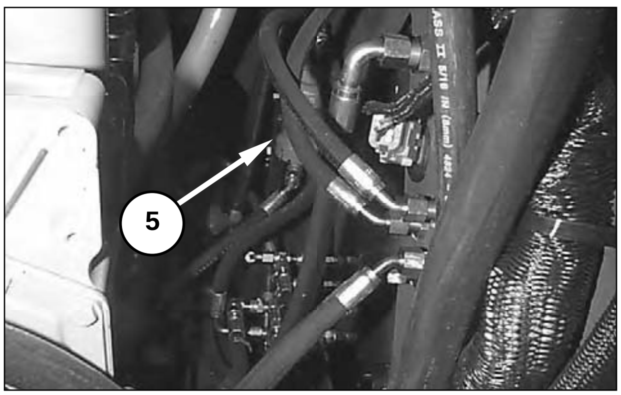
Plates (20) are splined to the brake housing and do not turn. Disks (21) are splined to the brake axle and turn with the axle. When the disks are pressed into the plates, the friction between the disks and plates stops the rotation of the axle.

When the parking brake is applied, chamber (24) is connected to the hydraulic tank. The force of springs (26) forces both brake pistons against disks (21) and plates (20) to apply the brake.

When the parking brake is released, chamber (24) is pressurized, which forces parking brake piston (25) to the right, against springs (26). If the service brakes are not applied, the pressure in chamber (23) is low and service brake piston (22) is not applying any force to the disks and plates. The axle is then free to rotate.

When the service brakes are applied, chamber (23) is pressurized. The pressure in the chamber pushes service brake piston (22) to the left, against the disks and plates. The brakes are applied proportionally to the pressure applied to the chamber.

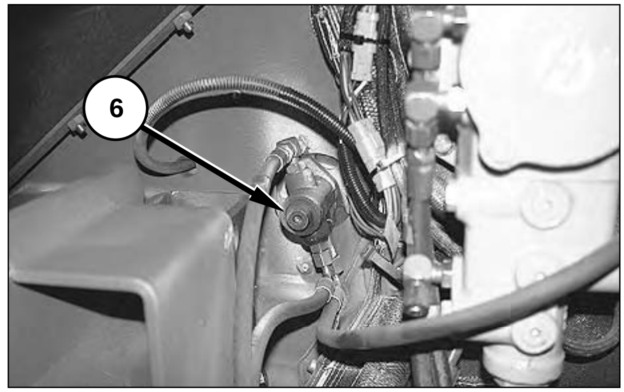
Strainer



Location of Strainer.
(5) Strainer.

Strainer (5) is mounted on the inside of the left main frame, near the front of the engine. The strainer stops any large particles from flowing from the brakes to the inlet of steering charge pump (12).

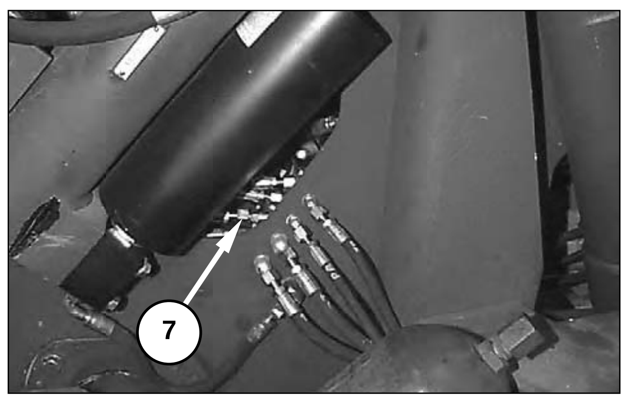
Brake Valve



Location of Brake Valve.
(6) Brake valve.

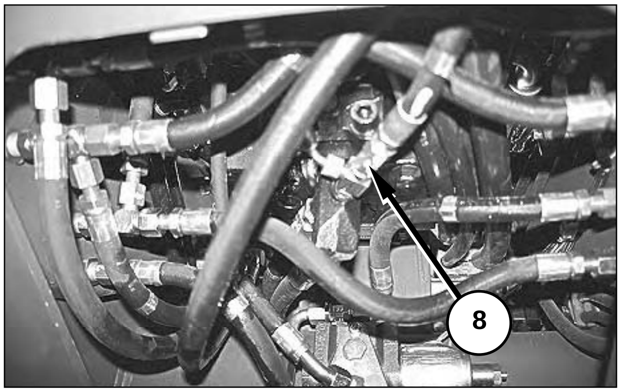
Brake valve (6) is located on the bottom of the cab floor, beneath the service brake pedal. The brake valve controls the service brakes. The brake valve connects the service brake piston to tank pressure when the brake pedal is not pressed. When the brake pedal is pressed, the brake valve directs pressure oil to the service brake piston to apply the brakes. The farther the brake pedal is pressed, the greater the pressure that the brake valve directs to the service brakes.

Check Relief Valves



Location of Check Relief Valve.
(7) Check relief valve.

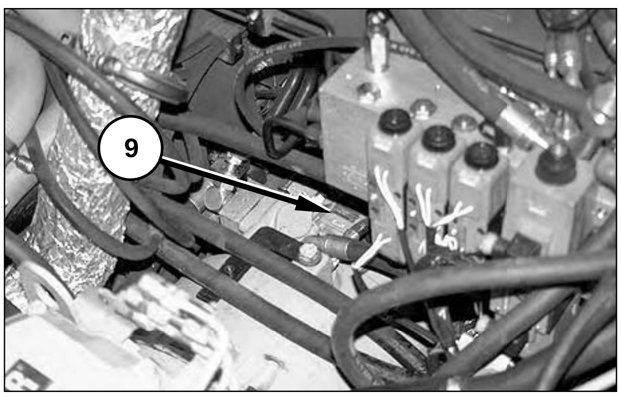
Check relief valve (7) relieves pressure in the brakes when the machine is operating with cold hydraulic oil. The check valve opens at approximately 170 kPa (25 psi).



Location of Check Relief Valve.
(8) Check relief valve.

Check relief valve (8) is located on the bottom of the steering pump. The check relief valve controls the amount of cooling oil that flows through the brakes. The check relief valve also limits the minimum charge pressure in the steering circuit to approximately 1310 kPa (190 psi), to ensure adequate charge pressure for the steering pump.

Implement Pump



Location of Implement Pump.
(9) Implement pump.

Implement pump (9) supplies hydraulic oil to the brake circuit.

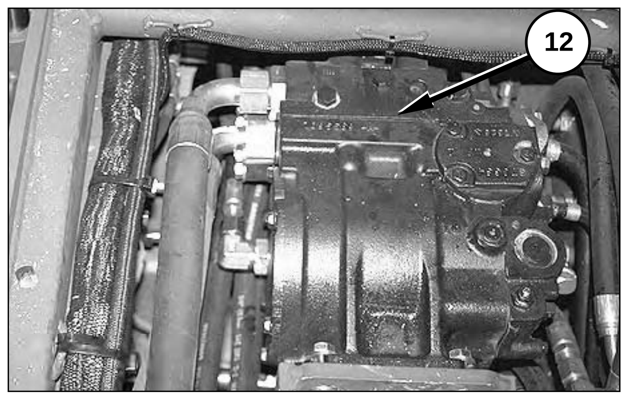
NOTE: Refer to *Specifications Systems Operation, Deployable Universal Combat Earthmover (DEUCE), Implement and Fan Hydraulic System,* "Systems Operation, Blade Hydraulic System" for more information on the implement pump.

Hydraulic Return Filter

Location of Hydraulic Return Filter.
(11) Hydraulic return filter.

Hydraulic return filter (11) is located in the oil filter compartment, on the right side of the machine. The hydraulic return filter cleans the return oil from most of the hydraulic circuits before the oil is returned to the hydraulic tank.

Steering Charge Pump



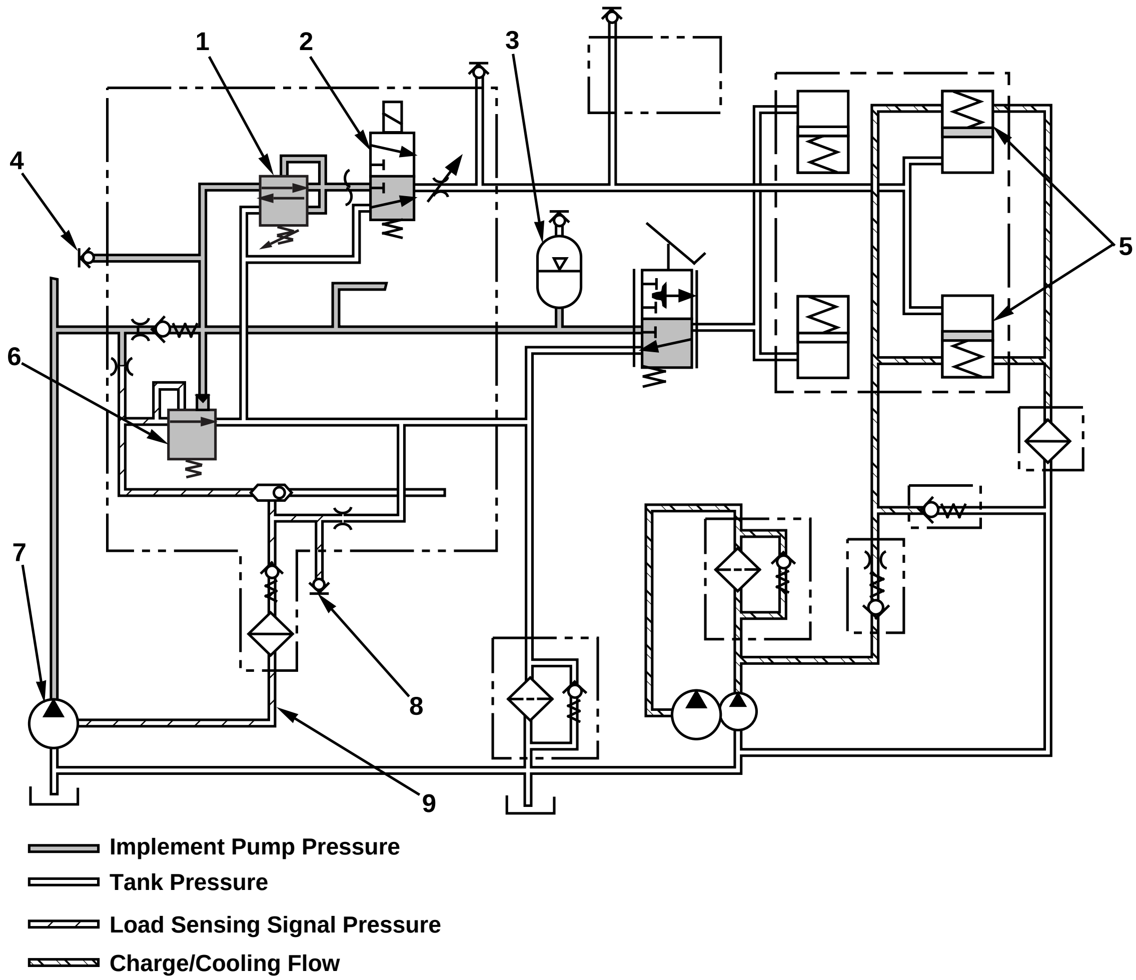
Location of Steering Charge Pump.
(12) Steering charge pump.

Steering charge pump (12) is integrated into the front of the steering pump. The steering charge pump provides hydraulic oil to cool the brakes.

NOTE: Refer to "Systems Operation, Steering System, Steering Pump Operation," in this module, for more information about the steering pump and the steering charge pump.

Brake Hydraulic System

Parking Brake Applied

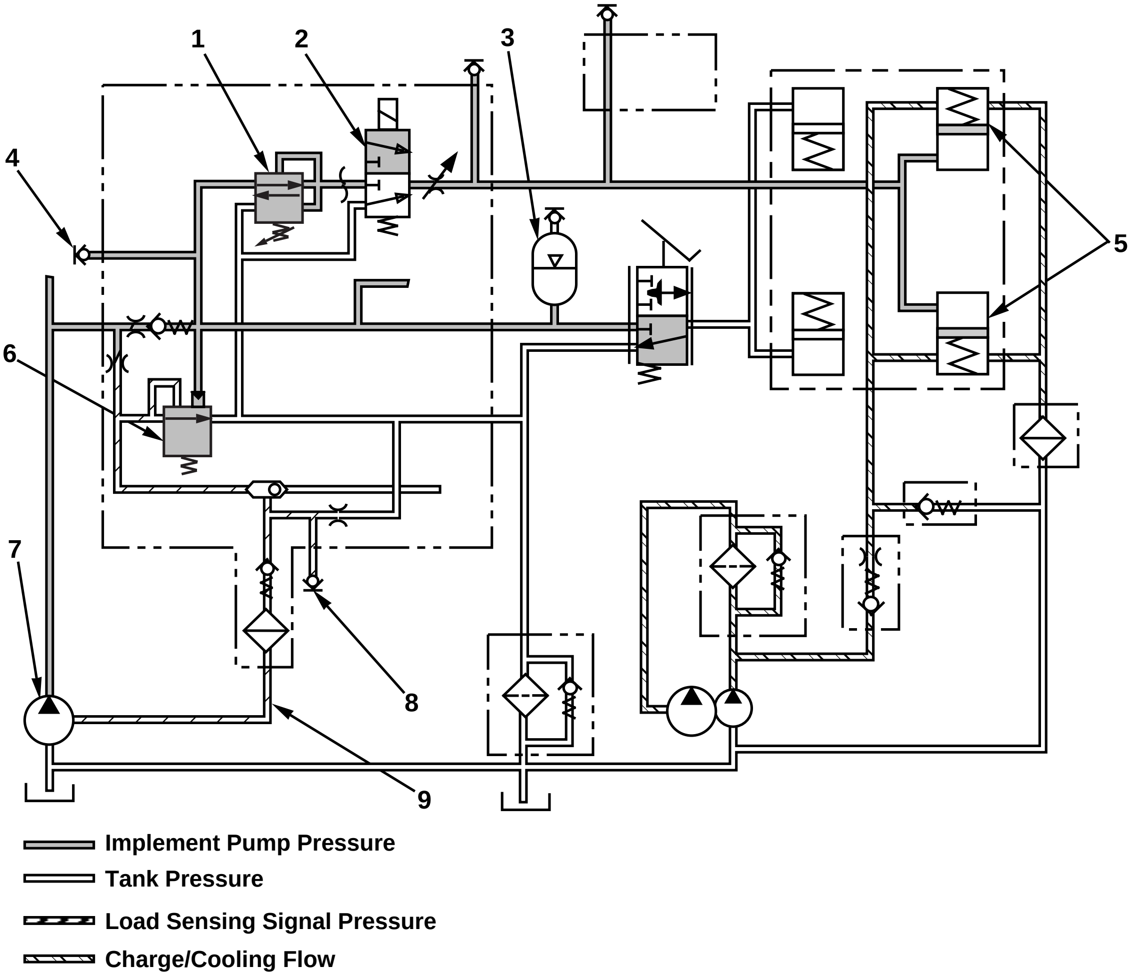


Brake System Schematic—Parking Brake Applied.
(1) Pressure limiter. (2) Parking brake solenoid valve. (3) Accumulator. (4) Test port. (5) Parking brakes. (6) Pilot unloading valve. (7) Implement pump. (8) Test port. (9) Line.

The parking brake (5) is applied when parking brake solenoid valve (2) is not energized. When the parking brake solenoid valve is not energized, the parking brake piston chamber is connected to the tank and the springs inside the brake group apply the brakes.

Implement pump (7), which also supplies oil to the blade and winch circuits, only provides enough flow to keep accumulator (3) charged. If the pressure in the brake system falls below 13 800 kPa (2000 psi), pilot unloading valve (6) closes and increases the load sensing signal pressure. The increased load sensing signal pressure in line (9) will increase implement pump flow and recharge the accumulator. Brake system pressure can be measured at pressure tap (4), and load sensing signal pressure can be measured at test port (8).

Parking Brake Released



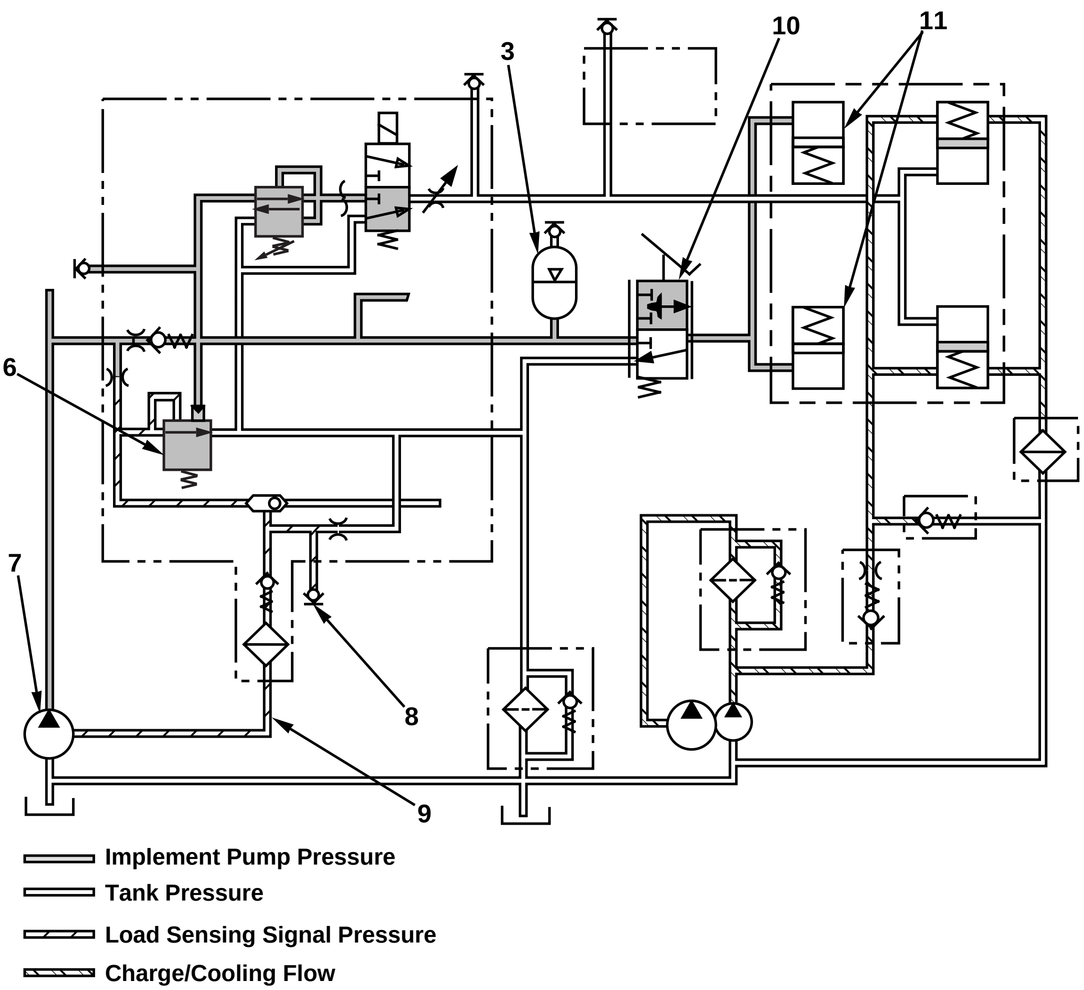
Brake System Schematic—Parking Brake Released.
(1) Pressure limiter. (2) Parking brake solenoid valve. (3) Accumulator. (4) Test port. (5) Parking brakes. (6) Pilot unloading valve. (7) Implement pump. (8) Test port. (9) Line.

When parking brake solenoid valve (2) is energized, the parking brakes (5) are released. When the parking brake solenoid is energized, oil from pressure limiter (1) is directed to the parking brake piston chamber in parking brakes (5). The pressure in the parking brake piston chambers releases the parking brakes.

Pressure limiter (1) limits the pressure in the parking brake piston chamber to 5515 kPa (800 psi). If the pressure in the circuit increases above this setting, the pressure limiter drains some of the oil to the tank and lowers the pressure.

Implement pump (7), which also supplies oil to the blade and winch circuits, only provides enough flow to keep accumulator (3) charged. If the pressure in the brake system falls below 13 800 kPa (2000 psi), pilot unloading valve (6) closes and increases the load sensing signal pressure. The increased load sensing signal pressure in line (9) will increase implement pump flow and recharge the accumulator. Brake system pressure can be measured at pressure tap (4), and load sensing signal pressure can be measured at test port (8).

Service Brake Applied



Brake System Schematic—Service Brake Applied.
(3) Accumulator. (6) Pilot unloading valve. (7) Implement pump. (8) Test port. (9) Line. (10) Brake control valve. (11) Service brakes.

When the service brake pedal is applied, brake control valve (10) directs reduced brake system pressure to the brake piston chambers in service brakes (11). The reduced brake system pressure moves the brake piston against the disks and plates and applies the brakes. The further the brake pedal is pushed down, the harder the brakes are applied.

Implement pump (7), which also supplies oil to the blade and winch circuits, only provides enough flow to keep brake accumulator (3) charged. If the pressure in the brake system falls below 13 800 kPa (2000 psi), pilot unloading valve (6) closes and increases the load sensing signal pressure. The increased load sensing signal pressure in line (9) will increase implement pump flow and recharge the accumulator. The load sensing signal pressure can be measured at test port (8).

Testing and Adjusting

Test Preparations

WARNING

Sudden movement of the machine or release of oil under pressure can cause injury to persons on or near the machine.

To prevent possible injury, perform the procedure that follows before testing and adjusting the machine.

1. Move the machine to a smooth, horizontal location away from working machines and personnel; lower the implements to the ground.

2. Permit only one operator on the machine. Keep all other personnel either away from the machine or in view of the operator.

3. Engage the parking brake.

WARNING

With the engine running, this machine will spot turn when the steering wheel is turned, even if the transmission is in NEUTRAL.

To avoid personal injury due to unexpected movement, engage the parking brake and make sure the area is free of personnel before starting the engine.

4. Stop the engine.

5. Make sure all hydraulic pressure is released before any fitting, hose, or component is loosened, tightened, removed or adjusted.

6. Move the steering wheel to the right and left to release any pressure in the steering hydraulic system.

7. Apply and release the service brake until no resistance is felt against the service brake pedal (approximately 120 times). This releases stored hydraulic pressure in the brake system accumulator.

WARNING

These procedures release the pressure in the steering and brake portions of the hydraulic system. Hydraulic pressure remains stored in the suspension portion of the hydraulic system. Follow the procedures given in "Suspension System Procedures," in this section, when performing work on the suspension hydraulic system.

Troubleshooting

Problem Identification Procedure

When defining a problem, first perform the following visual checks. As soon as the problem is defined, go to “Troubleshooting.” The “Troubleshooting” section will list the probable causes of a known problem. Since there may be more than one cause for a problem, this “Troubleshooting” section may suggest specific inspections or instrument tests. These inspections and tests will help identify which of the causes is most probable.

This list cannot give all possible problems and corrections. Service personnel must find the problem and its source, and then make the necessary repairs.

While diagnosing the system, remember that correct oil flow and pressure are necessary for correct operation. Oil pressure is caused by resistance to the flow of oil. The oil temperature must be at a minimum of 82°C (180°F) during the diagnosis.

When more checks are necessary, use the 8T-5320 Hydraulic Test Group and the 4C-4890/4C-4892 Fitting Groups, a stop watch, magnet, thermometer and a millimeter (inch) ruler for basic tests.

Visual Checks

⚠ WARNING

Personal injury or death can result from improperly checking for a leak.

Always use a board or cardboard when checking for a leak. Escaping fluid under pressure, through even a pin-hole size leak, can penetrate body tissue, causing serious injury and possibly death.

If fluid is injected into your skin, the skin must be treated immediately by a doctor familiar with this type of injury.

A visual inspection of the system and its components is the first step in diagnosing a problem.

Stop the engine and lower all implements to the ground.

Make the following inspections:

1. Check the hydraulic oil level. Refer to *Operator’s Manual, Deployable Universal Combat Earthmover (DEUCE),* “Maintenance Section, Every Ten Service Hours or Daily, Hydraulic Tank.”

2. Look for foam in the oil. Do this immediately after the machine is stopped. Use a clear bottle or container to get a sample of the oil. Look for air bubbles in the oil.

3. Remove the hydraulic return and charge filter elements and look for particles removed from the oil by the filter element. A magnet can be used to determine if the particles are made from an iron-based material, such as steel.

4. Inspect the oil lines and connections for damage or leaks.

Troubleshooting Problem List:

Steering System Problem List:

Brake System Problem List:

Troubleshooting Problems

Steering System

Problem 1: Steering Sluggish in Both Directions

Probable Cause(s):

- Hydraulic oil level low
- Charge pressure low
- Steering control valve output pressure low
- Steering pump oil pressure low
- Steering motor damaged

1. Hydraulic oil level low:

Check the hydraulic oil level and add oil if necessary. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Every Ten Service Hours or Daily,Hydraulic Tank."

2. Charge pressure low:

Check and adjust the steering charge pressure. Refer to "Testing and Adjusting, Steering System Procedures, Steering System Pressure Tests, Charge Oil Pressure Test," in this module.

3. Steering control valve output pressure low:

a. Check and adjust the steering charge pressure. Refer to "Testing and Adjusting, Steering System Procedures, Steering System Pressure Tests, Charge Oil Pressure Test," in this module.

b. Check and adjust the steering control valve output pressure. Refer to "Testing and Adjusting, Steering System Procedures, Steering System Pressure Tests, Steering Control Valve Pressure Test," in this module.

4. Steering pump oil pressure low:

a. Check and adjust the steering control valve output pressure. Refer to "Testing and Adjusting, Steering System Procedures, Steering System Pressure Tests, Steering Control Valve Pressure Test," in this module.

b. The multifunction valves are damaged. Clean or replace the multifunction valves. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Steering Pump."

c. The steering pump is damaged internally. Repair or replace the steering pump. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Steering Pump."

d. The steering motor is damaged internally. Perform the steering motor case drain check procedure. Refer to "Testing and Adjusting, Steering System Procedures, Steering System Pressure Tests, Case Drain Pressure Check of Steering Motor." Repair or replace the steering motor. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Steering Motor."

5. Steering motor damaged:

a. The cooling valve is damaged. Remove and inspect the cooling valve for visible damage or sticking due to contamination. Repair or replace the cooling valve if necessary. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Steering Motor, Disassemble and Assemble."

b. The steering motor is damaged internally. Perform the steering motor case drain check procedure. Refer to "Testing and Adjusting, Steering System Procedures, Steering System Pressure Tests, Case Drain Pressure Check of Steering Motor." Repair or replace the steering motor. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Steering Motor."

Problem 2: Machine Turns Slowly in One Direction

Probable Cause(s):

- Drive belt slipping
- One multifunction valve working incorrectly
- Cooling valve in steering motor working incorrectly
- Failed steering control valve
- Steering pump malfunctioning

1. Drive belt slipping:

a. Check the drive wheels for damage or wear. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Every 10 Service Hours or Daily, Walk-Around Inspection, Drive Wheels and Scraper Bars."

b. Check and adjust the belt tension. Refer to "Testing and Adjusting, Suspension System Procedures, Suspension Hydraulic Charging Procedure," in this module.

2. One multifunction valve working incorrectly:

Remove both multifunction valves from the steering pump and switch the installation locations on the steering pump. Refer to Systems Operation, Steering System" in this module for the location of the multifunction valves. If the steering problem occurs in the other direction, replace the faulty multifunction valve. If the problem does not change, a multifunction valve is not the cause of the fault.

3. Cooling valve in steering motor working incorrectly:

Remove and disassemble the steering motor. Look for debris or damage that could stop the cooling valve from moving smoothly in the bore. Repair or replace any damaged components in the cooling valve. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Steering Motor."

4. Failed steering control valve:

Check the steering control valve signal pressures. If the pressures are different when turning to the right and left, remove and disassemble the steering control valve. Repair or replace the steering control valve. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Steering Control Valve."

5. Steering pump malfunctioning:

Check the steering pump servo pressures. If one of the pressures is low, check the steering control valve signal pressures. If the steering control valve signal pressures are correct, remove and disassemble the steering pump. Repair or replace the steering pump. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Steering Pump."

Problem 3: Machine Turns in Opposite Direction of Steering Wheel in REVERSE and/or FORWARD

Probable Cause(s):

- Steering solenoid valve not receiving electrical signal when machine operates in REVERSE
- Oil lines incorrectly connected
- Steering solenoid valve damaged

1. Steering solenoid valve not receiving electrical signal when machine operates in REVERSE:

Test the steering solenoid. Refer to *Specifications Systems Operation Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* "Testing and Adjusting, Testing, Solenoid Test."

2. Oil lines incorrectly connected:

Switch the connection of the hydraulic lines at the output ports of the steering control valve. If the problem goes away, the lines were installed incorrectly. If the problem does not disappear, refer to Steps 1 and 3.

3. Steering solenoid valve damaged:

Remove and disassemble the steering solenoid valve. Look for debris or damage that could stop the valve spool from moving in the bore. Repair or replace the steering solenoid valve if necessary. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Steering Solenoid Valve."

Problem 4: Machine Turns Jerky, Erratic, or Hesitant

Probable Cause(s):

- Aerated hydraulic oil
- Slipping drive belt
- Failed brake
- Steering charge pressure adjusted incorrectly

- Steering control valve damaged internally
- Steering motor damaged internally
- Steering pump damaged internally
- Differential steering unit damaged internally

1. Aerated hydraulic oil:

Drain some of the hydraulic oil from the hydraulic tank into a suitable container. Check the oil for small air bubbles (the oil looks frothy or foamy). Replace the hydraulic oil if there are air bubbles in the oil.

2. Slipping drive belt:

a. Have a ground observer on both sides of the machine. Watch to see if the drive belt is slipping when the problem occurs. Perform the following steps if the drive belts are slipping.

b. Check the condition of the drive wheels. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Every 10 Service Hours of Daily, Walk-Around Inspection, Drive Wheels and Scraper Bars." Repair or replace the drive wheels if they are damaged. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Drive Wheels."

c. Check the drive belt tension. Refer to "Testing and Adjusting, Suspension System Procedure, Suspension Hydraulic Charging Procedure," in this module.

3. Failed brake:

Refer to Problem 13: "Parking Brakes Do Not Release."

4. Steering charge pressure adjusted incorrectly:

Check and adjust the steering charge pressure. Refer to "Testing and Adjusting, Steering System Procedures, Steering System Pressure Tests, Charge Oil Pressure Tests," in this module.

5. Steering control valve damaged internally:

Check the steering control valve pressure setting. Refer to "Testing and Adjusting, Steering System Procedures, Steering System Pressure Tests, Steering Control Valve Pressure Test," in this module. If it is not possible to adjust the valve, remove and disassemble the valve to look for damage. Repair or replace the steering valve, if necessary. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Steering Control Valve."

6. Steering motor damaged internally:

Remove and disassemble the steering motor. Repair or replace the steering motor, if necessary. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Steering Motor."

7. Steering pump damaged internally:

Remove and disassemble the steering pump. Repair or replace the steering pump, if necessary. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Steering Pump."

8. Differential steering unit damaged internally:

If the differential steering unit is causing the problem, the unit should be making abnormal noises (clunks or bangs) when the problem occurs. If abnormal noise is heard from the differential steering case, remove and disassemble the differential steering unit. Repair or replace the differential steering unit, if necessary. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Differential Steering Unit."

Problem 5: Machine Engine Lugs More Than Normal During Steering

Probable Cause(s):

- Multifunction relief valves working incorrectly
- Engine low on horsepower
- Excessive steering load
- Other systems drawing excessive power from engine

1. Multifunction relief valves working incorrectly:

Perform high pressure cutoff test. Replace the valves if they can not be adjusted correctly. Refer to "Testing and Adjusting, Steering System Procedure, Steering System Pressure Tests, and High Pressure Cutoff Test," in this module.

2. Engine low on horsepower:

Perform the torque converter stall test. Refer to *Specifications Systems Operation Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Transmission and Torque Converter,* “Testing and Adjusting, Torque Converter Hydraulic System, Outlet Pressure Test.”

3. Excessive steering load:

a. Check and adjust the drive belt tension, refer to “Testing and Adjusting, Suspension System Procedures, Suspension Hydraulic Charging Procedure,” in this module. If the belt tension is normal, perform Stem 3b.

b. Remove both drive belts. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* “Drive Belts.”

c. Perform the manual parking brake release procedure. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* “Operation Section, Machine Features, Parking Brake.” Attempt to rotate the front idler by hand. If the front idler cannot be rotated, repair the brake group. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* “Brake Group.”

4. Other systems drawing excessive power from engine:

If the problem occurs when no other machine function (blade, winch, air conditioning, etc.) is being operated, perform the following tests:

a. Check the signal relief pressure of the implement hydraulic pump.

b. Check the operating pressure of the fan hydraulic circuit.

c. Check and adjust, if necessary, the torque converter inlet pressure.

Problem 6: Machine Engine Speed Surges (Up and Down) During Steering

Probable Cause(s):

- Multifunction valves adjusted incorrectly, or damaged
- Signal oil pressure from steering control valve unstable

1. Multifunction valves adjusted incorrectly, or damaged:

Perform the high pressure cutoff test. Replace the valves if they cannot be adjusted correctly. Refer to “Testing and Adjusting, Steering System Procedures, Steering System Pressure Tests, High Pressure Cutoff Test,” in this module.

2. Signal oil pressure from steering control valve unstable:

a. Check the steering charge pump pressure. If the pressure is out of specification, adjust the pressure. If the pressure can not be adjusted correctly, or if the pressure is unstable (varies up and down), replace the charge pressure relief valve.

b. Remove and disassemble the steering control valve. Look for weak or broken valve springs. Look for debris or damage which could cause the valve to stick or move erratically. Repair or replace the steering control valve.

Problem 7: Machine Drifts or Pulls to One Side With no Operator Steering Input

Probable Cause(s):

- Belt tension incorrect
- Steering control valve damaged
- Steering pump neutral adjustment incorrect
- Brake dragging (internal seals leaking)

1. Belt tension incorrect:

Check and adjust the belt tension. Refer to “Testing and Adjusting, Suspension System Procedures, Suspension Hydraulic Charging Procedure,” in this module.

2. Steering control valve damaged:

Remove and disassemble the steering control valve. Refer to *Disassemble and Assemble, Deployable Universal Combat Earthmover (DEUCE), Power Train,* “Steering Control Valve.” Look for a weak or broken centering spring. Look for debris or damage to the valve plate which could cause pressure to leak into the steering pilot lines.

3. Steering pump neutral adjustment incorrect:

Perform the procedure, “Testing and Adjusting, Steering System Procedures, Steering Pump Hydraulic Displacement Control Neutral Adjustment,” found in this module.

4. Brake dragging (internal seals leaking):

Remove and disassemble the brake groups. Look for damage to the service brake seals and pistons. Repair or replace the brake groups, if necessary.

Problem 8: Excessive Steering Wheel Rotation Before Machine Starts to Steer

Probable Cause(s):

- Steering control valve damaged
- Pump and/or motor worn or damaged

1. Steering control valve damaged:

Remove and disassemble the steering control valve. Refer to *Disassemble and Assemble, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Steering Control Valve." Look for wear to the input splines. Look for debris or damage which could cause the valve plate to stick or move erratically. Repair or replace the steering control valve.

2. Pump and/or motor worn or damaged:

a. Check the case drain flow from the steering pump. If the flow is excessive, repair or replace the pump. Refer to *Disassemble and Assemble, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Steering Pump."

b. Check the case drain flow from the steering motor. If the flow is excessive, repair or replace the motor. Refer to *Disassemble and Assemble, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Steering Pump."

Brake System

Problem 9: Service Brakes Not Operating

Probable Cause(s):

- Hydraulic oil level low
- Brake system pressure low
- Brake valve damaged
- Failed brake seals or damaged brake piston

1. Hydraulic oil level low:

Check the hydraulic oil level, and add oil if necessary. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Every 10 Service Hours or Daily, Hydraulic Tank, Check Oil Level."

2. Brake system pressure low:

Check the brake system pressure. Refer to "Testing and Adjusting, Brake System Procedures, Brake System Pressure Check," in this module. If the pressure is low, check for the following causes:

a. The brake system inlet orifice is plugged. Clean the orifice of any debris.

b. The brake pilot unloading valve is not adjusted correctly. Check the brake pilot unloading valve pressure setting. If the correct setting cannot be obtained, replace the pilot unloading valve.

c. The brake signal relief pressure is not present at the implement pump. Check for debris or damage in the signal relief check/screen valve.

d. The implement hydraulic pump has failed. This is the most likely cause if other implement functions (winch and blade) are affected.

3. Brake valve damaged:

Remove and disassemble the brake valve. Look for debris or damage which could cause the spools in the valve to stick. Repair or replace the brake valve, if necessary.

4. Failed brake seals or damaged brake piston:

Remove and disassemble the brake groups. Look for damage to the service brake seals and pistons. Repair or replace the brake groups, if necessary.

Problem 10: Service Brakes Slip or Take Longer Than Normal to Stop Machine

Probable Cause(s):

- Drive belts slipping on front idlers
- Too much wear on brake disks
- Overheated brakes
- Brake pistons or seals damaged
- Failed brake valve

1. Drive belts slipping on front idlers:

Check and adjust the drive belt tension. Refer to "Testing and Adjusting, Suspension System Procedures, Suspension Hydraulic Charging Procedure," in this module.

2. Too much wear on brake disks:

Measure the wear on the brake disks. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* “Maintenance Section, Every 2000 Service Hours or Two Years, Brakes.” Replace the disks if the wear exceeds the specification. Refer to *Specifications Systems Operation Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Power Train,* “Brake Group.”

3. Overheated brakes:

a. The orifice check valve in the cooling oil line from the steering charge pump is blocked. Check the valve for blockage.

b. The cleaning screen in the brake cooling oil outlet line is plugged. Clean or replace the screen.

c. The brake cooling bypass check valve is stuck open. Clean or replace the check valve.

d. The brakes are not fully releasing. Refer to Step 4.

e. Steering charge pump flow is low (less than 15 L/min [4 gpm]).

4. Brake pistons or seals damaged:

If the machine tends to pull towards one direction upon stopping, remove and disassemble the brake on the side toward which machine turns. Look for debris or damage which could cause the brake pistons to stick in the bore. Also look for damage to the brake piston seals. Repair or replace the brake group, if necessary.

5. Failed brake valve:

Replace the brake valve. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* “Brake Pedal Assembly.”

Problem 11: Service Brake Application Not Smooth

Probable Cause(s):

- Worn brake disks
- Damaged brake valve
- Brake group internally damaged

1. Worn brake disks:

Measure the wear on the brake disks. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* “Maintenance Section, Every 2000 Service Hours or Two Years, Brakes.” Replace the disks if the wear exceeds the specification. Refer to *Specifications Systems Operation Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Power Train,* “Brake Group.”

2. Damaged brake valve:

Replace the brake valve. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* “Brake Pedal Assembly.”

3. Brake group internally damaged:

Remove and disassemble the brake groups. Inspect the disks and plates for evidence of overheating (glazing). Look for damaged pistons and seals and debris which could cause the brake pistons to stick in the bore. Repair or replace the brake group, if necessary. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* “Brake Group”

Problem 12: Too Much Force Needed to Push Brake Pedal

Probable Cause(s):

- Damaged brake valve

1. Damaged brake valve:

Replace the brake valve. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* “Brake Pedal Assembly.”

Problem 13: Parking Brakes Do Not Release

Probable Cause(s):

- Electrical problem
- Failed parking brake solenoid valve
- Parking brake pressure limiter has failed
- Brake group damaged internally

1. Electrical problem:

Perform the “Manual Parking Brake Release” procedure in *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* “Operation Section, Maintenance Features.” If the parking brakes do not release, proceed to Step 4. If the problem continues, refer to *Specifications Systems Operation Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* "Testing and Adjusting, Troubleshooting, Problem 12: 'Park Brake Will Not Release.'"

2. Failed parking brake solenoid valve:

Remove and disassemble the parking brake solenoid valve. Look for any debris or damage which could cause the valve spool to stick in the bore. Replace the valve if necessary.

3. Parking brake pressure limiter has failed:

Perform the parking brake pressure limiter adjustment procedure. Replace the parking brake pressure limiter valve if the valve cannot be adjusted.

4. Brake group damaged internally:

If one brake releases but the other one does not, remove and disassemble the brake that does not release. Look for damage to the brake piston seals, or debris or damage to the parking brake piston. Repair or replace the brake group if necessary. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Brake Group."

Problem 14: Parking Brake Does Not Hold Machine

Probable Cause(s):

- Low drive belt tension
- Too much wear on disks
- Weak or damaged brake springs
- Damaged brake piston

1. Low drive belt tension:

Check and adjust the drive belt tension. Refer to "Testing and Adjusting, Suspension System Procedures, Suspension Hydraulic Charging Procedure," in this module.

2. Too much wear on disks:

Measure the wear on the brake disks. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Every 2000 Service Hours or Two Years, Brakes." Replace the disks if the wear exceeds the specification. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Brake Group."

3. Weak or damaged brake springs:

Remove and disassemble the brakes. Replace the brake springs if they are weak or damaged. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Brake Group."

4. Damaged brake piston:

Remove and disassemble the brake groups. Look for damage to the brake pistons. Repair or replace the brake groups, if necessary.

Problem 15: Machine Pulls Hard to Right or Left When Service Brakes Are Applied

Probable Cause(s):

- Brake pilot line plugged or leaking
- Wear or failure of friction disks on one brake group
- Brake group damaged internally

1. Brake pilot line plugged or leaking:

a. Visually inspect the brake pilot line on the side toward which the machine turns, for external leaks.

b. If no leaks are found, remove the line to look for debris or damage which could plug the line.

2. Wear or failure of friction disks on one brake group:

Measure the wear on the brake disks. Replace the disks if the wear exceeds the specification. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Brake Group."

3. Brake group damaged internally:

If one brake releases but the other does not, remove and disassemble the brake that does not release. Look for damage to brake piston seals, or debris or damage to the parking brake piston. Repair or replace the brake group if necessary. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Brake Group."

Suspension System

Problem 16: Machine Not Level From Side to Side While Operating on Level Ground (When Machine Not Kneeled)

NOTE: Raise and lower the machine at least one time, using the kneeling function, to make sure the machine is fully raised.

Probable Cause(s):

- Leaking cylinder
- Suspension locked in awkward position after operating in REVERSE (in EARTHMOVING mode)
- Manual locking valve in CLOSED position on one side of machine
- Suspension charged incorrectly
- One kneeling solenoid valve failed
- Damaged swing arm

1. Leaking cylinder:

Inspect all suspension cylinders for leaks. Repair or replace damaged cylinders.

2. Suspension locked in awkward position after operating in REVERSE (in EARTHMOVING mode):

Operate the machine in REVERSE on level ground, or operate the machine in SELF-DEPLOY on level ground to allow the suspension to equalize.

3. Manual locking valve in CLOSED position on one side of machine:

Open the locking valve on the low side of the machine. Put the machine into SELF-DEPLOY mode. Kneel and raise the machine again. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Machine Operation, SELF-DEPLOY Mode."

4. Suspension charged incorrectly:

Check and adjust the suspension charge pressures. Refer to "Testing and Adjusting, Suspension System Procedures, Suspension Hydraulic Charging Procedure" in this module.

5. One kneeling solenoid valve failed:

Perform the solenoid test procedure on the solenoid corresponding to the low side of the machine. Refer to *Specifications Systems Operation Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* "Testing and Adjusting, Solenoid Test."

6. Damaged swing arm:

Visually inspect the front and rear swing arms on the side of the machine that is too low. With the machine parked on a level surface, the front and rear idler wheels should be vertical. Replace the swing arm if an idler wheel leans visibly in or out.

Problem 17: Machine Too High or Low Off Ground (When Level)

Probable Cause(s):

- Suspension charged incorrectly.

1. Suspension charged incorrectly:

Check and adjust the suspension charge pressures. Refer to "Testing and Adjusting, Suspension System Procedures, Suspension Hydraulic Charging Procedure," in this module.

Problem 18: Suspension Does Not Absorb Shocks in SELF-DEPLOY Mode

Probable Cause(s):

- Manual locking valves in CLOSED position
- Blade not up
- Suspension charged incorrectly
- Electrical system problem

1. Manual locking valves in CLOSED position:

Move the valves to the OPEN position. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Machine Operation, Earthmoving Mode, Manual Suspension Locking."

2. Blade not up:

The EPTC II will not put the machine into SELF-DEPLOY mode unless the blade is fully raised. If the blackout light switch is not in the STOP LIGHT or SERVICE DRIVE position, the blade alarm will not turn on and the SELF-DEPLOY indicator will not turn on.

3. Suspension charged incorrectly:

Check and adjust the suspension charge pressures. Refer to “Testing and Adjusting, Suspension System Procedures, Suspension Hydraulic Charging Procedure,” in this module.

4. Electrical system problem:

Refer to *Specifications Systems Operation Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* “Testing and Adjusting, Troubleshooting, Troubleshooting Problem List, Problem 17: ‘Self-Deploy Lamp Will Not Illuminate.’”

Problem 19: Machine Does Not Raise or Lower When Kneeling Switch Operates

Probable Cause(s):

- Electrical system problem
- Hydraulic system problem

1. Electrical system problem:

Refer to *Specifications Systems Operation Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* “Testing and Adjusting, Troubleshooting, Troubleshooting Problem List, Problem 24: ‘Machine Will Not Kneel and/or Kneeling Lamp Will Not Illuminate.’”

2. Hydraulic system problem:

a. The load sensing signal pressure from the kneeling solenoid is not reaching the implement pump.

b. The implement pump has failed. If the implement pump has failed, other systems such as the blade and the winch will not operate. Remove and disassemble the implement pump. Repair or replace the implement pump. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Hydraulic System,* “Implement Pump.”

Steering System Procedures

Steering Pump Efficiency Check

NOTE: The steering pump must be checked on a bench that simulates the machine's steering hydraulic system. The charge pump can be checked on the machine or a standard bench.

For any pump test, the pump flow measured in liters per minute (U.S. gallons per minute) at 690 kPa (100 psi) is larger than the pump flow at 6900 kPa (1000 psi) at the same speed.

The difference between the pump flow of two operating pressures is the flow loss.

The following example is one method for finding flow loss:

Pump flow at 690 kPa (100 psi) ....217.6 L/min
....(57.5 U.S. gpm)
Pump flow at 6900 kPa (1000 psi) ....196.8 L/min
....(52.0 U.S. gpm)
Flow loss.........................20.8 L/min (5.5 U.S. gpm)

Flow loss, when expressed as a percent of pump flow, is used as a measure of pump performance.

The following example is a method for finding the percent of flow loss:

$$\frac{\text{L/min (U.S. gpm) flow loss}}{\text{Pump flow @ 690 kPa (100 psi)}} \times 100 = \text{Percent of flow loss}$$

$$\frac{20.8^* \text{ L/min } (5.5^* \text{ U.S. gpm})}{217.6^* \text{ L/min } (57.5^* \text{ U.S. gpm})} \times 100 = 9.6\%$$

If the percent of flow loss is more than 10 percent, pump performance is insufficient.

*The numbers in the examples are for illustration and are not values for any specific pump or pump condition. Refer to "Specifications, Steering System, Pump Group," in this module, for the pump flow of a new pump at 690 kPa (100 psi) and 6900 kPa (1000 psi).

Test on Machine

Install a flow meter. Run the engine at 2400 rpm (use auxiliary engine speed control). Measure the pump flow at 690 kPa (100 psi) and at 6900 kPa (1000 psi). Use these values in the following formula:

$$\frac{\text{L/min @ 690 kPa} - \text{L/min @ 6900 KPa}}{\text{L/min @ 690 kPa}} \times 100 = \text{Percent of flow loss}$$

$$\frac{\text{gpm @ 100 psi} - \text{gpm @ 1000 psi}}{\text{gpm @ 100 psi}} \times 100 = \text{Percent of flow loss}$$

Steering System Pressure Tests

The hydraulic oil temperature must be at a minimum of 60°C (140°F) during tests.

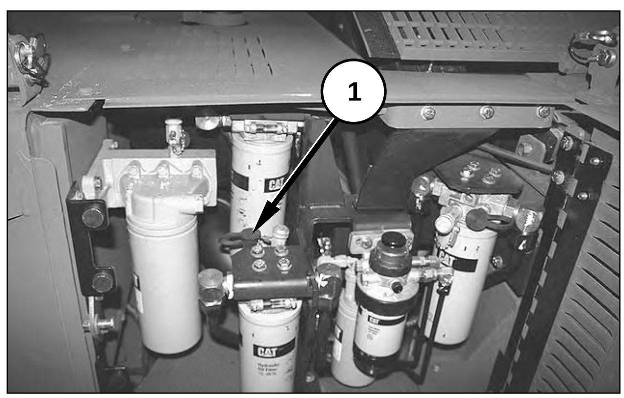
WARNING

Refer to the warning on the first page of the "Testing and Adjusting" section.

Charge Oil Pressure Test

Tools Needed		
177-7861	Hose Assembly	1
8T-4188	Adapter (1/8 INT NPT X 1/4 INT NPT)	3
6V-4143	Coupler, Quick Disconnect	2
6V-3966	Nipple, Quick Disconnect	1
8T-0855	Gauge 4000 kPa (580 psi)	1

NOTE: This procedure requires that the machine be operated. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE)* for information about machine operation.

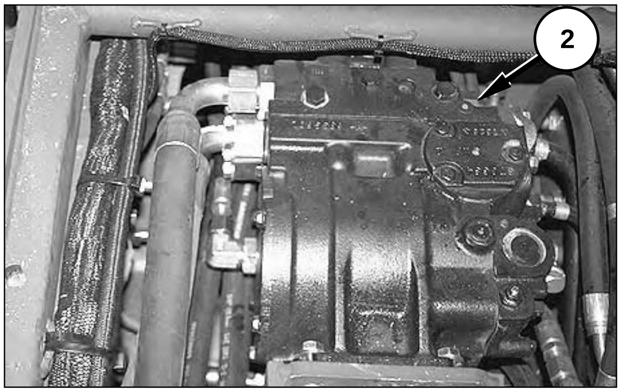


Oil Filter Compartment.
(1) Pressure tap (charge pressure).

1. Install a 0 to 4000 kPa (0 to 580 psi) gauge to pressure tap (1).

2. Start and run the engine at high idle.

3. Record the pressure on the gauge. Charge pressure should be 2415 ± 345 kPa (350 ± 50 psi).



Steering Pump, Cab Raised.
(2) Charge relief valve.

4. If the charge oil pressure is not correct, stop the engine, and raise the cab. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Features, Cab Tilt."

   Loosen the locknut on the charge relief valve, and adjust the inner nut. Turn the inner nut clockwise to increase the pressure and counterclockwise to decrease the pressure. Tighten the locknut to a torque of 52 N•m (38 lb ft).

5. If an adjustment is made, lower the cab, and repeat Steps 2 through 4 to verify the adjustment.

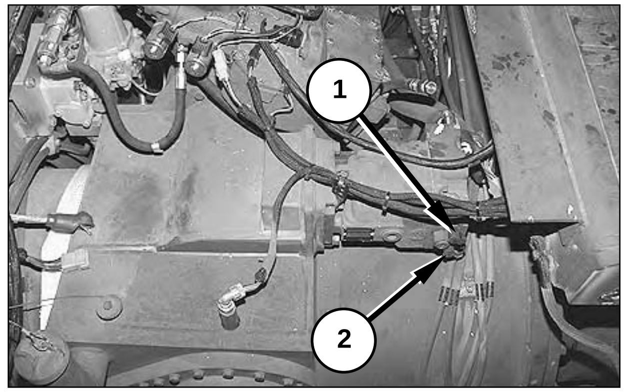
6. Remove all tooling.

High Pressure Cutoff Test

Tools Needed		
177-7861	Hose Assembly	2
8T-4188	Adapter (1/8 INT NPT X 1/4 INT NPT)	2
6V-4143	Coupler, Quick Disconnect	2
8T-0861	Gauge 60 000 kPa (8700 psi)	2

NOTE: Perform the "Charge Oil Pressure Test" prior to performing this procedure to make sure the charge pressure is within specifications.

NOTE: This procedure requires that the machine be operated. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE)* for information about machine operation.



Steering Motor, Fuel Tank Removed for Photographic Purposes.
(1) Port (right turn). (2) Port (left turn).

1. Install one 0 to 60 000 kPa (0 to 8700 psi) pressure gauge and extension hose on each pressure tap for the right and left turn.

2. Start and run the engine at high idle.

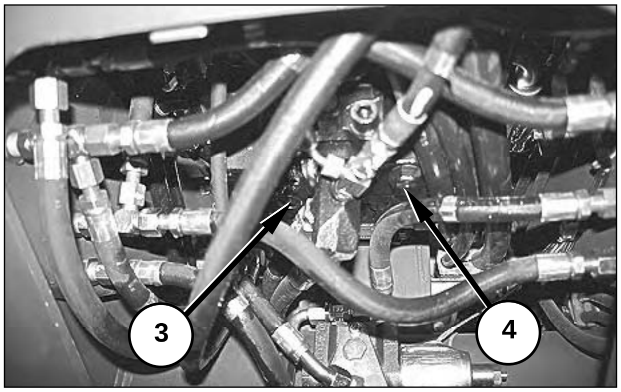
3. With the transmission in NEUTRAL and the service brakes APPLIED, carefully rotate the steering wheel to the FULL left turn position, and then to the FULL right turn position.

   Record the pressure readings from the gauges which were installed in Step 2.

   The pressure readings should be 41 340 ± 690 kPa (6000 ± 100 psi) above charge pressure.

WARNING

The machine will try to counterrotate during this procedure. Make sure that there is adequate clearance if the machine should move. Keep all personnel away from the machine. Injury or death may result.



Bottom of Steering Pump, Cover Removed.
(3) Multifunction valve corresponding to port (2).
(4) Multifunction valve corresponding to port (1).

4. If the pressure is not correct, stop the engine, remove the front bottom cover.

Loosen the locknut on the multifunction valve for the side of the loop that is not within the pressure specification; and then adjust the screw in the middle of the valve. Turn the screw clockwise to increase the pressure and counterclockwise to decrease the pressure.

Tighten the locknut to a torque of 16 N•m (12 lb ft).

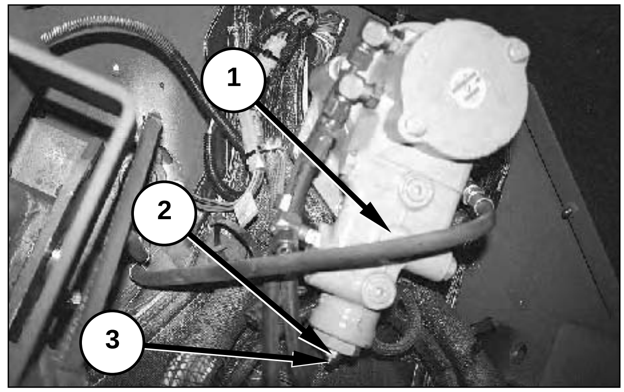
5. If an adjustment is made, repeat Steps 5 and 6 to verify the adjustment.

6. Remove all tooling, and replace all covers.

Steering Control Valve Pressure Test

Tools Needed		
177-7861	Hose Assembly	1
8T-4188	Adapter (1/8 INT NPT X 1/4 INT NPT)	3
6V-4143	Coupler, Quick Disconnect	2
6V-3966	Nipple, Quick Disconnect	1
8T-0855	Gauge 4000 kPa (580 psi)	1

NOTE: This procedure requires that the machine be operated. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE)* for information about machine operation.



Pilot Valve Pressure Taps.
(1) Port. (2) Locknut. (3) Adjustment screw.

1. Install a pressure tap to port (1), and a 0 to 4000 kPa (0 to 580 psi) pressure gauge with an extension hose to the pressure tap.

2. Apply the parking brake.

3. Start and run the engine at high idle.

WARNING

The machine will try to counterrotate during this procedure. Make sure that there is adequate clearance if the machine should move. Keep all personnel away from the machine. Injury or death may result.

4. Slowly rotate the steering wheel to the full left turn position or the full right turn position. Record the maximum pilot valve pressure from the tap in port (1). The pressure should be 1863 ± 69 kPa (270 ± 10 psi).

5. Stop the engine.

6. If the pressure setting is incorrect, loosen locknut (2). To increase the pressure setting, turn adjustment screw (3) clockwise. To decrease the pressure setting, turn the adjustment screw counterclockwise. Tighten the locknut to a torque of 25 ± 10 N•m (18.5 ± 7.4 lb ft).

7. Repeat Steps 3 through 6 until the pressure setting is within specification.

8. Remove all tooling.

Flushing Relief Valve Adjustment

Tools Needed		
177-7861	Hose Assembly	1
8T-4188	Adapter (1/8 INT NPT X 1/4 INT NPT)	3
6V-4143	Coupler, Quick Disconnect	2
6V-3966	Nipple, Quick Disconnect	1
8T-0855	Gauge 4000 kPa (580 psi)	1

NOTE: This procedure requires that the machine be operated. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE)* for information about machine operation.

Oil Filter Compartment.
(1) Pressure tap (charge pressure).

1. Install a 0 to 4000 kPa (0 to 580 psi) gauge to pressure tap (1).

2. Start and run the engine at high idle.

3. Record the pressure on the gauge.

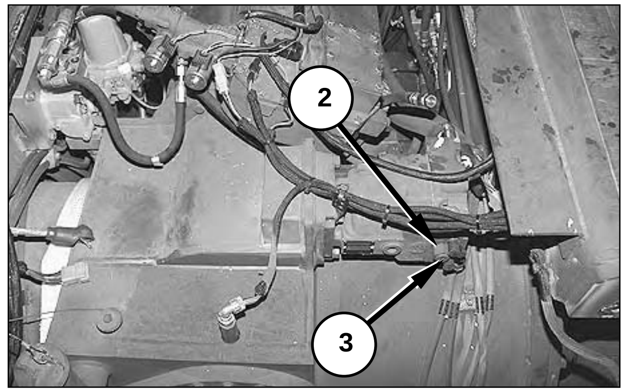
WARNING

The machine will try to counterrotate during this procedure. Make sure that there is adequate clearance if the machine should move. Keep all personnel away from the machine. Injury or death may result.

4. With the park brake engaged, rotate the steering wheel to the full turn position in either direction.

5. Record the pressure on the gauge.

6. Subtract the pressure recorded in Step 5 from the pressure recorded in Step 3. The pressure differential should be 242 ± 69 kPa (35 ± 10 psi).



Steering Motor, Fuel Tank Removed for Photographic Purposes.
(2) Locknut. (3) Inner nut.

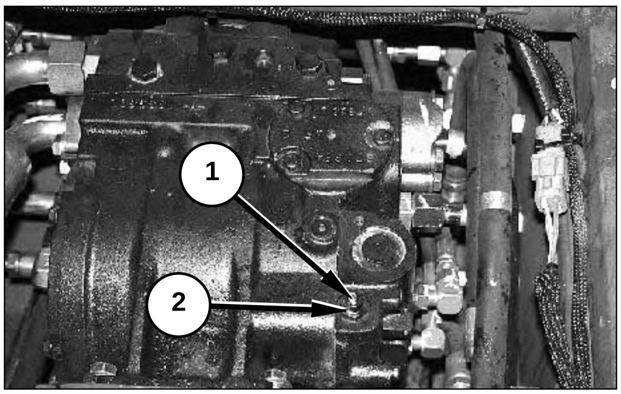
7. If the pressure is not correct, loosen lock nut (2) and turn inner nut (3) on the flushing relief valve clockwise to decrease the pressure differential, or counterclockwise to increase the pressure differential.

8. Stop the engine, and remove all tooling.

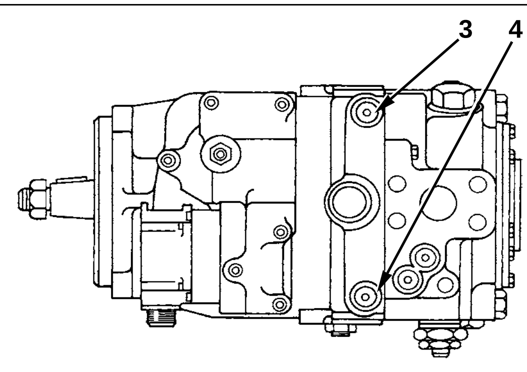
Steering Pump Hydraulic Displacement Control Neutral Adjustment

Tools Needed		
177-7861	Hose Assembly	2
8T-4188	Adapter (1/8 INT NPT X 1/4 INT NPT)	2
6V-4143	Coupler, Quick Disconnect	2
8T-0861	Gauge 60 000 kPa (8700 psi)	2
6V-3965	Nipple, Quick Disconnect	2
8T-0788	Elbow (9/16 - 18 to 11/16 -16 ORFS)	2
8T-6663	Adapter (11/16 - 16 to 9/16 - 18 ORFS)	2

NOTE: This procedure requires that the machine be operated. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE)* for information about machine operation.



Steering Pump, Cab Raised.
(1) Neutral adjustment screw. (2) Locknut.



Steering Pump.
(3) Port. (4) Port.

1. Raise the cab. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Features, Cab Tilt."

2. Install a 0 to 4000 kPa (0 to 600 psi) pressure gauge in ports (3) and (4) using the tooling in the chart.

3. Start and idle the engine.

WARNING

Take care when entering the cab while the cab is in the raised position. Maintain three points of contact between yourself and the cab at all times. Do not turn the steering wheel or attempt to drive the machine with the cab raised.

4. While holding the adjustment screw in place, loosen locknut (2) on neutral adjustment screw (1).

5. While watching the pressure gauges, slowly rotate neutral adjustment screw (1) clockwise. Mark the position at which pressure begins to appear on one of the gauges.

6. While watching the pressure gauges, slowly rotate neutral adjustment screw (1) counterclockwise. Mark the position at which pressure begins to appear on the other gauge.

7. Rotate neutral adjustment screw (1) clockwise until the screw is halfway between the marks made in Steps 5 and 6. Tighten the locknut to a torque of 7 N•m (60 lb in).

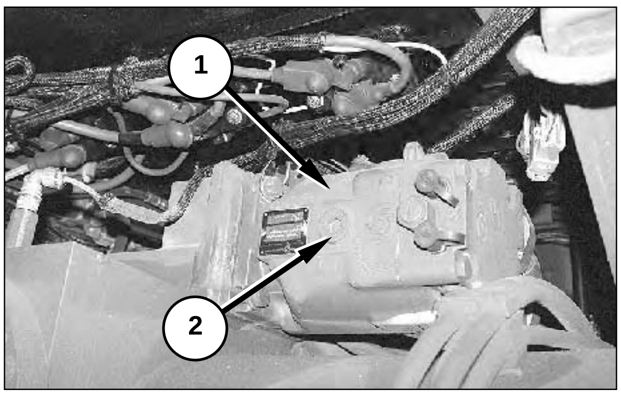
8. Remove all tooling, lower the cab and turn off the engine.

Case Drain Pressure Check of Steering Motor

Tools Needed		
177-7861	Hose Assembly	1
8T-4188	Adapter (1/8 INT NPT X 1/4 INT NPT)	1
6V-4143	Coupler, Quick Disconnect	1
8T-0853	Pressure Gauge 400 kPa (58 psi)	1
2P-8421	Adapter (-12 STOR to -6 STOR)	1

WARNING

Refer to the warning on the first page of the "Testing and Adjusting" section.



Steering Motor (Winch Mount Removed for Photographic Clarity).
(1) Steering motor. (2) Case drain port.

1. Install a coupler into case drain port (2).

2. Put a 0 to 345 kPa (0 to 50 psi) pressure gauge on the coupler.

3. Start and run the engine at high idle.

4. With the transmission in NEUTRAL and the service brakes applied, carefully turn the steering wheel to a FULL TURN position. Read the pressure on the gauge.

WARNING

The machine will try to counterrotate during this procedure. Make sure that there is adequate clearance if the machine should move. Keep all personnel away from the machine. Injury or death may result.

5. The pressure reading should be 105 ± 35 kPa (15 ± 5 psi). If the reading is greater than 275 kPa (40 psi), the case drain lines and steering motor should be inspected for plugging or internal damage.

Suspension System Procedures

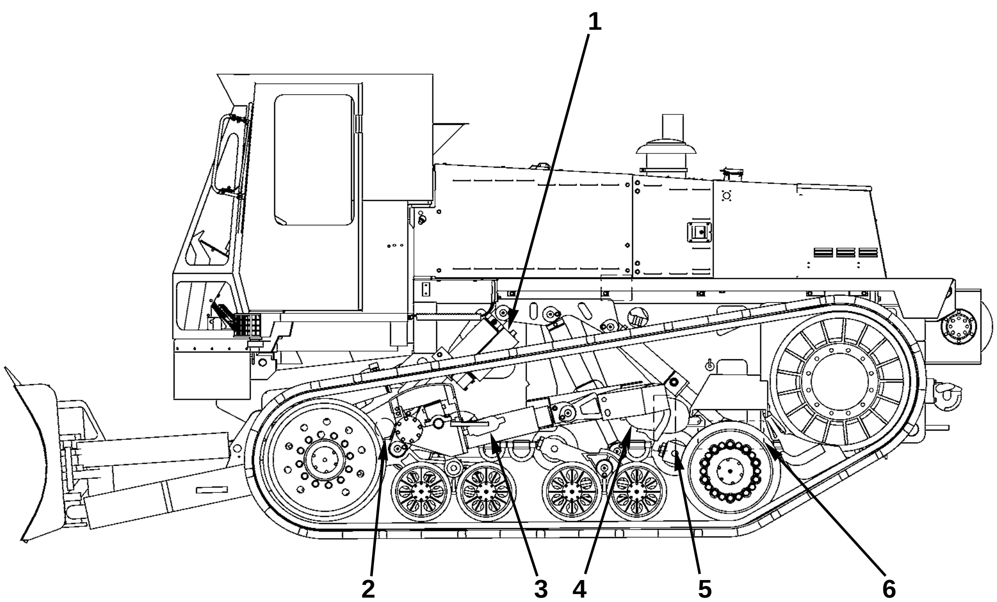
Accumulator Charging Procedure

Tools Needed		
7S5437	Nitrogen Charging Group	1

* There is one 7S-8714 Gauge Group included in the 7S-5437 Nitrogen Charging Group. One extra 7S-8714 Gauge Group is needed to charge the recoil cylinder accumulator.

WARNING

Dry nitrogen is the only gas approved for use in the accumulators on this machine. The charging of oxygen gas in these components by accident will cause an explosion. The danger can be avoided by the use of nitrogen cylinders with standard Compressed Gas Association, Inc. (CGA) No. 580 connections. When nitrogen gas is ordered, be sure to order cylinders with CGA No. 580 connections. Do not go by color codes or other methods of identification to tell the difference between nitrogen and oxygen cylinders. In any application, never use an adapter to connect your nitrogen charging group to a valve outlet that is used on both nitrogen and oxygen, and/or other gas cylinders. Be sure you use dry nitrogen.

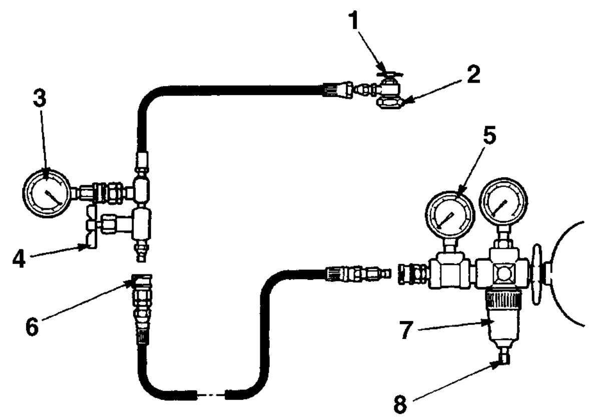


Accumulator Locations.
(1) Front suspension cylinder, bottom (rod end) accumulator. (2) Brake system accumulator. (3) Bogie cylinder accumulator. (4) Recoil cylinder accumulator. (5) Middle suspension cylinder accumulator. (6) Front suspension cylinder, top (head end) accumulator.

Accumulator Precharge Pressures–Dry Nitrogen Only			
No.	Accumulator	Precharge Pressure	
		kPa	psi
1	Front suspension cylinder, bottom (rod end) accumulator	2756	400
2	Brake system accumulator	5855	850
3	Bogie cylinder accumulator	6890	1000
4	Recoil cylinder accumulator	11 730	1700
5	Middle suspension cylinder accumulator	4483	650
6	Front suspension cylinder, top (head end) accumulator	2756	400

1. If the accumulator is installed on the machine, the hydraulic circuit in which the accumulator is installed must be open to air (there is no pressure in the hydraulic circuit). Refer to “Suspension Hydraulic Charging Procedure,” in this section, for instructions on how to relieve the hydraulic pressure in an accumulator.

2. Remove the protective cover from the charging valve on the accumulator to be charged.



7S-5437 Accumulator Charging Equipment.
(1) Valve. (2) Connector. (3) Pressure gauge. (4) Valve. (5) Pressure gauge. (6) Coupler. (7) Regulator. (8) Adjusting screw.

3. Install pressure gauges (3) and (5) according to the chart below.

Charging Pressure Gauges for Accumulators		
No.*	**Accumulator**	**Gauge Part Numbers**
1	Front suspension cylinder, bottom (rod end) accumulator	8T-0857
2	Brake system accumulator	8T-0857
3	Bogie cylinder accumulator	7S-8712
4	Recoil cylinder accumulator	7S-8712
5	Middle suspension cylinder accumulator	8T-0857
6	Front suspension cylinder, top (head end) accumulator	8T-0857

*** See the graphic at the beginning of the procedure for the location of the listed accumulators.**

4. Ensure that valve (4) is closed.

5. Attach connector (2) to the accumulator charging valve on the accumulator to be charged.

NOTE: The rear bottom cover must be dropped or removed to provide access to the middle suspension accumulator and the accumulator for the head end of the front suspension cylinder. The brake accumulator cover must be removed to provide access to the accumulator in the brake system. Covers over the bogie cylinder accumulator and the recoil cylinder accumulator must be removed to provide access to the charging valves.

NOTE: If necessary, move the accumulator for the head end of the front suspension cylinder towards the rear of the machine to attach connector (2) to the charging valve on the accumulator.

6. Turn valve (1) clockwise, until tight. The accumulator nitrogen gas pressure will be shown on pressure gauge (3).

7. If the pressure is higher than the value specified in the chart, remove coupler (6) and open valve (4) slightly, until the pressure reaches the specified value.

8. If the pressure is less than the value specified in the chart, attach coupler (6) to valve (4), and attach regulator (7) to the nitrogen cylinder.

9. With valve (4) closed, open the nitrogen cylinder valve and turn adjusting screw (8) until pressure gauge (5) indicates the desired charging pressure.

10. Open valve (4) and allow the accumulator to charge.

11. When the pressure on both pressure gauge (3) and (5) reaches the desired charging pressure, the accumulator is correctly charged. Repeat Steps 9 and 10, until the gauge readings agree.

12. Close valve (4) and the main valve on the nitrogen cylinder.

13. Turn valve (1) fully counterclockwise, and remove the test equipment.

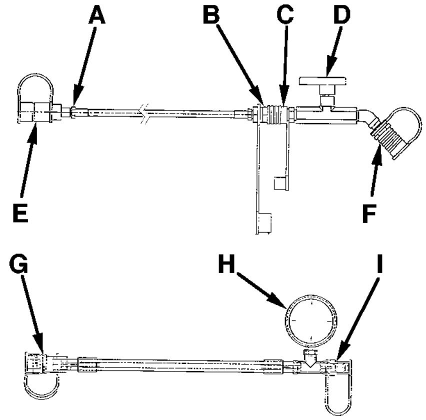
14. Apply soapy water to the accumulator charging valve to check for leaks. If no leaks are present, install the protective cap on the charging valve.

15. Perform the following “Suspension Hydraulic Charging Procedure.”

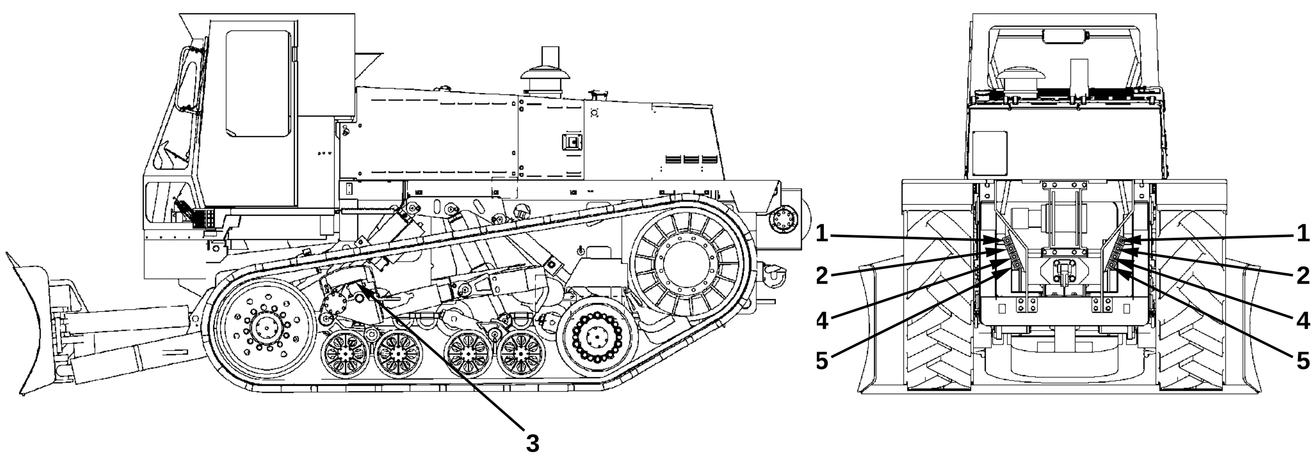
Suspension Hydraulic Charging Procedure

Tools Needed		
1U-5719	Hydraulic Pump * (115V)	1

*Can be used in place of the remote tool manifold pressure port if the on-board charging system is not functional.



Lines Group Coupler and Lines Group Gauge.
(A) Nut. (B) Coupling. (C) Coupling. (D) Valve. (E) Coupling. (F) Coupling. (G) Coupling. (H) Gauge. (I) Coupling.



Suspension Hydraulic Charging Port Identification.
(1) Middle suspension cylinders. (2) Front suspension cylinders, top. (3) Bogie cylinder charging valves (located on both sides of machine). (4) Recoil cylinders. (5) Front suspension cylinders, bottom.

Suspension Hydraulic Charging Specifications			
		Pressure kPa (psi)	
Charge Order	Description	Machine On Stands (With Suspension Components in the Air)	Minimum Charge With Machine On Ground
1	Middle Suspension Cylinders	7240±690 (1050±100)	8276±690 (1200±100)
2	Front Suspension Cylinders, Top	5157±690 (750±100)	6210±690 (900±100)
3	Bogie Cylinder Charging Valves	7000±1400 (1015±200)	11 790±690 (1710±100)
4	Recoil Cylinders	10 340 (1500)*	15 170±690 (2200±100)
5	Front Suspension Cylinders, Bottom	–	6210±690 (900±100)

*Initial charge pressure on stands, final charge pressure on ground as shown.

NOTE: Remove the lines group coupler and the lines group gauge from the basic issue items (BII) compartment. Disconnect coupling (B) from coupling (C) on the lines group coupler; connect coupling (G) of the lines group gauge to coupling (C) of the lines group coupler; and connect coupling (I) of the lines group gauge to coupling (B) of the lines group coupler.

NOTE: The suspension hydraulic charging specifications chart assumes that the machine will be operated in temperatures approximately equal to the ambient temperature during suspension charging. If the machine will be operated at lower temperatures, the pressure in the recoil cylinder must be increased. For each 22°C (40°F) drop between the charging and operating temperatures, increase the pressure in the recoil cylinder 1380 kPa (200 psi).

NOTE: Charge the suspension accumulators to the correct pressure with dry nitrogen before performing the suspension hydraulic charging procedure.

NOTE: When the entire system must be charged, charge the circuits only in the order shown in this procedure. This will ensure that the suspension is charged correctly.

NOTE: Individual suspension hydraulic circuits can be recharged without performing the entire procedure. However, to ensure machine balance, accumulators must be charged in matched pairs. For example, if the recoil cylinder accumulator on the right side of the machine is charged, the recoil cylinder accumulator on the left side of the machine must also be charged.

NOTE: The following procedure is written for use with the on-board suspension charging system. If the engine or hydraulic system is disabled, use an electrically driven hydraulic pump instead of the on-board charging system. Be sure to fill the electric hydraulic pump with the correct hydraulic oil for the operating conditions. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Lubrication Viscosities and Refill Capacities."

⚠ WARNING

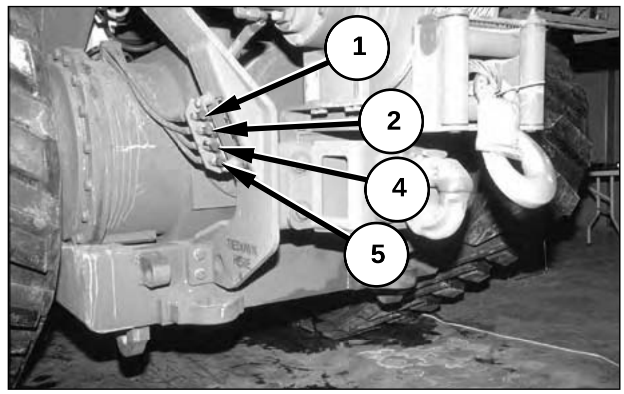
Wear gloves and eye protection during this procedure. Escaping fluid under pressure, even a pin-hole size leak, can penetrate body tissue, causing serious injury, and possible death. If fluid is injected into skin, it must be treated immediately by a doctor familiar with this type of injury.

Machine On Stands

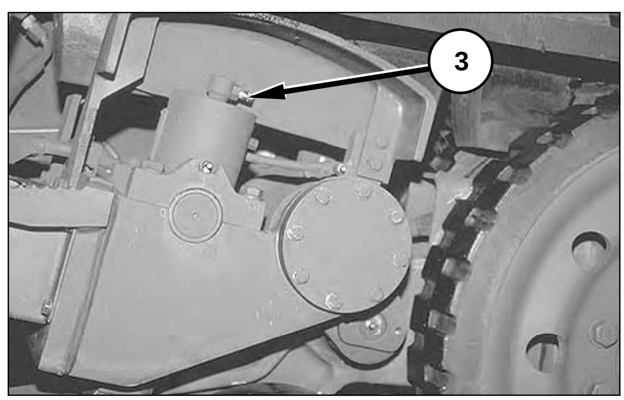
1. Park the machine on flat, level ground. Raise the machine until the midrollers are off the ground. Support the machine with suitable stands. The weight of the machine is approximately 15 910 kg (35 000 lb).

⚠ WARNING

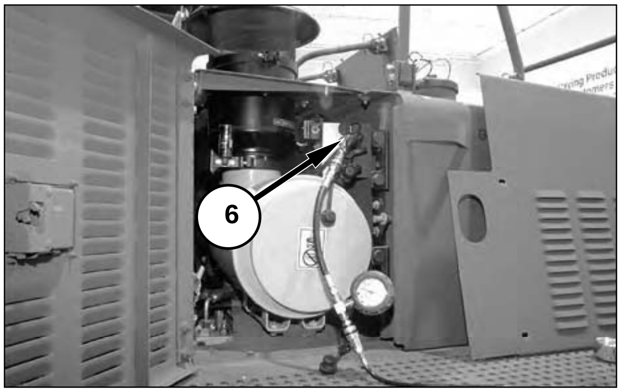
Place the stands under the machine frame. Do not place the stands under the bottom covers or under the C-frame. The bottom covers will not support the weight of the machine. Blade movement can cause the C-frame to move, which may allow the machine to fall.



Suspension Hydraulic Charging Valves (Left Side Shown, Right Side Symmetrical).
(1) Middle suspension cylinder charging valve. (2) Front suspension cylinder charging valve, top. (4) Recoil cylinder charging valve. (5) Front suspension cylinder charging valve, bottom.



Bogie Cylinder Charging Valve.
(3) Bogie cylinder charging valve.

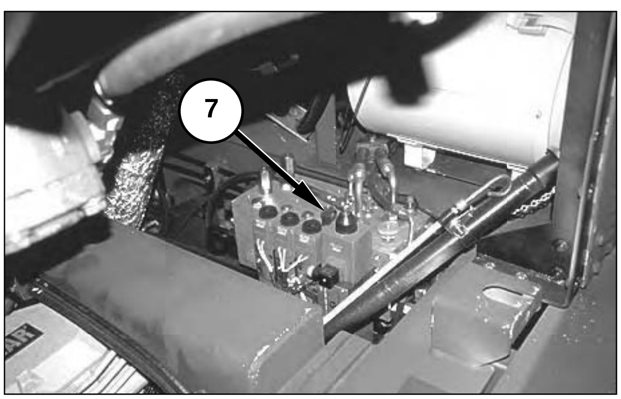


Remote Tool Manifold.
(6) Port ("T-IN").

2. Attach coupling (F) of the lines group coupler to port (6) marked "T-IN" on the remote tool manifold, in the air intake compartment. Open valve (D) by turning the knob in line with the hose.

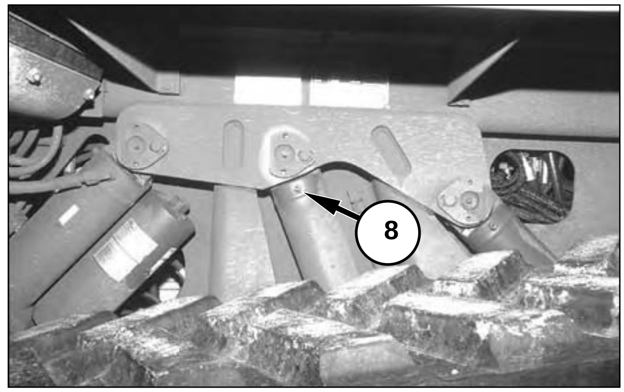
3. Attach coupling (E) of the lines group coupler to each fitting on charging valves (1) through (5). After the coupling is attached to a fitting, turn nut (A) clockwise to open the valve in the coupling. This action allows the existing pressure in the system to return to the hydraulic tank. After the pressure in the system has been vented, turn the nut counterclockwise to close the valve in the coupling, and attach the coupling to the next fitting. Perform this step on each fitting on both sides of the machine. When the pressure in the last circuit has been vented to the tank, remove coupling (E).

4. Close valve (D), and remove coupling (F) from port (6).



Multifunction Control Valve.
(7) Port ("A3").

5. Connect coupling (F) of the lines group coupler to port (7) (marked "A3") on the multifunction control valve. Open valve (D).

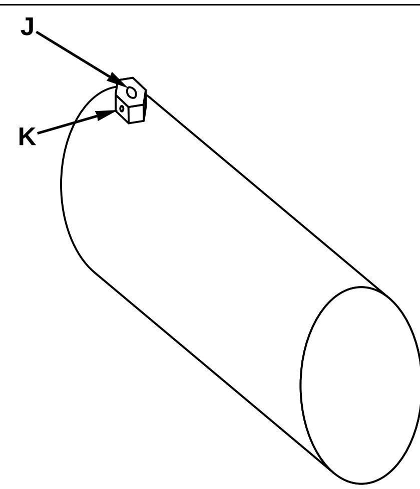


Middle Cylinder Bleed Valve (Left Side Shown, Right Side Similar).
(8) Bleed valve.

6. Open bleed valve (8) on the middle suspension cylinder, on the right side of the machine.

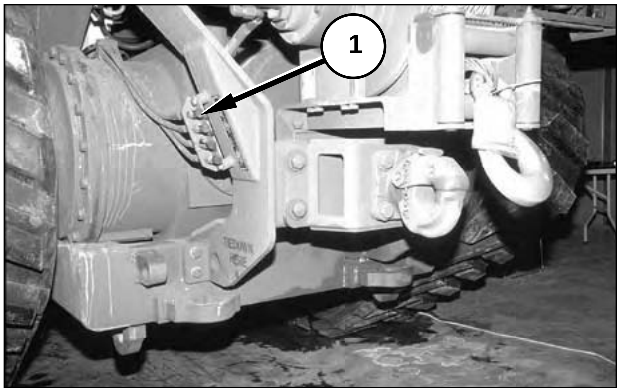
WARNING

Do not open the bleed valve on any cylinder unless the machine is off the ground and the pressure is removed from the cylinder. High pressure oil escaping from the bleed valve can cause injury or death.



Bleed Valve Operation.
(J) Hole for screw plug. (K) Bleed hole for oil.

NOTE: To open the bleed valve, insert a one-eighth inch hex wrench into the screw plug in hole (J), and turn the plug counterclockwise. Air and oil will flow from hole (K) on the side of the bleed valve when the screw plug opens. Turn the screw plug clockwise to close the bleed valve.



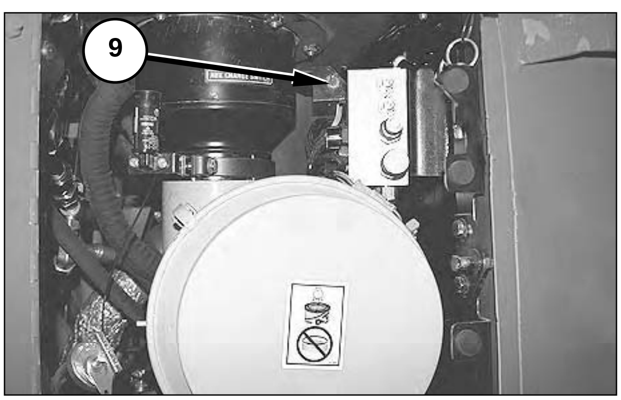
Middle Cylinder Charging Valve (Left Side Shown, Right Side Similar).
(1) Middle suspension cylinder charging valve.

7. Attach coupling (E) of the lines group coupler to charging valve (1) on the right side of the machine. After the coupling is attached to the fitting, turn nut (A) clockwise to open the valve in the coupling.

8. Start and idle the engine. Ensure that the manual suspension lockout valves are open, and place the machine in SELF-DEPLOY. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Machine Operation, Earthmoving Mode, Manual Suspension Locking" and "SELF-DEPLOY Mode."

WARNING

Do not operate the engine above low idle when bleeding air from the suspension cylinders. Oil that is under excessive pressure and escaping from the cylinder bleed valve can cause injury or death.



Remote Charging Valve Switch.
(9) Switch.

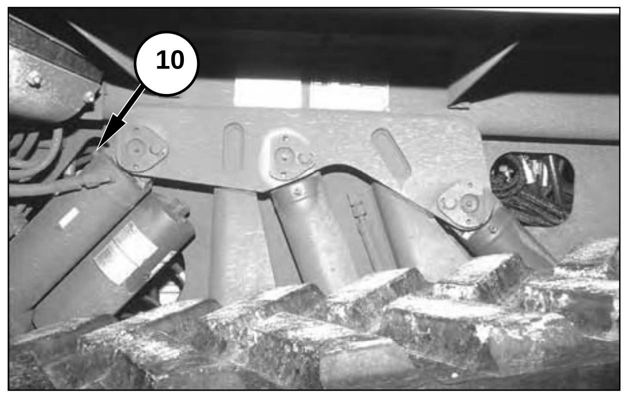
9. Move switch (9) up to fill the middle suspension cylinder with hydraulic oil until oil begins to leak from bleed valve (8).

10. Close bleed valve (8) when there is no air in the oil flowing from the bleed valve.

11. Continue adding hydraulic oil through charging valve (1) while watching the pressure on gauge (H). Release switch (9) when the oil pressure reaches 7240 ± 690 kPa (1050 ± 100 psi), then quickly close valve (D).

NOTE: If valve (D) is left open while switch (9) is in the center position, the pressure in the circuit will slowly decrease. This reduction is caused by natural leakage through the control valve.

12. Turn nut (A) counterclockwise to close the valve in coupling (E). Open valve (D), and remove coupling (E) from fitting (1).

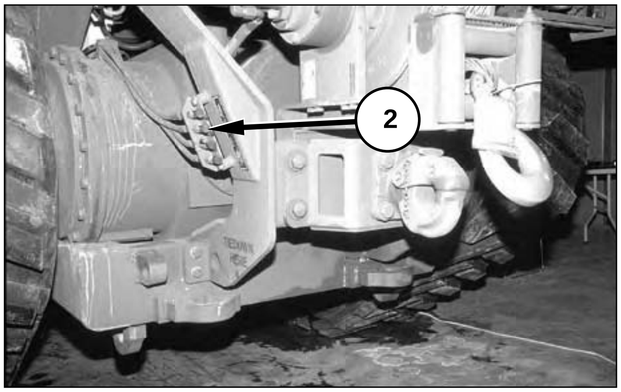


Front Suspension Cylinder Bleed Valve, Top.
(10) Bleed valve.

13. Open bleed valve (10) on the front suspension cylinder, on the right side of the machine.

WARNING

Do not open the bleed valve on any cylinder unless the machine is off the ground and the pressure is removed from the cylinder. High pressure oil escaping from the bleed valve can cause personal injury or death.

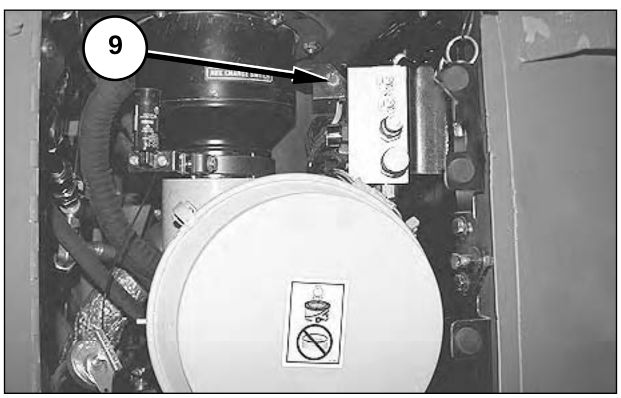


Front Suspension Cylinder Top End Charging Valve (Left Side Shown, Right Side Similar).
(2) Front suspension cylinder charging valve, top.

14. Attach coupling (E) of the lines group coupler to charging valve (2), on the right side of the machine. After the coupling is attached to the fitting, turn nut (A) clockwise to open the valve in the coupling.

⚠ WARNING

Do not operate the engine above low idle when bleeding air from the suspension cylinders. Oil that is under excessive pressure and escaping from the cylinder bleed valve can cause injury or death.



Remote Charging Valve Switch.
(9) Switch.

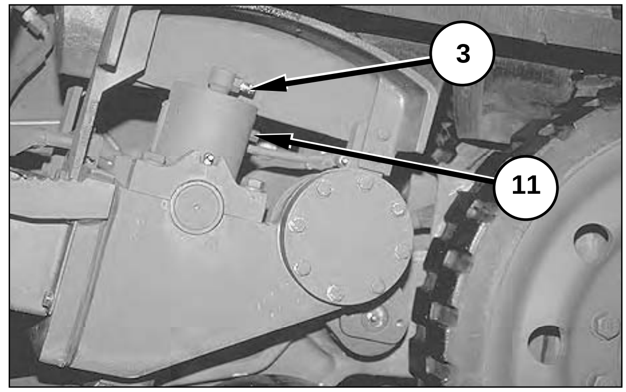
15. Move switch (9) up to fill the top end of the front suspension cylinder with hydraulic oil, until oil begins to leak from the bleed valve.

16. Close bleed valve (10) when there is no air in the oil flowing from the bleed valve.

17. Continue adding hydraulic oil through charging valve (2) while watching the pressure on gauge (H). Release switch (9) when the oil pressure reaches 5175 ± 690 kPa (750 ± 100 psi), and then quickly close valve (D).

NOTE: If valve (D) is left open while switch (9) is in the center position, the pressure in the circuit will slowly decrease. This reduction is caused by natural leakage through the control valve.

18. Turn nut (A) counterclockwise to close the valve in coupling (E). Open valve (D), and remove coupling (E) from fitting (2).



Bogie Suspension Cylinder Bleed and Charging Valve (Right Side Shown, Left Side Similar).
(3) Bogie cylinder charging valve. (11) Bleed valve.

19. Open bleed valve (11) on the bogie cylinder on the right side of the machine.

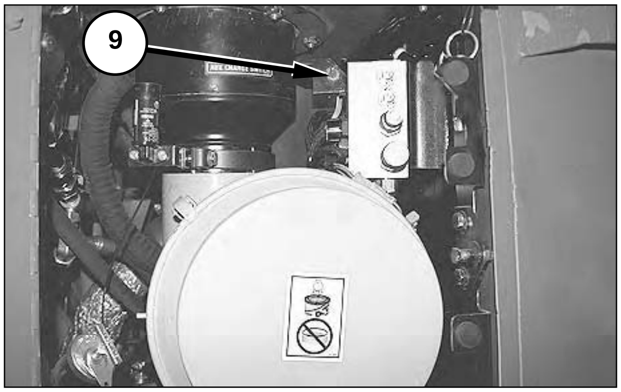
⚠ WARNING

Do not open the bleed valve on any cylinder unless the machine is off the ground and the pressure is removed from the cylinder. High pressure oil escaping from the bleed valve can cause injury or death.

20. Attach coupling (E) of the lines group coupler to charging valve (3) on the right side of the machine. After the coupling is attached to the fitting, turn nut (A) clockwise to open the valve in the coupling.

⚠ WARNING

Do not operate the engine above low idle when bleeding air from the suspension cylinders. Oil that is under excessive pressure and escaping from the cylinder bleed valve can cause injury or death.



Remote Charging Valve Switch.
(9) Switch.

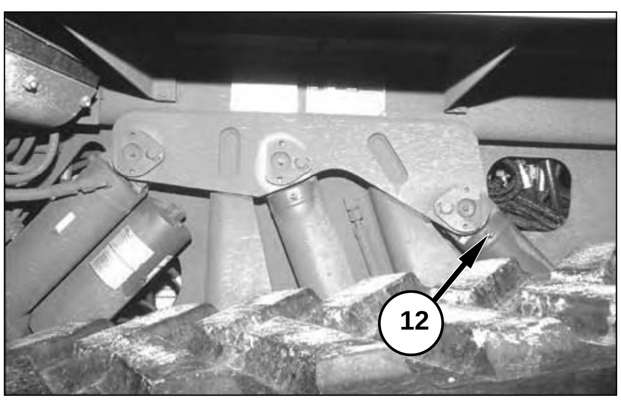
21. Move switch (9) up to fill the top end of the bogie cylinder with hydraulic oil, until oil begins to leak from the bleed valve.

22. Close bleed valve (11) when there is no air in the oil flowing from the bleed valve.

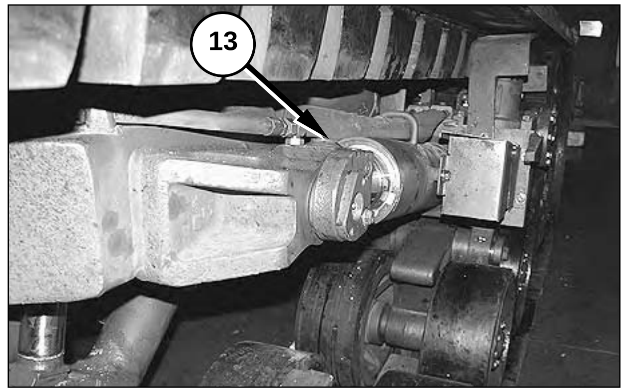
23. Continue adding hydraulic oil through charging valve (3) while watching the pressure on gauge (H). Release switch (9) when the oil pressure reaches 7000 ± 1400 kPa (1015 ± 200 psi), and then quickly close valve (D).

NOTE: If valve (D) is left open while switch (9) is in the center position, the pressure in the circuit will slowly decrease. This reduction is caused by natural leakage through the control valve.

24. Turn nut (A) counterclockwise to close the valve in coupling (E). Open valve (D), and remove coupling (E) from fitting (3).



Rear Suspension Cylinder Bleed Valve.
(12) Bleed valve.

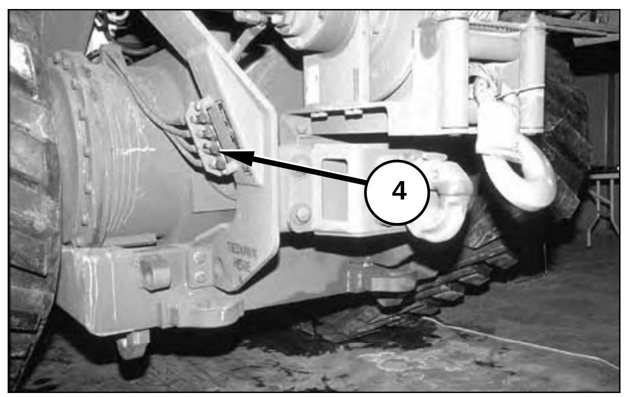


Recoil Cylinder Bleed Valve (Right Side Shown, Left Side Similar).
(13) Bleed valve.

25. Open bleed valve (12) on the rear suspension cylinder, and bleed valve (13) on the recoil cylinder on the right side of the machine.

WARNING

Do not open the bleed valve on any cylinder unless the machine is off the ground and the pressure is removed from the cylinder. High pressure oil escaping from the bleed valve can cause injury or death.

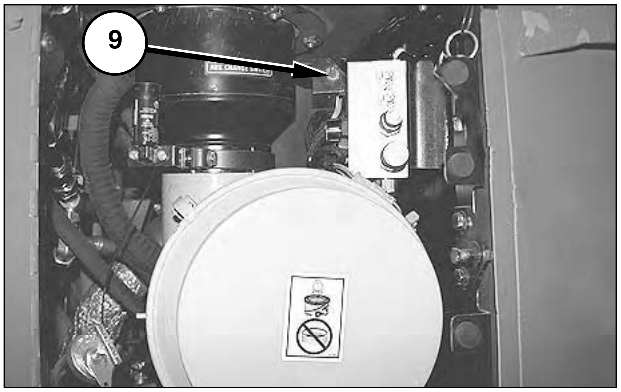


Recoil Charging Valve (Left Side Shown, Right Side Similar).
(4) Charging valve.

26. Attach coupling (E) of the lines group coupler to charging valve (4) on the right side of the machine. After the coupling is attached to the fitting, turn nut (A) clockwise to open the valve in the coupling.

WARNING

Do not operate the engine above low idle when bleeding air from the suspension cylinders. Oil that is under excessive pressure and escaping from the cylinder bleed valve can cause injury or death.



Remote Charging Valve Switch.
(9) Switch.

27. Move switch (9) up to fill the rear suspension cylinder with hydraulic oil until oil begins to leak from the bleed valve (13) on the recoil cylinder.

28. Close bleed valve (13) when there is no air in the oil flowing from the bleed valve.

29. Continue to hold switch (9) up to fill the rear suspension cylinder with hydraulic oil until oil begins to leak from the bleed valve (12) on the rear suspension cylinder.

30. Close bleed valve (12) when there is no air in the oil flowing from the bleed valve.

31. Continue adding hydraulic oil through charging valve (4) while watching the pressure on gauge (H). Release switch (9) when the oil pressure reaches 10 340 kPa (1500 psi), and then quickly close valve (D).

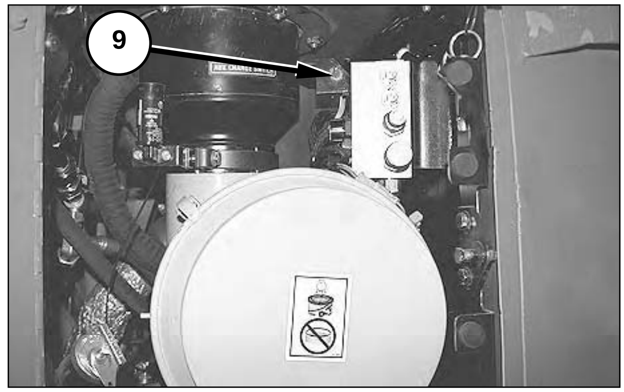
NOTE: If valve (D) is left open while switch (9) is in the center position, the pressure in the circuit will slowly decrease. This reduction is caused by natural leakage through the control valve.

32. Turn nut (A) counterclockwise to close the valve in coupling (E). Open valve (D), and remove coupling (E) from fitting (4).

33. Repeat Steps 6 through 32 for the suspension components on the left side of the machine.

34. Raise the machine, remove the support stands, and lower the machine to the ground.

35. Attach coupling (E) of the lines group coupler to charging valve (4), on the right side of the machine. After the coupling is attached to the fitting, turn nut (A) clockwise to open the valve in the coupling.



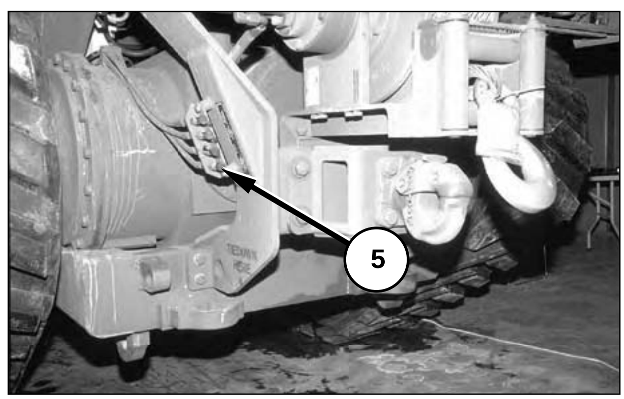
Remote Charging Valve Switch.
(9) Switch.

36. Move switch (9) up to add oil to the rear suspension and recoil cylinders. Continue adding hydraulic oil through charging valve (4) while watching the pressure on gauge (H). Release switch (9) when the oil pressure reaches 15 170 ± 690 kPa (2200 ± 100 psi), and then quickly close valve (D).

37. Turn nut (A) counterclockwise to close the valve in coupling (E). Open valve (D), and remove coupling (E) from fitting (4).

38. Repeat Steps 35 through 37 on the left side of the machine.

39. Operate the kneeling function. Lower and raise the machine five times (finish with the machine in the UP position). Refer to *Operator's Manual. Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Machine Features, Kneeling Switch."

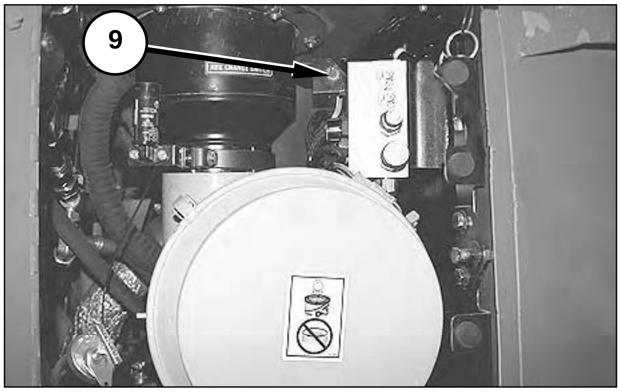


Charging Valve for Bottom of Front Suspension Cylinder (Left Side Shown, Right Side Similar).
(5) Charging valve.

40. Attach coupling (E) of the lines group coupler to charging valve (5) on the right side of the machine. After the coupling is attached to the fitting, turn nut (A) clockwise to open the valve in the coupling.

⚠ WARNING

Do not operate the engine above low idle when bleeding air from the suspension cylinders. Oil that is under excessive pressure and escaping from the cylinder bleed valve can cause injury or death.



Remote Charging Valve Switch.
(9) Switch.

41. Move switch (9) up to fill the bottom end of the front suspension cylinder with hydraulic oil. Continue adding hydraulic oil through charging valve (5) while watching the pressure on gauge (H). Release switch (9) when the oil pressure reaches 6210 ± 690 kPa (900 ± 100 psi), and then quickly close valve (D).

NOTE: If valve (D) is left open while switch (9) is in the center position, the pressure in the circuit will slowly decrease. This reduction is caused by natural leakage through the control valve.

42. Turn nut (A) counterclockwise to close the valve in coupling (E). Open valve (D), and remove coupling (E) from fitting (5).

43. Perform Steps 40 through 42 for the left side of the machine.

NOTE: Steps 44 and 45 can be skipped if the "Machine on Stands" procedure is immediately performed.

44. Close valve (D), and remove coupling (F) from port (7).

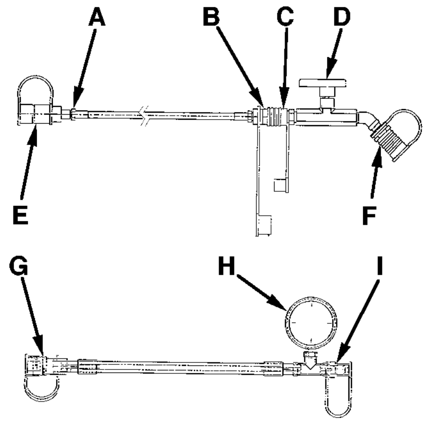
45. Disconnect coupling (G) of the lines group gauge and coupling (C) of the lines group coupler; and disconnect coupling (I) of the lines group gauge and coupling (B) of the lines group coupler. Connect coupling (B) and coupling (C) on the lines group coupler. Install the caps on the loose couplings, and return the lines group coupler and the lines group gauge to the BII compartment.

NOTE: To ensure that the suspension is functioning correctly, perform the "Machine on Ground" procedure below, after setting the pressures with the machine on stands.

Machine on Ground

NOTE: If any hydraulic component in the suspension has been removed or replaced, perform the "Machine on Stands" procedure before performing the "Machine on Ground" procedure.

NOTE: Refer to the "Tools Needed" chart and the "Suspension Hydraulic Charging Specifications" chart, in this module.



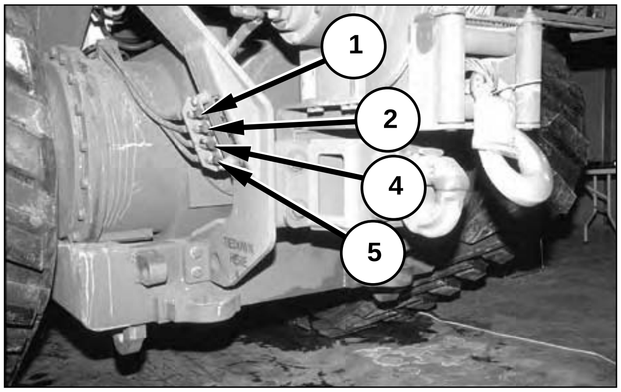
Lines Group Coupler and Lines Group Gauge.
(A) Nut. (B) Coupling. (C) Coupling. (D) Valve. (E) Coupling. (F) Coupling. (G) Coupling. (H) Gauge. (I) Coupling.

NOTE: Remove the lines group coupler and the lines group gauge from the BII compartment. Disconnect coupling (B) from coupling (C) on the lines group coupler; connect coupling (G) of the lines group gauge to coupling (C) of the lines group coupler; and connect coupling (I) of the lines group gauge to coupling (B) of the lines group coupler.

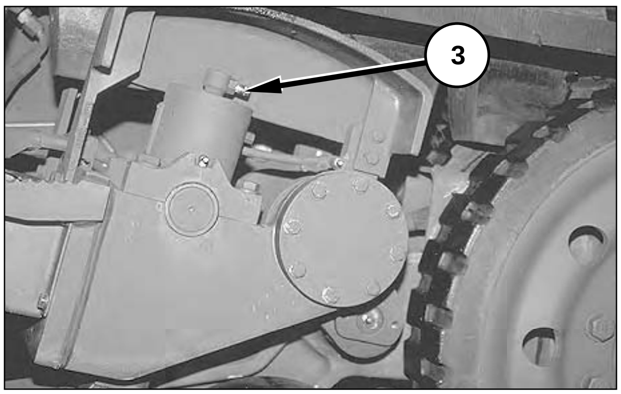
⚠ WARNING

Do not open the bleed valve on any cylinder unless the machine is off the ground and the pressure is removed from the cylinder. High pressure oil escaping from the bleed valve can cause injury or death.

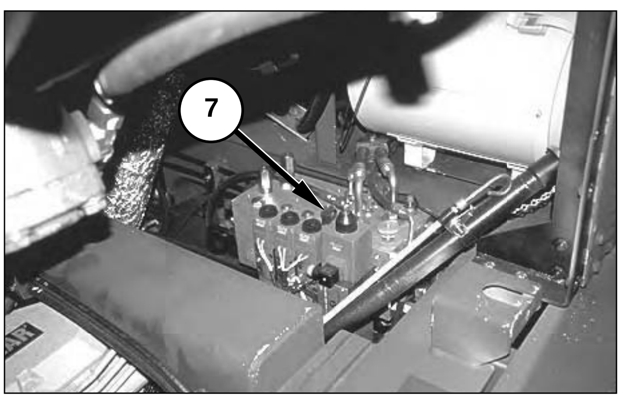
1. Park the machine on flat, level ground.



Suspension Hydraulic Charging Valves (Left Side Shown, Right Side Symmetrical).
(1) Middle suspension cylinder charging valve. (2) Front suspension cylinder charging valve, top. (4) Recoil cylinder charging valve. (5) Front suspension cylinder charging valve, bottom.

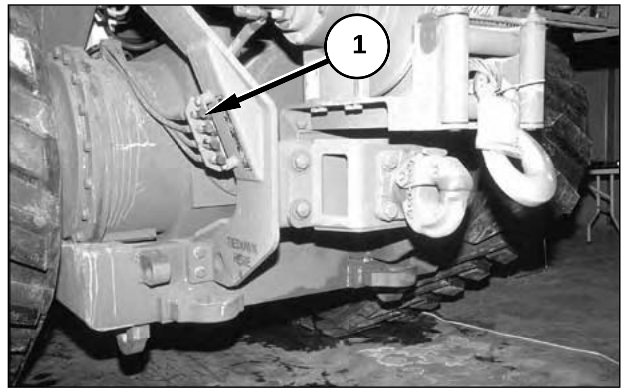


Bogie Cylinder Charging Valve.
(3) Bogie cylinder charging valve.



Multifunction Control Valve.
(7) Port ("P-OUT").

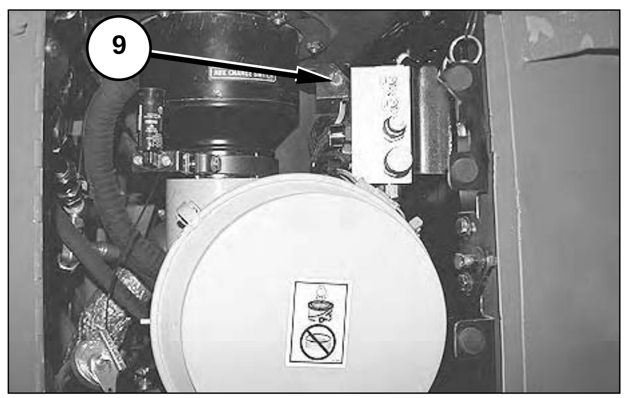
2. Connect coupling (F) of the lines group coupler to port (7) (marked "A3") on the multifunction control valve. Open valve (D).



Middle Cylinder Charging Valve (Left Side Shown, Right Side Similar).
(1) Middle suspension cylinder charging valve.

3. Attach coupling (E) of the lines group coupler to charging valve (1) on the right side of the machine. After the coupling is attached to the fitting, turn nut (A) clockwise to open the valve in the coupling.

4. Start and idle the engine. Ensure that the manual suspension lockout valves are open, and place the machine in SELF-DEPLOY. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Machine Operation, Earthmoving Mode, Manual Suspension Locking," and "SELF-DEPLOY Mode."

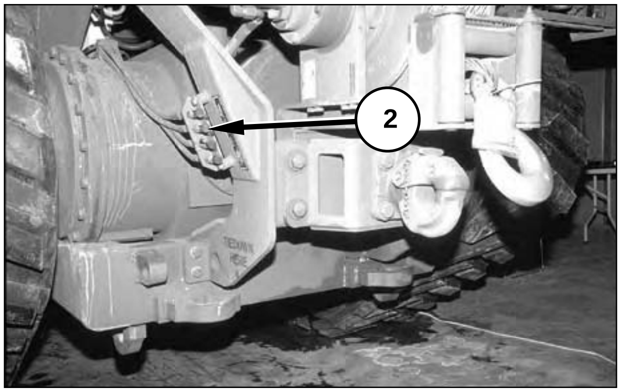


Remote Charging Valve Switch.
(9) Switch.

5. Move switch (9) up to fill the middle suspension cylinder with hydraulic oil. Continue adding hydraulic oil through charging valve (1) while watching the pressure on gauge (H). Release switch (9) when the oil pressure reaches 8276 ± 690 kPa (1200 ± 100 psi), then quickly close valve (D).

NOTE: If valve (D) is left open while switch (9) is in the center position, the pressure in the circuit will slowly decrease. This reduction is caused by natural leakage through the control valve.

6. Turn nut (A) counterclockwise to close the valve in coupling (E). Open valve (D), and remove coupling (E) from fitting (1).



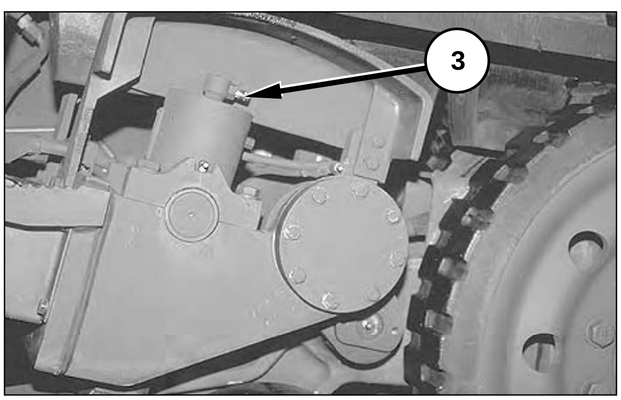
Front Suspension Cylinder Top End Charging Valve (Left Side Shown, Right Side Similar).
(2) Front suspension cylinder charging valve, top.

7. Attach coupling (E) of the lines group coupler to charging valve (2) on the right side of the machine. After the coupling is attached to the fitting, turn nut (A) clockwise to open the valve in the coupling.

8. Move switch (9) up to fill the top of the front suspension cylinder with hydraulic oil. Continue adding hydraulic oil through charging valve (2) while watching the pressure on gauge (H). Release switch (9) when the oil pressure reaches 6210 ± 690 kPa (900 ± 100 psi), then quickly close valve (D).

NOTE: If valve (D) is left open while switch (9) is in the center position, the pressure in the circuit will slowly decrease. This reduction is caused by natural leakage through the control valve.

9. Turn nut (A) counterclockwise to close the valve in coupling (E). Open valve (D), and remove coupling (E) from fitting (2).



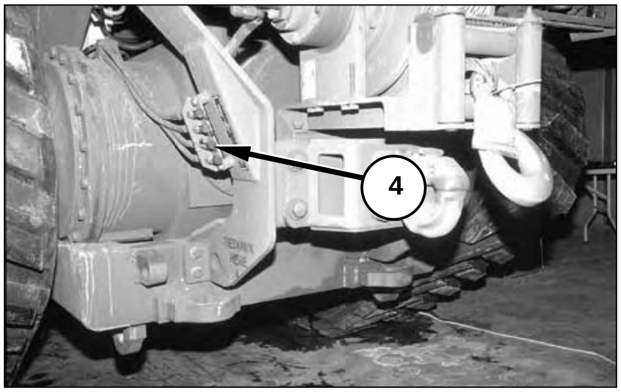
Bogie Suspension Cylinder Bleed and Charging Valve (Right Side Shown, Left Side Similar).
(3) Bogie cylinder charging valve.

10. Attach coupling (E) of the lines group coupler to charging valve (3) on the right side of the machine. After the coupling is attached to the fitting, turn nut (A) clockwise to open the valve in the coupling.

11. Move switch (9) up to fill the top of the bogie cylinder with hydraulic oil. Continue adding hydraulic oil through charging valve (3) while watching the pressure on gauge (H). Release switch (9) when the oil pressure reaches 11 790 ± 690 kPa (1710 ± 100 psi), then quickly close valve (D).

NOTE: If valve (D) is left open while switch (9) is in the center position, the pressure in the circuit will slowly decrease. This reduction is caused by natural leakage through the control valve.

12. Turn nut (A) counterclockwise to close the valve in coupling (E). Open valve (D), and remove coupling (E) from fitting (3).



Recoil Charging Valve (Left Side Shown, Right Side Similar).
(4) Recoil cylinder charging valve.

13. Attach coupling (E) of the lines group coupler to charging valve (4) on the right side of the machine. After the coupling is attached to the fitting, turn nut (A) clockwise to open the valve in the coupling.

14. Move switch (9) up to fill the top of the recoil cylinder with hydraulic oil. Continue adding hydraulic oil through charging valve (4) while watching the pressure on gauge (H). Release switch (9) when the oil pressure reaches 15 170 ± 690 kPa (2200 ± 100 psi), then quickly close valve (D).

NOTE: If valve (D) is left open while switch (9) is in the center position, the pressure in the circuit will slowly decrease. This reduction is caused by natural leakage through the control valve.

15. Turn nut (A) counterclockwise to close the valve in coupling (E). Open valve (D), and remove coupling (E) from fitting (4).

16. Perform Steps 3 through 15 for the left side of the machine.

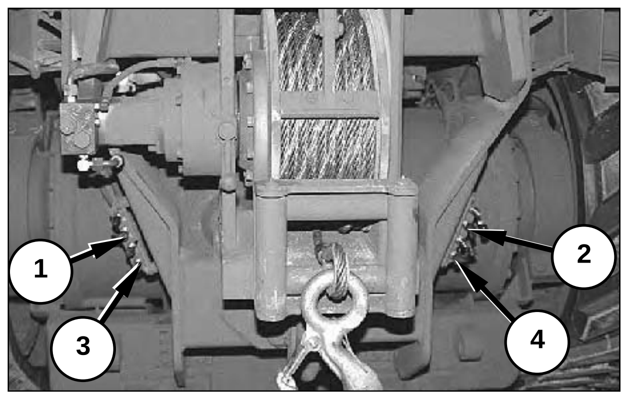
17. Close valve (D), and remove coupling (F) from port (7).

18. Disconnect coupling (G) of the lines group gauge and coupling (C) of the lines group coupler; and disconnect coupling (I) of the lines group gauge and coupling (B) of the lines group coupler. Connect coupling (B) and coupling (C) on the lines group coupler. Install the caps on the loose couplings, and return the lines group coupler and the lines group gauge to the BII compartment.

Kneeling System Pressure Adjustments

Tools Needed		
6V-4143	Quick Disconnect	2
4M-5317	Bushing Reducer	2
177-7861	Hose Assembly	2
148-1886	Quick Disconnect	2
8T-4188	Adapter (1/8 INT NPT X 1/4 INT NPT)	2
6V-3966	Nipple	2
8T-0859	Gauge 25 000 kPa (3600 psi)	2

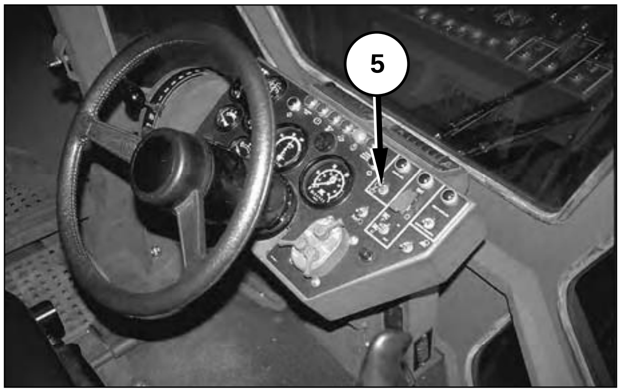
NOTE: This procedure requires that the machine be operated. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE)* for information about machine operation.



Suspension Charge Ports.
(1) Charging valve (left cylinder, top). (2) Charging valve (right cylinder, top). (3) Charging valve (left cylinder, bottom).
(4) Charging valve (right cylinder, bottom).

1. For testing the left front kneeling system, connect the hoses and pressure gauges to charging valves (1) and (3). For testing the right front kneeling system, connect the hoses and pressure gauges to charging valves (2) and (4).

2. Start the engine and allow the hydraulic oil to reach normal operating temperature.



Instrument Panel.
(5) Kneeling switch.

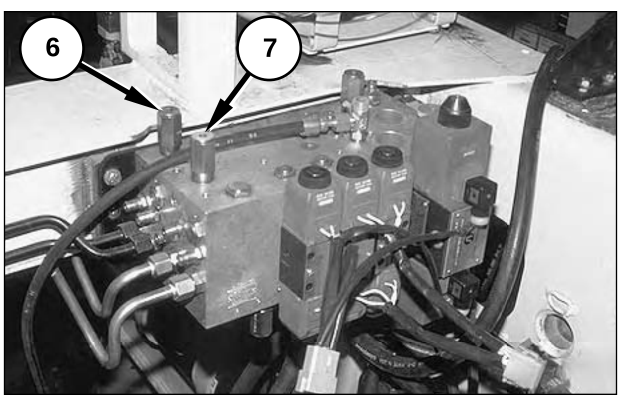
3. Operate the engine at high idle. Lower and raise the machine once using kneeling switch (5), and then lower the machine.

4. Raise the machine using kneeling switch (5). Observe the pressure reading on the gauges while the machine is raising. The pressure readings on both gauges should be 6210 ± 345 kPa (900 ± 50 psi).

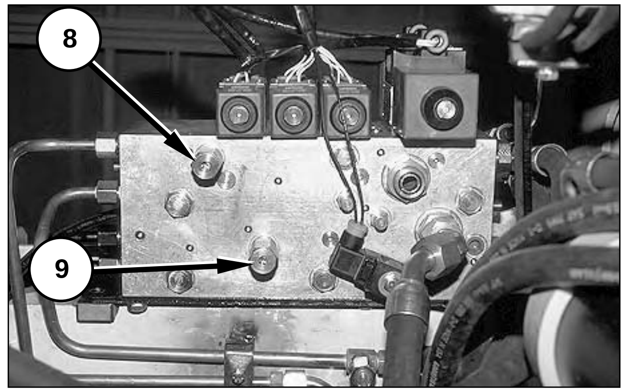
5. If the pressure values measured in Step 4 are within specification, go to Step 10. If the pressure values measured in Step 4 are out of specification, go to Step 6.

6. Stop the engine.

7. Raise the radiator. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Machine Features, Radiator Tilt."



Multifunction Valve (Machine Shown Partially Assembled for Photographic Clarity).
(6) Relief valve (right cylinder). (7) Relief valve (left cylinder).



Bottom View of Multifunction Valve (Machine Shown Partially Assembled for Photographic Clarity).
(8) Pressure reducing valve (left cylinder). (9) Pressure reducing valve (right cylinder).

Pressure Tap to Valve Adjustment	
Pressure Tap	Valve
(1)	(8)
(2)	(9)
(3)	(7)
(4)	(6)

8. Adjust the valve which corresponds to the pressure reading that was out of specification. Refer to the chart for the correct valve.

   To adjust the valve, remove the plug in the end of the valve to get access to the adjustment screw. Turn the adjustment screw clockwise to increase the pressure setting. Turn the adjustment screw counterclockwise to decrease the pressure setting.

9. Repeat Steps 2 through 8 until the pressure readings on the gauges are within specification.

10. Stop the engine.

11. Lower the radiator.

12. Remove the pressure gauges and the suspension charging hoses.

Undercarriage Alignment Procedures

Alignment Check

NOTE: This procedure requires a laser pointer, a precision V-block, a carpenter's level at least 1.2 m (4 ft) long, a straight edge approximately 30 cm (12 in) long, a scale with a nonreflective finish, and adhesive tapes of varying thicknesses. The laser pointer is supplied but the remainder of these materials should be obtained locally.

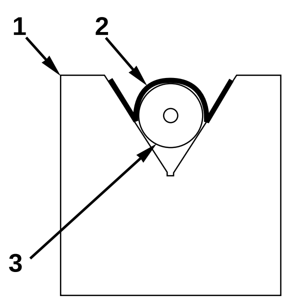
WARNING

This procedure requires the use of a laser pointer. Read and understand all safety information provided with the laser pointer. If no safety information is available, do not use the laser pointer to perform this procedure.

The scale used in this procedure must have a nonreflective finish.

Laser light can cause severe eye injury.

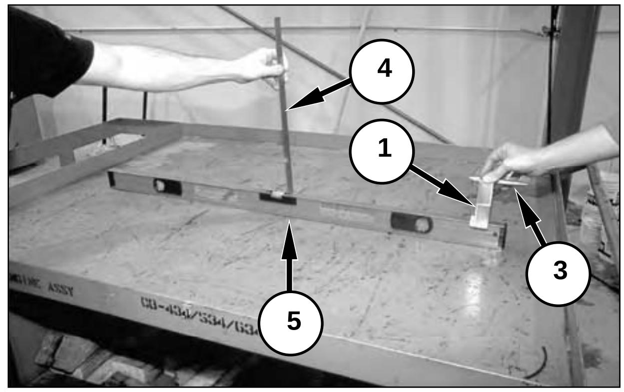
NOTE: This procedure can be performed with the outer drive wheel and/or drive belt on or off of the machine.



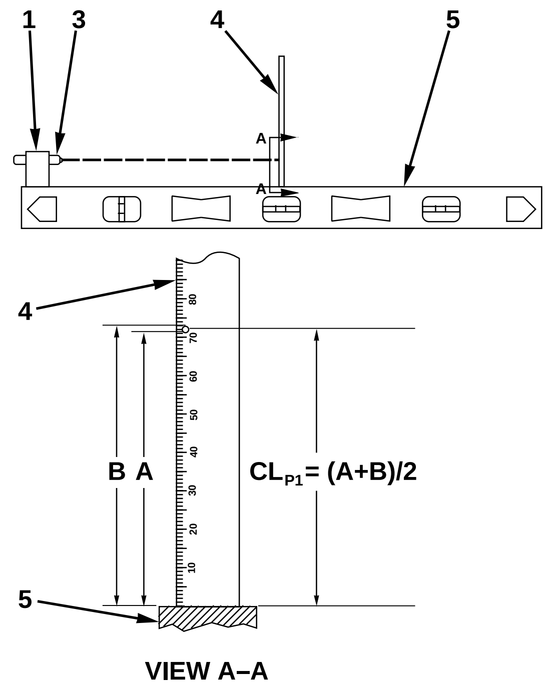
V-block and Laser Pointer.
(1) Precision V-block. (2) Adhesive tape. (3) Laser pointer.

1. Use adhesive tape (2) to secure laser pointer (3) in the cradle of precision V-block (1).

NOTE: The relative position of the laser pointer to the V-block must not change throughout the entire alignment check procedure. Place the laser pointer in the V-block in a position which allows easy access to the ON/OFF switch.



Determination of Centerline of Laser Pointer.
(1) Precision V-block. (3) Laser pointer. (4) Scale. (5) Carpenter's level.



Determination of Centerline of Laser Pointer.
(1) Precision V-block. (3) Laser pointer. (4) Scale. (5) Carpenter's level.

2. Determine the distance from the bottom of precision V-block (1) to the center of the beam from laser pointer (3), using the following procedure:

a. Place the V-block at one end of carpenter's level (5), with the laser pointer parallel to the level.

b. Place scale (4) approximately one-half the distance between the ends of the level with the measuring face of the scale perpendicular to the line of sight of the laser pointer.

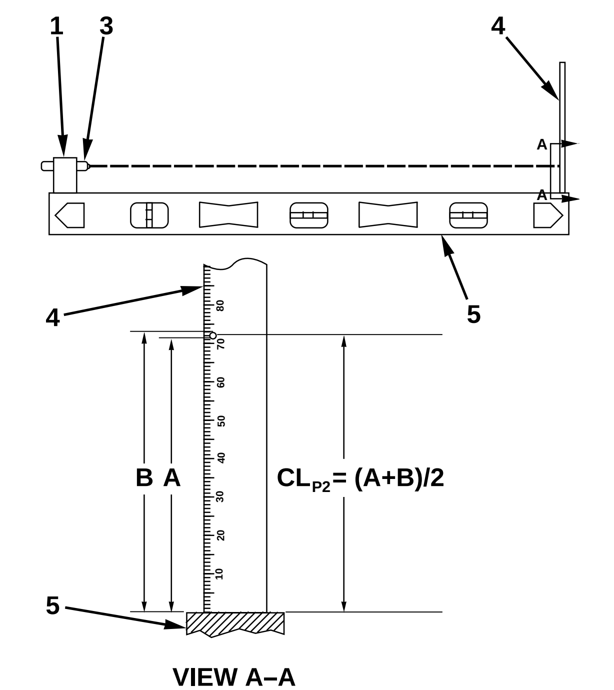
c. Turn the laser pointer on and shoot the beam on the face of the scale. The light will make a dot on the scale.

d. Record the measurement from the level to the bottom of the laser dot (A) and from the level to the top of the laser dot (B).

Average the two measurements (add the two measurements together and divide the number by two [{A+B}÷2]) to determine the center point of the laser dot (CL_{P1}).

Repeat this step until a consistent measurement of the center point (CL_{P1}) is obtained.

NOTE: Do not estimate the center point of the dot and/or do not simply use the measurement to the top or the bottom of the laser dot as the reference distance. The size of the laser dot may increase as the distance from the laser pointer to the scale increases.



Determination of Centerline of Laser Pointer.
(1) Precision V-block. (3) Laser pointer. (4) Scale. (5) Carpenter's level.

e. Move the scale to the end of the level. Turn the laser pointer on and shoot the beam on the face of the scale.

f. Record the measurement from the straight edge to the bottom of the laser dot (A) and from the straight edge to the top of the laser dot (B).

Average the two measurements to determine the center point of the laser dot (CL_{P2}).

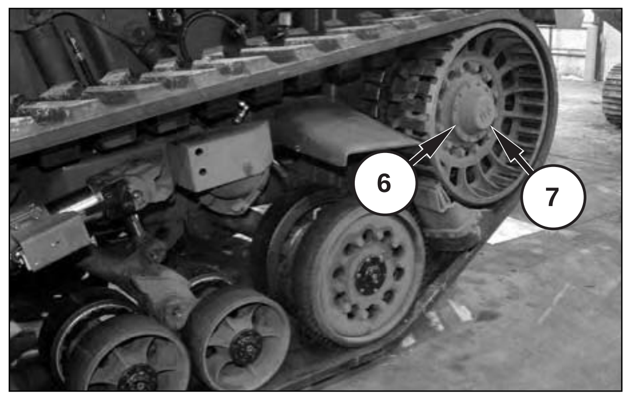
Repeat this step until a consistent measurement of the center point (CL_{P2}) is obtained.

g. Compare the center point of the laser dot measured in Step d (CL_{P1}) to the center point of the laser dot measured in Step f (CL_{P2}). If the measurements are equal, record the measurement as CL_P and go to Step 3. If the measurements are not equal, go to Step h.

h. If CL_{P1} is less than CL_{P2}, add the shims under the back side of the precision V-block. If CL_{P1} is greater than CL_{P2}, add the shims under the front of the precision V-block.

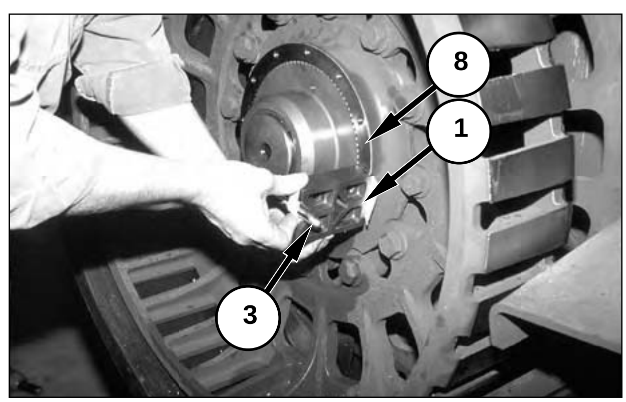
NOTE: Tape of varying thickness (duct tape, electrical tape, masking tape, and clear tape) can be used as shimming material. Attach the tape to the bottom of the precision V-block.

i. Repeat Steps a through g until CL_{P1} and CL_{P2} are equal.

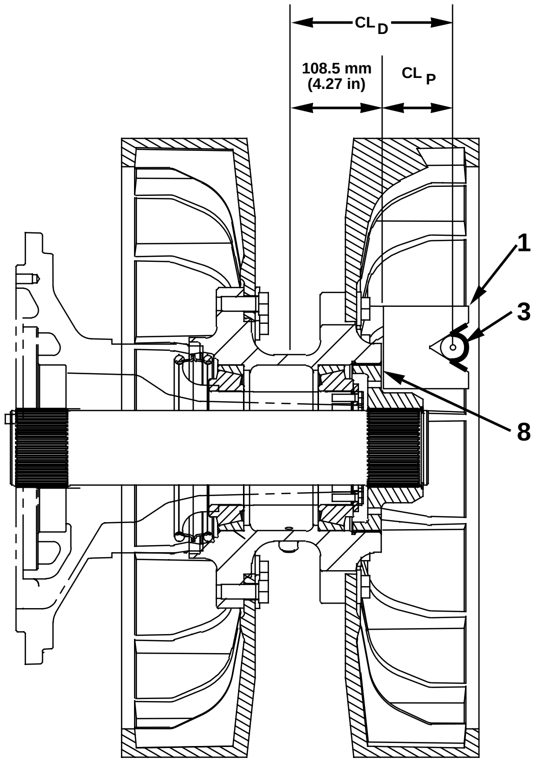


Rear Drive Hub.
(6) Bolts. (7) Cover.

3. Remove twelve bolts (6) with washers, and remove cover group (7) with the O-ring. Replace the cover after the alignment procedure has been completed.



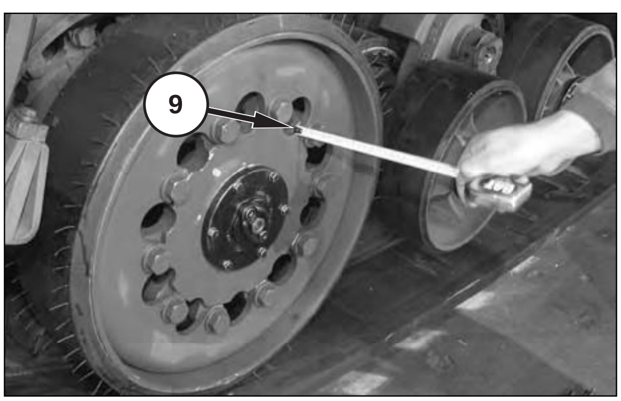
Rear Drive Hub.
(1) Precision V-block. (3) Laser pointer. (8) Cover group mounting surface.



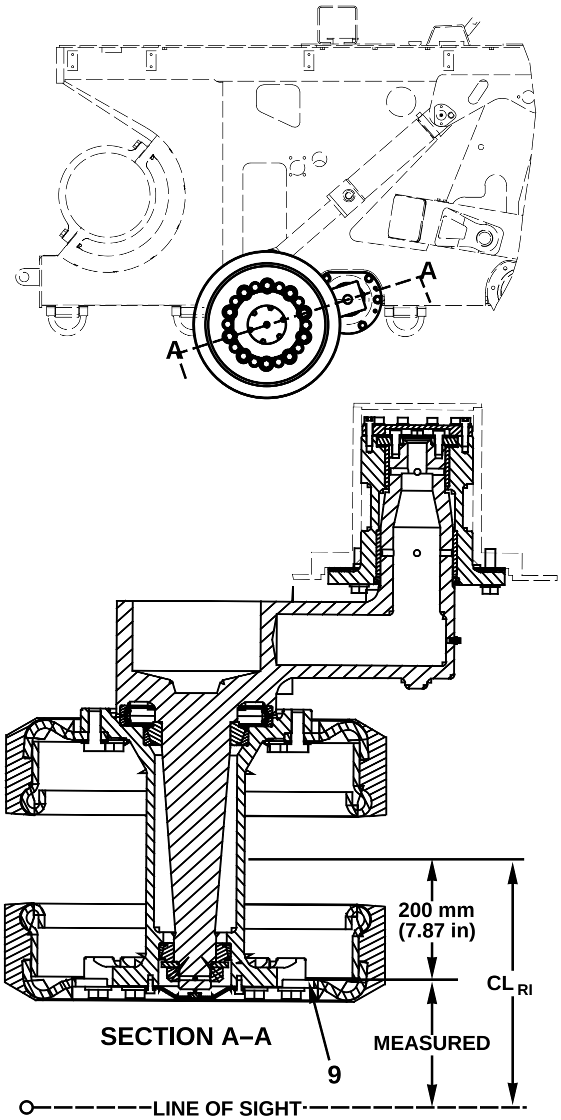
Drive Wheel Mounting Group.
(1) Precision V-block. (3) Laser pointer. (8) Cover group mounting surface.

4. Place precision V-block (1) on cover group mounting surface (8) so laser pointer (3) can shoot a beam along the suspension components.

NOTE: The distance from the centerline of the drive wheels to the cover group mounting surface is 108.5 mm (4.27 in). Therefore, the distance from the centerline of the drive wheels to centerline of the laser pointer is CL_P + 108.5 mm (CL_P + 4.27 in). This distance should be calculated and recorded as CL_D.



Rear Idler.
(9) Outside mounting face.



Determination of CL_{RI}.
(9) Outside mounting face.

5. Measure the distance from the outside mounting face (9) of the rear idler group to the center of the laser beam. Repeat this measurement in several different positions. Average the measurements. Add 200 mm (7.87 in) to the average measurement and record the sum as CL_{RI}.

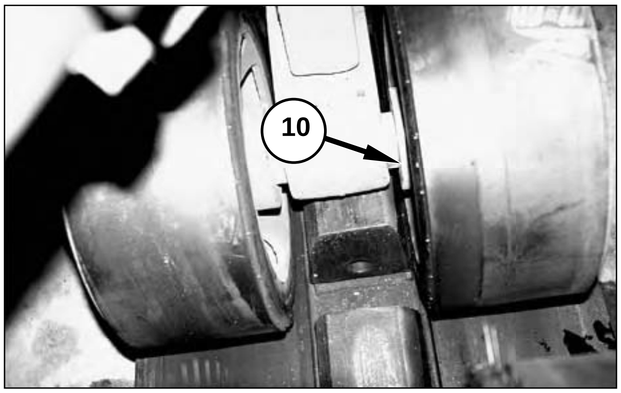
NOTE: CL_{RI} gives the distance from the centerline of the laser beam to the centerline of the rear idler group.

6. Subtract CL_{RI} from CL_D to determine the difference between the centerline of the drive wheels and the centerline of the rear idler group.

If CL_{RI} - CL_D is not 0.0 ± 1.5 mm (0.00 ± 0.06 in), shims must be added to or subtracted from the joint between the rear swing arm and the machine frame.

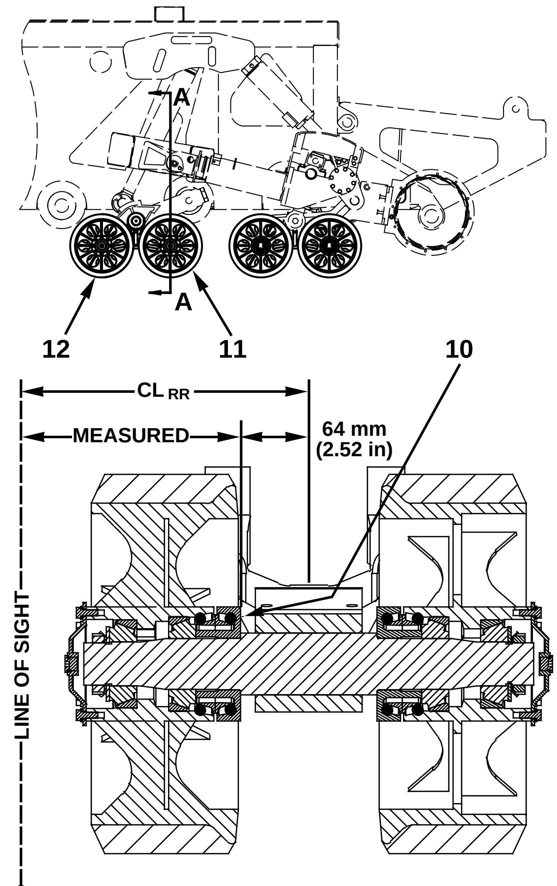
Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train*, “Swing Arm, Rear, Left and Right.”

NOTE: Repeat Steps 5 and 6 until the rear idler group alignment is within specification.



Midroller Group.
(10) Inside bearing face.

Determination of CL_{RR}.



SECTION A-A

Determination of CL_{RR}.
(10) Inside bearing face. (11) Front roller in rear midroller group.
(12) Rear roller in rear midroller group.

7. Measure the distance from the inside bearing face (10) of the rear roller (12) in the rear midroller group to the center of the laser dot. Repeat this measurement until a consistent measurement is obtained. Add 64 mm (2.52 in) to the measurement and record the sum as CL_{RR1}.

NOTE: CL_{RR1} gives the distance from the centerline of the laser beam to the centerline of the rear roller in the rear midroller group.

8. Measure the distance from the inside bearing face of the front roller (11) in the rear midroller group to the center of the laser dot. Repeat this measurement until a consistent measurement is obtained. Add 64 mm (2.52 in) to the measurement, and record the measurement as CL_{RR2}.

NOTE: CL_{RR2} gives the distance from the centerline of the laser beam to the centerline of the front roller in the rear midroller group.

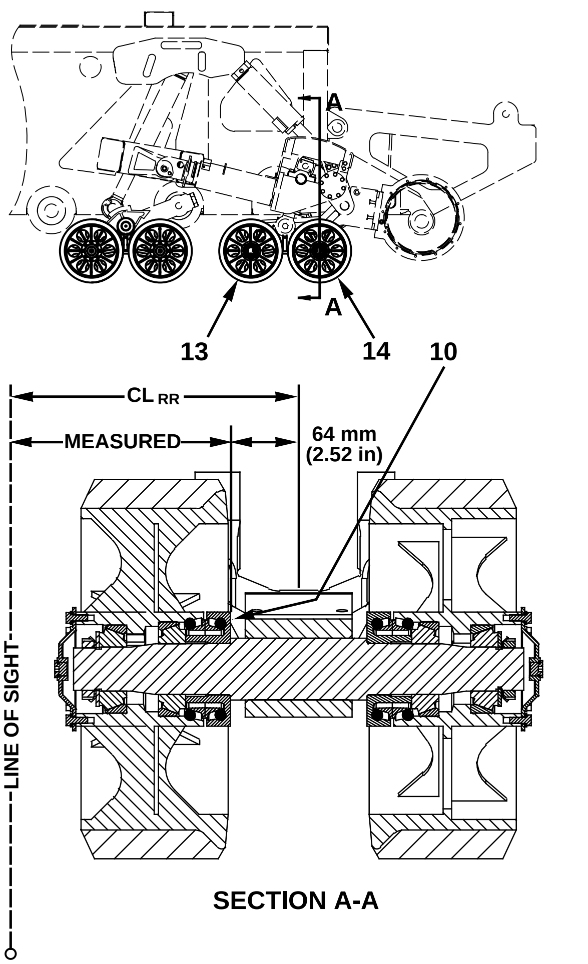
9. Average the measurements CL_{RR1} and CL_{RR2} Record the average as CL_{RR}.

10. Subtract CL_{RR} from CL_D to determine the difference between the centerline of the drive wheels and the centerline of the rear roller group.

If CL_{RR} - CL_D is not 0.0 ± 1.5 mm (0.00 ± 0.06 in), shims must be added to or subtracted from the joint between the support group and the machine frame.

Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Support Group, Left and Right."

NOTE: Repeat Steps 7 through 10 until the alignment of the rear midroller group is within specification.



Determination of CL_{FR}.
(10) Inside bearing face. (13) Rear roller in front midroller group. (14) Front roller in front midroller group.

11. Measure the distance from the inside bearing face of the rear roller (13) in the front midroller group to the center of the laser dot. Repeat this measurement until a consistent measurement is obtained. Add 64 mm (2.52 in) to the measurement and record the sum as CL_{FR1}.

NOTE: CL_{FR1} gives the distance from the centerline of the laser beam to the centerline of the rear roller in the front midroller group.

12. Measure the distance from the inside bearing face of the front roller (14) in the front midroller group to the center of the laser dot. Repeat this measurement until a consistent measurement is obtained. Add 64 mm (2.52 in) to the measurement, and record the measurement as CL_{FR2}.

NOTE: CL_{FR2} gives the distance from the centerline of the laser beam to the centerline of the front roller in the front midroller group.

13. Average the measurements CL_{FR1} and CL_{FR2}. Record the average as CL_{FR}.

14. Subtract CL_{FR} from CL_D to determine the difference between the centerline of the drive wheels and the centerline of the front roller group.

If CL_{FR} - CL_D is not 0.0 ± 1.5 mm (0.00 ± 0.06 in), shims must be added to or subtracted from the joint between the front swing arm and the machine frame.

Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Swing Arm, Front, Right and Left."

NOTE: Repeat Steps 7 through 10 until the alignment of the front midroller group is within specification.

Toe-In Procedure

Tools Needed		
164-3310	Infrared Thermometer	1

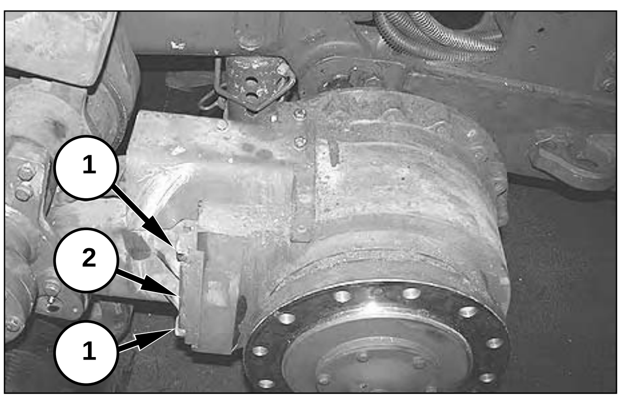
NOTE: This procedure should be performed if one side of the guide blocks shows a greater degree of wear than the other.

NOTE: A temperature difference of greater than 11°C (20°F) between the inside and outside of the guide blocks is an early indication of a toe-in problem. To check the temperature difference, the machine should be operated on flat ground (no crown) with a minimal amount of steering for at least 15 minutes. An infrared thermometer can be used to determine the temperature difference between the sides of the guide blocks. The side with the greatest temperature will eventually show signs of increased wear.

1. Determine the side of the guide blocks which exhibits the greatest amount of wear (or has the higher temperature).

2. Remove the outer front idler group. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Front Idler Group, Outer."

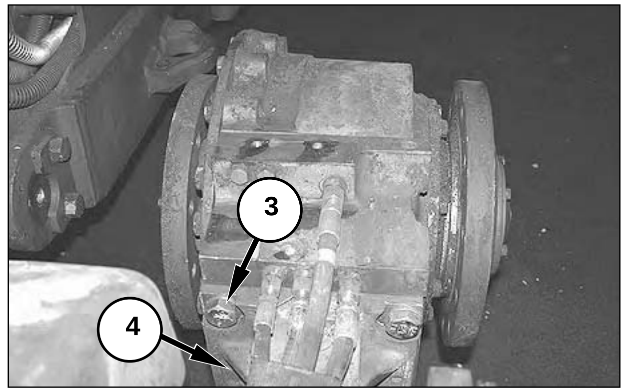
3. If the outside of the guide blocks has the greatest amount of wear (or higher temperature), go to Step 6. If the inside of the guide blocks has the greatest amount of wear (or higher temperature), go to Step 4.



Brake Group, Front Idlers and Drive Belt Removed.
(1) Outer bolts. (2) Jacking bolt (hole location).

4. Loosen outer bolts (1), insert jacking bolt in hole (2), and remove a shim. Go to Step 7.

NOTE: If no shims are present on the outside, go to Step 5.



Brake Group.
(3) Inner bolts. (4) Hole.

5. Remove the inner front idler, loosen inner bolts (3) (one shown), insert a jacking bolt in hole (4), and add a shim. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Front Idler Group, Inner, Left and Right" for the procedure to remove the inner front idler. Go to Step 7.

6. Loosen outer bolts (1), insert jacking bolt in hole (2) and add a shim. Go to Step 7.

7. Reassemble the tractor, and operate the machine on flat ground (no crown) with a minimal amount of steering, for at least 15 minutes. Use an infrared thermometer to determine the temperature difference between the sides of the guide blocks. If a temperature difference of greater than 11°C (20°F) is present between the sides of the guide blocks, go to Step 1.

Brake System Procedures

Accumulator Charging Procedure

Refer to “Testing and Adjusting, Suspension System Procedures, Accumulator Charging Procedure” in this module.

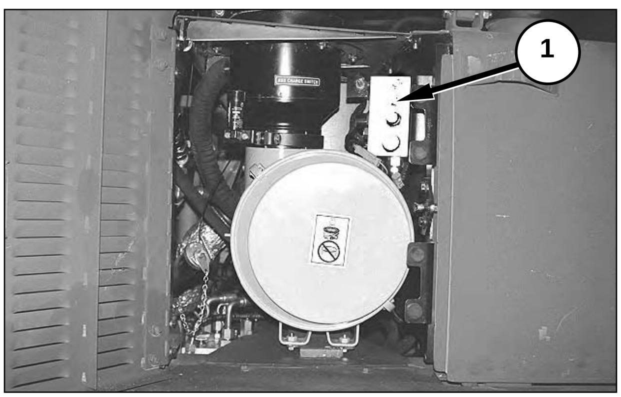
NOTE: Release the pressure in the brake system prior to this beginning procedure by pumping the brake pedal to the floor at least 120 times.

Parking Brake Pressure Limiter Adjustment Procedure

NOTE: This procedure requires that the machine be operated. Refer to *Operator’s Manual, Deployable Universal Combat Earthmover (DEUCE)* for information about machine operation.

⚠ WARNING

The machine may move during this procedure. Ensure that there is adequate space, and keep personnel away from the machine.



Air Intake Compartment.
(1) Brake system pressure tap.

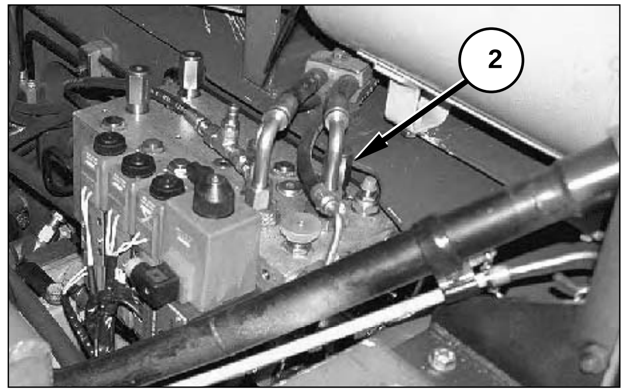
1. Open the air intake compartment and install the lines group gauge stored in the BII box to brake system pressure tap (1).

2. Block the tracks.

3. Start and idle the engine.

4. Release the park brake, and record the pressure on the gauge. The pressure reading on the gauge should be 5515 ± 205 kPa (800 ± 30 psi).

5. If the pressure reading is incorrect, stop the engine.



Brake Pressure Limiter Valve (Radiator Shown Raised for Photographic Clarity).
(2) Brake pressure limiter valve.

NOTE: Brake pressure limiter valve (2) can be accessed directly through the air intake compartment. It is not necessary to raise the radiator.

6. Loosen the cap on brake pressure limiter valve (2). Turn the adjusting screw clockwise to increase the pressure. Turn the adjusting screw counterclockwise to decrease the pressure.

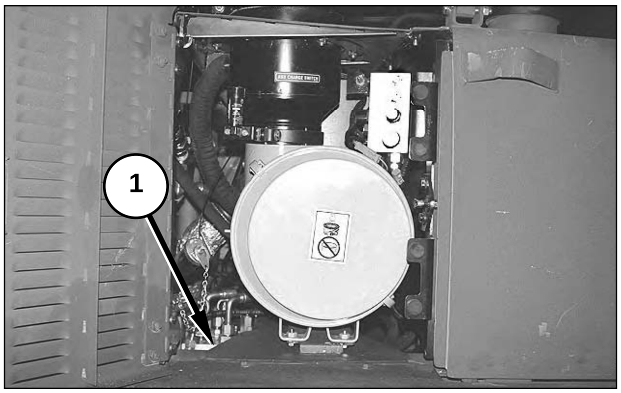
7. Repeat Steps 2 through 5 until the pressure is within specification.

8. Remove all tooling, store the lines group gauge in the BII compartment, replace the cap on brake pressure limiter valve, close the air intake compartment door, and remove the blocks.

Brake System Pressure Check

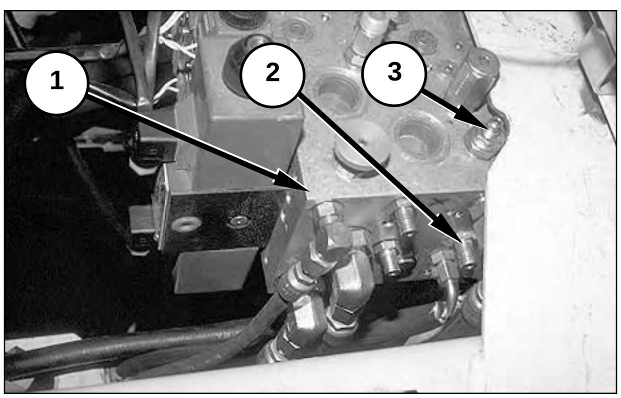
Tools Needed		
177-7861	Hose Assembly	1
3B-6552	Adapter	1
6V-4143	Quick Disconnect	1
8T-0859	Gauge 25 000 kPa (3600 psi)	1
8T-4188	Adapter (1/8 INT NPT X 1/4 INT NPT)	1

NOTE: This procedure requires that the machine be operated. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE)* for information about machine operation.



Air Intake Compartment.
(1) Multifunction valve.

1. Open the air intake compartment door.



Multifunction Valve (Machine Shown Partially Assembled for Photographic Clarity).
(1) Multifunction valve. (2) Pressure tap. (3) Brake pilot unloading valve.

2. Install a 0 to 25 000 kPa (0 to 3600 psi) pressure gauge on pressure tap (2).

3. Start and run the engine at high idle for one minute.

4. The pressure reading on the gauge should increase to 20 355 ± 690 kPa (2950 ± 100 psi) and then hold at that pressure.

5. If the pressure does not reach 20 355 ± 690 kPa (2950 ± 100 psi), remove the plastic cap on brake pilot unloading valve (3), loosen the locknut, and turn the plunger in the center of the valve to adjust the pressure.

NOTE: Clockwise rotation of the plunger increases the pressure, and counterclockwise rotation decreases the pressure. After the pressure has been adjusted, tighten the locknut, and install the plastic cap on brake pilot unloading valve (3).

6. Allow the engine to idle, and pump the service brake pedal repeatedly, to lower the brake system pressure.

7. The pressure should fall to a minimum of 15 180 ± 1380 kPa (2200 ± 200 psi). If the pressure falls below specification, replace brake pilot unloading valve (3).

8. Remove all tooling and close the air intake compartment door.

TM5-2430-200-24

Disassembly & Assembly

Deployable Universal Combat Earthmover (DEUCE)

Power Train

PIN: 7RR00003-Up

Important Safety Information

Most accidents involving product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “WARNING” as shown below.

The meaning of this safety alert symbol is as follows:

⚠ WARNING

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning, explaining the hazard, can be either written or pictorially presented.

Operations that may cause product damage are identified by NOTICE labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are therefore not all inclusive. If a tool, procedure, work method or operating technique not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and others. You should also ensure that the product will not be damaged or made unsafe by the operation, lubrication, maintenance or repair procedures you choose.

The information, specifications, and illustrations in this publication are on the basis of information available at the time it was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service given to the product. Obtain the complete and most current information before starting any job. Caterpillar dealers have the most current information available. For a list of the most current publication form numbers available, see the Service Manual Contents Microfiche, REG1139F.

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Belt Tension Group

Remove and Install

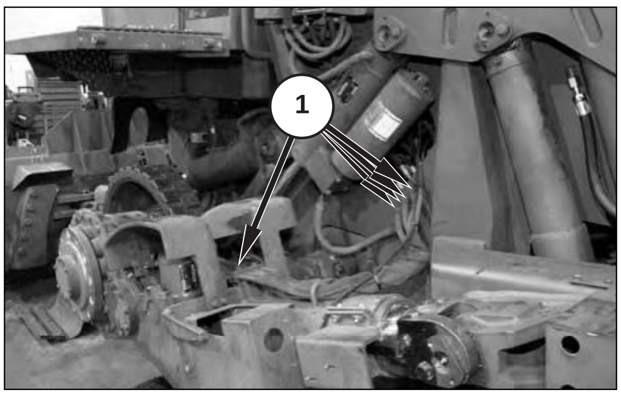
NOTE: Group numbers related to this procedure include 142-0071, 142-0073, 169-7416, and 169-7417.

NOTE: The following procedure is for the component on the left side of the machine. The procedure for the component on the right side of the machine is the same. Ensure that the pivot arm does not pivot over the center during this procedure.

Start By:

a. Remove the rear fender.

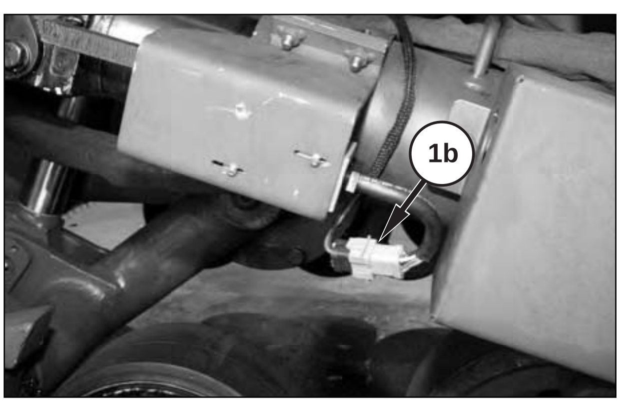
b. Remove the drive belt.



1. Release the pressure in the brake system by pumping the brake pedal to the floor at least 120 times.

WARNING

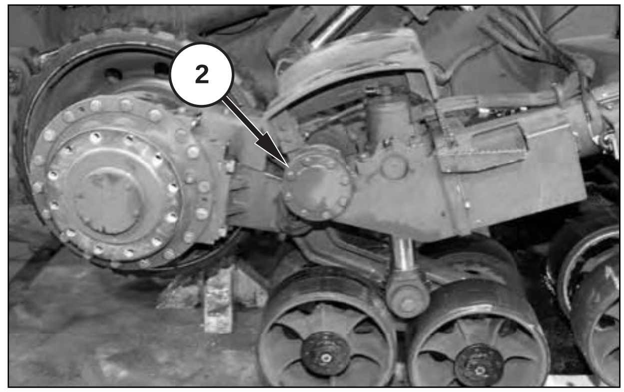
The brake accumulator stores hydraulic pressure even after the engine has stopped running. Do not disconnect any lines until the hydraulic pressure in the accumulator has been released.



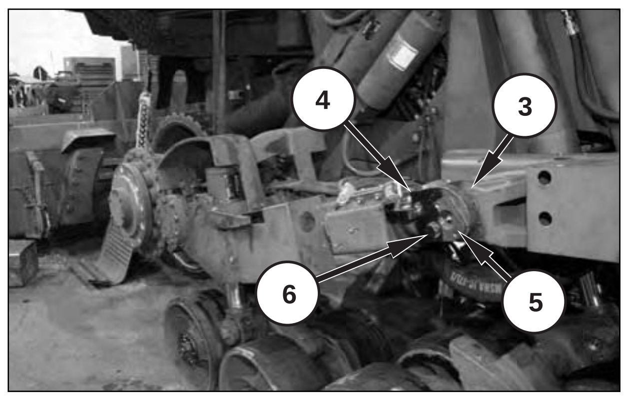
2. Disconnect, cap and plug six brake lines (1). Mark the lines for correct connection during reassembly.

a. Disconnect recoil alert connector (1b), cut wire ties as necessary.

NOTE: If the hydraulic tank has not been drained, oil may spill from brake lines (1). Use a suitable container to catch any spilled oil, and dispose of the oil according to local regulations.



3. Remove eight bolts with washers and cover (2). Clean the sealing material from the face of the cover and from the mounting face of the tension assembly.



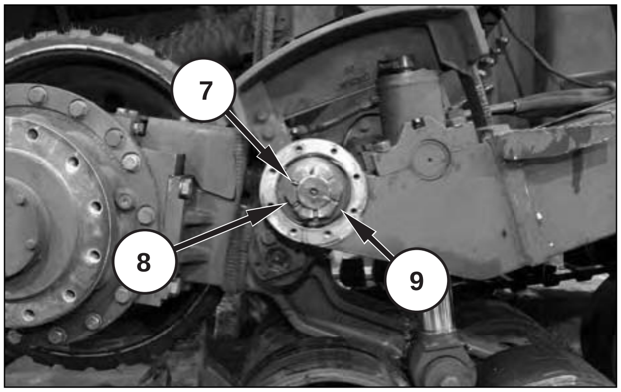
4. Support recoil cylinder (4) with a hoist to remove bolt (6) with washer.

NOTE: The weight of the belt tension assembly with the major bogie and brake group is **771 kg (1700 lb)**.

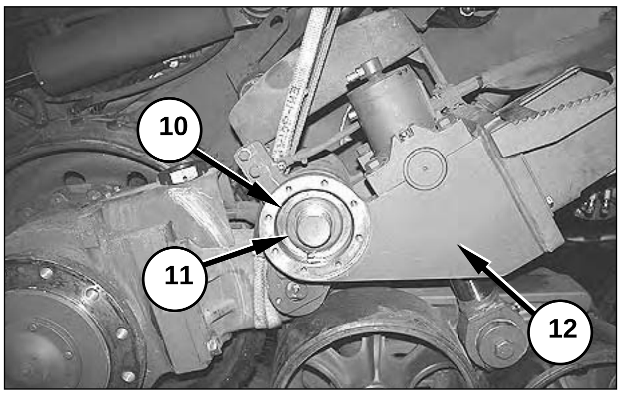
5. Remove pin (5) with shims, and allow recoil cylinder (4) to pivot up until the recoil cylinder is clear of pin boss (3) on the machine frame. Note the location of the shims for correct location during reassembly.

6. Block recoil cylinder (4) to support the entire tension assembly and major bogie.

NOTE: The weight of the belt tension assembly with the major bogie and brake group is **771 kg (1700 lb)**.

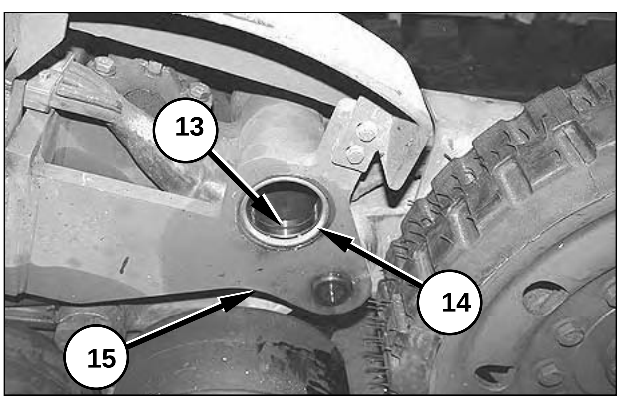


7. Remove cotter pin (7), nut (8), and spacer (9). Use a three-inch socket to remove nut (8).



8. Remove shims (10) and thrust washer (11). Note the location of the shims for correct location during reassembly.

9. Remove belt tension group (12) with the major bogie and brake group. The weight of the belt tension assembly with the major bogie and brake group is **771 kg (1700 lb)**.



10. If necessary, remove one seal (14) and two bearings (13) from belt tension assembly (15). Replace the seal and bearings if they are worn or damaged.

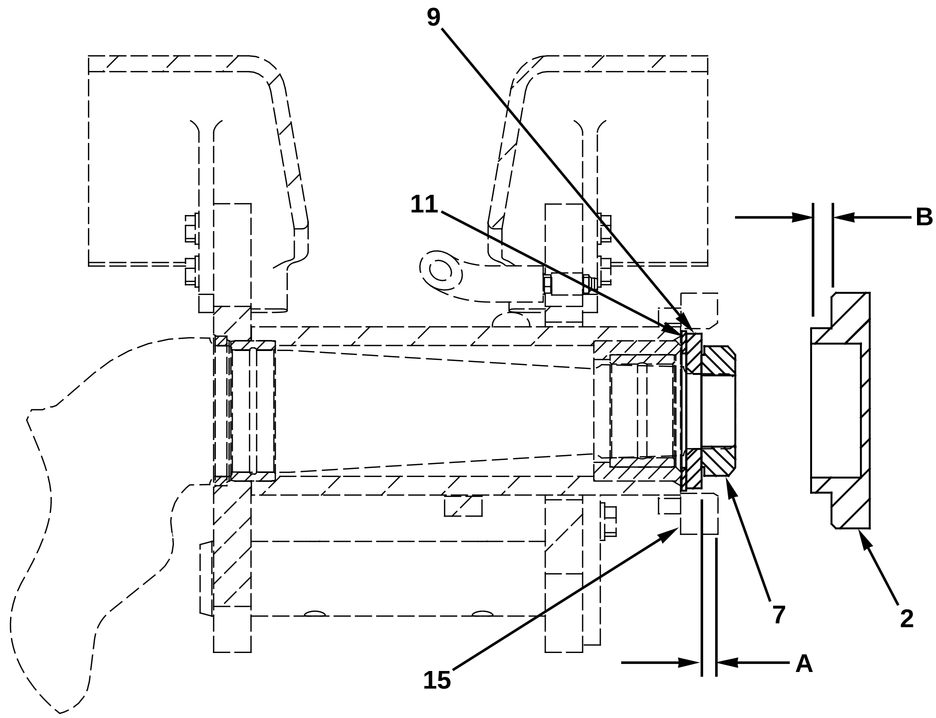
NOTE: There are two bearings (13) installed in the tension assembly. The outer bearing is not visible in the photograph.

NOTE: The following steps are for installing the belt tension group.

11. If necessary, install two bearings (13) and one seal (14). Chill the bearings to **–75°C (–100°F)** before installing them.

NOTE: If necessary, drive the bearings into position with a plastic sledge or a press.

12. Install belt tension group (12) with the major bogie and brake group. The weight of the belt tension assembly with the major bogie and brake group is **771 kg (1700 lb)**.



Belt Tension Group Bearing Preload Adjustment.
(2) Cover. (7) Nut. (9) Spacer. (11) Thrust washer. (15) Belt tension assembly.

13. Determine the correct number of shims (10) to set the bearing preload as follows:

a. Install thrust washer (11), spacer (9) and nut (7). Tighten nut (7) to a torque of **65 N•m (50 lb ft)**, and then rotate belt tension group (12) back and forth, and retighten the nut to the same torque.

b. Measure depth (A) between the edge of belt tension assembly (15) and spacer (9).

c. Measure depth (B) on cover (2).

d. Subtract measurement (B) from measurement (A) to determine the value of (C). The correct thickness of shims (10) is the value of (C) **±0.4 mm (0.0016 in)**.

e. Remove nut (7) and spacer (9).

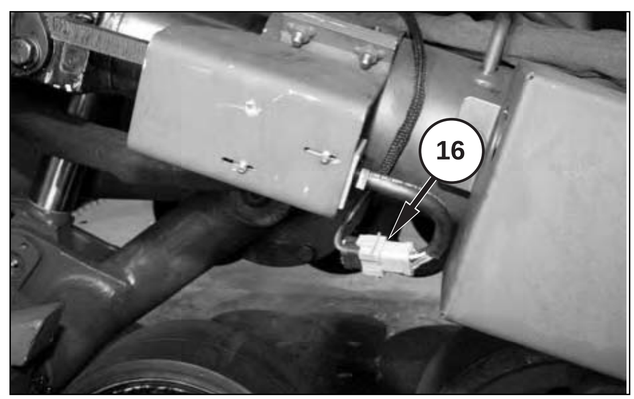
14. Install the number of shims (10) as determined in Step 12, and install spacer (9) and nut (7). Tighten nut (7) to a torque of **136 ± 40 N•m (100 ± 30 lb ft)**. Install wire (8) through the slots in nut (7) and the hole in the shaft. If necessary, continue tightening nut (7) to align the next slot with the hole in the shaft.

15. Install pin (5) with shims.

NOTE: If new shims are used, install the number of shims required to remove the space between the cylinder eye and the mounting surface.

16. Apply **9S-3263 Compound (Loctite™ 242)** to the threads of bolt (6), and install the bolt with washer. Tighten the bolt to a torque of **300 ± 40 N•m (222 ± 30 lb ft)**.

17. Apply **8T-9022 Sealant (RTV Silicone)** to the sealing face on cover (2), and install the cover with eight bolts and washers.



18. Reconnect recoil alert connector (16), replace wire ties as necessary.

19. Reconnect six lines (1).

20. Refill the pivot arm with grease.

End By:

a. Install the drive belt.

b. Install the rear fender.

Brake Accumulator

Remove and Install

Start By:

a. Remove the steering pump drive shaft.

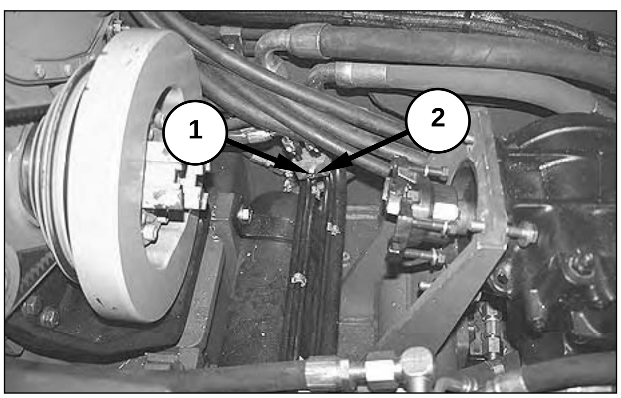
NOTE: Group numbers related to this procedure include 129-3016, 130-9241, 144-8605, 144-8614, and 145-0073.

1. Release the pressure in the brake system by pumping the brake pedal to the floor at least 120 times.

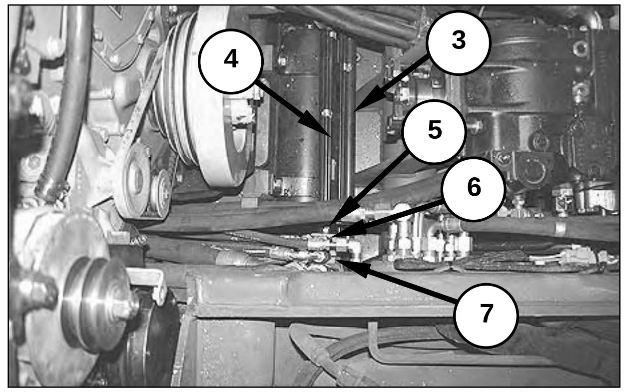
WARNING

The brake accumulator stores hydraulic pressure even after the engine has stopped running. Do not disconnect any lines to the accumulator until the hydraulic pressure in the accumulator has been released.

2. Drain the oil from the hydraulic tank into a suitable container. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Maintenance Intervals, Every 1000 Service Hours or One Year." The capacity of the hydraulic tank is approximately **72 L (19 U.S. gal)**. If the hydraulic oil will not be reused, dispose of the oil according to local regulations.



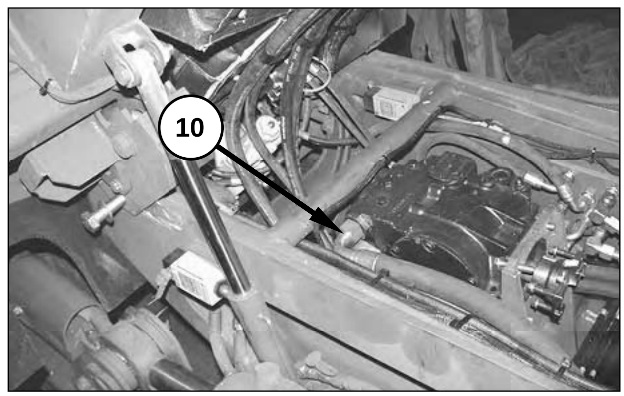
3. Remove bolt (1) and clamp plate (2).



4. Remove bolt (5) and clamp plate (6).

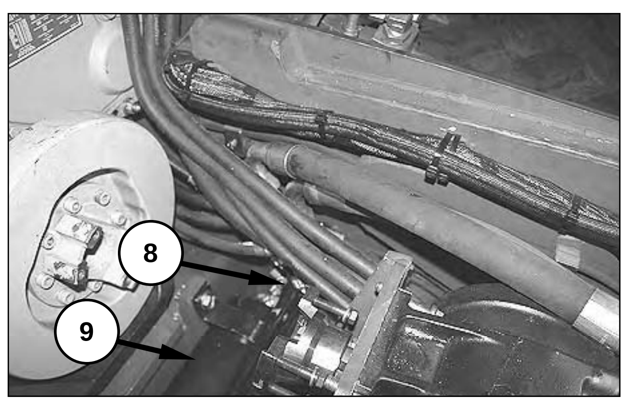
5. Move the first two smaller lines (4) out of clamp halves (7).

6. Continue removing nuts, clamps and lines until all smaller lines (4) and two bigger lines (3) are out of the clamps.



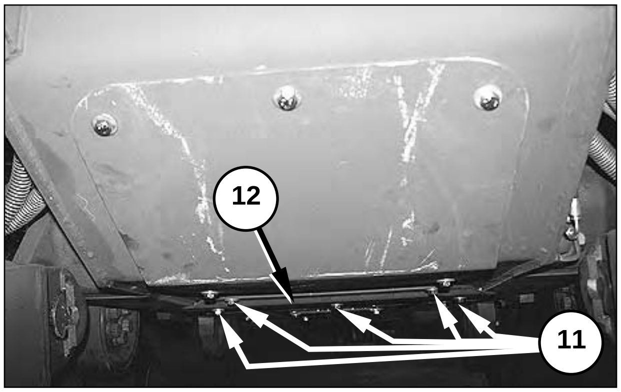
7. Disconnect, cap and plug suction line (10) from the steering pump.

NOTE: A large amount of oil may flow out of suction line (10) when it is disconnected. Catch the oil in a suitable container, and dispose of the oil in accordance with local regulations.

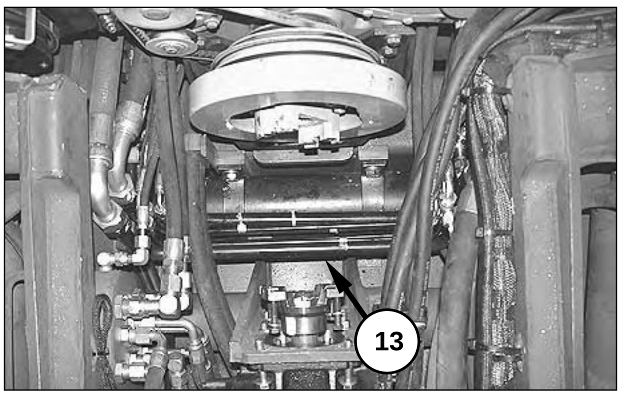


8. Disconnect, cap and plug two lines (8) on the end of brake accumulator (9).

NOTE: If desired, lines (8) can be disconnected from under the machine after Step 9 has been completed.

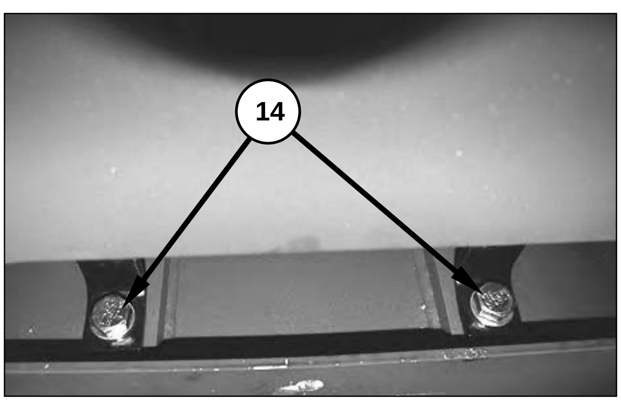


9. Remove five bolts (11) with washers, and bottom cover (12).

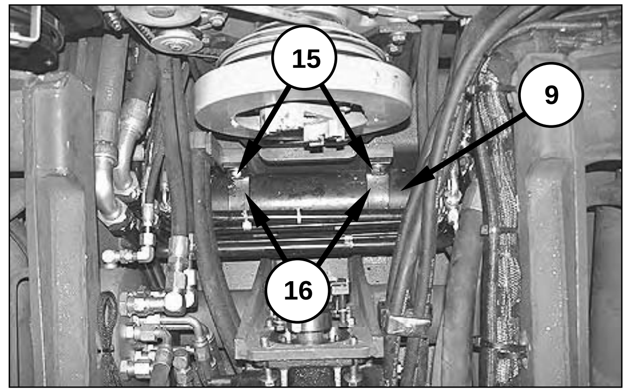


10. Disconnect large line (13) from the hoses at both ends of the line. Pull up on the right side of the line to remove the line from the clamp on the right side of the machine. Remove the line from the clamp on the left side of the machine, and lower the line through the bottom access hole.

NOTE: If necessary, disconnect additional hoses on the left side of the machine to provide clearance to disconnect the left side of line (13). Cap, plug, and mark any additional hose which was disconnected.



11. Remove two bolts (14) with washers.



12. Remove two bolts (15) with washers, and two brackets (16).

13. Push the remaining lines out of the way, and remove brake accumulator (9) from the top (fitting end first).

NOTE: To install the brake accumulator, reverse the removal steps. Torque the clamp mounting bolts (14, 15) to 125±20 Nm (92±14 lb ft).If installing a new brake accumulator, charge the accumulator with nitrogen gas prior to installation. Refer to *Specifications, Systems Operation, Testing and Adjusting, DEUCE, Undercarriage Steering and Brakes*, “Testing and Adjusting, Suspension System Procedures, Accumulator Charging Procedure.”

End By:

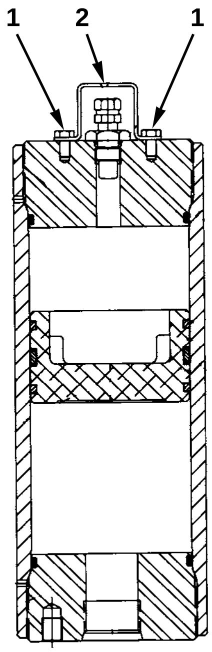
a. Install the steering pump drive shaft.

Disassemble and Assemble

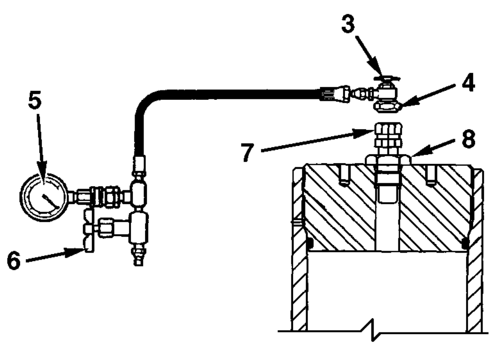
Tools Needed	
7S5437 Nitrogen Charging Group	1

Start By:

a. Remove the brake accumulator.



1. Remove bolts (1), and remove cover (2).



2. Install 8T-0857 Pressure Gauge (5) to the fitting on the 7S-5437 Nitrogen Charging Group.

3. Ensure that valve (6) is closed.

4. Attach connector (4) of the 7S-5437 Nitrogen Charging Group to gas valve (7) on the accumulator.

5. Turn valve (3) clockwise, until tight, and read the pressure which registers on pressure gauge (5).

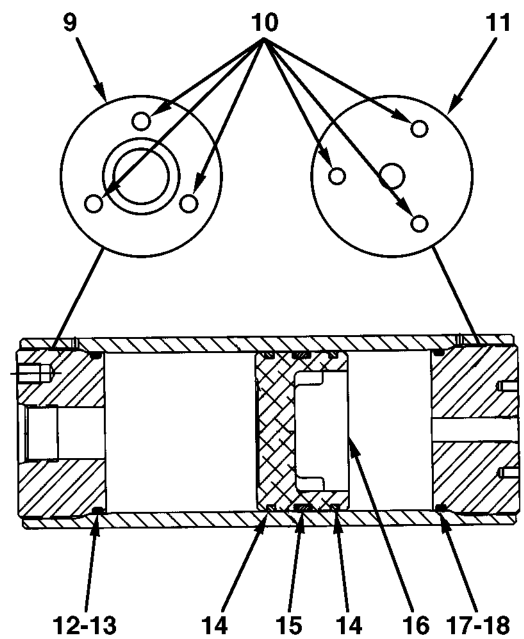
6. If the pressure is greater than **0 kPa (0 psi)**, open valve (6) slightly to slowly release the nitrogen gas. Direct the discharge of nitrogen away from personnel in the area. When the pressure on gauge (5) registers **0 kPa (0 psi)**, slowly open valve (6) completely to ensure that all of the nitrogen has been discharged from the accumulator.

7. Close valve (6), and remove connector (4) from gas valve (7).

8. Loosen nut (8), and remove gas valve (7) with the O-ring seal. Replace the O-ring seal if necessary.

⚠ WARNING

Do not remove gas valve (7) until all of the nitrogen gas has been removed from the accumulator.



9. Secure the accumulator with a strap wrench, or place the accumulator horizontally in a vise.

10. Remove gas end cap (11), and then remove hydraulic end cap (9).

NOTE: To remove end caps (9) and (11), place pins in holes (10), position a long bar between two of the pins, and use the bar and pins to unscrew the cap from the accumulator body.

11. Remove O-ring seal (17) and backup ring (18) from gas end cap (11).

12. Remove O-ring seal (13) and backup ring (12) from hydraulic end cap (9).

13. Use a bar to push piston (16) out of the accumulator housing.

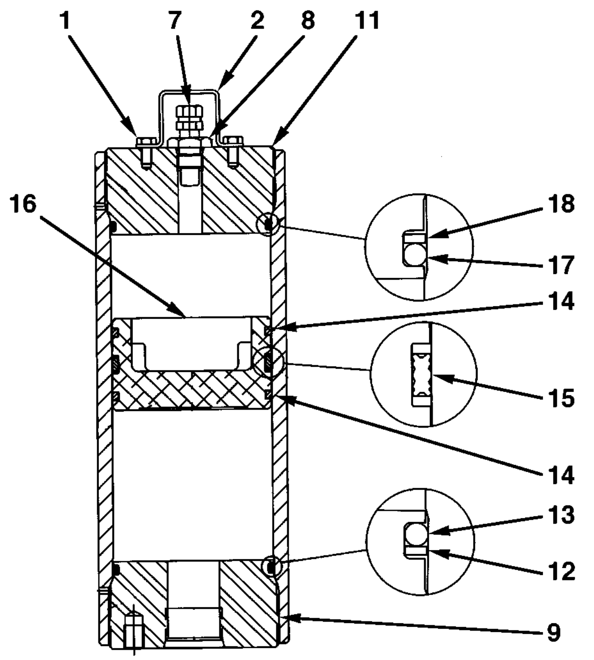
NOTE: Push on the hydraulic side of piston (16). The hydraulic side of the piston is flat and faces the end of the accumulator from which hydraulic end cap (9) was removed.

14. Remove wear rings (14) from piston (16).

15. Remove V-O-ring seal (15) with backup washers from piston (16).

NOTE: The following steps describe the procedure to assemble the accumulator.

NOTE: Ensure that all components are clean and dry. Coat internal parts with clean hydraulic oil before assembly.



16. Install V-O-ring seal (15) with backup washers on piston (16).

17. Install wear rings (14) on piston (16).

18. Place piston (16) in the accumulator housing with the flat end of the piston facing the hydraulic end of the accumulator. Ensure that the threads do not damage V-O-ring seal (15).

19. Use a wood block and a hammer to tap piston (16) into the accumulator housing until the face of the piston is approximately **50 mm (2 in)** below the beginning of the honed bore in the accumulator housing.

NOTE: Install the piston slowly and ensure that the face of the piston remains square with the end of the accumulator housing. The piston fits snugly in the accumulator housing. As the piston is forced up the chamfer and into the housing, the V-O-ring seal compresses. To prevent the piston from springing out of the housing, constant force must be applied to the piston as the piston is forced up the chamfer.

20. Install backup ring (12), and then install O-ring seal (13) on hydraulic end cap (9).

21. Install hydraulic end cap (9) in the accumulator bore. Tighten the end cap until the face of end cap is **1.6 ± 0.8 mm (0.0625 ± 0.0313 in)** above the face of the accumulator housing.

NOTE: Ensure that the flat side of piston (16) is facing hydraulic end cap (9).

22. Install backup ring (18), and then install O-ring seal (17) on gas end cap (11).

23. Install gas end cap (11) in the accumulator bore. Tighten the end cap until the face of end cap is **1.6 ± 0.8 mm (0.0625 ± 0.0313 in)** above the face of the accumulator housing.

24. Install gas valve (7) with the O-ring seal. Tighten the gas valve to a torque of **1.4 ± 0.3 N•m (12.5 ± 2.5 lb in)**. Tighten nut (8) to a torque of **35 N•m (26 lb ft)** to secure gas valve (7) in gas end cap (11).

25. Charge the accumulator with nitrogen. For the charging procedure, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage, Steering and Brakes,* “Testing and Adjusting, Suspension System Procedures.”

26. Place cover (2) over gas valve (7), and install bolts (1).

End By:

a. Install the brake accumulator.

Brake Group

Remove and Install

Tools Needed	A
138-7574 Link Bracket	2

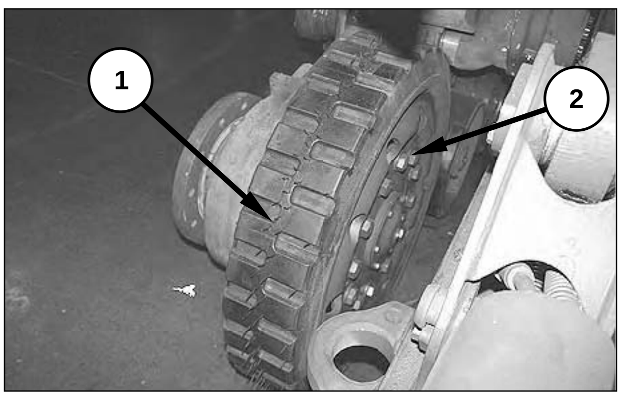
NOTE: Group numbers related to this procedure include 141-9989 and 143-0837.

NOTE: The following procedure is for the component on the right side of the machine. The procedure for the component on the left side of the machine is the same.

Start By:

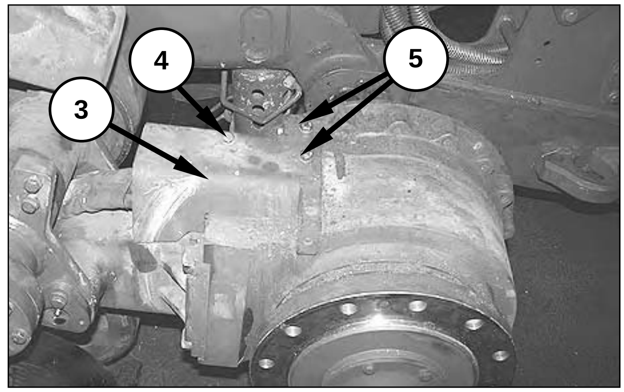
a. Remove the drive belt.

b. Remove the cab fender. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Machine Systems,* "Fender Group. Left."



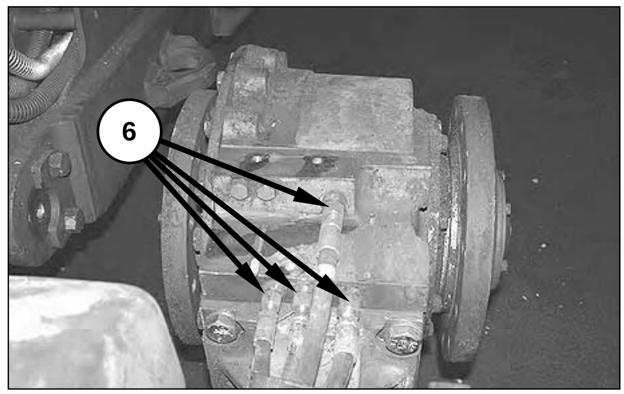
1. Support the bottom of inner front idler (1), and remove 12 bolts (2) with washers. The weight of inner front idler (1) is approximately **73 kg (161 lb).** Upon installation, apply **154-9731 Thread Compound (Loctite™ 271)** to the threads of 12 bolts (2), and tighten the bolts to a torque of **530 ± 70 N•m (392 ± 52 lb ft).**

2. Remove inner front idler (1).

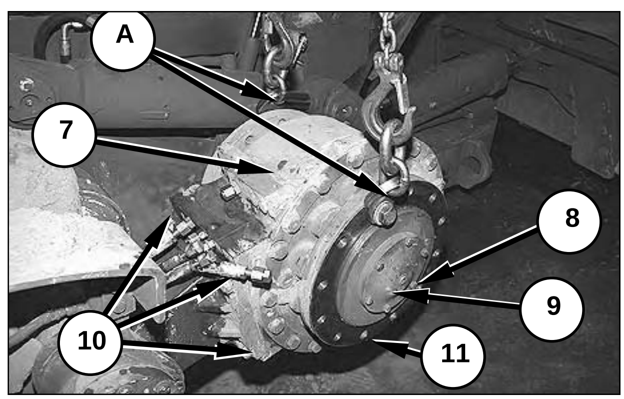


3. Remove one long bolt (4) and two short bolts (5), with washers.

4. Remove cover (3).



5. Disconnect, cap and plug four brake lines (6). Mark the lines for correct connection during reassembly.



6. Remove drain plug (11) and drain the oil from the brake housing. Catch the oil in a suitable container, and discard the oil according to local regulations. Replace the drain plug.

NOTE: Oil drained from the brake housing does not need to be replaced. The hydraulic system replaces the oil during normal operation.

7. Remove six bolts (8) with washers, and cover (9) from both sides of the brake. Catch any oil that may leak in a suitable container, and discard the oil according to local regulations.

8. Install Tooling (A), fasten a hoist to brake group (7), and support the weight of the brake assembly. The weight of brake group (7) is **272 kg (600 lb)**.

9. Place a spacer beneath the midrollers on the major bogie to keep the midrollers from falling when the brake group is removed.

10. Remove four bolts (10) with the washers and shims, and remove brake assembly (7). The weight of brake group (7) is **272 kg (600 lb)**. Mark the shims for replacement. If necessary, perform the toe-in procedure. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage, Steering, and Brakes,* "Testing and Adjusting, Suspension System Procedures, Undercarriage Alignment Procedure."

NOTE: To install the brake group, reverse the removal steps.

End By:

a. Install the cab fender.

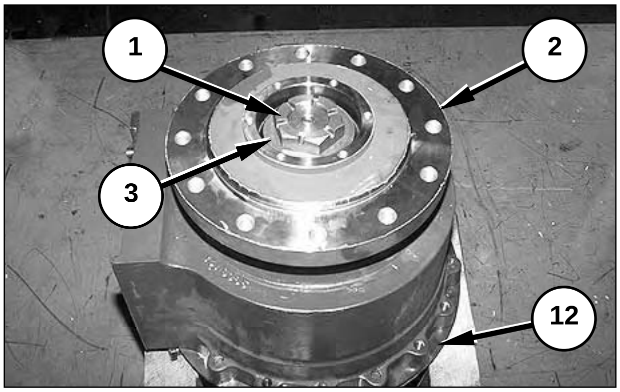
b. Install the drive belt.

Disassemble and Assemble

Tools Needed		A	B
8T-5096	Indicator Group	1	
1U-8697	Installer Assembly		1

Start By:

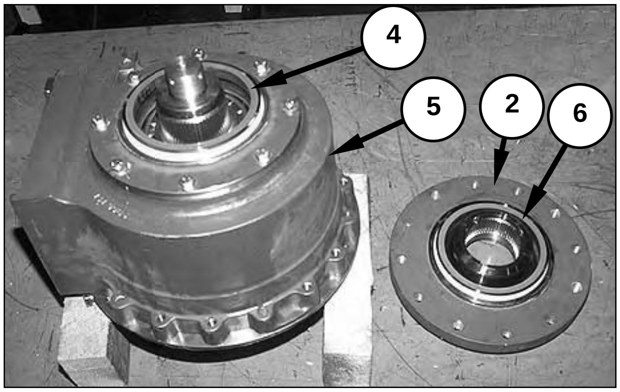
a. Remove the brake assembly.



1. Support the brake group on blocks, as shown. Remove the wire and nut (1), and washer (3).

2. Remove hub (2).

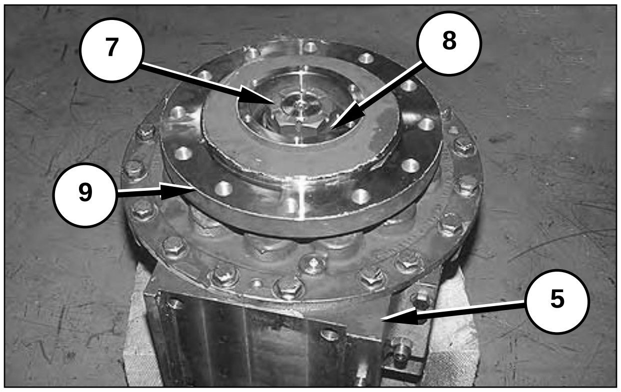
NOTE: Do not touch the polished sealing face of the Duo-Cone Seals while handling hub (2).



3. Remove outer Duo-Cone Seal (6) from hub (2), and inner Duo-Cone Seal (4) from brake group (5). Discard the seals if there are any visible signs of wear or scratches on the polished sealing surfaces of the sealing rings.

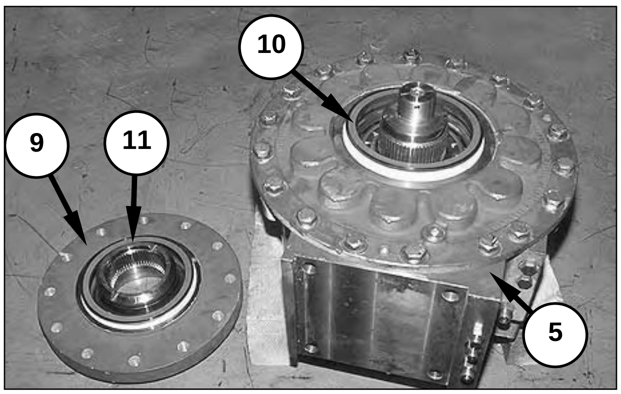
NOTE: Do not touch the polished sealing face of the Duo-Cone Seals if they will be reused.

4. Turn brake group (5) over on the blocks.



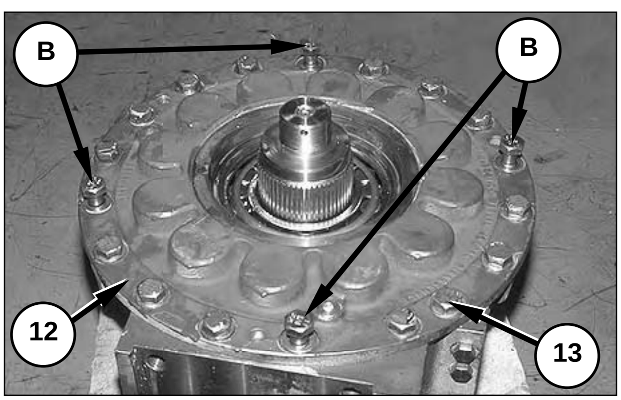
5. Remove the wire, and remove nut (7) and washer (8).

6. Remove hub (9).



7. Remove outer Duo-Cone Seal (11) from hub (9), and inner Duo-Cone Seal (10) from brake group (5). Discard the seals if there are any visible signs of wear, or scratches on the polished sealing surfaces of the sealing rings.

NOTE: Do not touch the polished sealing face of the Duo-Cone Seals if they will be reused.



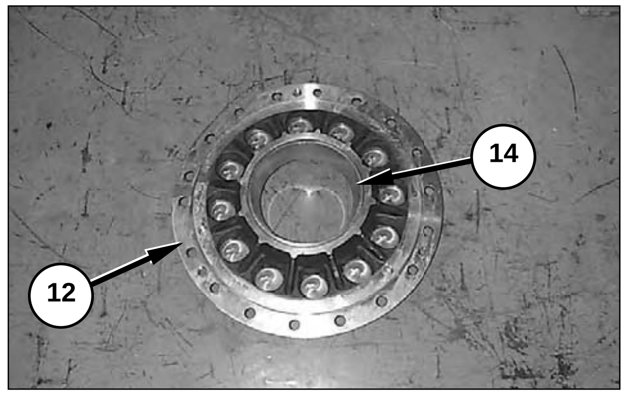
8. Remove four of 18 bolts (13) and replace the four bolts with **M16 X 60 mm** retaining bolts (B). Screw retaining bolts (B) into the brake group to approximately the same depth.

WARNING

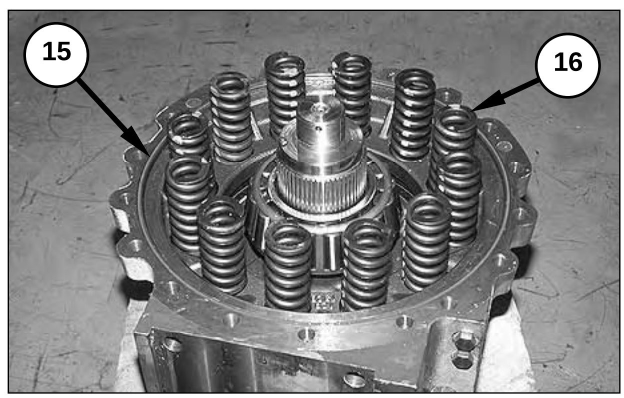
There is a large spring force behind cover (12). Do not remove bolts (13) without first installing retaining bolts (B). Do not remove retaining bolts (B) until all of the spring force is off cover (12).

9. Remove the remaining 14 bolts (13).

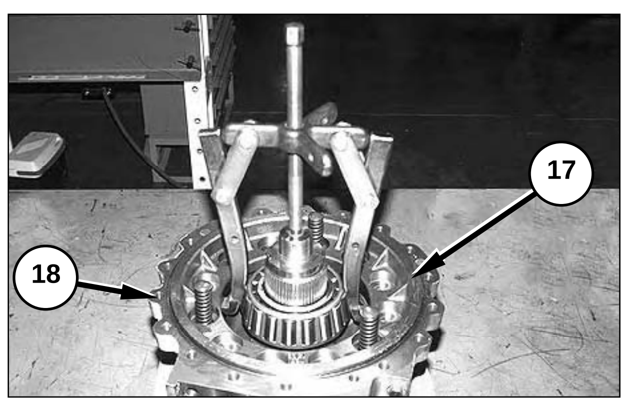
10. Loosen retaining bolts (B) evenly, until the spring force is off of cover (12). Remove retaining bolts (B) and cover (12).



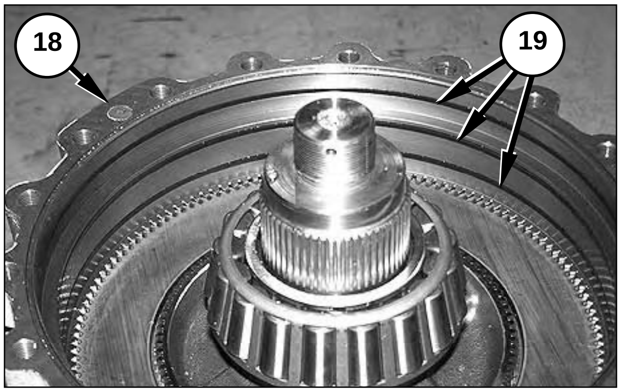
11. If necessary, remove ring (14) from cover (12) and discard the ring.



12. Remove twelve springs (16) and O-ring seal (15).

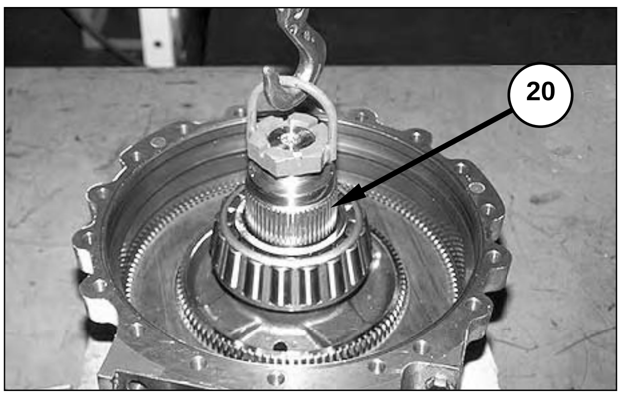


13. Remove parking brake piston (17) from brake housing (18).

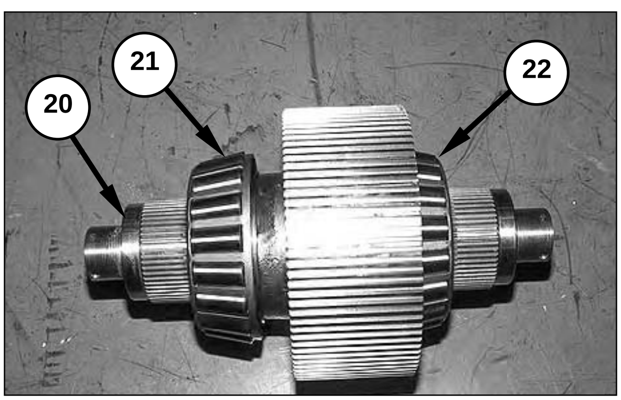


14. Remove three piston seals (19) from brake housing (18).

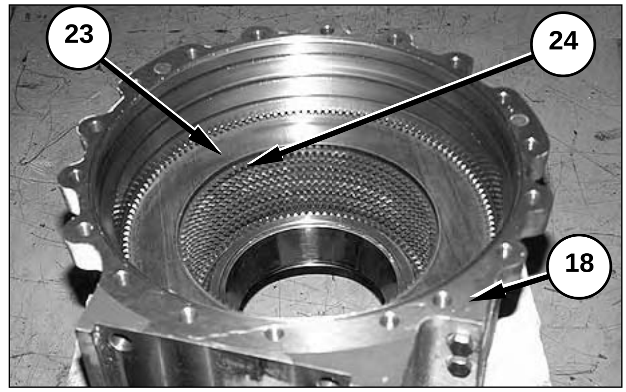
NOTE: The top seal is different from the bottom two seals.



15. Use a suitable lifting eye and a hoist to remove shaft (20). The weight of shaft (20) is **34 kg (75 lb)**.

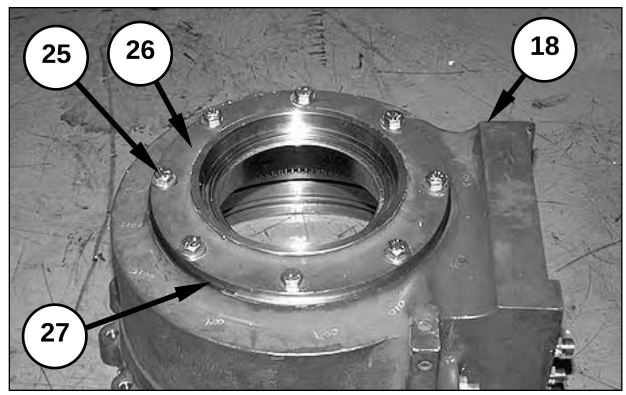


16. If necessary, use a suitable puller to remove bearings (21) and (22) from shaft (20).



17. Remove nine plates (23) and nine disks (24) from brake housing (18).

NOTE: Plates (23) have teeth on the outer diameter. Disks (24) have teeth on the inner diameter.

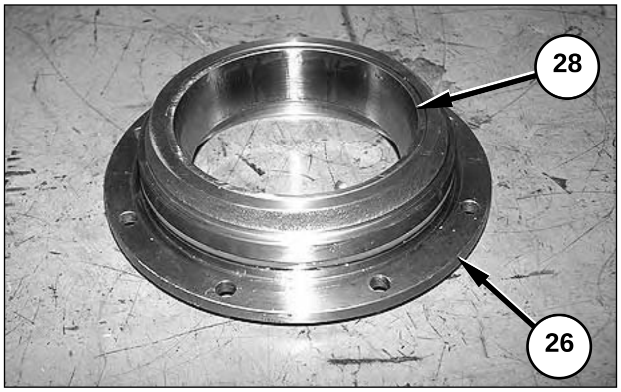


18. Turn brake housing (18) over to remove eight bolts (25) with washers, cage (26), and shims (27) from brake housing (18).

19. Remove seal (29) from cage (26). Discard seal (29) if there is wear or damage.

20. If necessary, remove race (28) from cage (26).

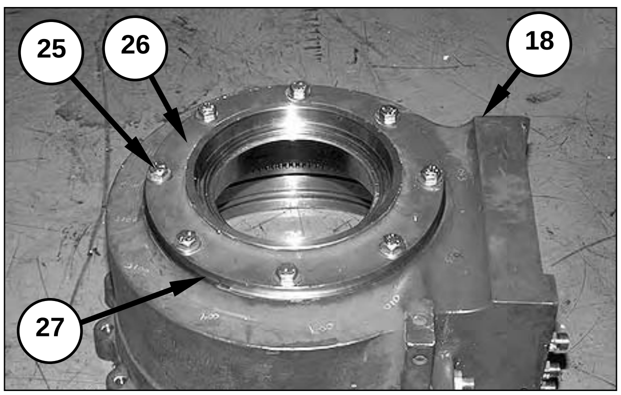
NOTE: The following steps are for assembly of the brake group.



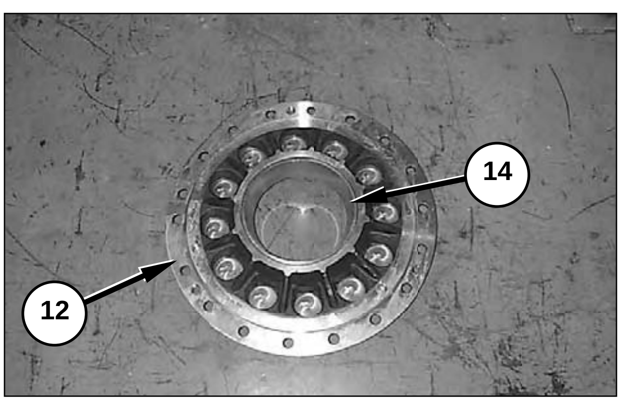
21. Cool race (28) to a temperature of **–75°C (–100°F)** before installation in cage (26).

NOTE: Cage (26) may be heated to **121°C (250°F)** to install race (28). DO NOT use a torch to heat the cage.

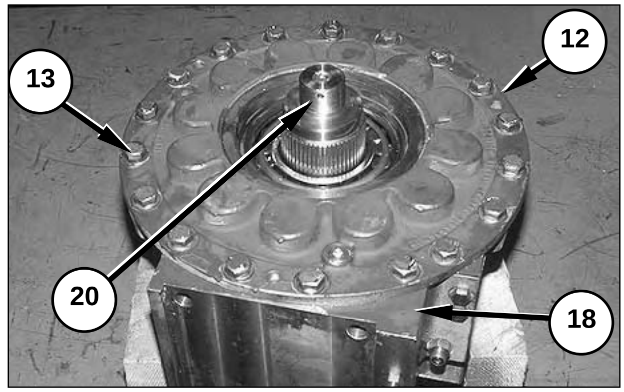
NOTE: Do not install seal (29) at this time.



22. Assemble **1.27mm (0.0500 in)** thickness of shims (27). Install cage (26) using bolts (25) with washers, to brake housing (18). Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage Steering and Brakes,* "Specifications, Brake System, Brake Group" for a chart of the thickness of shim combinations.



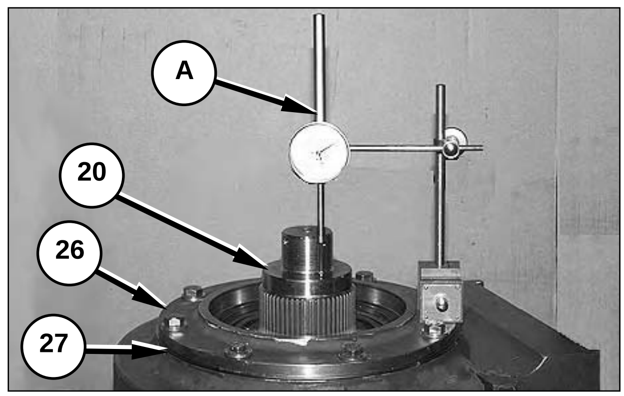
23. Chill ring (14) to a temperature of **–100°C (–150°F)** and install the ring in cover (12).



24. Install shaft (20) into brake housing (18).

NOTE: If bearings (21) and (22) were removed from shaft (20) during disassembly, the bearings must be installed on the shaft before the shaft is installed in brake housing (18).

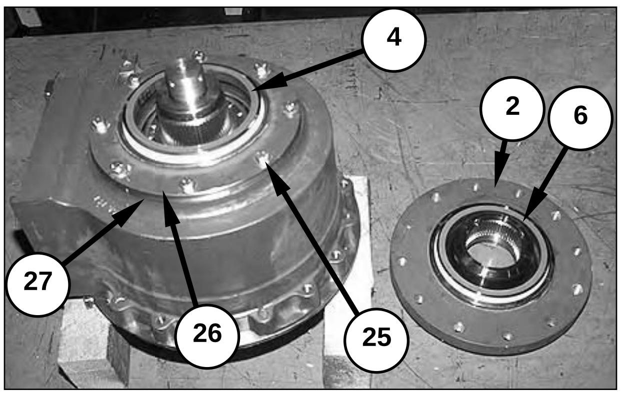
25. Install cover (12) onto brake housing (18) using 18 bolts (13) with washers.



26. Turn brake housing (18) over and install Tooling (A). Install the dial indicator so that the base is mounted on cage (26), and the tip is resting on a flat face on the end of shaft (20).

27. Use a suitable tool to pry up on the bottom of shaft (20), and measure the end play on the shaft. Subtract **0.10 ± 0.05 mm (0.004 ± 0.002 in)** from the measured value to determine the correct thickness of shims (27). Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage Steering and Brakes,* "Specifications, Brake System, Brake Group" for a chart of the thickness of shim combinations. Remove Tooling (A).

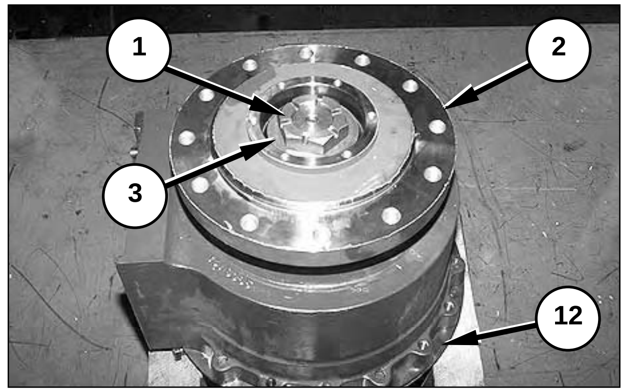
28. Remove cage (26) and install seal (29). Use grease to hold the seal in place. Lubricate the seal with clean hydraulic oil prior to installation.



29. Install the correct thickness of shims (27) (as determined in Step 27) and cage (26), using eight bolts (25) with washers.

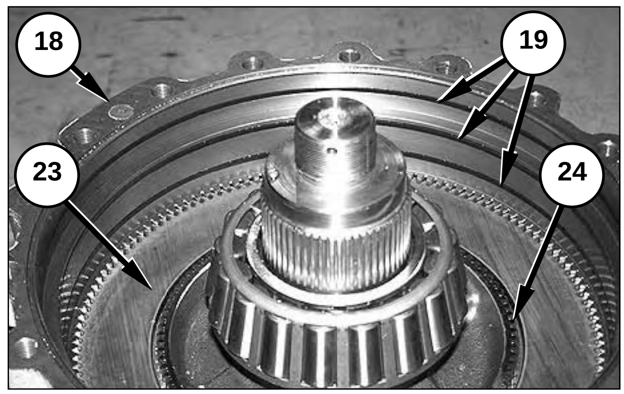
30. Measure the torque required to rotate shaft (20). After the breakout torque is reached, the torque required to continue rotating the shaft should be **5.9 ± 0.28 N•m (52.5 ± 2.5 lb in)**. If the torque is greater than this specification, shims must be removed. If the torque is less than this specification, shims must be added.

31. Install inner Duo-Cone Seal (4) to cage (26) and outer Duo-Cone Seal (6) to hub (2). Refer to "Duo-Cone Seals" in this module.



32. Install hub (2) with washer (3) and nut (1). Tighten, but do not fully torque the nut.

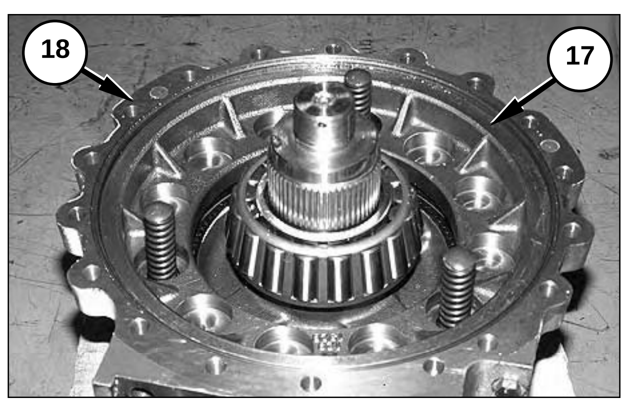
33. Turn the brake housing over to remove cover (12).



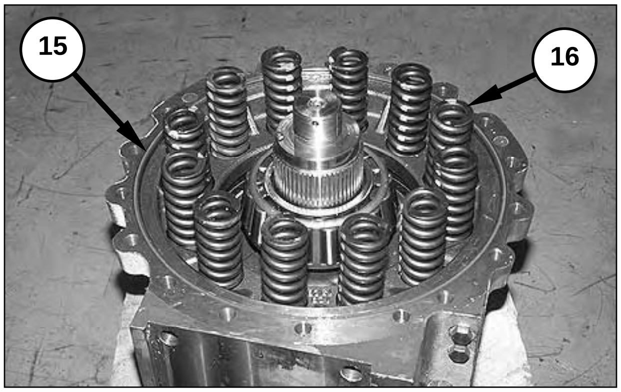
34. Install one disk (24) and one plate (23). Continue installing one disk (24) and one plate (23), alternately, until a total of nine disks and plates have been installed. Plate (23) will be the last one installed if the disks and plates are installed correctly.

NOTE: Plates (23) have teeth on the outer diameter. Disks (24) have teeth on the inner diameter.

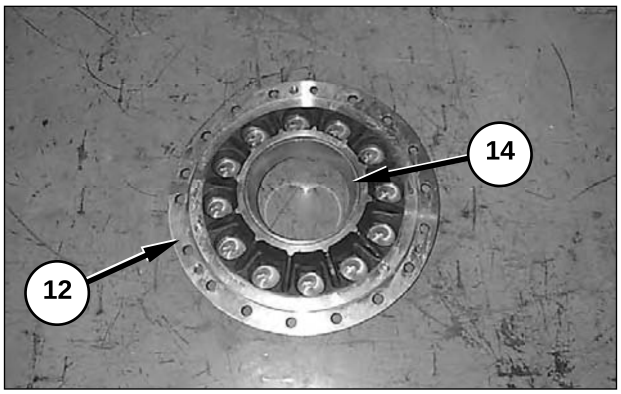
35. Install four (three shown) piston seals (19). Lubricate the seals with clean hydraulic oil prior to assembly.



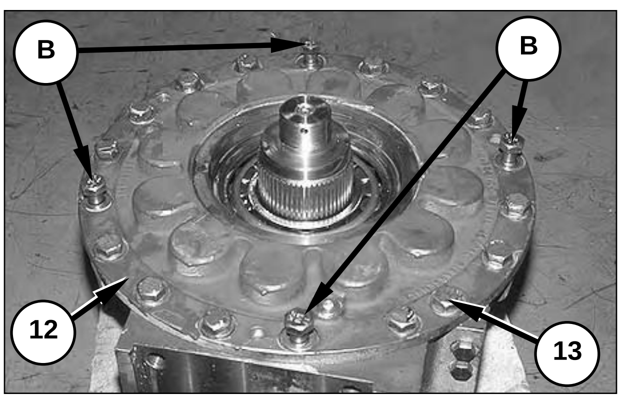
36. Install parking brake piston (17) into brake housing (18).



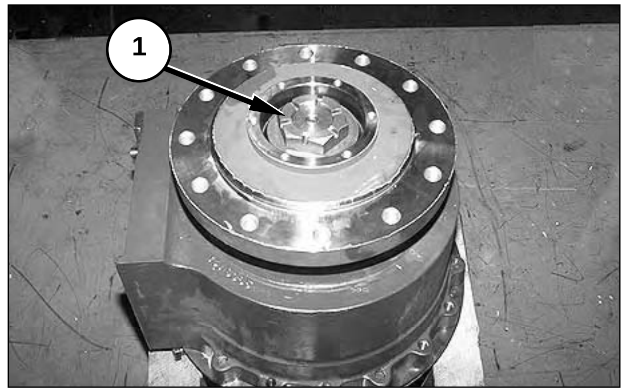
37. Install twelve springs (16) and O-ring seal (15). Lubricate the O-ring seal prior to installation.



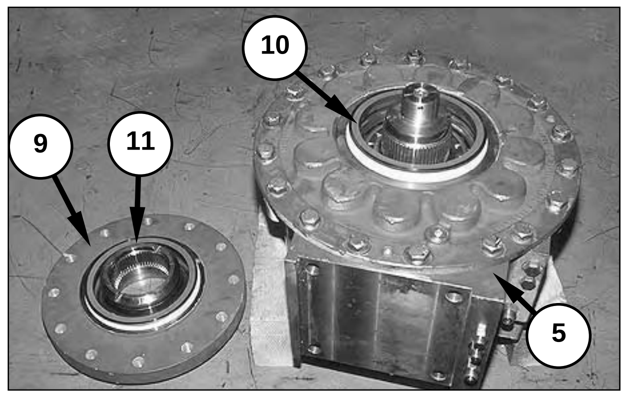
38. If necessary, chill ring (14) to **–100°C (–150°F)** and install the ring in cover (12).



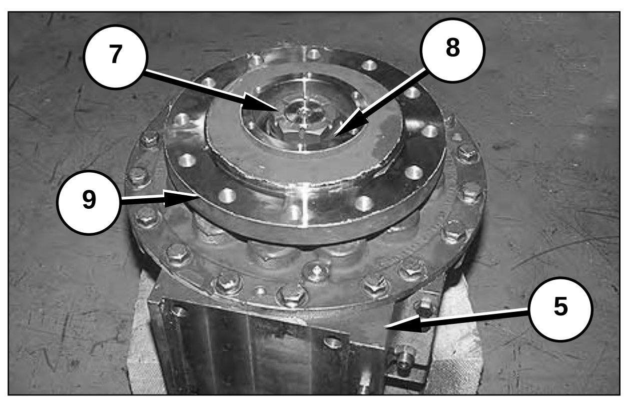
39. Install cover (12) using four **M16 X 60mm** retaining bolts (B). Tighten the four bolts evenly to compress the springs until bolts (13) with washers can be installed. Then remove the four M16 bolts and replace them with washers and bolts (13). Tighten bolts (13) one turn at a time to bring cover (12) down evenly. Tighten bolts (13) to the final torque in a crisscross pattern.



40. Turn the brake group over and tighten nut (1) to a torque of **743 N•m (550 lb ft)**. Install two strands of wire through the slots in nut (1) and the hole in the brake shaft. If necessary, continue to tighten nut (1) to align the closest slot with the hole in the shaft.



41. Turn the brake group over and use Tool B to install inner Duo-Cone Seal (10) to cover (12), and outer Duo-Cone Seal (11) to hub (9). Refer to "Duo-Cone Seals." in this module.



42. Install hub (9) with washer (8) and nut (7). Tighten the nut to a torque of **743 N•m (550 lb ft)**. Install two strands of wire through the slots in nut (7) and the hole in the brake shaft. If necessary, continue to tighten nut (7) to align the closest slot with the hole in the shaft.

End By:

a. Install the brake assembly.

Brake Solenoid Valve

Remove and Install

NOTE: The group number related to this procedure is 124-4624.

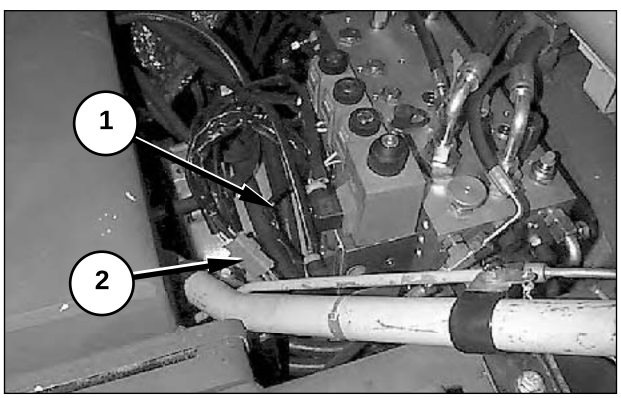
1. Release the pressure in the brake system by pumping the brake pedal to the floor at least 120 times.

WARNING

The brake accumulator stores hydraulic pressure even after the engine has stopped running. Do not disconnect any lines to the accumulator until the hydraulic pressure in the accumulator has been released.

2. Turn the main disconnect switch OFF. Refer to *Operation and Maintenance Manual, Deployable Universal Combat Earthmover (DEUCE), Operator's Manual,* "Operation Section, Machine Features, Main Disconnect Switch."

3. Raise the radiator. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Machine Features, Radiator Tilt."

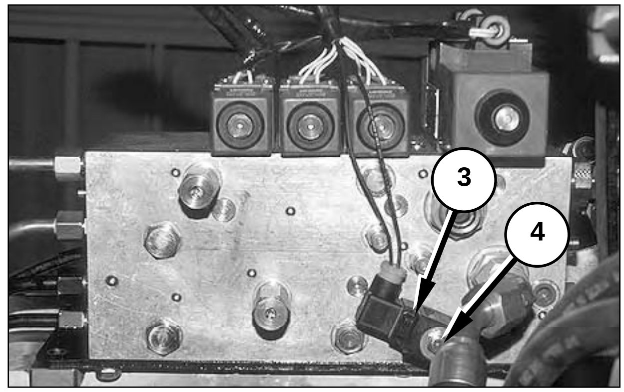


4. Disconnect connector C204 (2).

5. Remove wires (1) from the sockets numbered "1" and "2" in connector C204 (2).

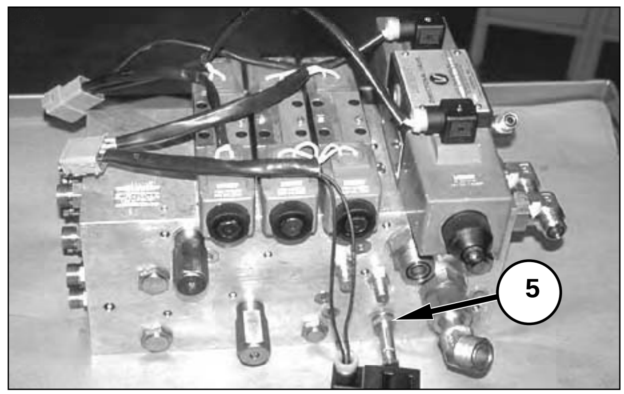
NOTE: The L966-PK wire is connected to socket "1," and the 200-BK wire is connected to socket "2."

6. Cut the cable ties which hold wires (1) to the wire bundle.



Bottom View of Multifunction Valve (Shown Out of Machine for Photographic Clarity).

7. Loosen nut (4) to remove coil (3). Upon reassembly, tighten nut (4) to a torque of **6.5 ± 1.5 N•m (60 ± 12 lb in)**.



Bottom View of Multifunction Valve (Shown Out of Machine for Photographic Clarity).

8. Remove the brake valve spool (5). An O-ring seal will come out with the spool. Upon reassembly, tighten the brake valve spool to a torque of **50.5 ± 3.5 N•m (37.5 ± 2.5 lb ft)**.

NOTE: If the hydraulic tank is full, a large amount of oil can flow from the brake valve installation port. Catch the oil in a suitable container, and discard the oil according to local regulations. A plug can be installed in the hole to limit the oil loss.

NOTE: To install the brake solenoid valve, reverse the removal steps.

Brake Pedal Assembly

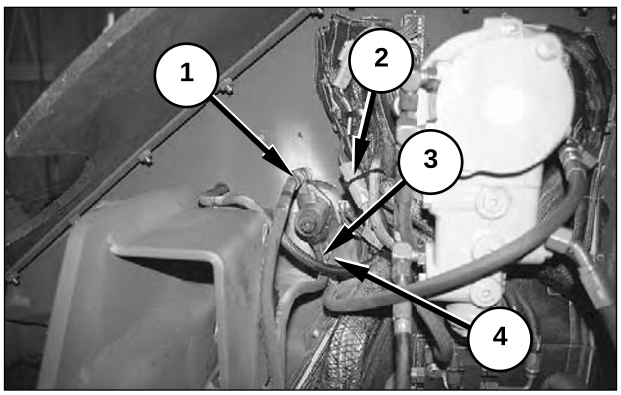
Remove and Install

NOTE: The group number related to this procedure is 126-5851.

1. Release the pressure in the brake system by pumping the brake pedal to the floor at least 120 times.

WARNING

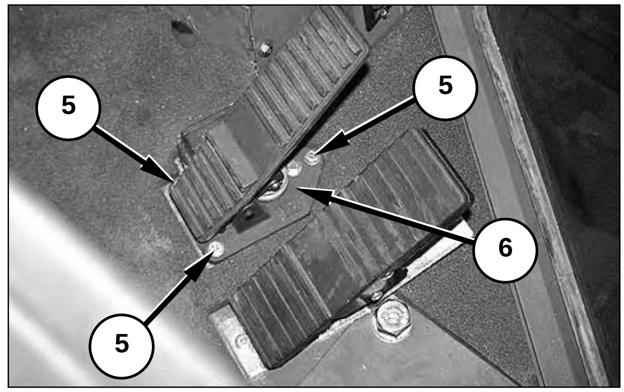
The brake accumulator stores hydraulic pressure even after the engine has stopped running. Do not disconnect any lines to the accumulator until the hydraulic pressure in the accumulator has been released.



View of Bottom of Cab Platform, Front Left Side.

1. Disconnect, cap and plug lines (1), (3) and (4), to remove the adapters from the brake valve. Mark the lines for correct connection during reassembly.

2. Cut the tire wraps and disconnect connector SW21 (2).



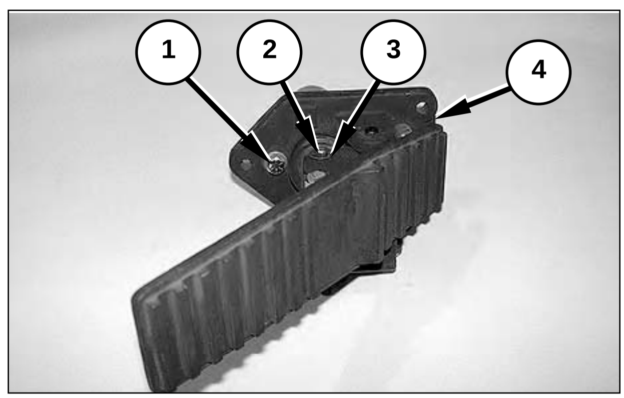
3. Remove three bolts (5) with washers, and brake pedal assembly (6). Clean off any remaining sealant from the bottom of the brake pedal mounting base and the cab floor. Upon reassembly, apply **8T-9014 Sealant (RTV Silicone-Clear)** between the cab floor and the brake pedal mounting base.

NOTE: To install the brake pedal assembly, reverse the removal steps.

Disassemble and Assemble

NOTE: Group numbers related to these procedures include 106-5512, 126-5851, and 130-2969.

To Replace Brake Valve:



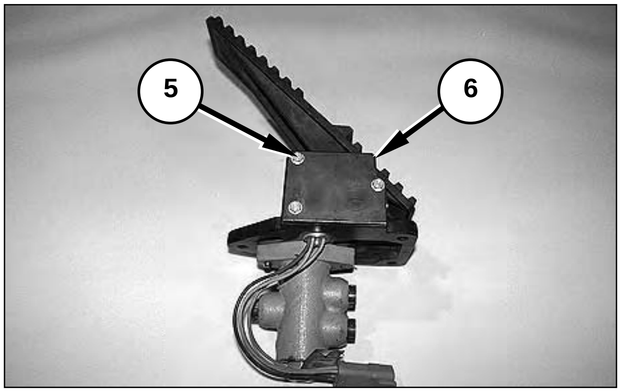
1. Remove two clips (2) and shaft (3).

2. Remove two bolts (1) with washers.

3. Separate the brake valve from base assembly (4).

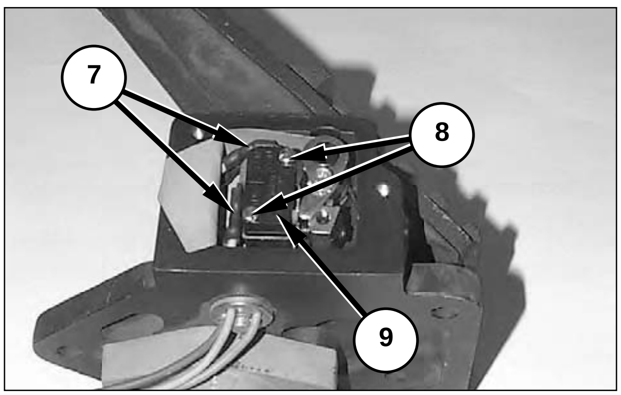
NOTE: The brake valve does not contain any serviceable parts. Replace the valve if the valve has failed.

To Replace Limit Switches:



4. Remove three bolts (5) and cover (6).

NOTE: Cover (6) is not serviced separately.



5. Remove two screws (8).

6. Disconnect wire terminals (7).

7. Remove two switches (9).

Brake Pilot Unloading Valve

Remove and Install

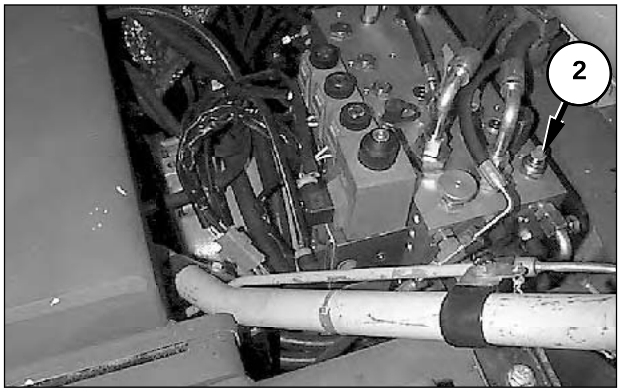
NOTE: The group number related to this procedure is 124-4624.

NOTE: Before the brake pilot unloading valve is removed, the pressure in the brake accumulator must be released. Release the pressure in the brake system by pumping the brake pedal to the floor at least 120 times. A difference in the back pressure on the brake pedal should be felt when the pressure has been released in the brake system. If a difference in pedal effort is not noticed during the first 120 applications of the brake, continue to pump the pedal until a difference is felt.

WARNING

The brake accumulator stores hydraulic pressure even after the engine has stopped running. Do not disconnect any lines to the accumulator until the hydraulic pressure in the accumulator has been released.

1. Open air intake compartment door (1).



Radiator Shown Raised for Photographic Clarity.

2. Remove brake pilot unloading valve (2) with the O-ring seal by turning the valve counterclockwise. Upon reassembly, tighten brake pilot unloading valve (2) to a torque of **50 ± 3.5 N•m (40 ± 2.5 lb ft)**. Replace the O-ring seal if necessary.

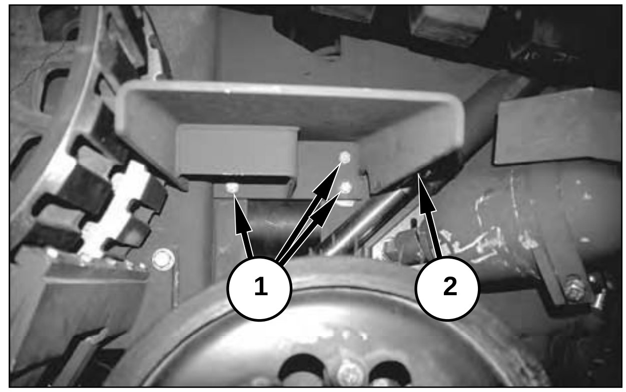
NOTE: Hydraulic oil may leak from the brake pilot unloading valve mounting port. Catch the oil in a suitable container and discard the oil according to local regulations.

NOTE: To install the brake pilot unloading valve, reverse the removal steps.

Cover Group, Suspension

Remove and Install

NOTE: The group number related to this procedure is 165-9877.



1. Remove four bolts (1) with washers, and remove suspension cover group (2). Upon reassembly, apply **9S-3263 Thread Compound (Loctite™ 242)** to the bolts.

NOTE: Only three of the four bolts (1) are shown. The right suspension cover group is shown; the left suspension cover group is a mirror image.

NOTE: To install the suspension cover group, reverse the removal steps.

Differential Steering Unit and Transmission

Remove and Install

Tools Needed		
6V6146	Load Leveler	1
1387574	Link Bracket (3/4 in)	1

Start By:

a. Remove idler scraper group.

b. Remove the drive belts (right and left).

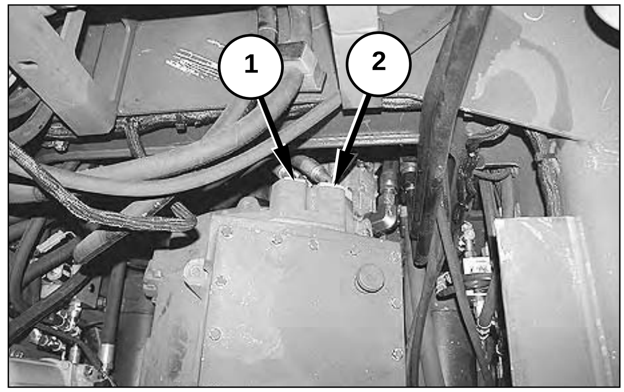
c. Remove the fuel tank. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Machine Systems,* "Fuel Tank."

d. Remove the winch with bracket. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Hydraulic Systems,* "Winch Bracket with Winch Assembly."

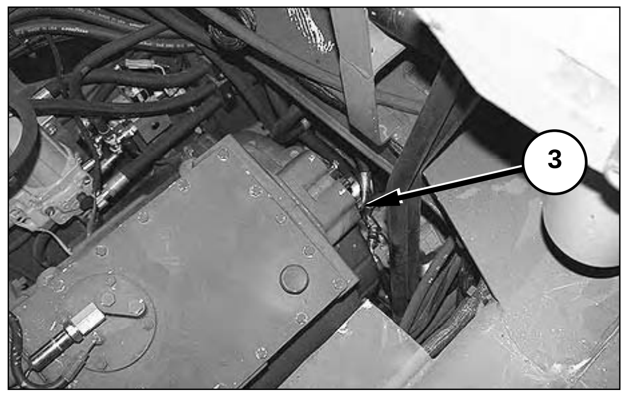
e. Remove the power train bottom cover. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Maintenance Features, Bottom Cover Tilt."

NOTE: Group numbers related to this procedure include 122-8643, 125-0110, 144-8605, 144-8606, 156-1565.

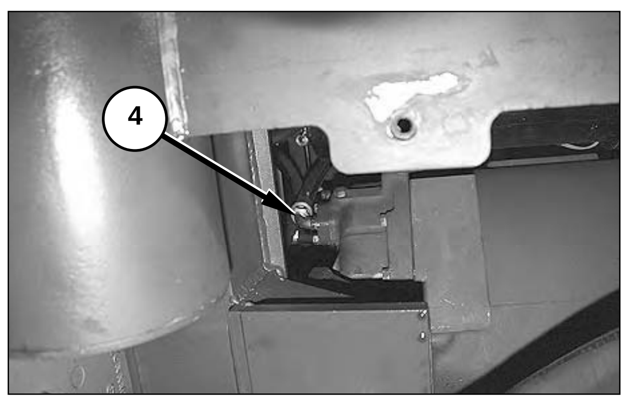
1. Drain the power train oil into a suitable container. The capacity of the power train oil system is approximately **152 L (40 U.S. gal)**. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Maintenance Intervals, Every 2000 Service Hours or Two Years, Power train, Change Oil, Clean Suction Screens, and Clean Transmission Breather."



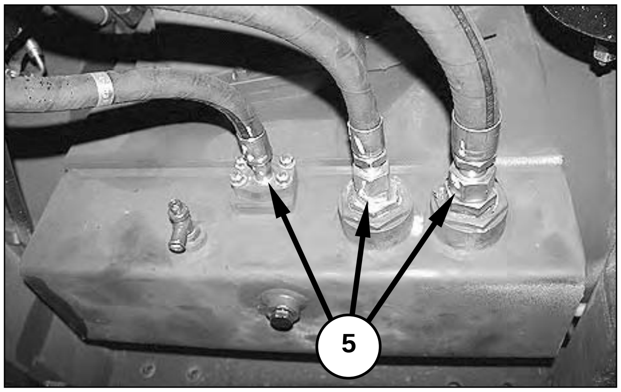
2. Disconnect, cap and plug transmission input line (1) and transmission output line (2). Mark the lines for correct connection during reassembly.



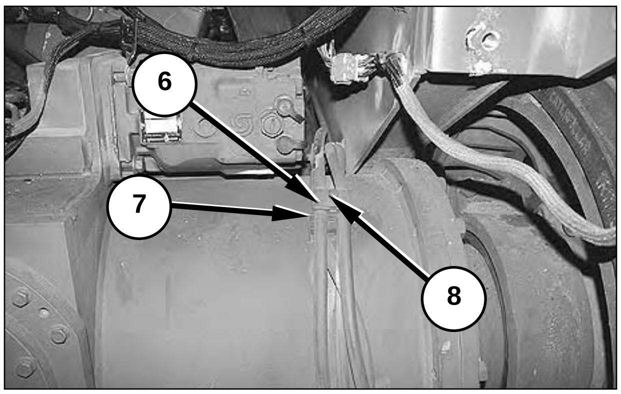
3. Disconnect, cap and plug line (3). Mark the line for correct connection during reassembly.



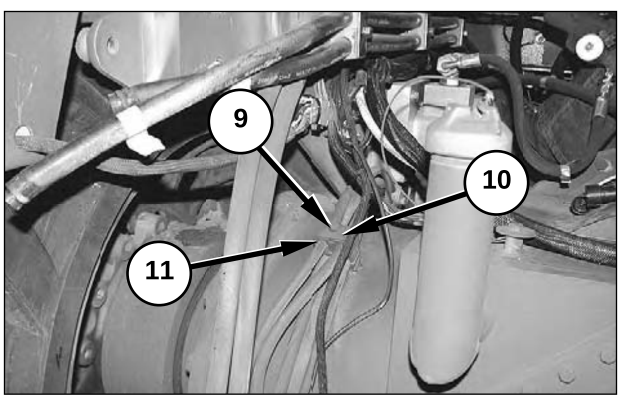
4. Disconnect, cap and plug line (4). Mark the line for correct connection during reassembly.



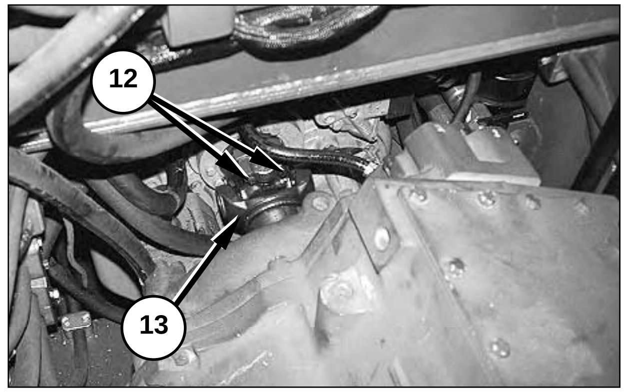
5. Disconnect, cap and plug three lines (5). Mark the lines for correct connection during reassembly.



6. Remove bolt (8) with washer, retainer (6) and two clamp halves (7) from the right side of the differential steering unit.

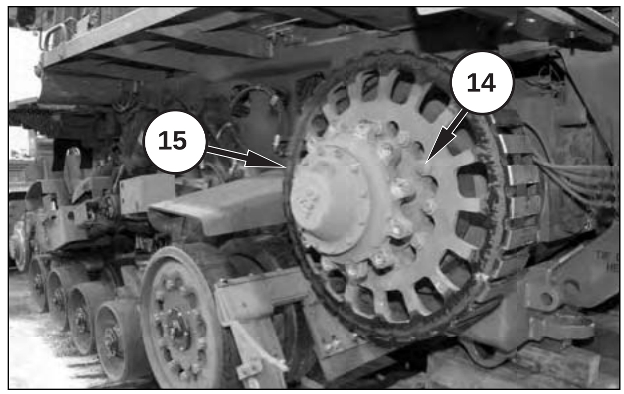


7. Remove bolt (9) with washer, retainer (10) and two clamp halves (11) from the left side of the differential steering unit.

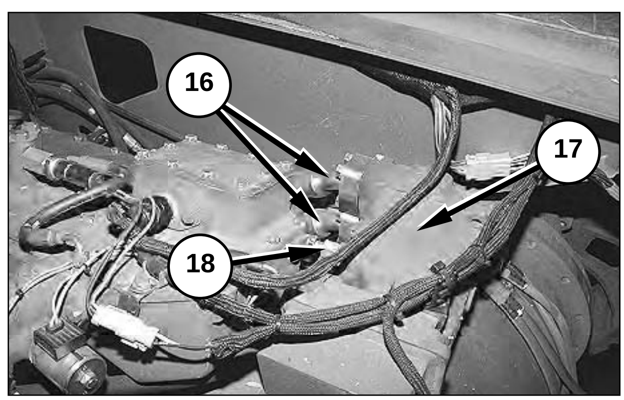


8. Remove eight bolts (12) to remove main drive shaft (13).

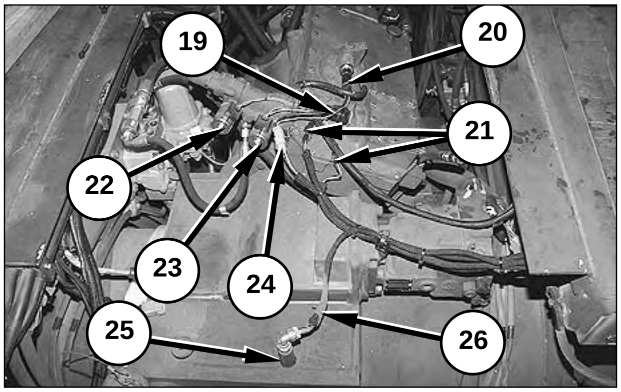
NOTE: Only two of eight bolts (12) are visible. There are four bolts retaining each end of drive shaft (13).



9. Remove twelve bolts (14) with washers, and use a suitable lifting device to remove inner drive wheel (15) from both sides of the machine. The weight of the inner drive wheel is approximately **80 kg (176 lb).** Upon reassembly, apply **154-9731 Thread Compound (Loctite™ 271)** to the threads of twelve bolts (14), and tighten the bolts to a torque of **530 ± 70 N•m (391 ± 52 lb ft)**.



10. Disconnect, cap and plug two steering lines (16) and one case drain line (18) from steering motor (17).



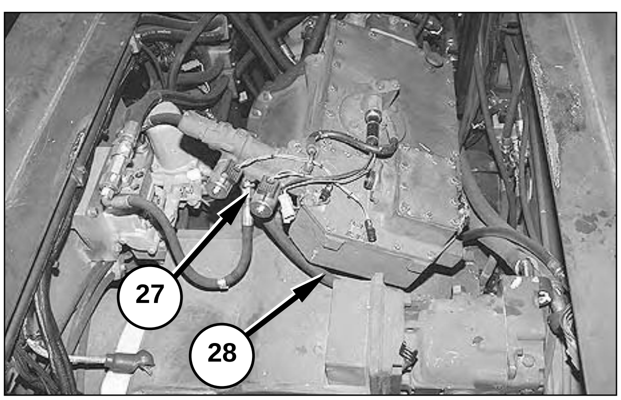
11. Disconnect connector C352 (26) from transmission speed sensor (25).

12. Disconnect connector C342 (24) from P2 pressure switch (20).

13. Disconnect two connectors (21), C312 from upshift solenoid (23) and C322 from downshift solenoid (22). Mark the connectors to ensure correct connection during reassembly.

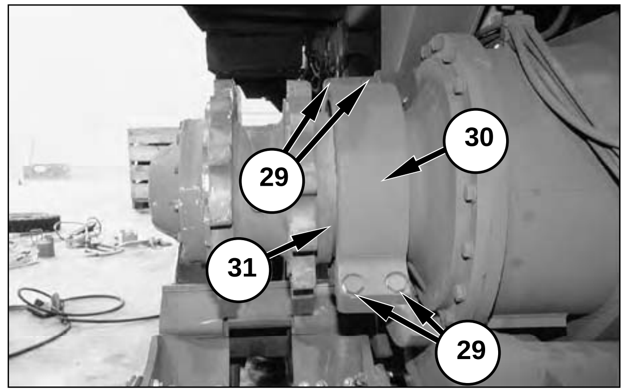
14. Cut the lock wire and disconnect connector C332 (19) from the transmission gear switch. Cut the cable tie to allow the harness to be moved out of the way.

NOTE: When connector C332 (19) is reconnected to the transmission gear switch, install lock wire. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Transmission and Torque Converter,* "Testing and Adjusting, Transmission Hydraulic System, Installation of Lock Wire on Transmission Gear Switch and Transmission Speed Sensor Connectors."

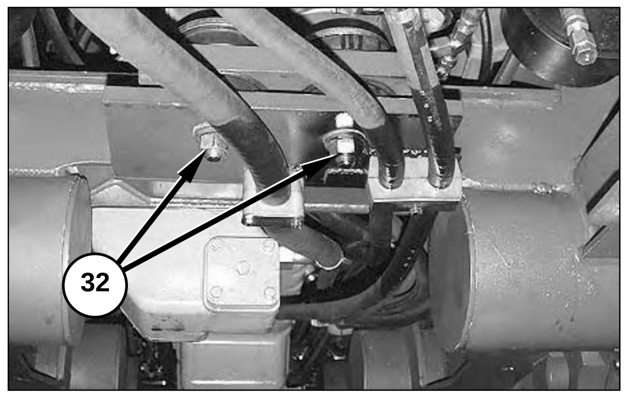


15. Disconnect, cap and plug shift pressure line (27).

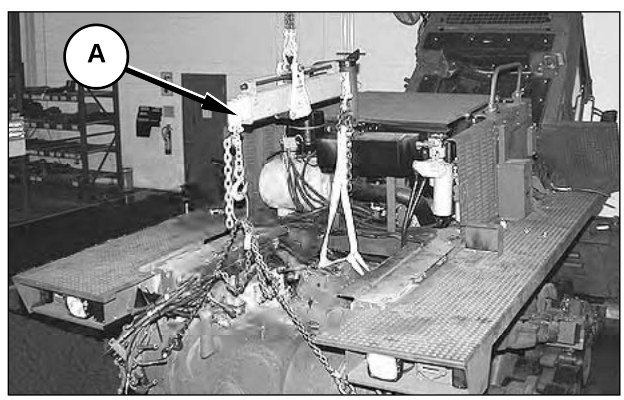
16. Disconnect, cap and plug transmission return line (28).



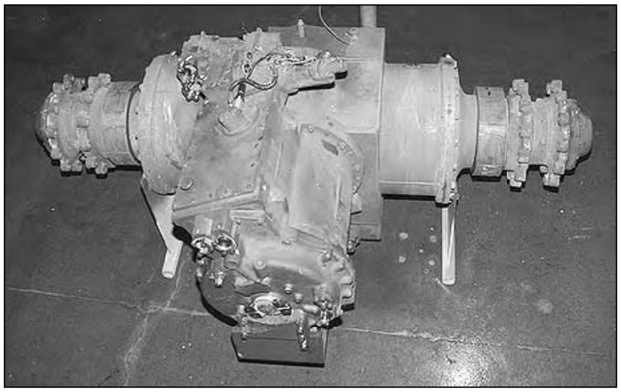
17. Remove four bolts (29) with washers, and retainer (30) from both sides of the differential steering unit. There are eight bolts (29) with washers, and two retainers (30). Upon reassembly, apply **4C-5592 Thread Lubricant (Antiseize)** to the outer diameter of bushing (31), on both sides of the machine.



18. Remove two nuts (32) with washers, from the transmission mounting bolts.



19. Install Tooling (A) to remove the transmission and differential steering unit together. The weight of the differential steering unit with the transmission is approximately **2177 kg (4800 lb)**.



20. Place the transmission and differential steering unit on wood blocks, or other suitable supports. Rest the differential steering unit and the transmission on level ground.

NOTE: To install the differential steering unit and transmission, reverse the removal steps. After the differential steering unit and transmission have been installed, check the oil in the hydraulic tank. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Maintenance Intervals, Every 10 Service Hours or Daily."

End By:

a. Install the power train bottom cover.

b. Install the winch with bracket.

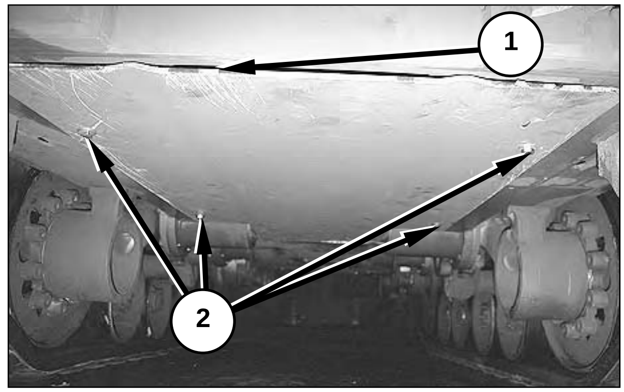
c. Install the fuel tank.

d. Install the drive belts (right and left).

e. Install idler scraper group.

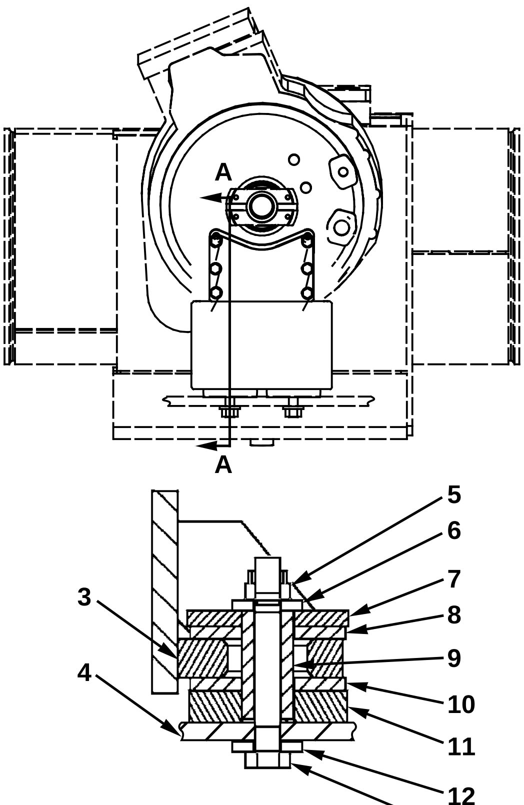
Remove and Install Front Mount Assembly

NOTE: The group number related to this procedure is 156-1565.



1. Remove four bolts (2) with washers, and bottom cover (1). The weight of the cover is **50.5 kg (111 lb).**

NOTE: If dirt or other debris has accumulated on the top side, the bottom cover may weigh more than **50.5 kg (111 lb)**. Use a suitable floor jack or other tool to support the bottom cover, if there is a large amount of debris.



SECTION A-A

2. Remove bolt (13), washer (12), and sleeve (9) from the bottom of support (4), on both sides.

3. Remove nut (5), washer (6), plate (7), and belt (8) from the top of support (3), on both sides.

4. Use a floor jack to lift the front of the transmission. The weight of the differential steering unit with the transmission is approximately **2177 kg (4800 lb)**.

NOTICE

Ensure that the transmission control valve does not contact the bottom of the fuel tank when the transmission is raised.

5. Use a hook to remove plate (11) and belt (10) from between supports (3) and (4).

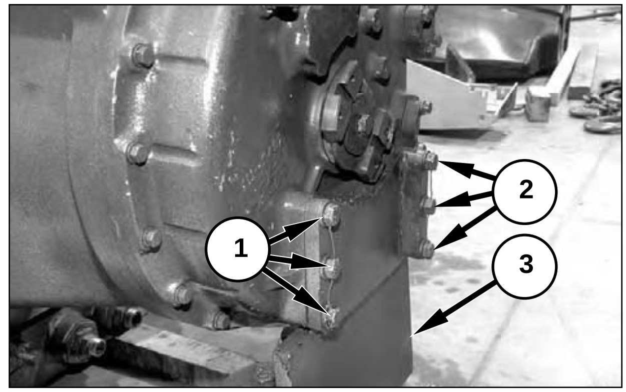
NOTE: To install the front mount assembly, reverse the removal steps.

Replace Front Support

Start By.

a. Remove the differential steering unit and transmission.

NOTE: The group number related to this procedure is 156-1565.



1. Cut the wire, and remove three bolts (1) with the washers, and three bolts (2) with the washers, from support (3).

2. Replace parts, if necessary.

3. Upon reassembly, apply **9S-3263 Thread Compound (Loctite™ 242)** to the threads of bolts (1) and (2). Tighten the bolts to a torque of **120 ± 20 N•m (90 ± 15 lb ft)**. After the bolts have been tightened, install wire on the bolts.

End By:

a. Install the differential steering unit and transmission.

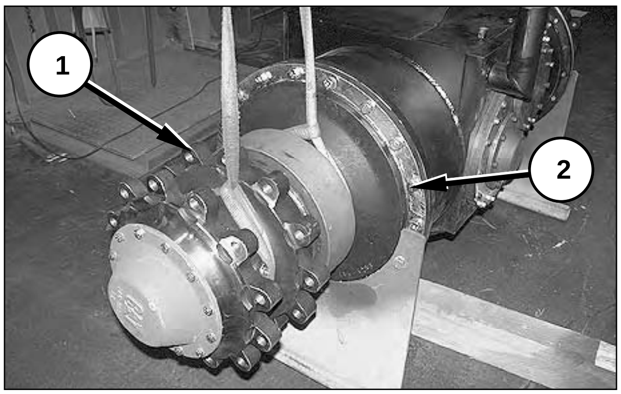
Remove and Install Left Rear Mount

Tools Needed		A	B	C	D
3E-3879	Eyebolt (M16-2-6)	1			
1P-2322	Puller		1		
138-7576	Link Brackets			1	
1U-6437	Seal Installer				1

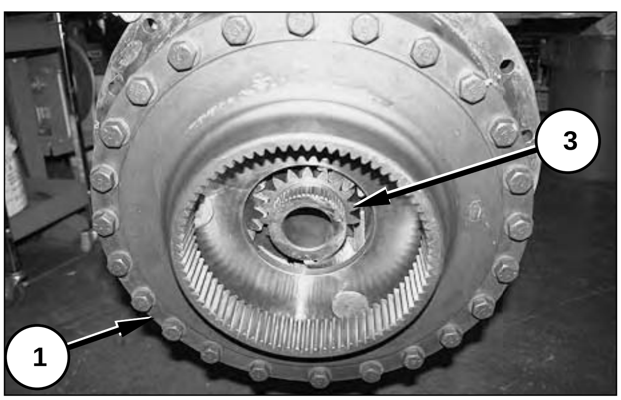
Start By.

a. Remove the differential steering unit and transmission.

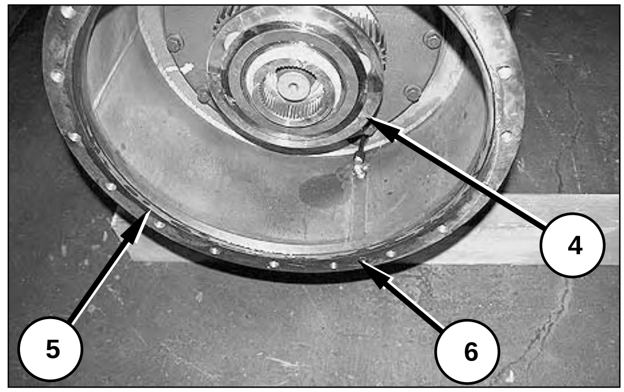
NOTE: Group numbers related to this procedure include 125-0110, 130-2595, and 145-5248.



1. Fasten a hoist to left spindle assembly (1). Support the left side of the differential steering unit with blocks, and remove 18 bolts (2) with washers, and the spindle assembly. The weight of the left spindle assembly is approximately **300 kg (661 lb)**.

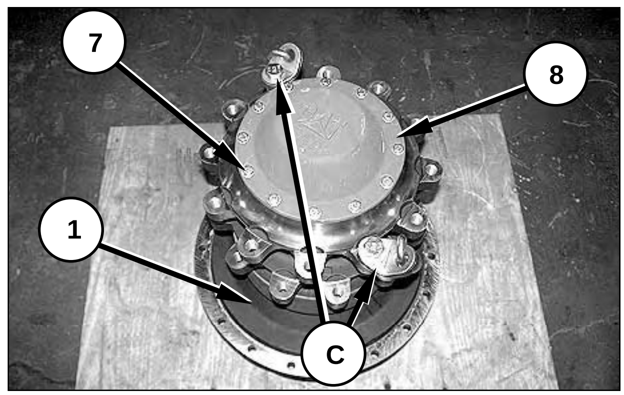


2. Remove sun gear (3) from left spindle assembly (1).

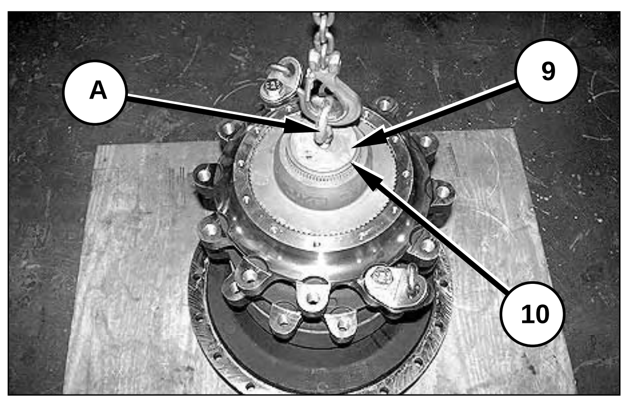


3. Remove large O-ring seal (5) and small O-ring seal (6). Replace the O-ring seals if they are damaged or worn.

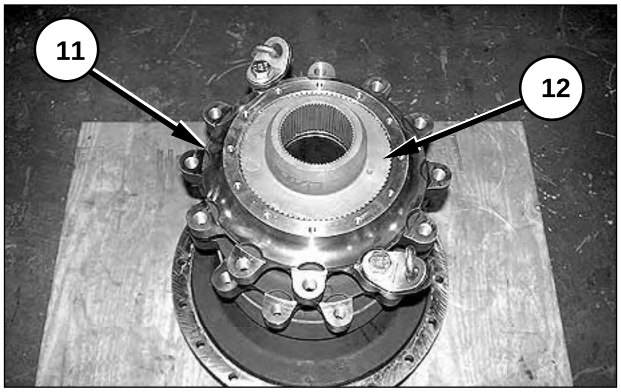
NOTE: Do not remove left inner planetary group (4).



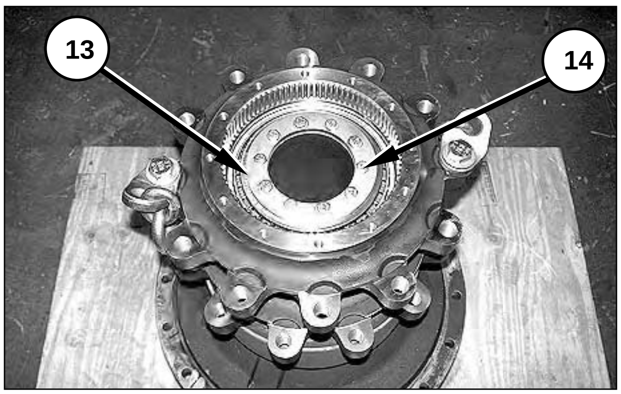
4. Install Tooling (C), and remove 12 bolts (7) with washers, and cover (8) with the O-ring, from left spindle assembly (1).



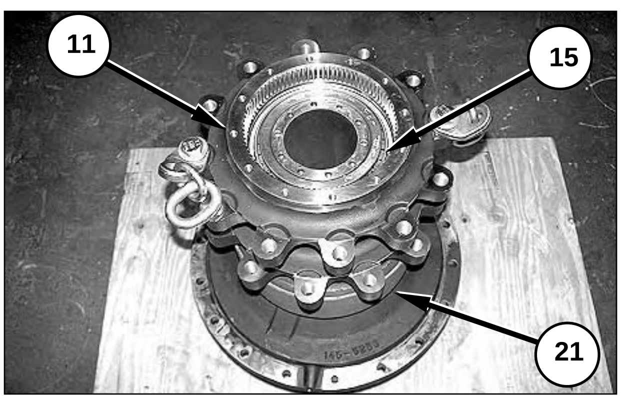
5. Install Tooling (A), and remove drive shaft (9) and retainer clip (10).The weight of the drive shaft is **35.9 kg (79 lb)**.



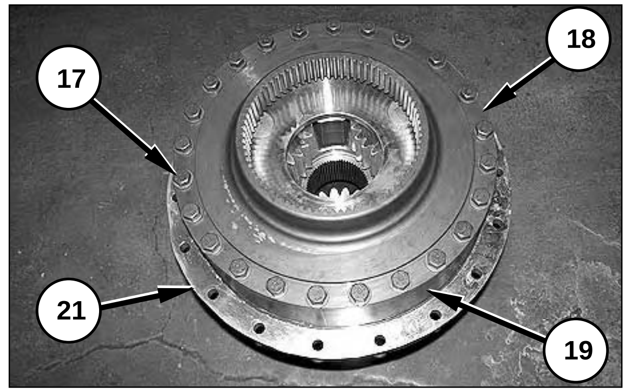
6. Remove coupling (12) from hub (11).



7. Remove 10 bolts (14) with washers, and ring (13) with shims.

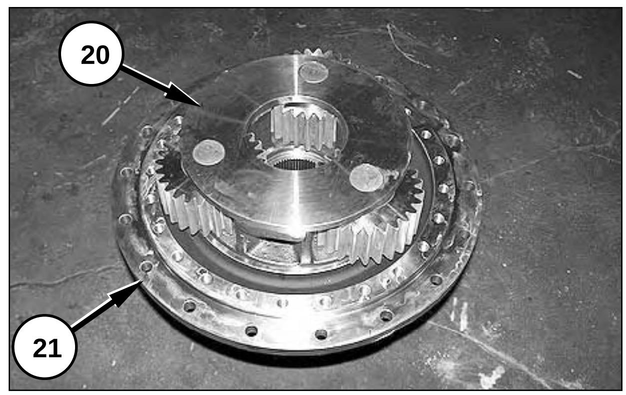


8. Use Tooling (B) to remove hub (11) and bearing (15), with the Duo-Cone Seal, from spindle (21). The weight of hub (11) is **60 kg (132 lb)**.



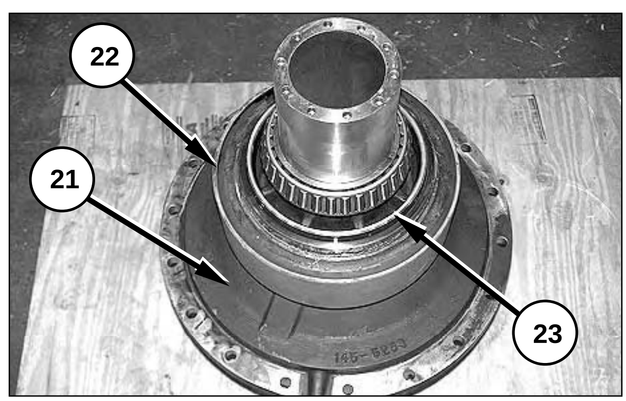
9. Use Tooling (C) and a hoist to turn left spindle (21) over. Remove 24 bolts (17) with washers, and cover (18) from spindle assembly (1).

10. Remove ring gear (19).



11. Remove output planetary group (20) from spindle (21).

12. Use Tooling (A) and a hoist to turn left spindle assembly (1) over.

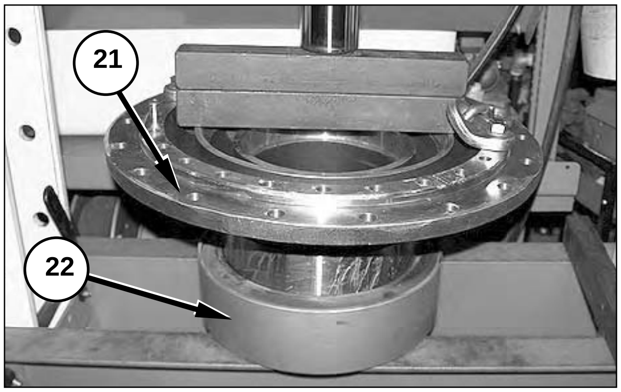


13. Remove Duo-Cone Seal (23) from spindle (21).

14. If necessary, use a disk grinder or other suitable tool to remove bushing (22). Do not damage the mounting surface of spindle (21) when removing the bushing.

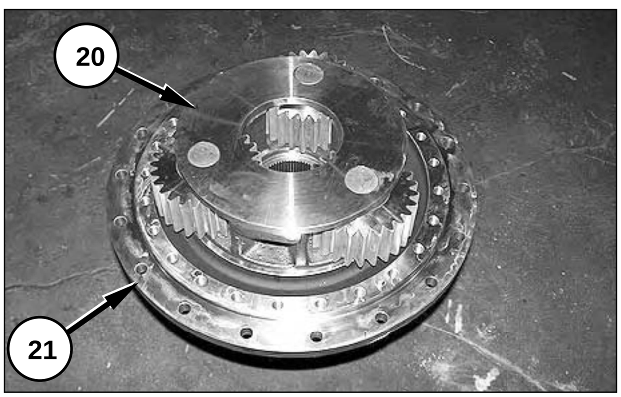
NOTE: Cutting the bushing will generate debris. Keep all removed components away from the debris to minimize the amount of cleaning required before reassembly.

NOTE: The following steps are for the installation of the left rear mount.

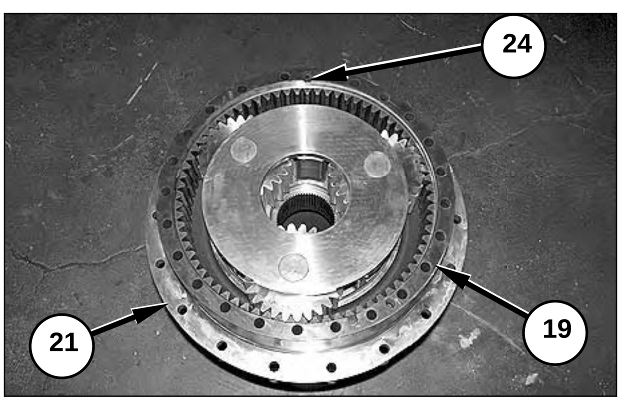


15. Apply **4C-5591 Thread Lubricant** to the inside of bushing (22). Use a press to push the bushing onto spindle (21).

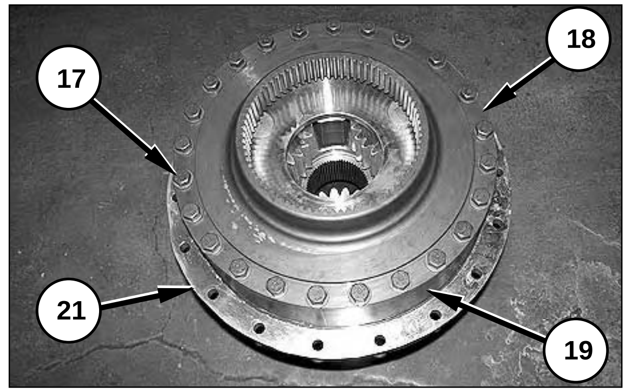
NOTE: Take care not to damage the bearing on spindle (21).



16. Install output planetary group (20) onto spindle (21).

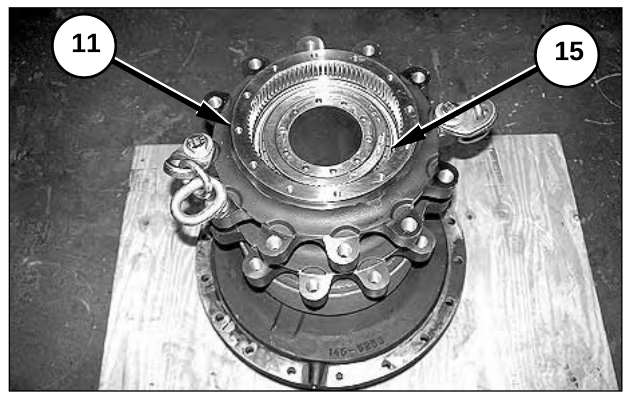


17. Install ring gear (19) on spindle (21). Align oil passage (24) in ring gear (19) with the oil passage hole in spindle (21).



18. Install cover (18) with 24 bolts (17) to spindle (21). Tighten bolts (17) to a torque of **270 ± 40 N•m (199 ± 29 lb ft)**.

NOTE: DO NOT install the Duo-Cone Seal on the spindle at this time. The bearing preload must be determined before the Duo-Cone Seal is installed.

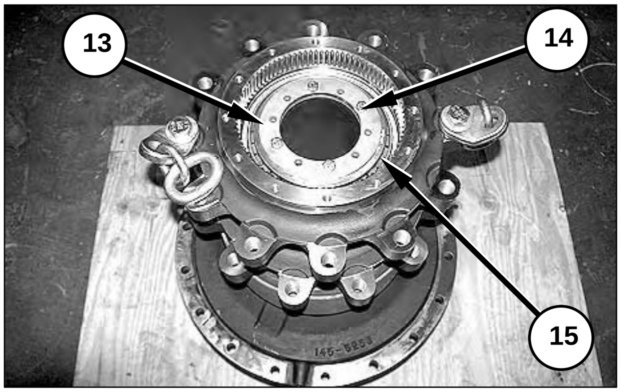


a. Install hub (11) onto the spindle.

b. Heat bearing (15) to a temperature of **150°C (250°F),** and install the bearing in hub (11). If necessary, use a brass drift to tap the bearing into position.

NOTICE

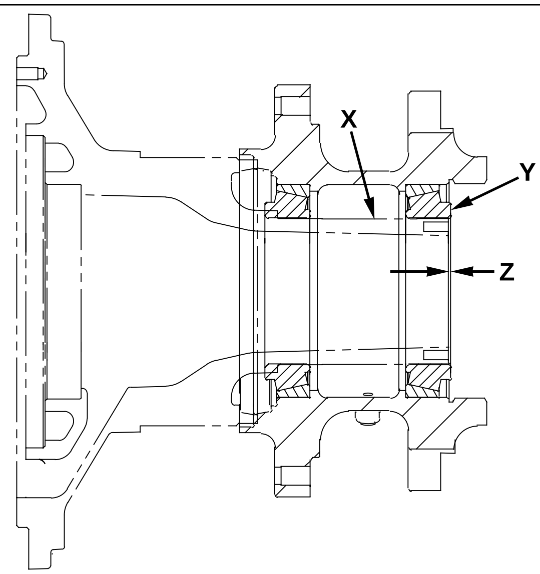
Do not overheat the bearing. If any part of the bearing starts to turn blue, replace the bearing.



c. Quickly install ring (13) and four of 10 bolts (14) with the washers. Fully tighten the bolts in a diamond pattern to fully seat bearing (15) while the bearing is still hot.

NOTE: Do not install the shims with ring (13) at this time.

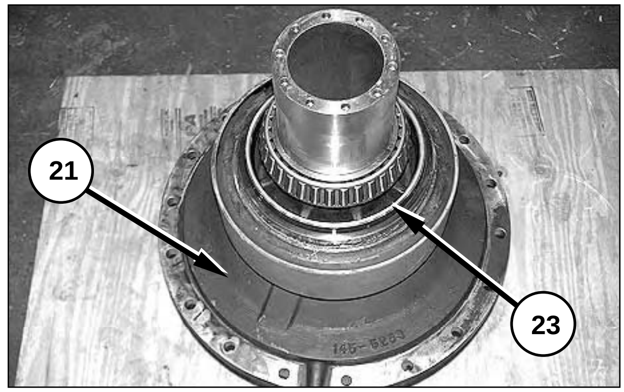
d. Remove four bolts (14) and ring (13).



e. Measure distance (Z), between bearing (Y) and the end of spindle (X).

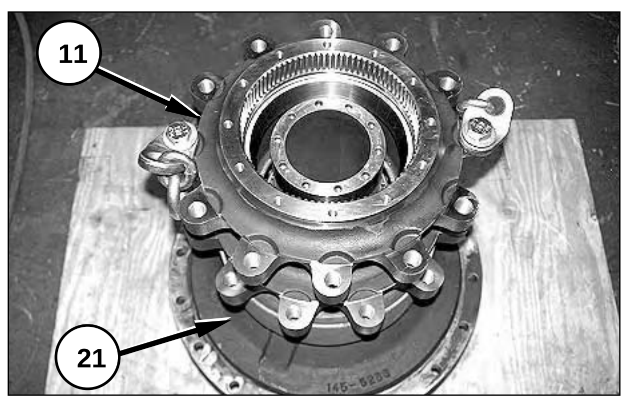
f. Subtract **0.0254 mm (0.001 in)** from distance (Z) to determine the thickness of shims to install with ring (13).

g. Use Tooling (B) to remove hub (11) with bearing (15).

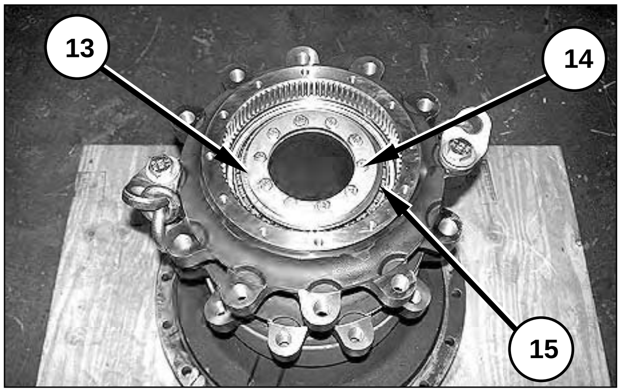


19. Install Duo-Cone Seal (23) into spindle (21) using Tooling (D). Refer to “Duo-Cone Seals,” in this module, for the correct procedure to install Duo-Cone Seals.

20. Install Duo-Cone Seal (23) into hub (11) using Tooling (D). Refer to “Duo-Cone Seals” in this module, for the correct procedure to install Duo-Cone Seals.



21. Install hub (11) with the Duo-Cone Seal, onto spindle (21). Use Tooling (C) to lift the hub. The weight of hub (11) is **60 kg (132 lb)**.

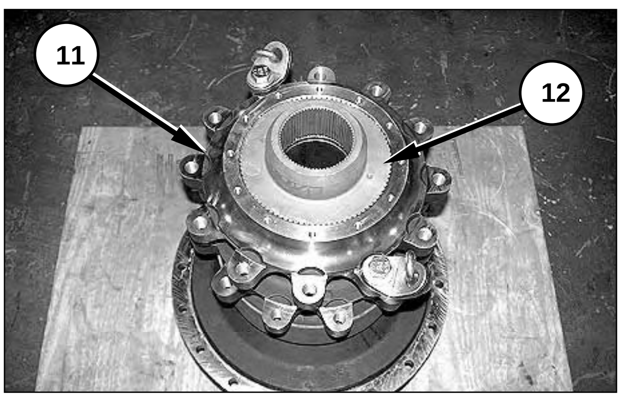


22. Heat bearing (15) to a temperature of **150°C (250°F),** and install the bearing in hub (11). If necessary, use a brass drift to tap bearing (15) into position.

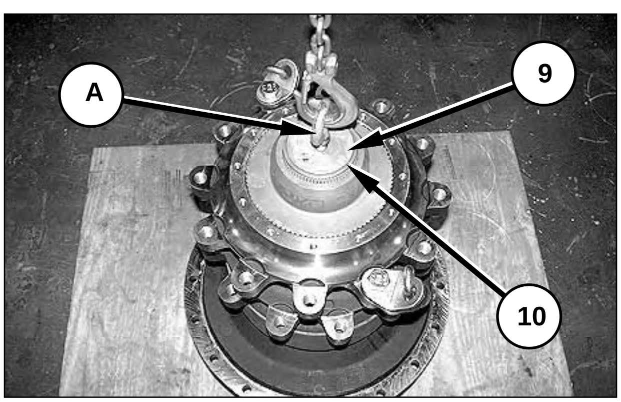
NOTICE

Do not overheat the bearing. If any part of the bearing starts to turn blue, replace the bearing.

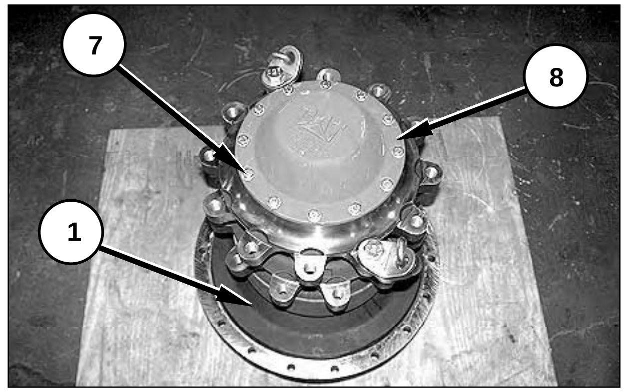
23. Quickly install ring (13) with ten bolts (14) with washers, and the correct amount of shims, as determined in Step 18f. Fully tighten bolts (14) in a star pattern to seat bearing (15) while the bearing is still hot.



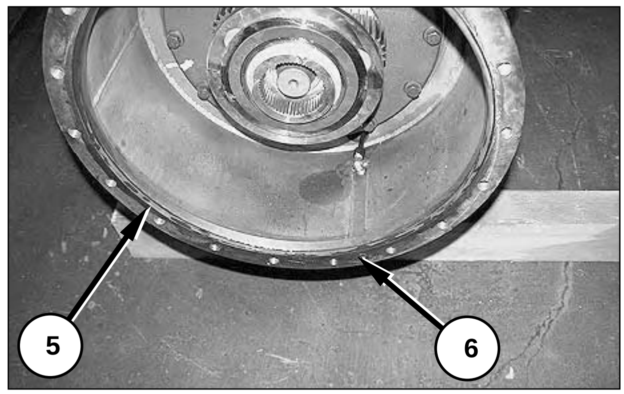
24. Install coupling (12) into hub (11).



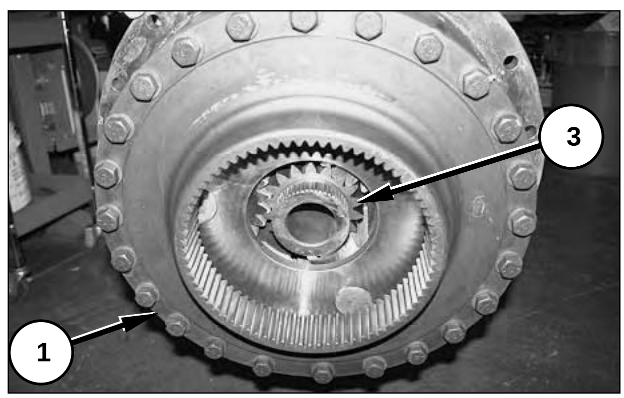
25. Use Tooling (A) to install drive shaft (9) and retainer clip (10).



26. Install cover (8) with O-ring, and 12 bolts (7) with washers, on spindle assembly (1).

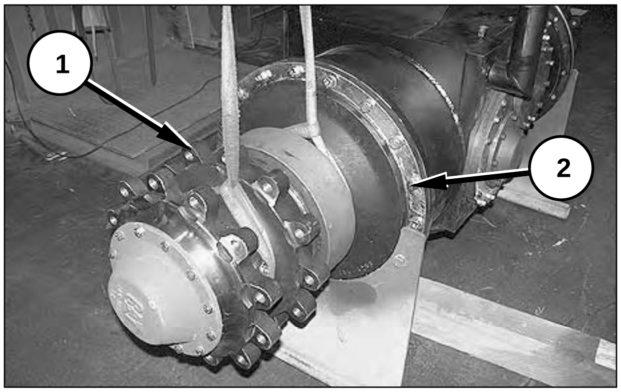


27. Install large O-ring seal (5) and small O-ring seal (6).



28. Use two lifting straps to position left spindle assembly (1) horizontally. The weight of the left spindle assembly is approximately **300 kg (661 lb)**.

29. Install sun gear (3) on left spindle assembly (1).



30. Fasten a hoist to left spindle assembly (1). Support the left side of the differential steering unit with blocks and remove 18 bolts (2) with washers, and the spindle assembly. The weight of the left spindle assembly is approximately **300 kg (661 lb)**.

End By:

a. Install the differential steering unit and transmission.

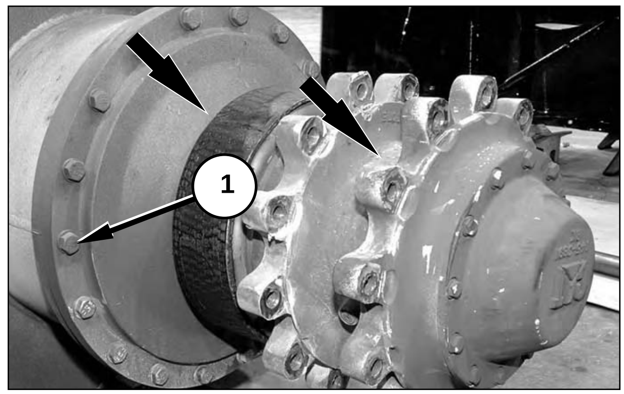
Remove and Install Right Rear Mount

Tools Needed		A	B	C	D
3E-3879	Eyebolt (M16-2-6)	1			
1P-2322	Puller		1		
138-7576	Link Brackets			1	
1U-6437	Seal Installer				1

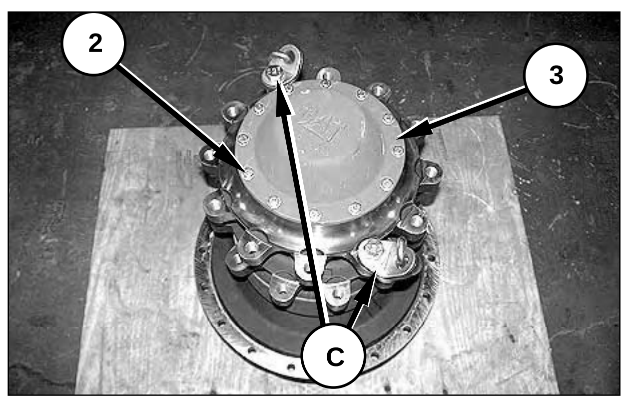
Start By:

a. Remove the differential steering unit and transmission.

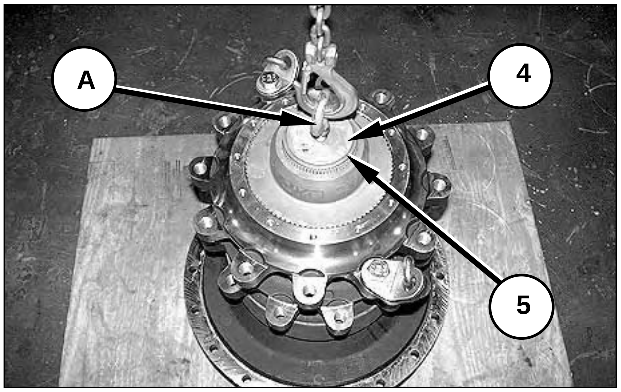
NOTE: Group numbers related to this procedure include 125-0110, 130-2595, and 145-5248.



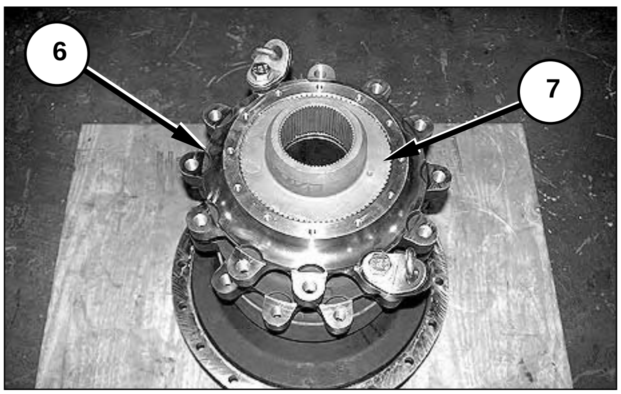
1. Fasten a hoist to the right spindle assembly, and remove 18 bolts (1) with washers, to remove the right spindle assembly from the differential steer housing. The weight of the right spindle assembly is approximately **300 kg (661 lb)**.



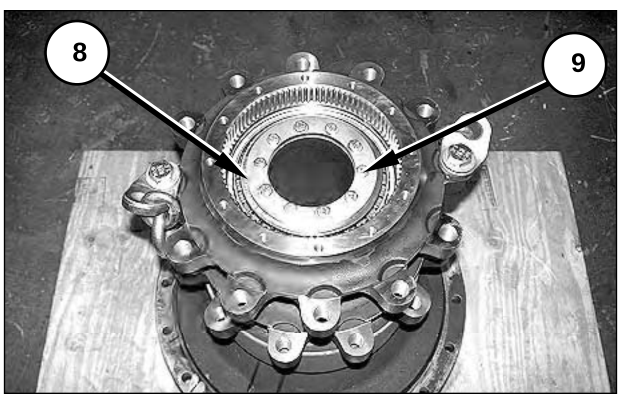
2. Remove 12 bolts (2) with washers, and cover (3) with the O-ring, from the right spindle assembly. Install Tooling (C).



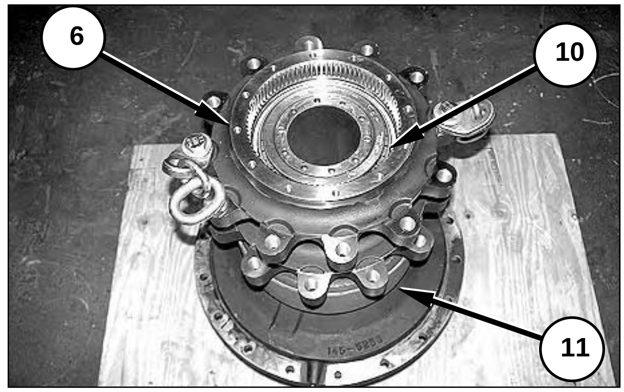
3. Install Tooling (A), remove drive shaft (4) and retainer clip (5).The weight of the drive shaft is **35.9 kg (79 lb)**.



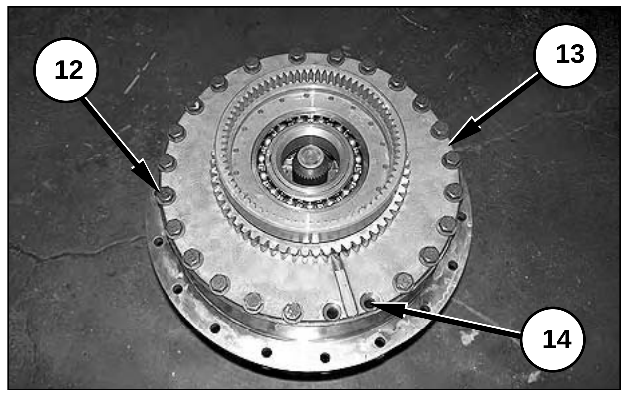
4. Remove coupling (7) from hub (6).



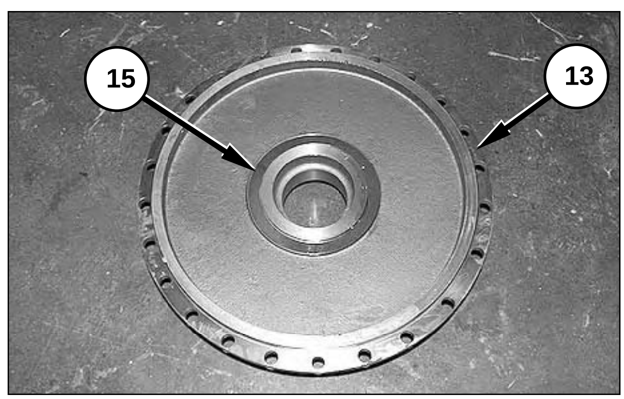
5. Remove 10 bolts (9) with washers, and ring (8) with shims.



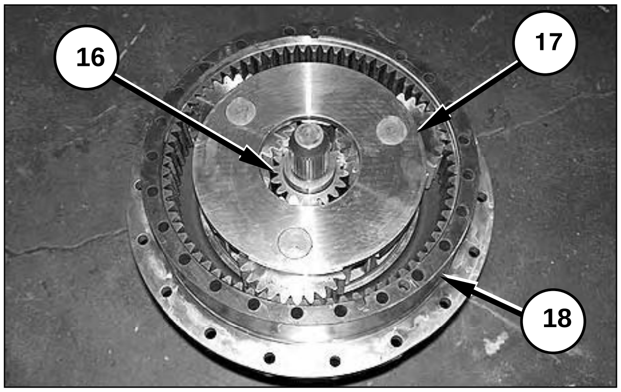
6. Use Tooling (B) to remove hub (6) and bearing (10), with the Duo-Cone Seal, from spindle (11). The weight of hub (6) is **60 kg (132 lb)**.



7. Use Tooling (C) and a hoist to turn the right spindle assembly over. Remove 22 bolts (12) with washers, two bolts (14), and cage assembly (13) from the right spindle assembly.



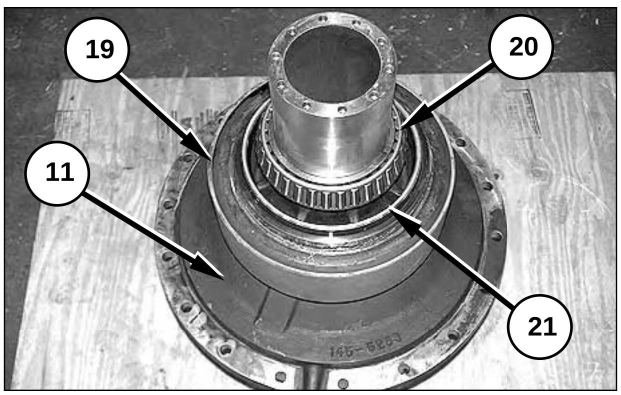
8. Remove thrust washer (15) from cage assembly (13).



9. Remove sun gear (16) and output planetary group (17) from the right spindle assembly.

10. Remove ring gear (18).

11. Use Tooling (C) and a hoist to turn the right spindle assembly over.

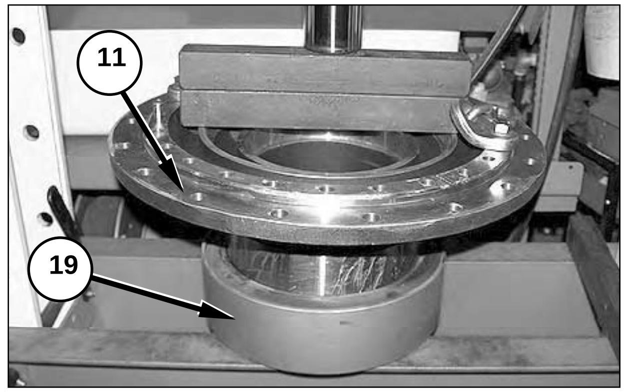


12. Remove Duo-Cone Seal (21) and bearing (20) from spindle (11).

13. If necessary, use a disk grinder or other suitable tool to remove bushing (19). Take care not to damage the mounting surface of spindle (11) when removing the bushing.

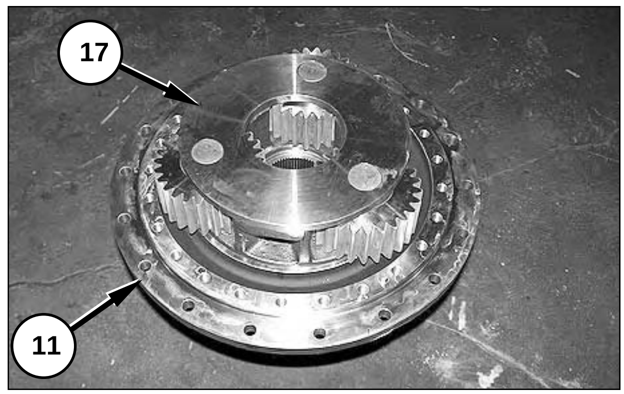
NOTE: Cutting the bushing will generate debris. Keep all removed components away from the debris to minimize the amount of cleaning required before reassembly.

NOTE: The following steps are for the installation of the right rear mount.

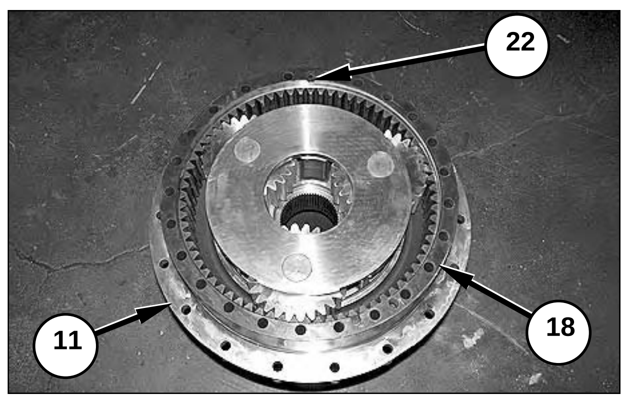


14. Apply **4C-5591 Thread Lubricant** to the inside of bushing (19). Use a press to push the bushing onto spindle (11).

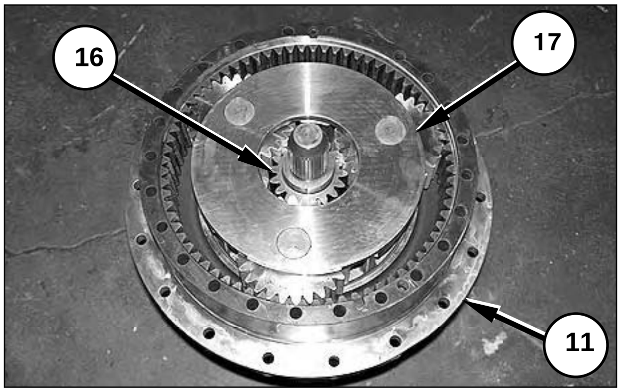
NOTE: Take care not to damage the bearing.



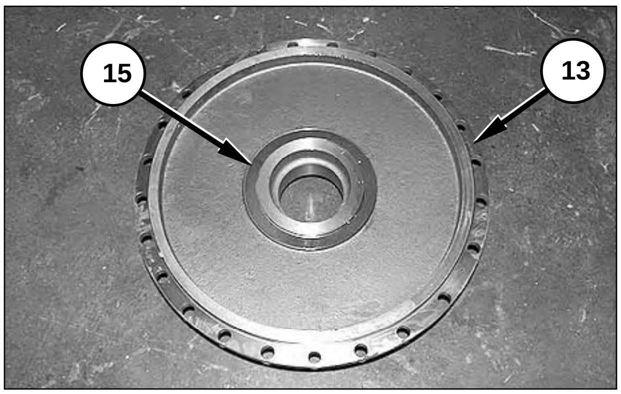
15. Install output planetary group (17) into spindle (11).



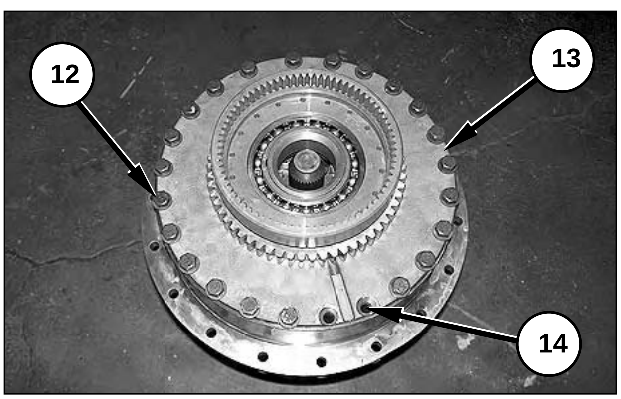
16. Install ring gear (18) on spindle (11). Align oil passage (22) in ring gear (18) with the oil passage hole in spindle (11).



17. Install sun gear (16) into output planetary group (17) on spindle (11).

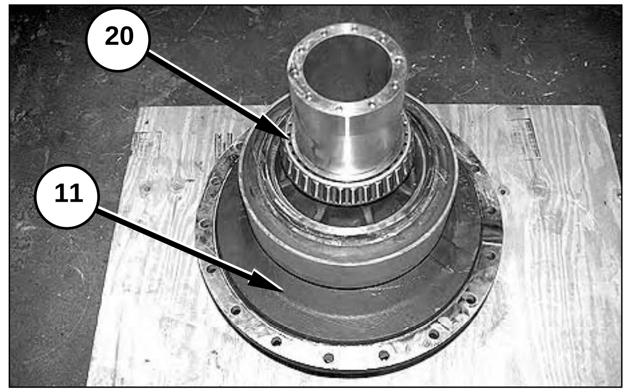


18. Install thrust washer (15) onto cage assembly (13). Use clean grease to temporarily fasten thrust washer (15) to cage assembly (13).



19. Install cage assembly (13), with thrust washer (15), using 22 bolts (12) with washers, and two bolts (14). Tighten bolts (12) to a torque of **270 ± 40 N•m (199 ± 29 lb ft)**. Tighten bolts (14) to a torque of **240 ± 40 N•m (177 ± 30 lb ft)**.

NOTE: Do not install Duo-Cone Seal (21) at this time. The bearing preload must be determined before the Duo-Cone Seal is installed.



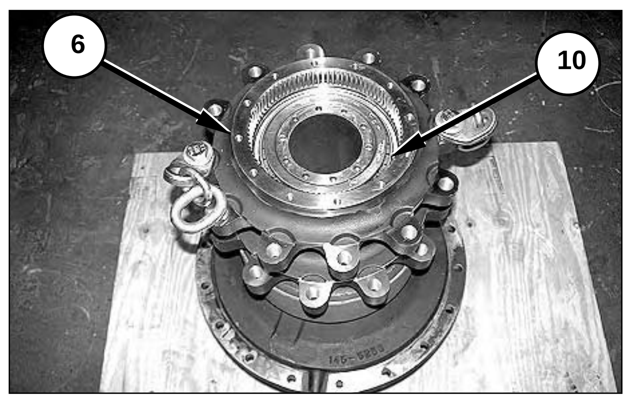
20. Heat bearing (20) to a temperature of **150°C (250°F),** and install the bearing onto spindle (11).

NOTICE

Do not overheat the bearing. If any part of the bearing starts to turn blue, replace the bearing.

NOTE: Do not install the Duo-Cone Seal on the spindle at this time. The bearing preload must be determined before the Duo-Cone Seal is installed.

21. Set the bearing preload in the right spindle assembly as follows:

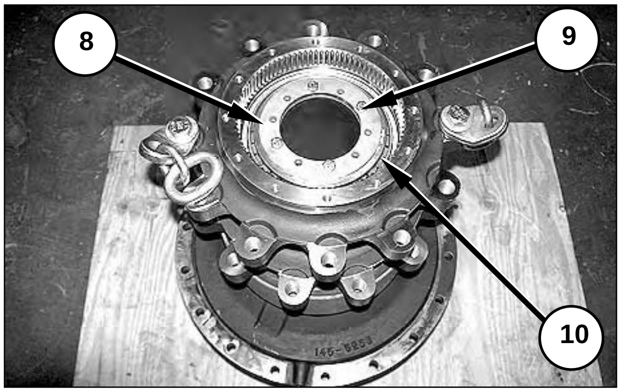


a. Install hub (6) onto the spindle.

b. Heat bearing (10) to a temperature of **150°C (250°F),** and install the bearing in hub (6). If necessary, use a brass drift to tap the bearing into position.

NOTICE

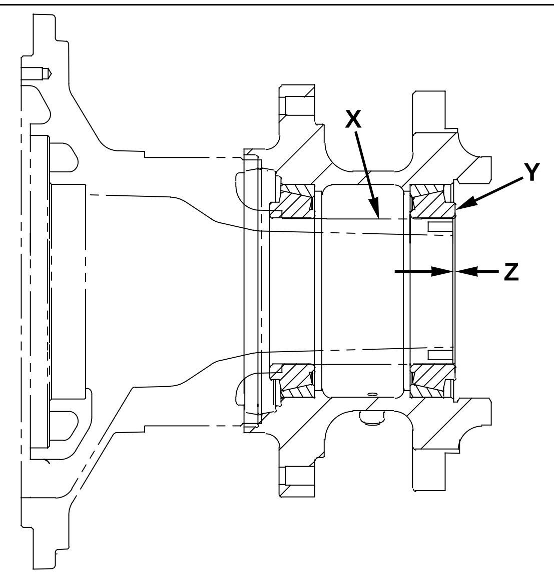
Do not overheat the bearing. If any part of the bearing starts to turn blue, replace the bearing.



c. Quickly install ring (8) and four of 10 bolts (9) with the washers. Fully tighten bolts (9) in a star pattern to fully seat bearing (10), while the bearing is still hot.

NOTE: Do not install the shims with ring (8) at this time.

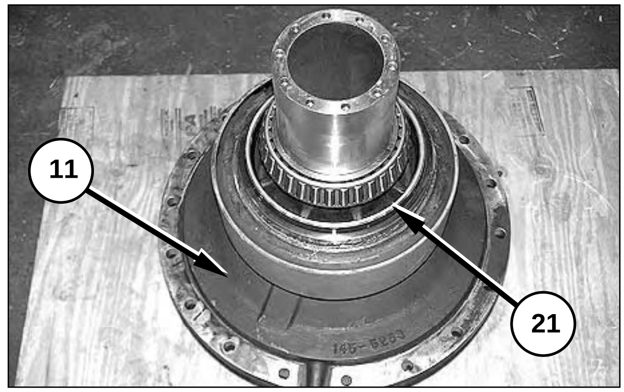
d. Remove four bolts (9) and ring (8).



e. Measure distance (Z), between bearing (Y) and the end of spindle (X).

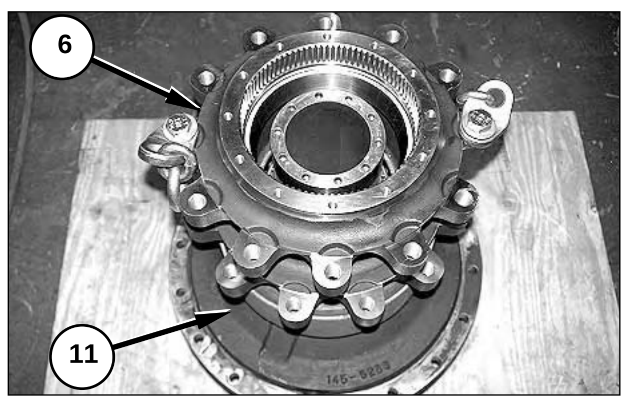
f. Subtract **0.0254 mm (0.001 in)** from distance (Z) to determine the thickness of shims to install with ring (8).

g. Use Tooling (C) to remove hub (6) with bearing (10).

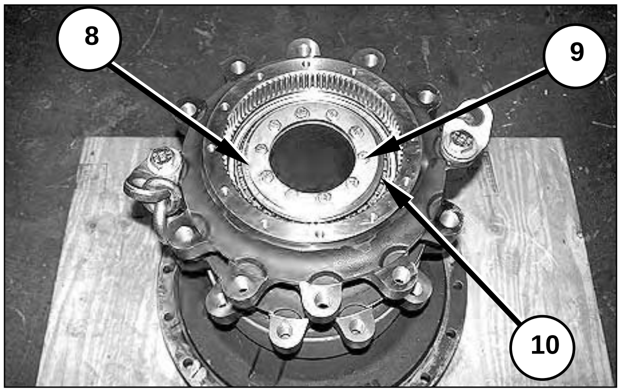


22. Install Duo-Cone Seal (21) into spindle (11) using Tooling (D). Refer to “Duo-Cone Seals” in this module, for installation of Duo-Cone Seals.

23. Install Duo-Cone Seal (21) into hub (6) using Tooling (D). Refer to “Duo-Cone Seals“ in this module, for the correct procedure to install Duo-Cone Seals.



24. Install hub (6), with the Duo-Cone Seal, onto spindle (11). Use Tooling (C) to lift the hub. The weight of hub (6) is **60 kg (132 lb)**.

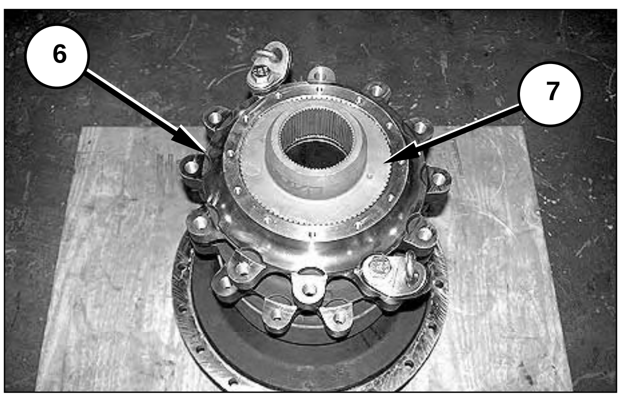


25. Heat bearing (10) to a temperature of **120°C (250°F),** and install the bearing in hub (6). If necessary, use a brass drift to tap the bearing into position.

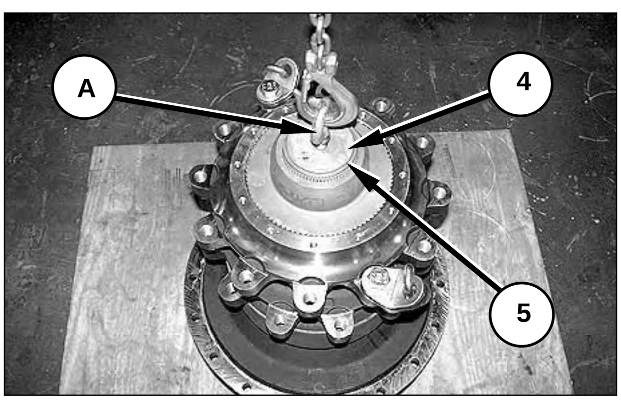
NOTICE

Do not overheat the bearing. If any part of the bearing starts to turn blue, replace the bearing.

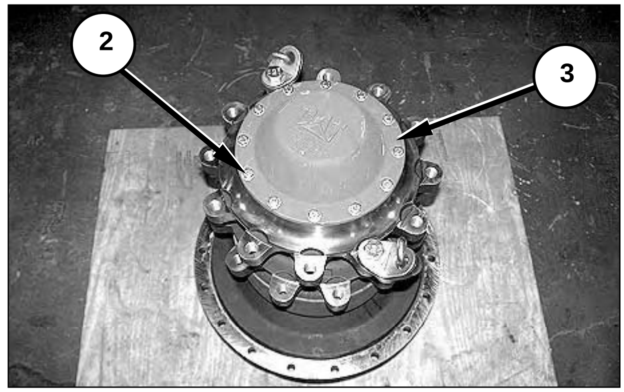
26. Quickly install ring (8) with ten bolts (9) with washers, and the correct amount of shims, as determined in Step 21f. Fully tighten bolts (9) in a star pattern to seat bearing (10), while the bearing is still hot.



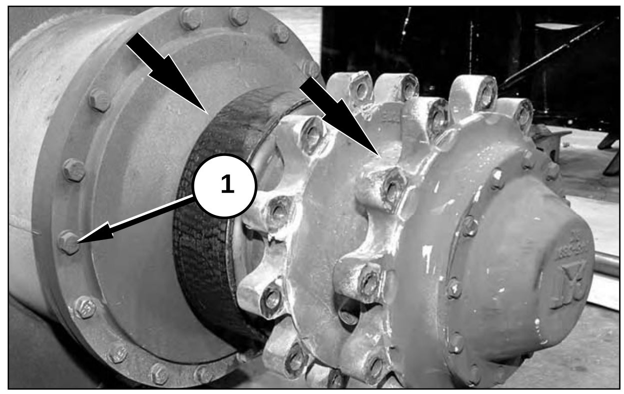
27. Install coupling (7) into hub (6).



28. Use Tooling (A) to install drive shaft (4) and retainer clip (5).



29. Install cover (3) with the O-ring, and 12 bolts (2) with the washers.



30. Install 18 bolts (1) with washers, and use a hoist to install the right spindle assembly on the differential steer housing. The weight of the right spindle assembly is approximately **300 kg (661 lb)**.

End By:

a. Install the differential steering unit and transmission.

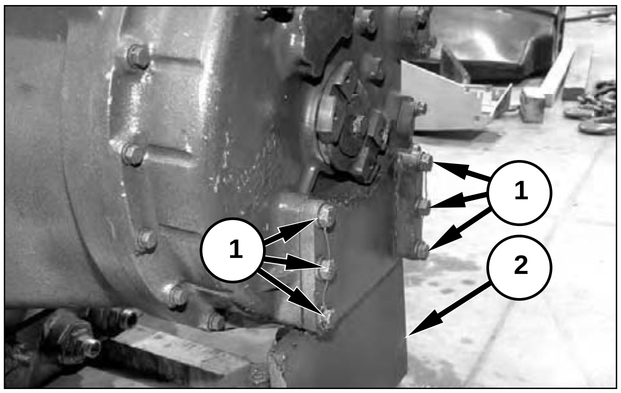
Separate and Connect

Tools Needed	A	B
138-7575 Link Bracket	2	
138-7575 Link Bracket		3

Start By:

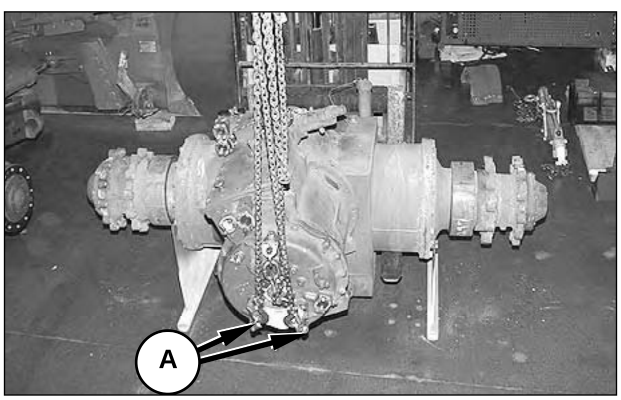
a. Remove the differential steering unit and transmission.

NOTE: Group numbers related to this procedure include 130-7416, 144-7165 and 156-1565.

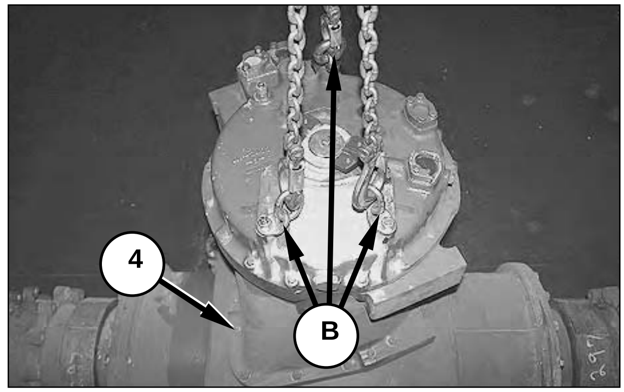


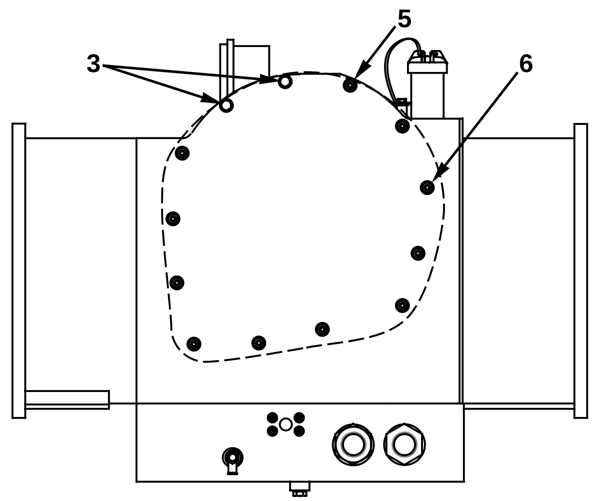
1. Cut the wire, and remove six bolts (1) with washers, and mounting bracket (2).

NOTE: Upon reassembly, apply **4C-4032 Thread Compound (Loctite™ 271)** to the threads of bolts (1), and tighten the bolts to a torque of **120 ± 20 N•m (90 ± 15 lb ft)**. After the bolts have been tightened, install wire on the bolts.



2. Attach Tooling (A), and support the differential steering unit with a forklift. Use a suitable lifting device to rotate the differential steering unit so that the transmission is pointing up. The weight of the differential steering unit, together with the transmission, is approximately **2177 kg (4800 lb)**.





3. Install Tooling (B).

4. Remove 10 nuts (6), with washers.

5. Remove two bolts (3) with washers.

6. Remove bolt (5) with nut and washers.

7. Use a hoist to lift transmission assembly (4) out of the differential steering unit. The weight of transmission assembly (4) is approximately **746 kg (1645 lb)**.

NOTE: To install the differential steering unit and transmission, reverse the removal steps.

End By:

a. Install the differential steering unit and transmission.

Differential Steering Unit

Disassemble and Assemble

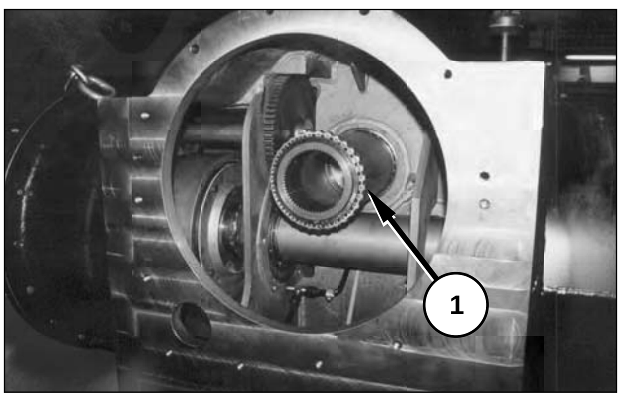
Tools Needed		A	B	C	D	E	F
138-7576	Link Brackets	2					
3E-3879	Eyebolt (M16-2-6)		1				
8T-2839	Spanner			1			
1P-2322	Puller				1		
1P-0524	Plate				1		
1U-6437	Seal Installer					1	
5T-5096	Indicator Group						1
5/8 UNC X 152 mm (6 in) Threaded Rod							1

Start By:

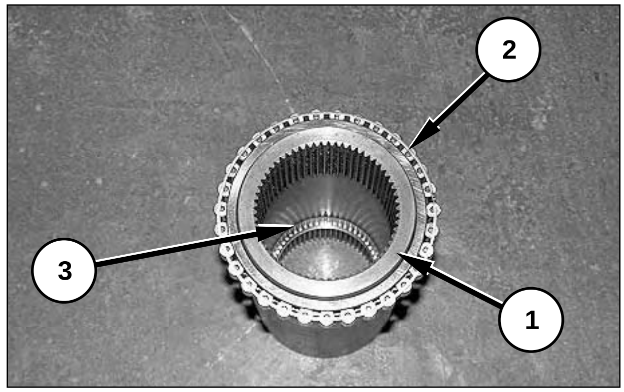
a. Remove the differential steering unit and transmission.

b. Separate the differential steering unit and transmission.

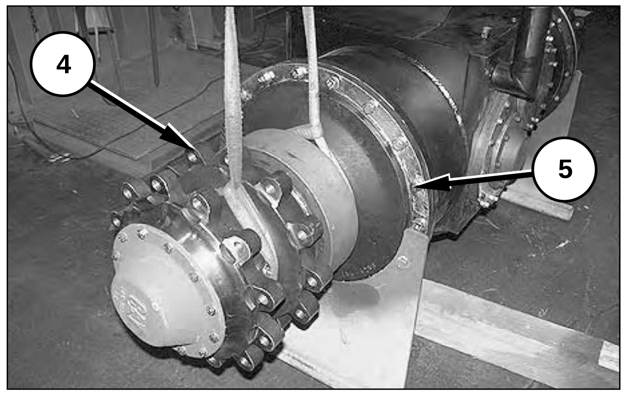
NOTE: Group numbers related to this procedure include 125-0110, 130-2595, 130-7416, and 145-5248.



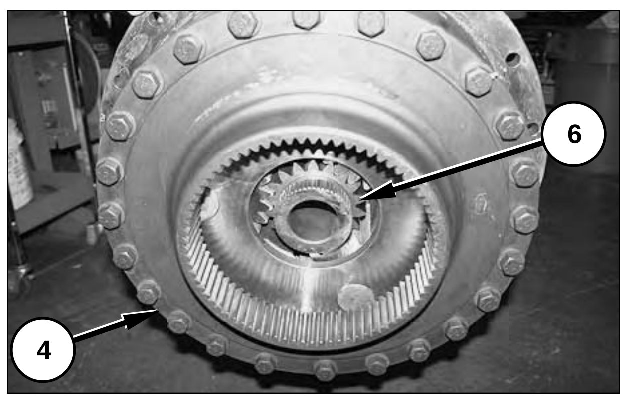
1. Remove input shaft (1).



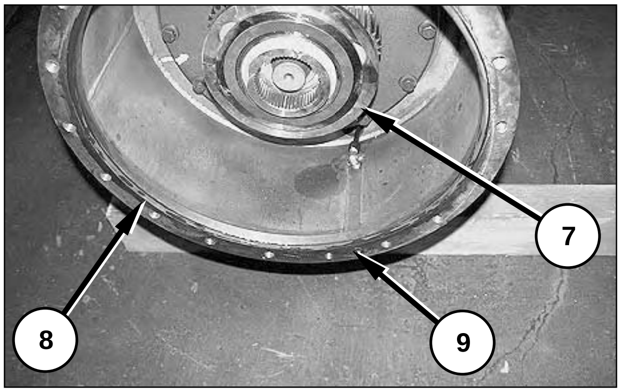
2. Remove bearing (2) and ring (3) from input shaft (1).



3. Fasten a hoist to left spindle assembly (4). Support the left side of the differential steering unit with blocks and remove 18 bolts (5) with washers, and the left spindle assembly. The weight of the left spindle assembly is approximately **300 kg (661 lb)**.

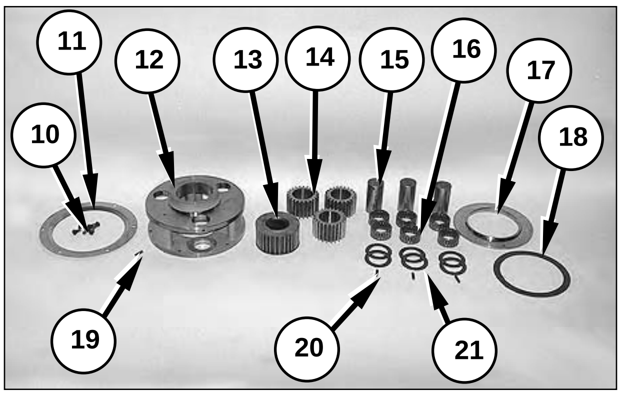


4. Remove sun gear (6) from left spindle assembly (4).

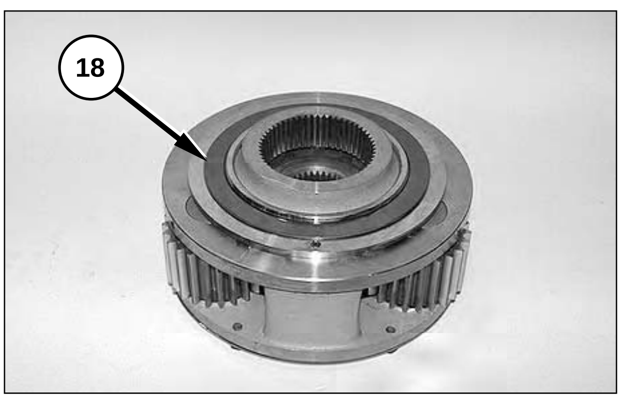


5. Remove large O-ring seal (8) and small O-ring seal (9). Replace the O-ring seals if they are damaged or worn.

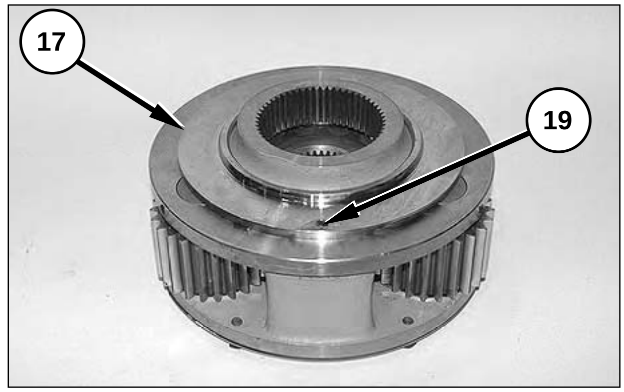
6. Remove left inner planetary group (7).



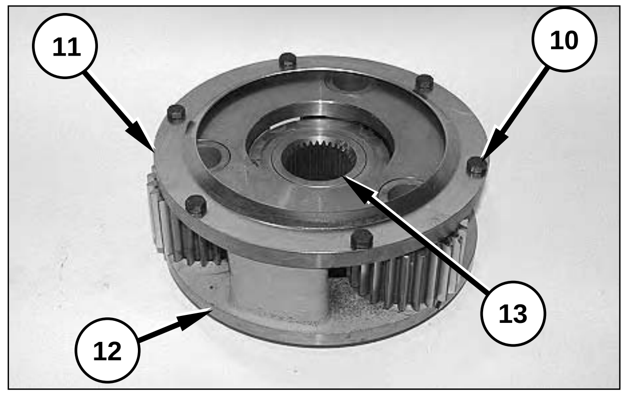
7. The exploded view of left inner planetary group (7) components is shown above.



8. Remove disk (18).

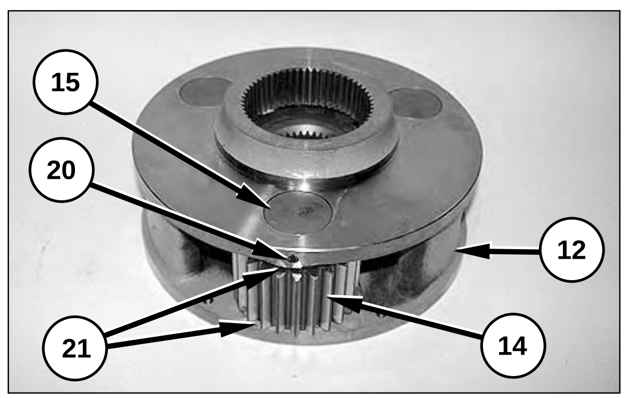


9. Remove retainer (17) and pin (19).



10. Remove six bolts (10) and slinger (11) from planet carrier (12).

11. Remove sun gear (13).

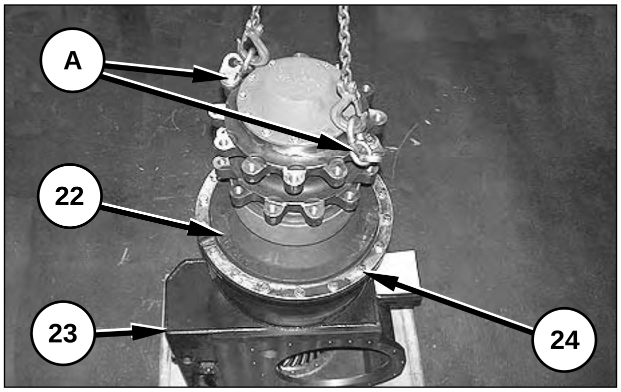


12. Drive pin (20) into planet shaft (15) to remove the planet shaft. Remove the pin from the shaft, and discard the pin.

13. Remove planet gear (14), two thrust washers (21), and two bearings (16) from planet carrier (12).

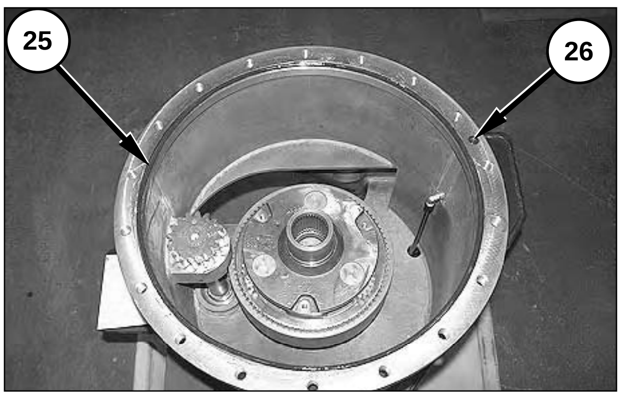
NOTE: Two bearings (16) are installed inside planet gear (14) and are not visible in the photograph.

14. Repeat Steps 12 and 13 to remove two more planet gears from planet carrier (12).



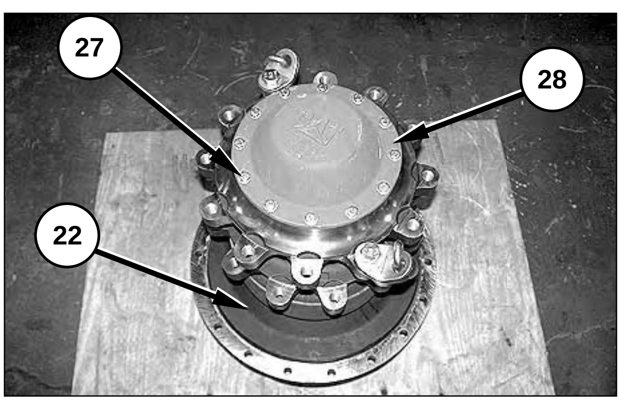
15. Reposition housing (23), as shown and attach Tooling (A).

16. Remove 18 bolts (24) with washers, to remove right spindle assembly (22) from housing (23). The weight of right spindle assembly (22) is approximately **300 kg (661 lb)**.

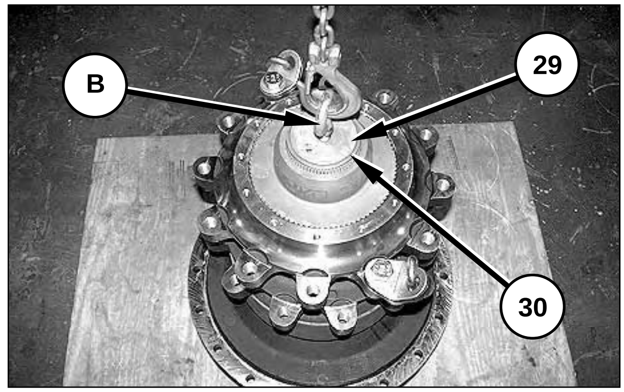


17. Remove large O-ring seal (25) and small O-ring seal (26). Replace the O-ring seals if they are damaged or worn.

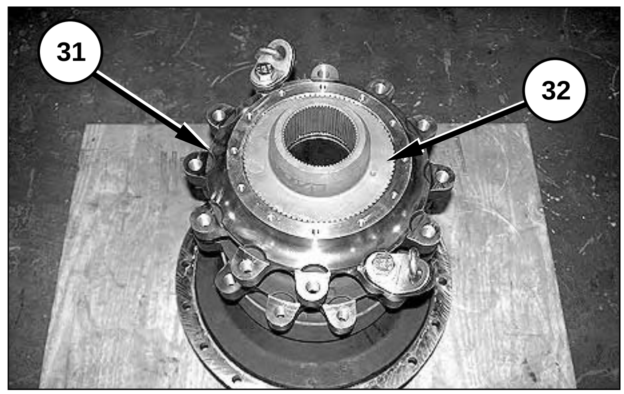
NOTE: Steps 18 through 26 are the same for right spindle assembly (22) and left spindle assembly (4).



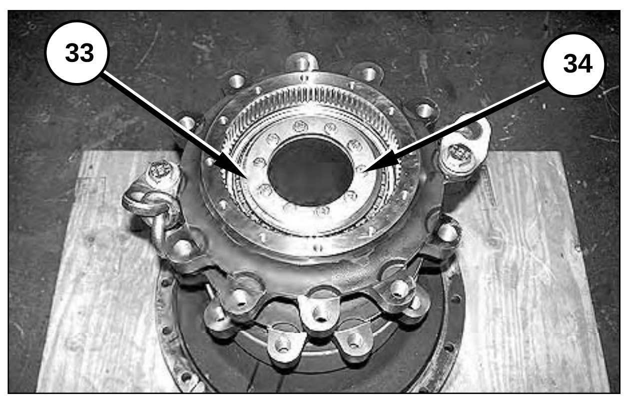
18. Remove 12 bolts (27) with washers, and cover (28) with the O-ring, from right spindle assembly (22).



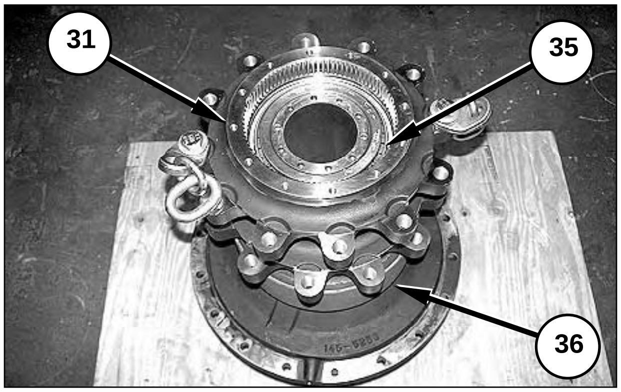
19. Install Tooling (B), and remove drive shaft (29) and retainer clip (30).The weight of drive shaft (29) is **35.9 kg (79 lb)**.



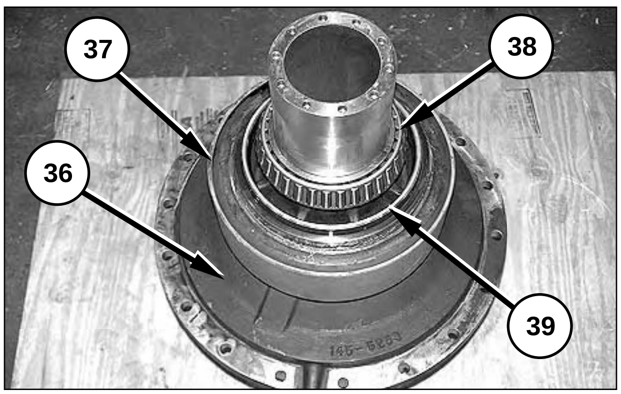
20. Remove coupling (32) from hub (31).



21. Remove 10 bolts (34), and ring (33) with shims.

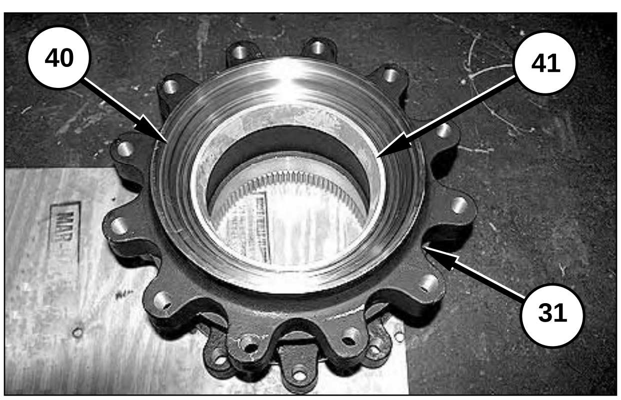


22. Use Tooling (D) to remove hub (31) and bearing (35) with the Duo-Cone Seal, from right spindle (36). The weight of the hub is **60 kg (132 lb)**.

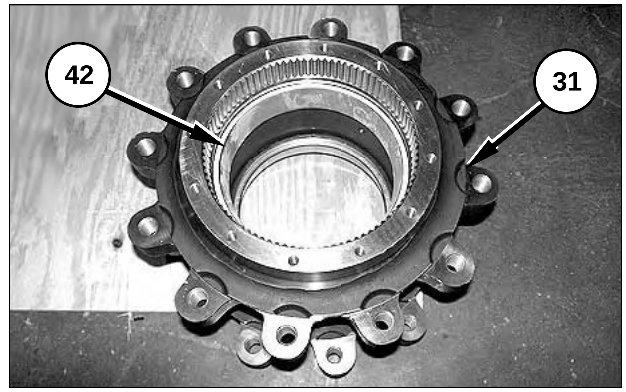


23. Remove Duo-Cone Seal (39) and bearing (38) from right spindle (36).

24. If necessary, use a disk grinder or other suitable tool to remove bushing (37). Take care not to damage the mounting surface of the spindle when removing the bushing.

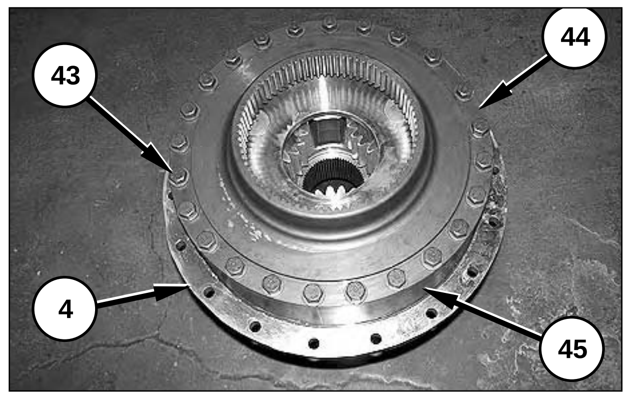


25. Remove Duo-Cone Seal (40) and race (41) from hub (31).



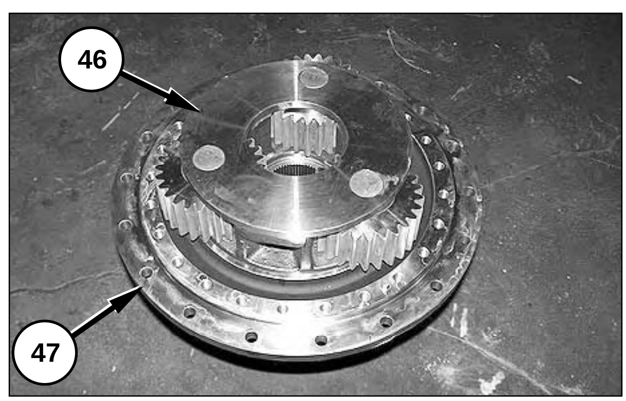
26. Remove race (42) from hub (31).

27. Repeat Steps 18 through 26 for the right spindle assembly.

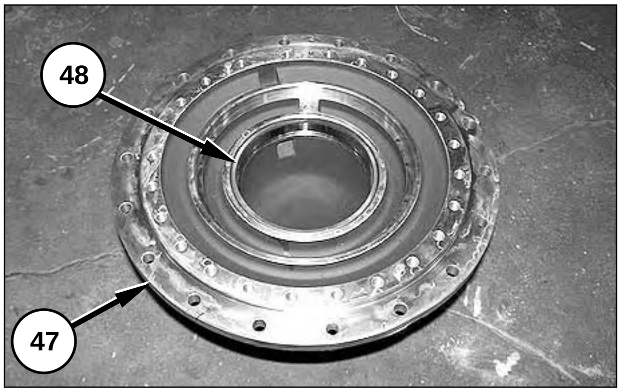


28. Use Tooling (A) and hoist to turn left spindle assembly (4) over. Remove 24 bolts (43) with washers, and cover (44) from left spindle assembly (4).

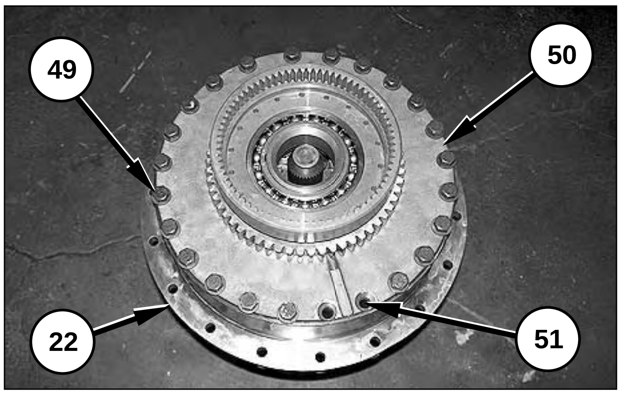
29. Remove ring gear (45).



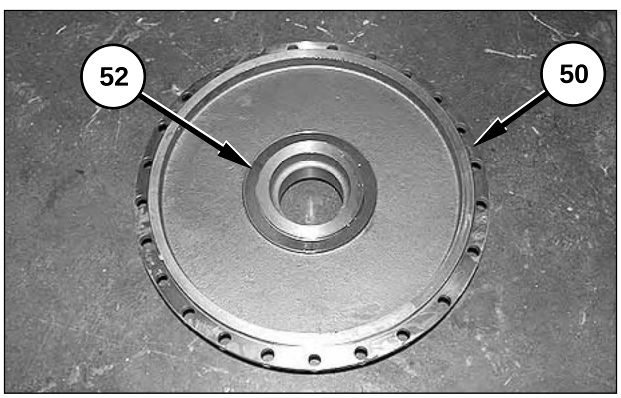
30. Remove left output planetary group (46) from left spindle (47).



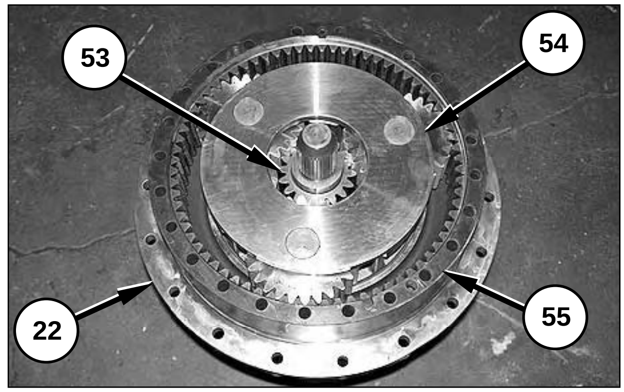
31. Remove bearing race (48) from left spindle (47).



32. Use Tooling (A) and a hoist to turn right spindle assembly (22) over. Remove 22 bolts (49) with washers, two bolts (51), and cage assembly (50) from right spindle assembly (22).

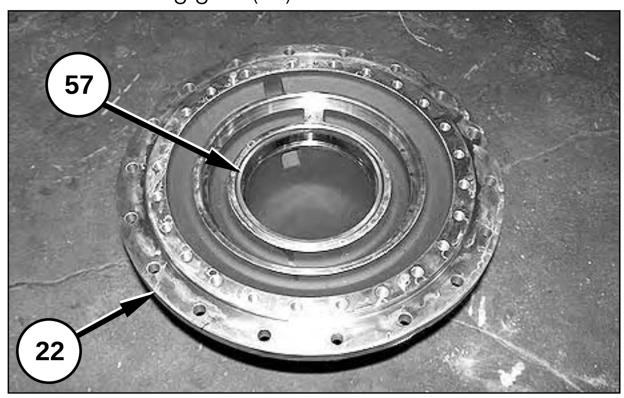


33. Remove thrust washer (52) from cage assembly (50).

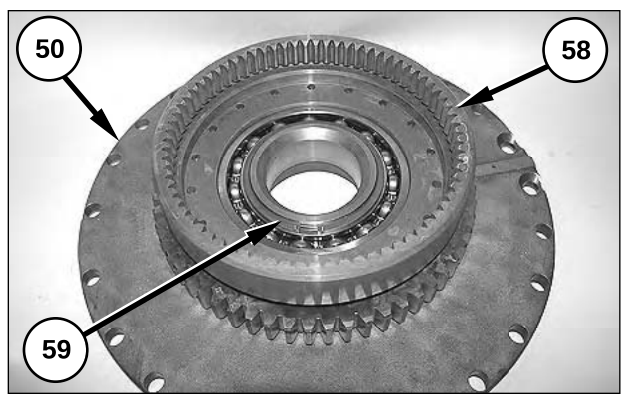


34. Remove sun gear (53) and right output planetary group (54) from right spindle assembly (22).

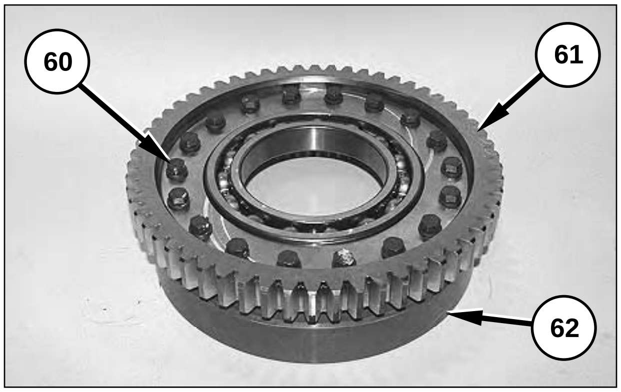
35. Remove ring gear (55).



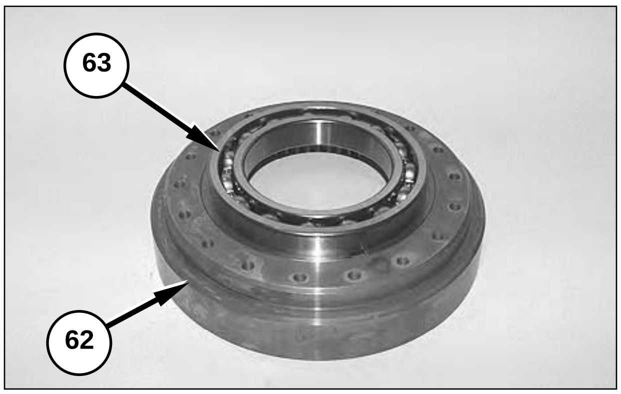
36. Remove bearing race (57) from right spindle assembly (22).



37. Remove snap ring (59) and steering gear group (58) from cage assembly (50).

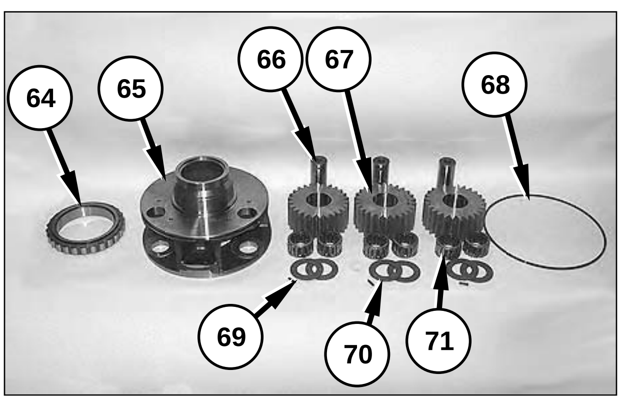


38. Remove 18 bolts (60) with washers and gear (61) from ring gear (62).

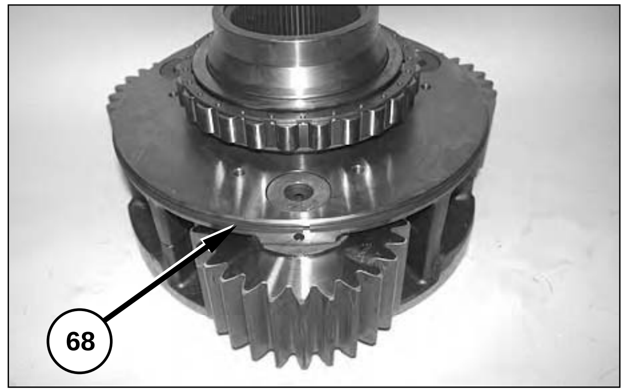


39. Use a suitable puller to remove bearing (63) from ring gear (62).

NOTE: Steps 40 through 43 are the same for the left output planetary group (46) and right output planetary group (54).

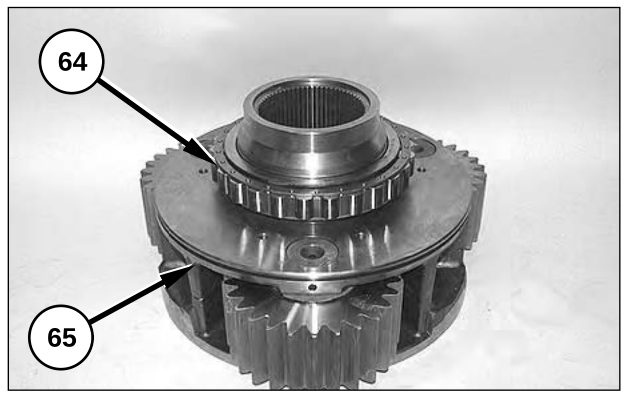


40. Exploded view of left output planetary group (40) and right output planetary group (54).

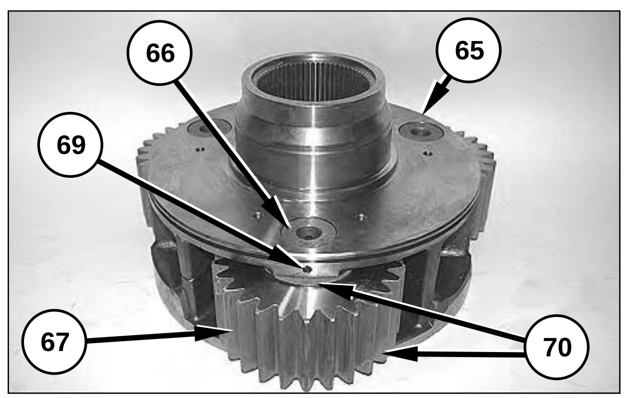


41. Remove seal ring (68), and replace the seal ring if there is wear or damage.

NOTE: There is a small spring in the end of seal ring (68). Take care not to damage the spring during removal if the seal ring is to be reused.



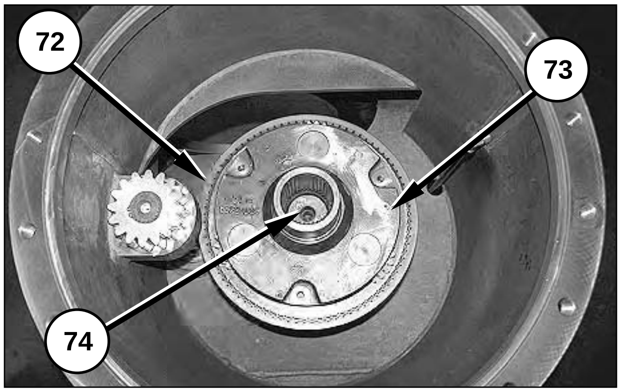
42. If necessary, remove bearing (64) from carrier (65).



43. Drive pin (69) into planet shaft (66) to remove planet gear (67) with two thrust washers (70), two bearings (71), and planet shaft (66). Drive pin (69) out of planet shaft (66) and discard the pin.

44. Repeat Step 43 to remove two more planet gears (67) from carrier (65).

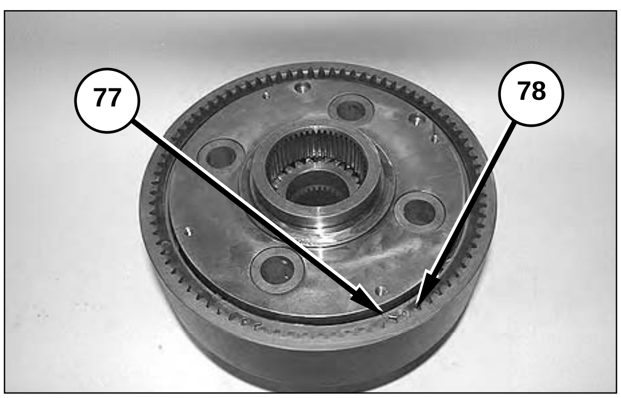
45. Repeat Steps 41 through 44 to disassemble the second output planetary group.



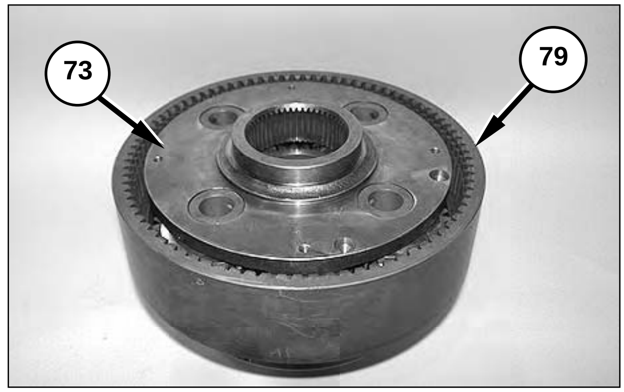
46. Remove shaft (74).

47. Remove right inner planetary group (73) and right outer planetary group (72) as a unit.

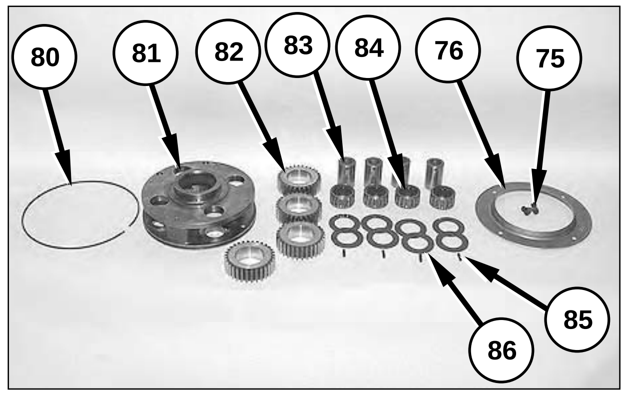
48. Remove four bolts (75) and slinger (76).



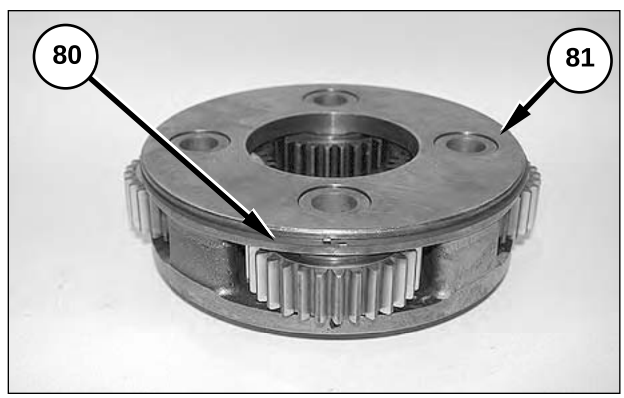
49. Remove snap ring (77) and spacer (78).



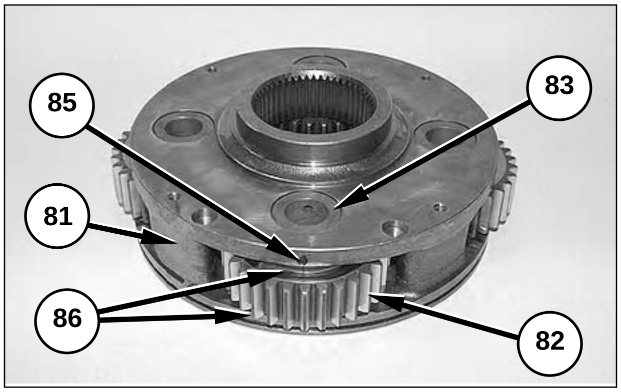
50. Remove right inner planetary group (73) from ring gear (79).



51. The exploded view of right inner planetary group (73) components is shown above.



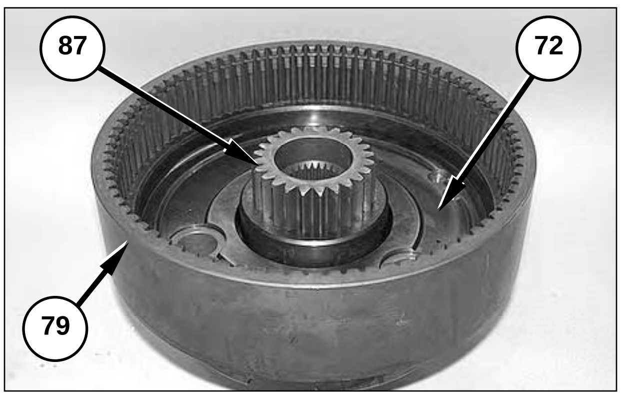
52. Remove seal (80) from carrier (81).



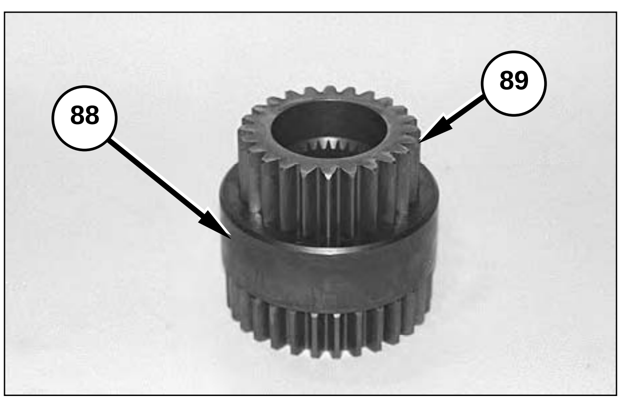
53. Drive pin (85) into planet shaft (83), to remove the planet shaft. Drive pin (85) out of planet shaft (83) and discard the pin.

54. Remove planet gear (82) with two thrust washers (86), and bearing (84) from carrier (81).

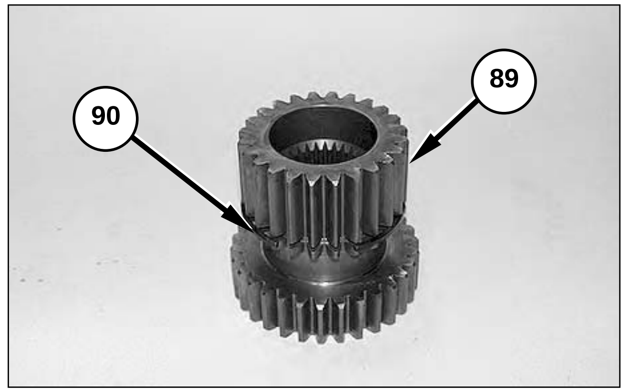
55. Repeat Steps 53 and 54 to remove three more planet gears (82) from carrier (81).



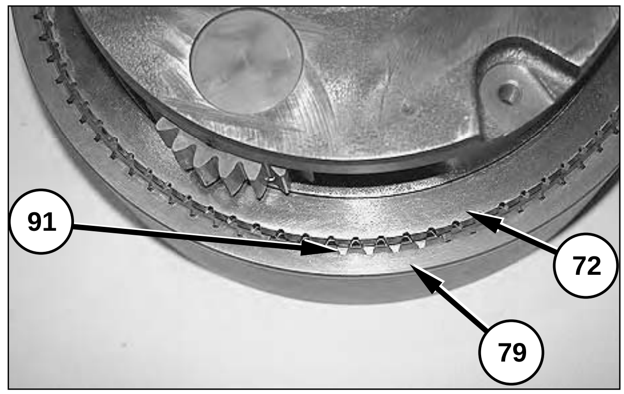
56. Remove left inner sun gear assembly (87) from right outer planetary group (72) and ring gear (79).



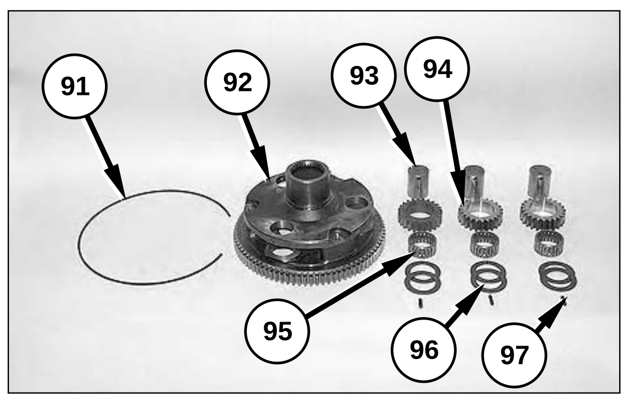
57. Remove spacer (88) from sun gear (89).



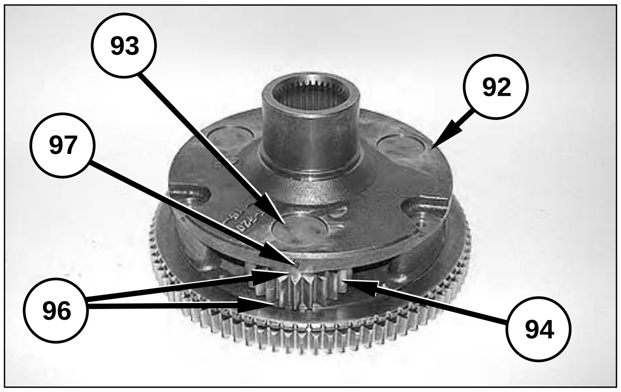
58. Remove ring (90) from sun gear (89).



59. Separate right outer planetary group (72) from ring gear (79) by compressing ring (91). Insert three or four tapered picks or other suitable tools into the gear teeth around ring gear (79), to compress ring (91).



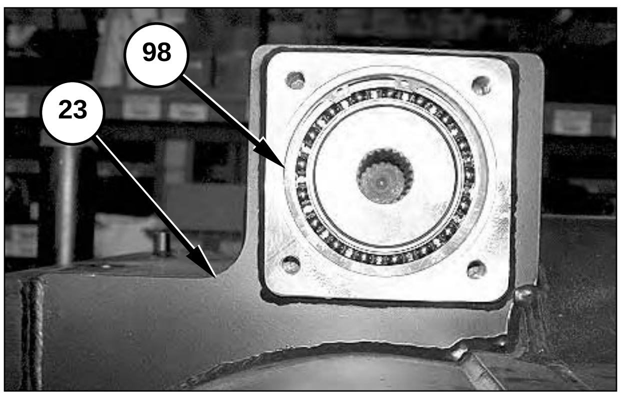
60. The exploded view of the right outer planetary group (72) components is shown above.



61. Drive pin (97) into the center of planet shaft (93) to remove the shaft. Drive the pin out of the planet shaft and discard the pin.

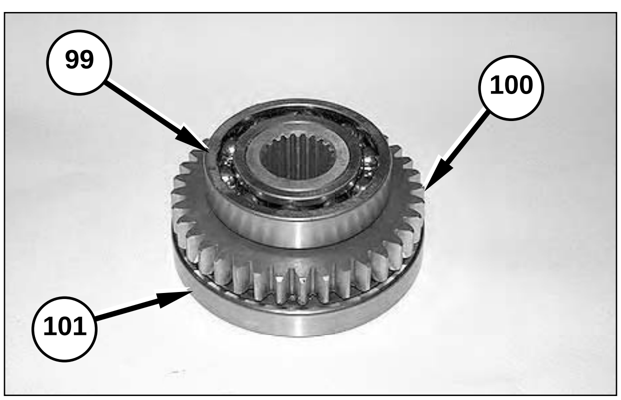
62. Remove planet gear (94) with bearing (95), and two thrust washers (96).

63. Repeat Steps 61 and 62 to remove two more planet gears (94) from carrier (92).

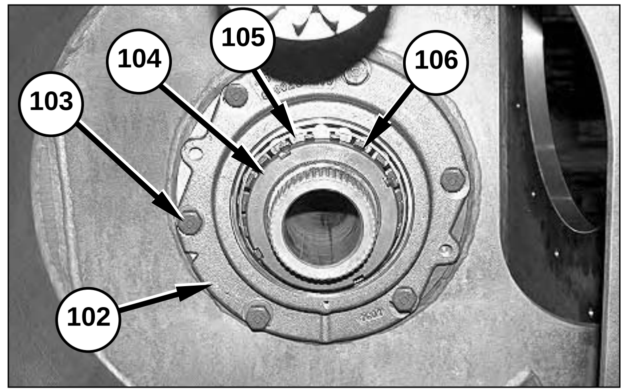


64. Position housing (23) horizontally.

65. Remove steering gear assembly (98) from housing (23).

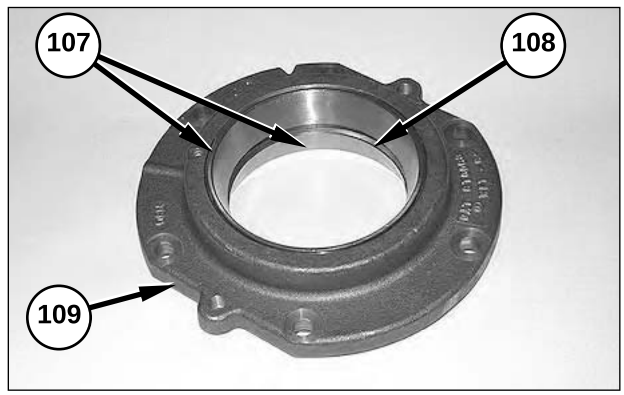


66. If necessary, remove bearings (99) and (101) from steering gear (100).

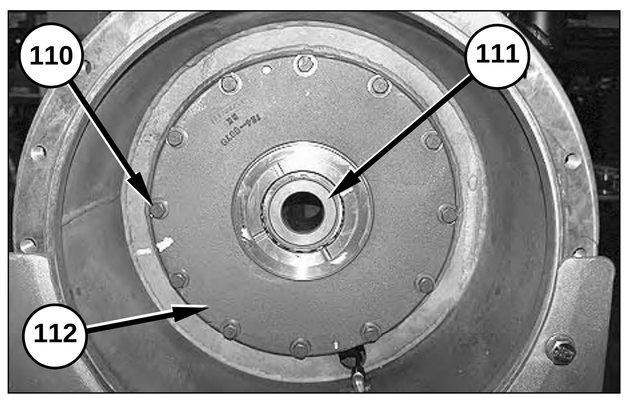


67. Bend the tangs on lock washer (106) back. Use Tooling (C) to remove nut (104), lock washer (106) and bearing (105).

68. Remove six bolts (103) with washers, and cage (102) with shims.

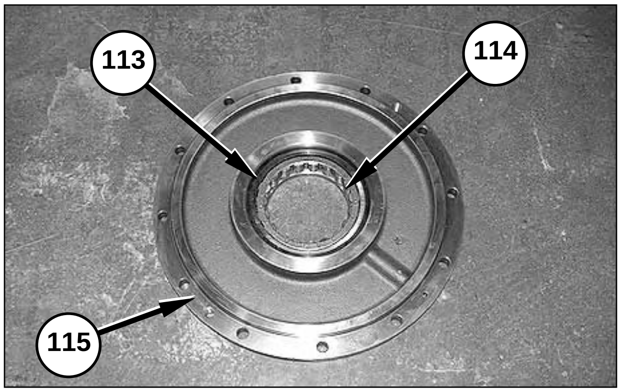


69. If necessary, remove two bearing races (107) and spacer (108) from cage assembly (109).

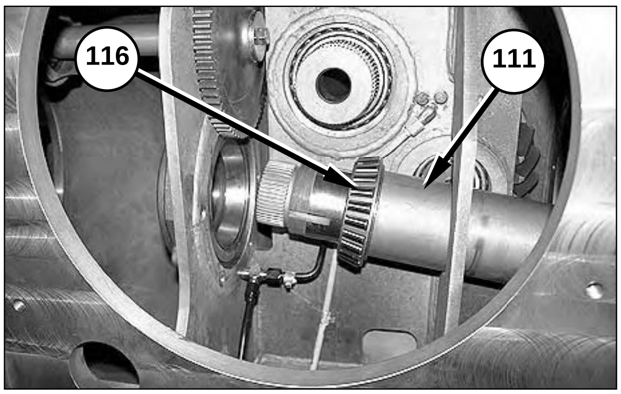


70. Support shaft assembly (111) with a pry bar through the center to keep the shaft assembly from dropping when cage assembly (112) is removed. Mark the orientation of the cage assembly to assist with reassembly.

71. Remove 12 bolts (110) with washers, and cage assembly (112).

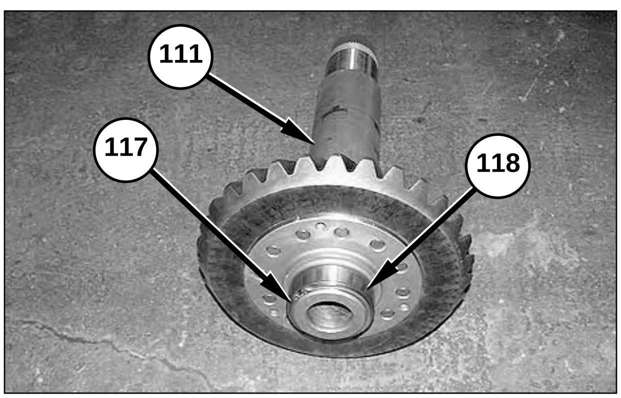


72. If necessary, remove snap ring (113) and bearing (114) from cage assembly (115).

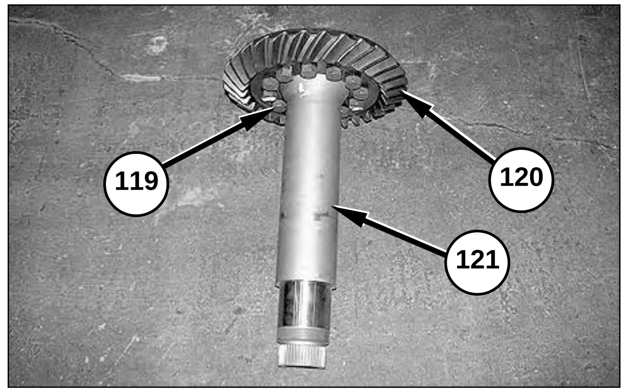


73. Remove bearing (116) from shaft assembly (111).

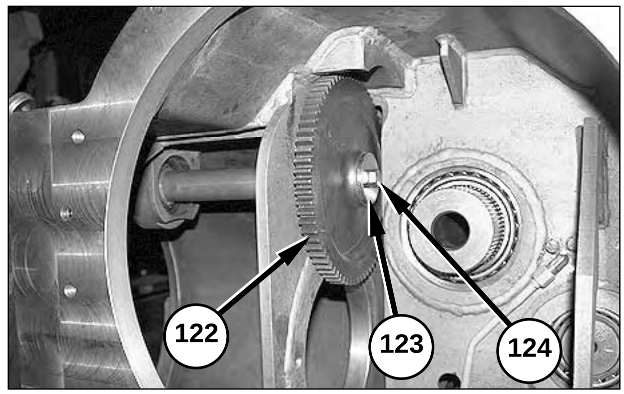
74. Use two people to remove shaft assembly (111). The weight of shaft assembly (111) is approximately **30 kg (64 lb)**.



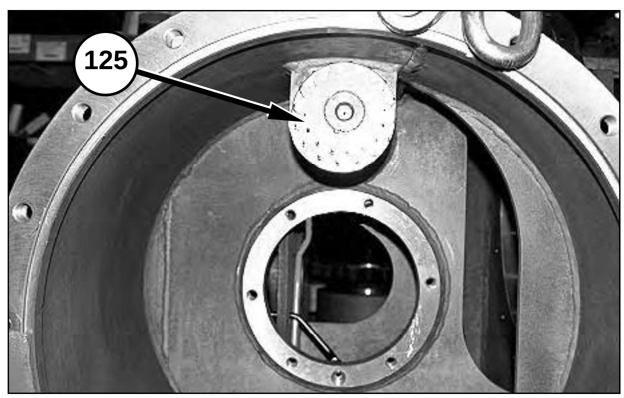
75. If necessary, remove snap ring (117) and bearing race (118) from shaft assembly (111).



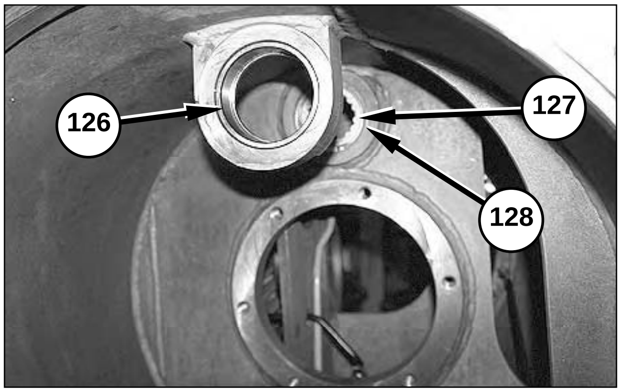
76. Remove 12 bolts (119) and gear (120) from shaft (121).



77. Remove bolt (124), washer (123), and steering gear (122).

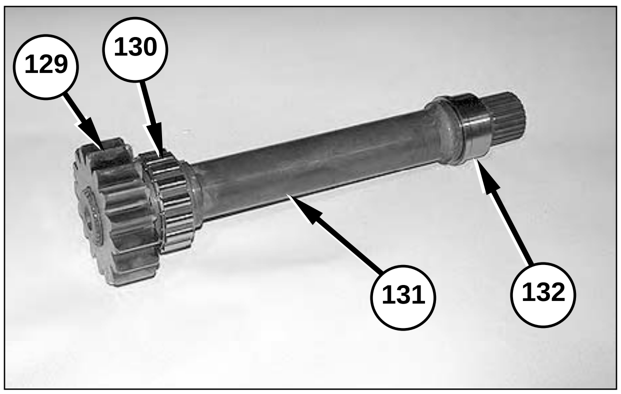


78. Remove steering shaft assembly (125).



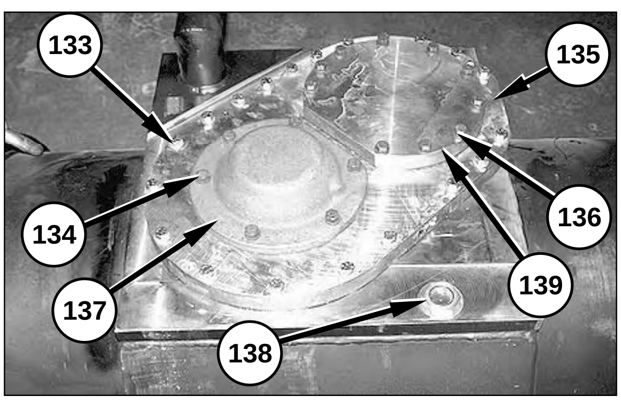
79. Remove bearing race (126).

80. Remove snap ring (128) and bearing (127).



81. Remove steering gear (129) from steering shaft (131).

82. Remove bearing (130) and bearing race (132) from steering shaft (131).

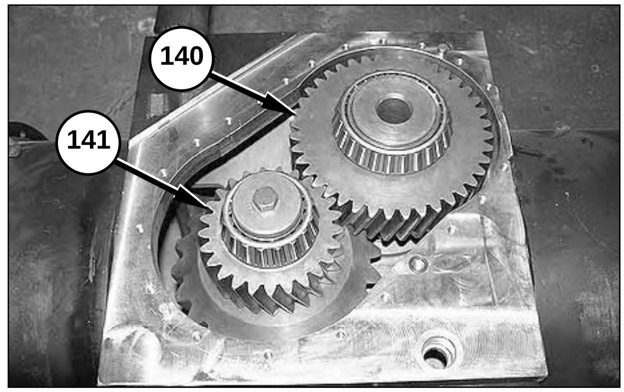


83. Remove 20 bolts (133) with washers, and plate (135).

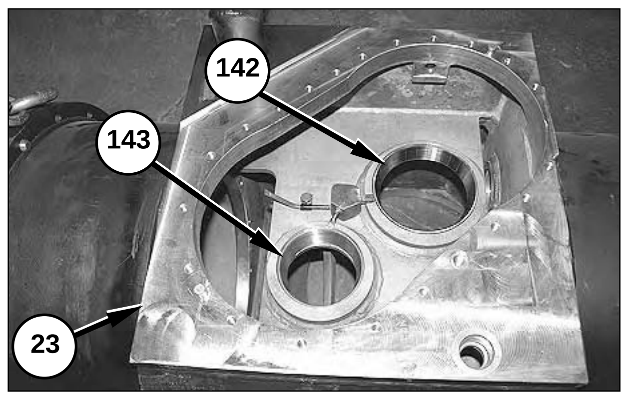
84. If necessary, remove six bolts (134) with washers, and cage assembly (137) with shims, O-ring seal, and bearing race. If necessary, remove the O-ring seal and bearing race from the cage assembly.

85. If necessary, remove ten bolts (136) with washers, and cage assembly (139) with shims, O-ring seal, and bearing race. If necessary, remove the O-ring seal and bearing race from the cage assembly.

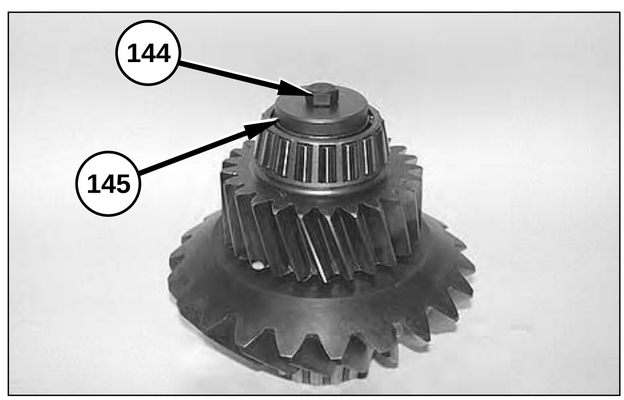
86. If necessary, remove sight gauge (138) with O-ring seal.



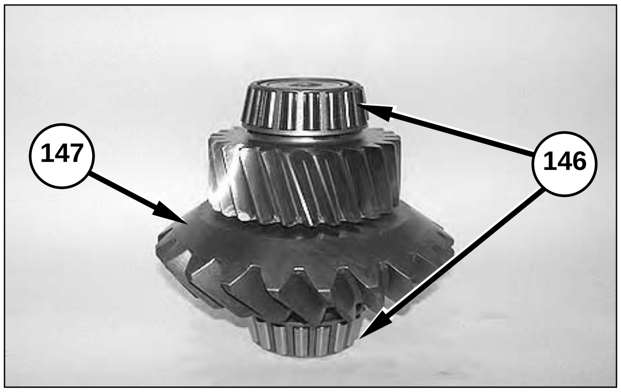
87. Remove gear assembly (140) and pinion assembly (141).



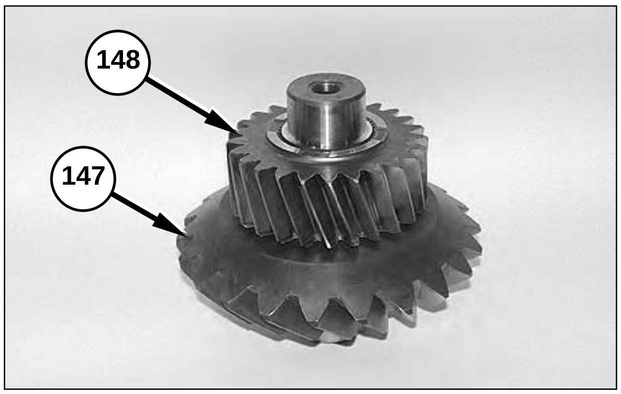
88. If necessary, remove bearing races (143) and (142) from housing (23).



89. Remove bolt (144) and spacer (145) from pinion assembly (141).

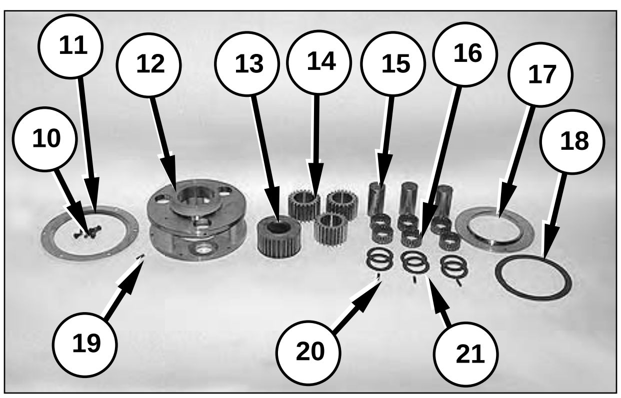


90. Remove bearings (146) from pinion (147).

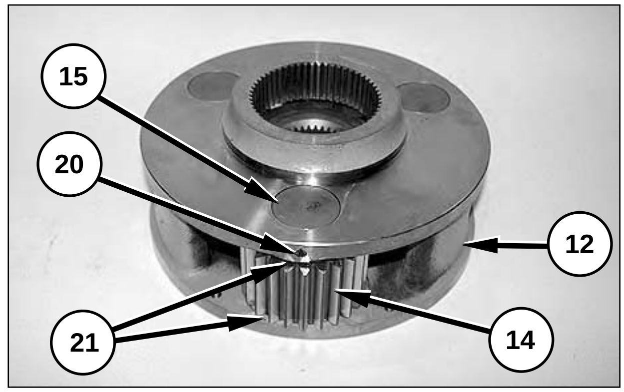


91. Remove gear (148) from pinion (147).

NOTE: The following steps are for assembling the differential steering unit.



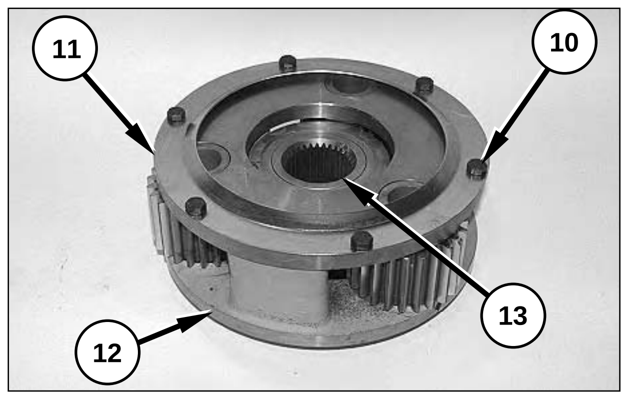
92. The exploded view of the components of left inner planetary group (7) is shown above.



93. Install planet gear (14), two thrust washers (21), two bearings (16), and planet shaft (15) to planet carrier (12).

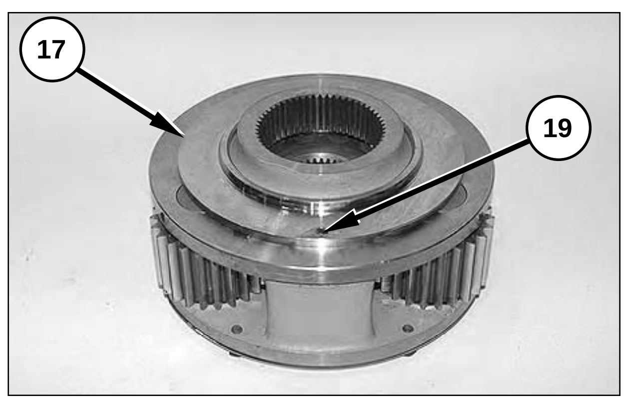
94. Drive a new pin (20) into the hole in planet carrier (12) and planet shaft (15).

95. Repeat Steps 93 and 94 for two more planet gears (14).

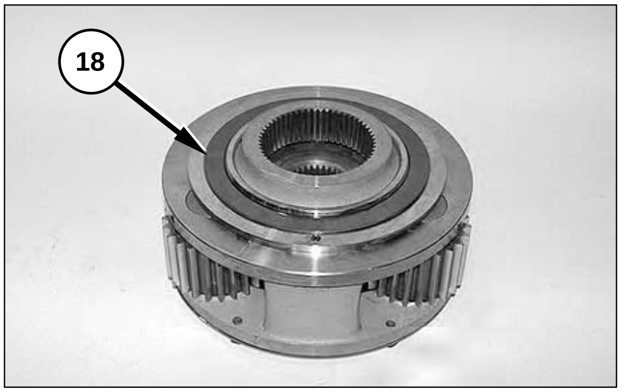


96. Install slinger (11) with six bolts (10) to planet carrier (12).

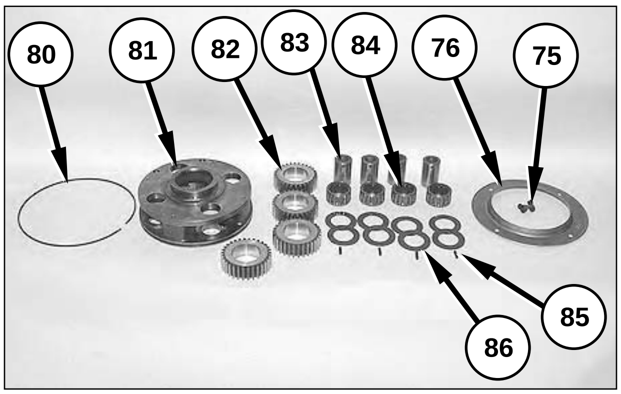
97. Install sun gear (13).



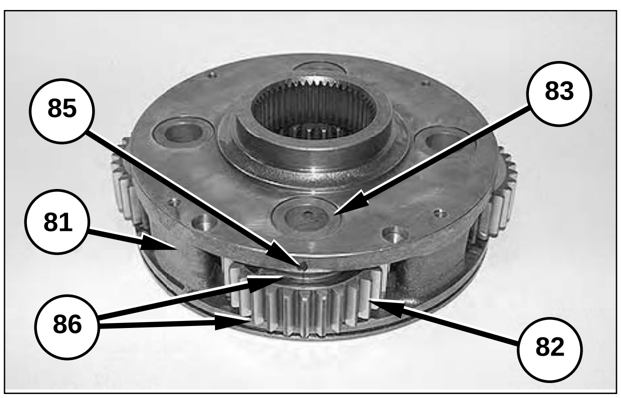
98. Install retainer (17) using pin (19).



99. Install disk (18). Use clean grease to temporarily secure the disk.



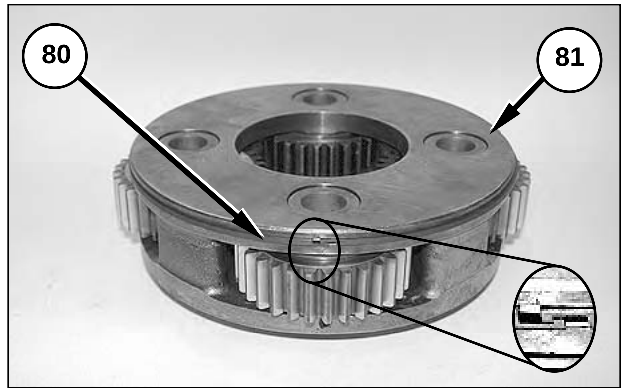
100. The exploded view of right inner planetary group (73) components is shown above.



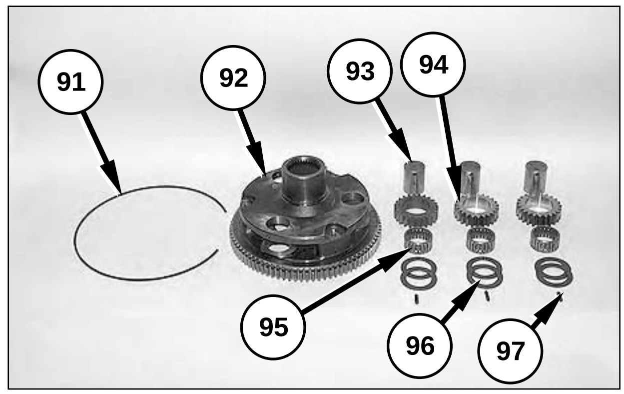
101. Install planet gear (82) with two thrust washers (86), bearing (84) and planet shaft (83), to carrier (81).

102. Drive a new pin (85) into the hole in carrier (81) and planet shaft (83).

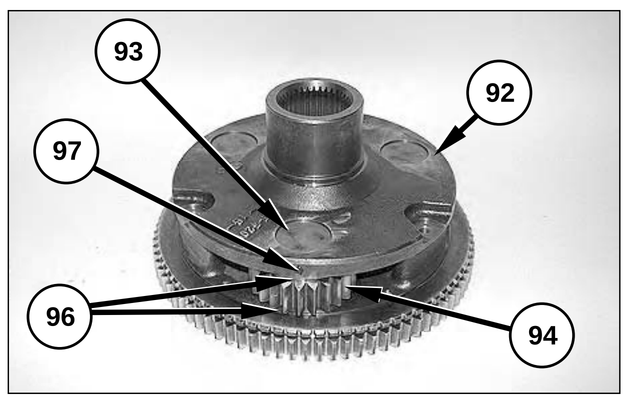
103. Repeat Steps 101 and 102 to install three more planet gears (82) in carrier (81).



104. Install seal (80) in carrier (81). Note the orientation of the seal joint.



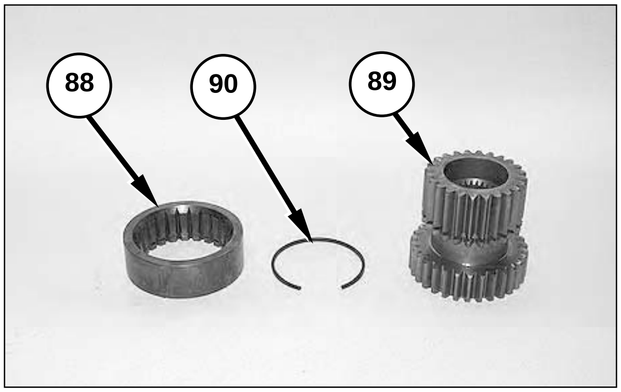
105. The exploded view of the right outer planetary group (72) components is shown above.



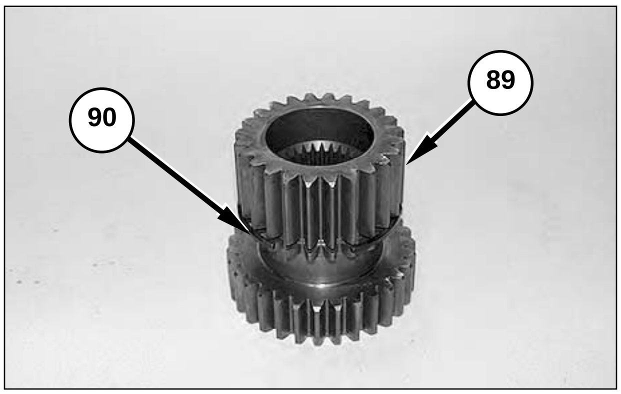
106. Install planet gear (94) with bearing (95), two thrust washers (96) and planet shaft (93).

107. Drive a new pin (97) into the hole in carrier (92) and planet shaft (93).

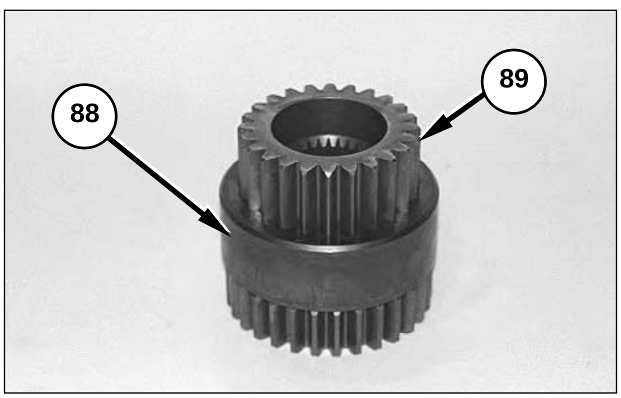
108. Repeat Steps 106 and 107 for two more planet gears (94).



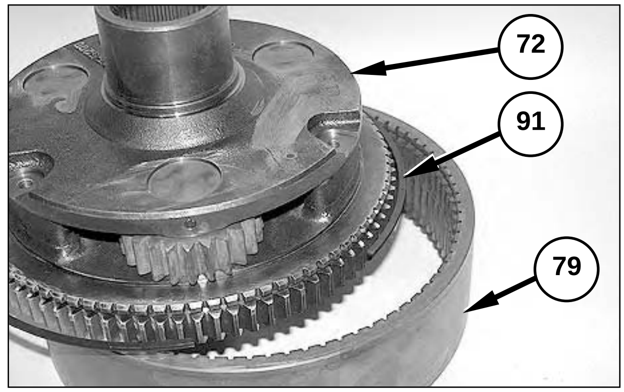
109. Exploded view of left inner sun gear assembly (87) components.



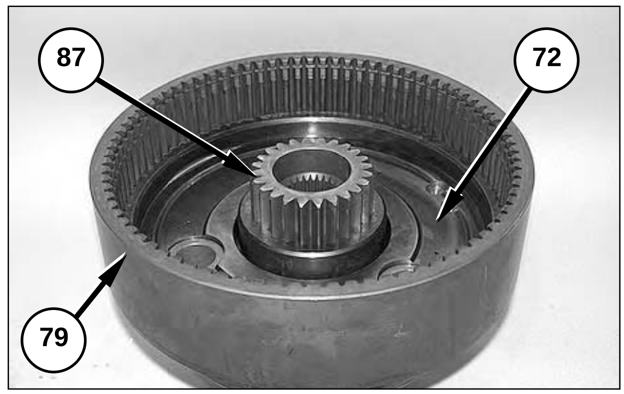
110. Install ring (90) onto sun gear (89).



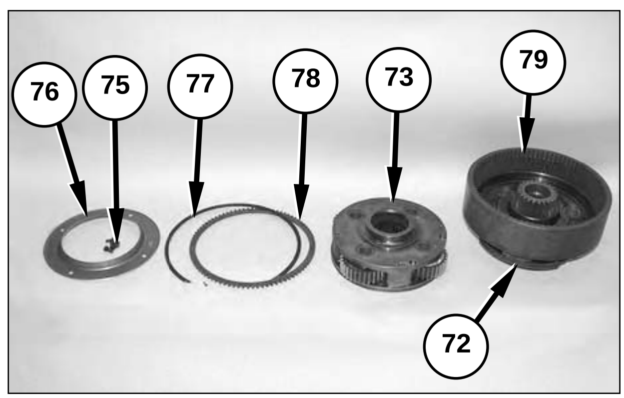
111. Install spacer (88) on sun gear (89).



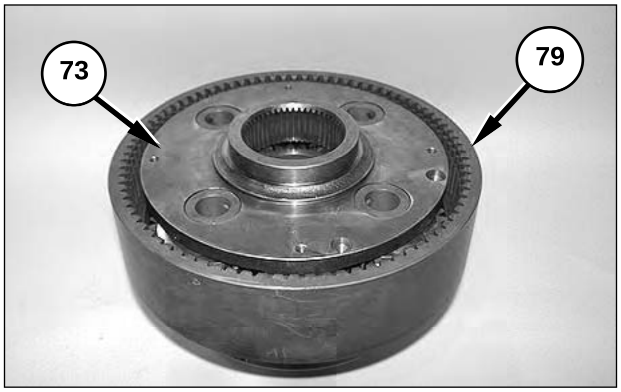
112. Install right outer planetary group (72) into ring gear (79) using ring (91).



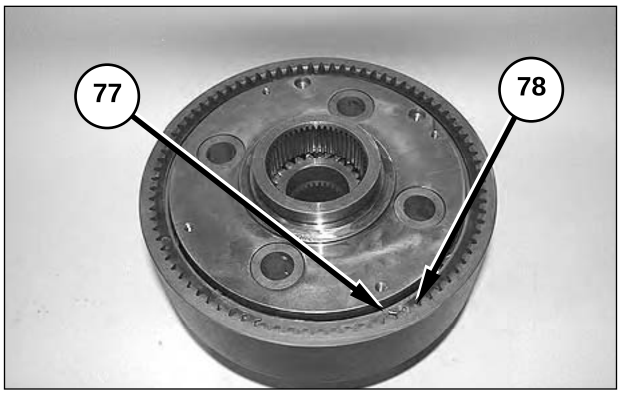
113. Install left inner sun gear assembly (87) on right outer planetary group (72) and ring gear (79).



114. The exploded view of components used to install right inner planetary group (73) into ring gear (79) and right outer planetary group (72) is shown above.

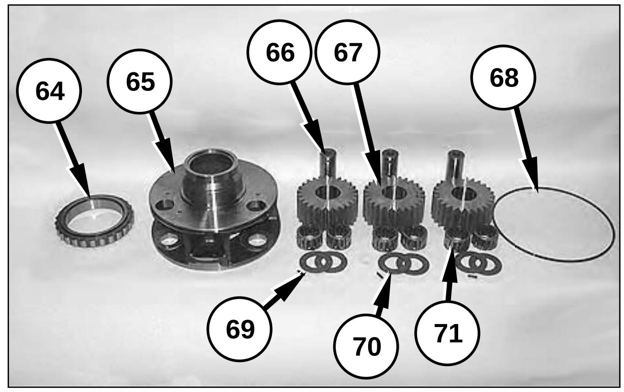


115. Install right inner planetary group (73) into ring gear (79).

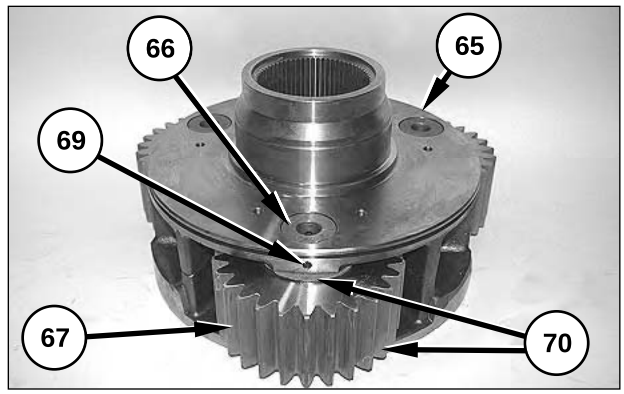


116. Install spacer (78) and snap ring (77).

117. Install slinger (76) with four bolts (75).



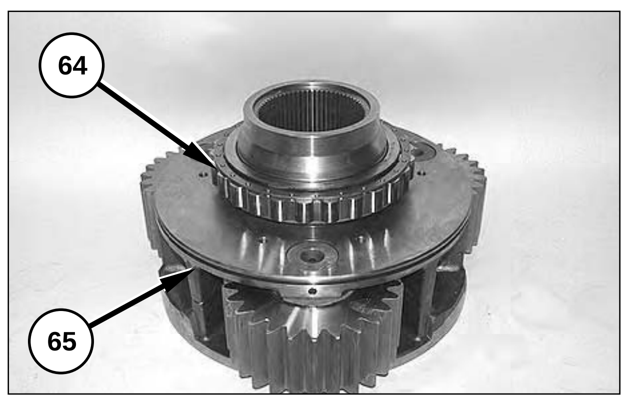
118. Exploded view of left and right output planetary groups (46) and (54).



119. Install planet gear (67) with two thrust washers (70), two bearings (71), and planet shaft (66).

120. Drive a new pin (69) into the hole in carrier (65) and planet shaft (66).

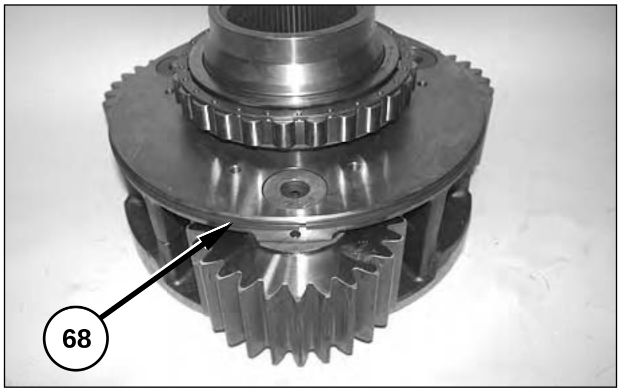
121. Repeat steps 119 and 121 to install two more planet gears (67) in carrier (65).



122. Heat bearing (64) to **121°C (250°F),** and install one bearing on carrier (65).

NOTICE

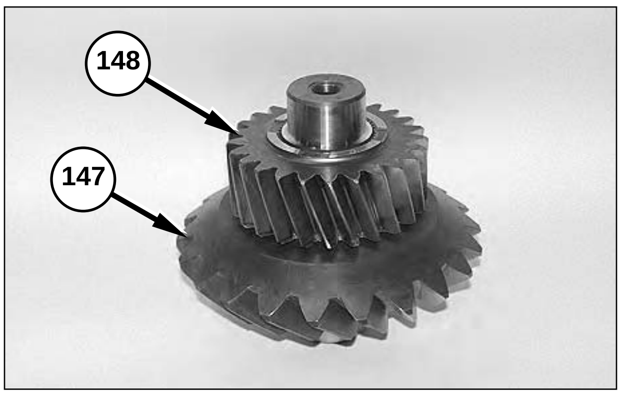
Do not overheat the bearing. If any part of the bearing starts to turn blue, replace the bearing. Do not heat the bearing with a torch.



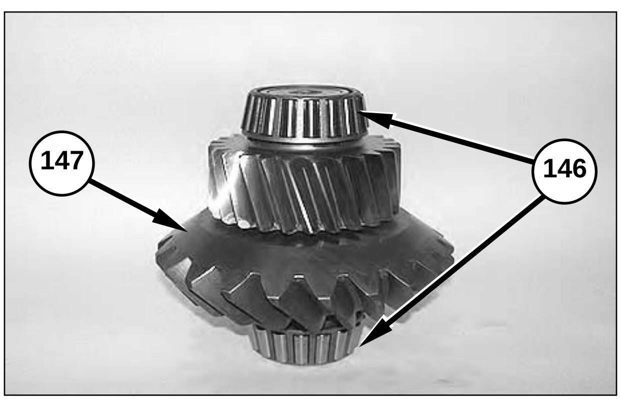
123. Install seal ring (68).

NOTE: There is a small spring in the end of seal ring (68). Take care not to damage the spring during installation of the seal ring.

124. Repeat Steps 119 through 123 to assemble the second output planetary group.



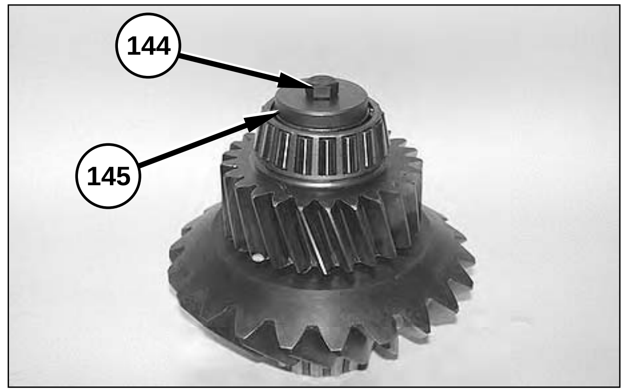
125. Install gear (148) on pinion (147).



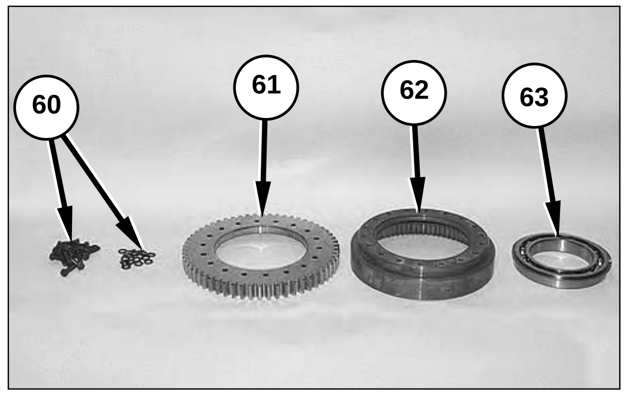
126. Heat bearings (146) to **121°C (250°F),** and install the bearings on pinion (147).

NOTICE

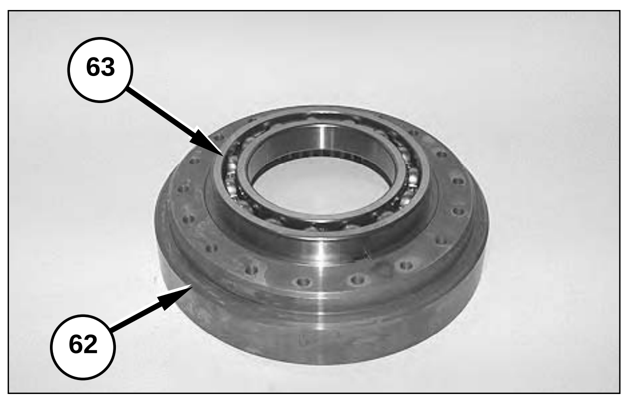
Do not overheat the bearing. If any part of the bearing starts to turn blue, replace the bearing.



127. Install spacer (145) and bolt (144). Tighten the bolt to a torque of **270 ± 40 N•m (199 ± 29 lb ft)**.



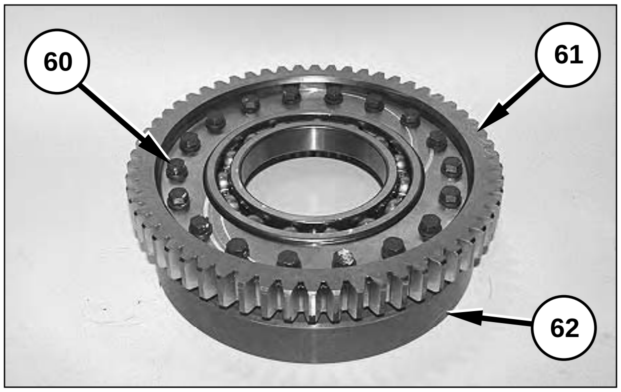
128. The exploded view of the components of steering gear group (58) is shown above.



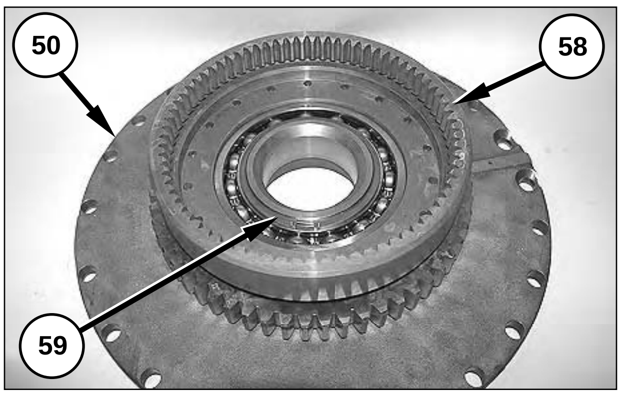
129. Heat bearing (63) to **121°C (250°F)**, and install the bearing on ring gear (62).

NOTICE

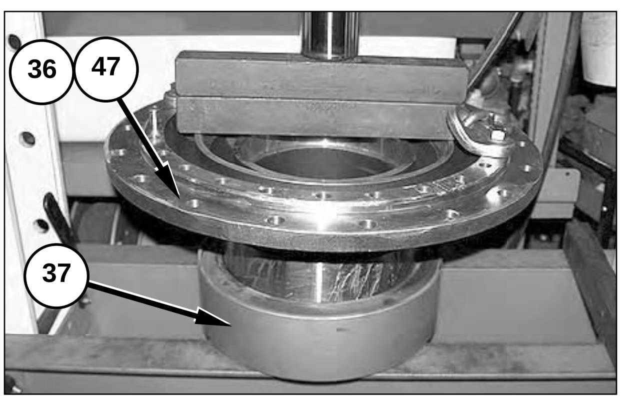
Do not overheat the bearing. If any part of the bearing starts to turn blue, replace the bearing.



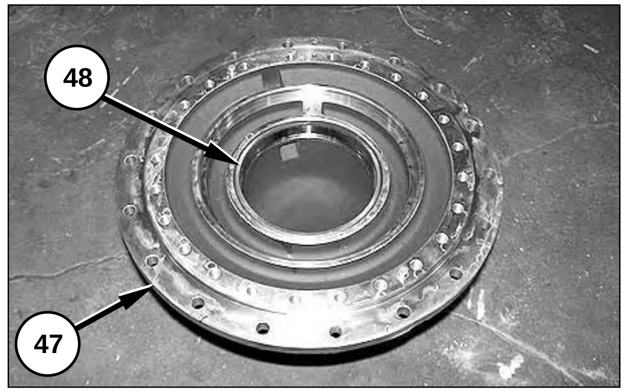
130. Install gear (61) and 18 bolts (60) with washers to ring gear (62). Tighten the bolts to a torque of **55± 10 (40 ± 7.4 lb ft)**.



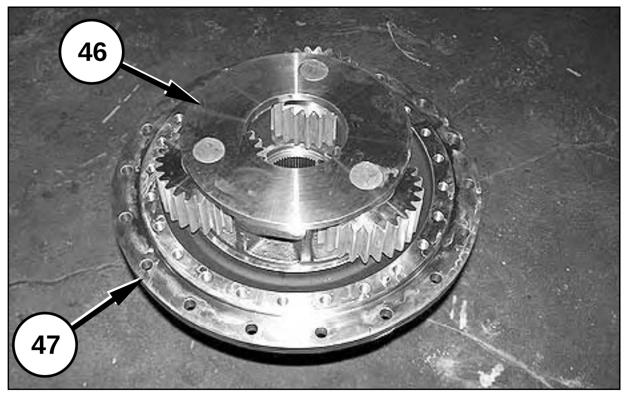
131. Install steering gear group (58) to cage assembly (50), using snap ring (59).



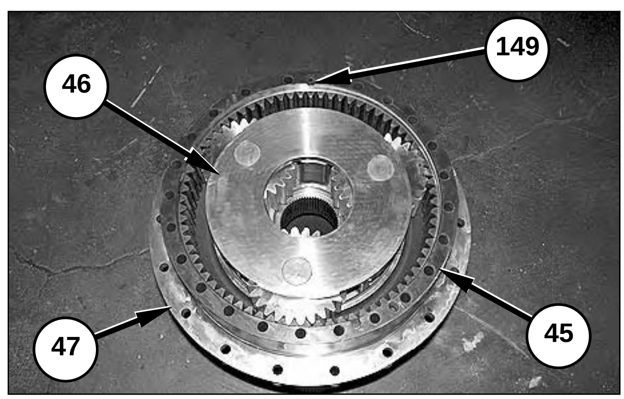
132. Apply **4C-5591 Thread Lubricant** to the inside of bushing (37). Use a press to push the bushing onto left spindle (47) and right spindle (36).



133. Chill bearing race (48) to a temperature of **–100°C (–150°F)**, and install the bearing race into left spindle (47).

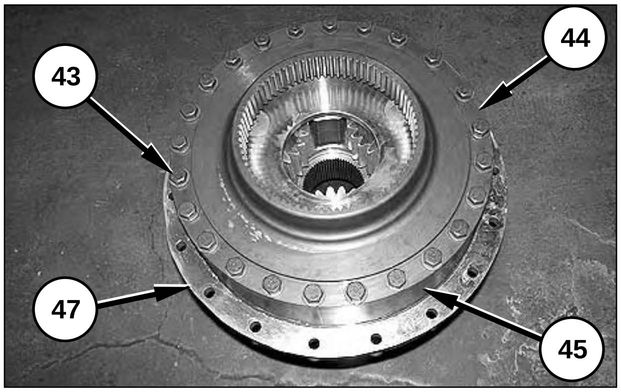


134. Install left output planetary group (46) into left spindle (47).

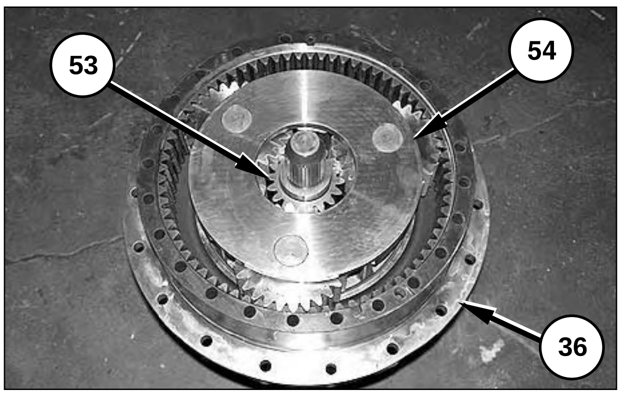


135. Install ring gear (45) on left spindle (47). Align oil passage (149) in ring gear (45) with the oil passage hole in the spindle.

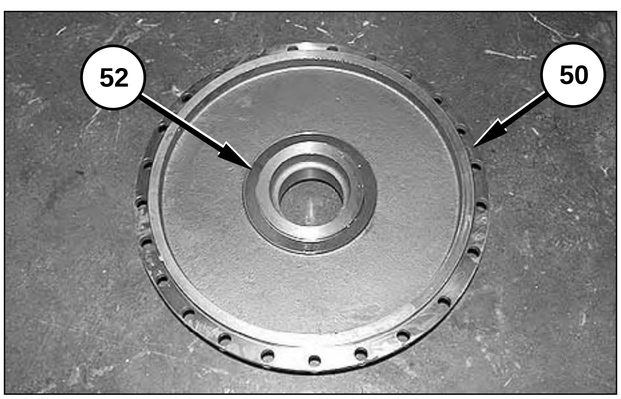
136. Repeat Steps 132 through 135 for right spindle (36) and right output planetary group (54).



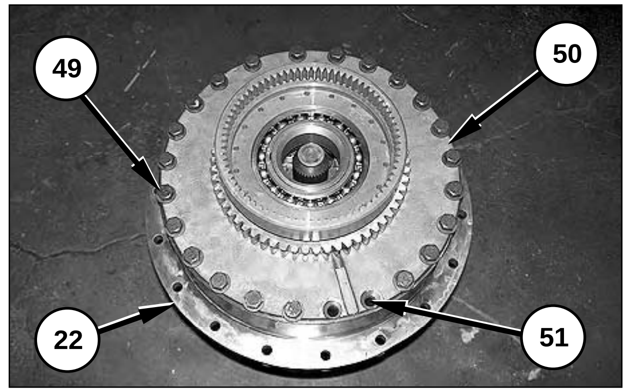
137. Install cover (44) and ring gear (45) with 24 bolts (43) to left spindle (47). Tighten the bolts to a torque of **270 ± 40 N•m (199 ± 29 lb ft)**.



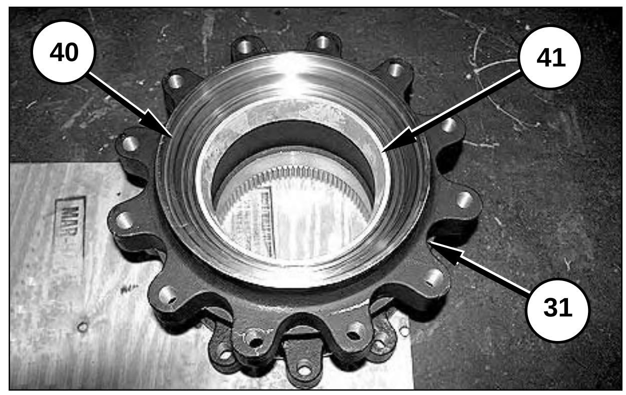
138. Install sun gear (53) into right output planetary group (54) on right spindle assembly (22).



139. Install thrust washer (52) onto cage assembly (50). Use clean grease to temporarily fasten thrust washer (52) to cage assembly (50).

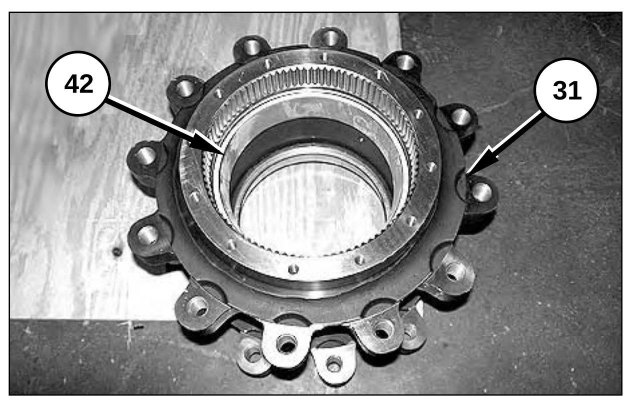


140. Install cage assembly (50) with thrust washer (52), using 22 bolts (49) with washers, and two bolts (51). Tighten bolts (49) to a torque of **270 ± 40 N•m (199 ± 29 lb ft)**. Tighten bolts (51) to a torque of **240 ± 40 N•m (177 ± 30 lb ft)**.



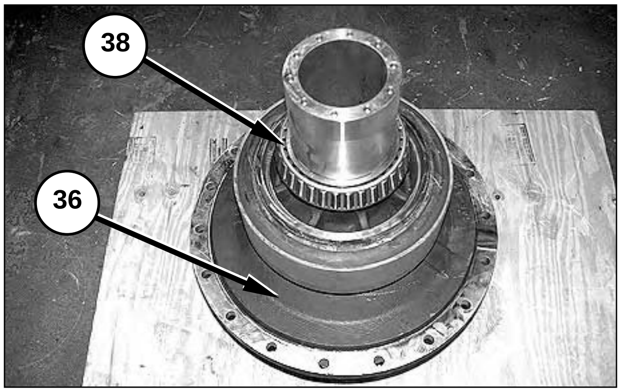
141. Cool race (41) to a temperature of **–100°C (–150°F)** and install the race into hub (31).

NOTE: Do not install Duo-Cone Seal (40) at this time. The bearing preload must be determined before the Duo-Cone Seal is installed.



142. Cool race (42) to a temperature of **-100°C (-150°F),** and install the race into hub (31).

143. Repeat Steps 141 and 142 for the second hub.



144. Heat bearing (38) to a temperature of **150°C (250°F),** and install the bearing onto right spindle (36).

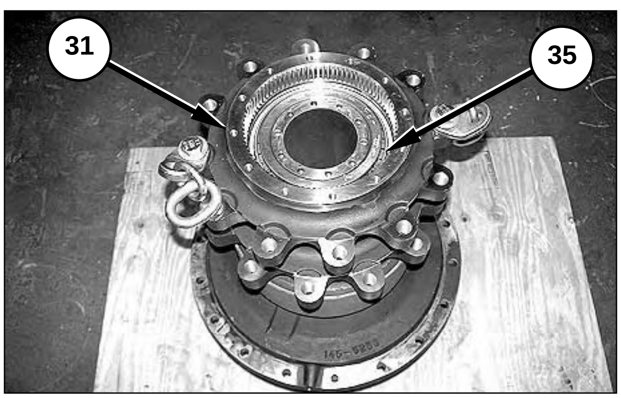
NOTICE

Do not overheat the bearing. If any part of the bearing starts to turn blue, replace the bearing.

NOTE: Do not install the Duo-Cone Seal on the spindle at this time. The bearing preload must be determined before the Duo-Cone Seal is installed.

145. Repeat Step 144 for left spindle (47).

146. Set the bearing preload in left spindle assembly (4) and right spindle assembly (22) as follows:

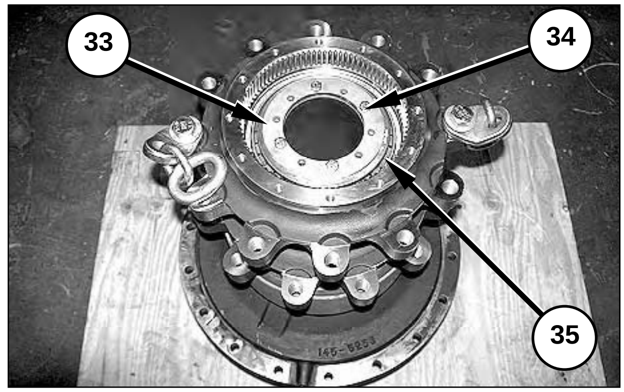


a. Use Tooling (D) to install hub (31) onto the spindle. The weight of the hub is **60 kg (132 lb)**.

b. Heat bearing (35) to a temperature of **150°C (250°F),** and install the bearing in hub (31). If necessary, use a brass drift to tap the bearing into position.

NOTICE

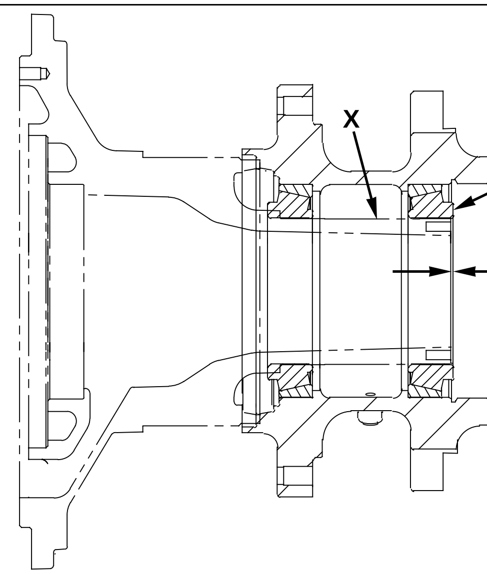
Do not overheat the bearing. If any part of the bearing starts to turn blue, replace the bearing.



c. Quickly install ring (33) and four bolts (34) with washers. Fully tighten the bolts in a diamond pattern to fully seat bearing (35) while the bearing is still hot.

NOTE: Do not install the shims with ring (33) at this time.

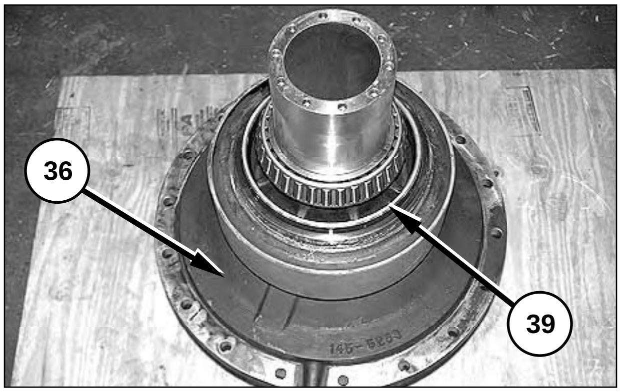
d. Remove four bolts (34) and ring (33).



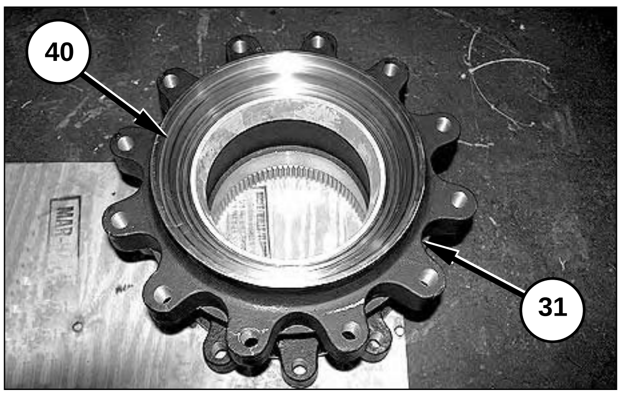
e. Measure distance (Z), between bearing (Y) and the end of spindle (X).

f. Subtract **0.0254 mm (0.001 in)** from distance (Z) to determine the thickness of shims to install with ring (33).

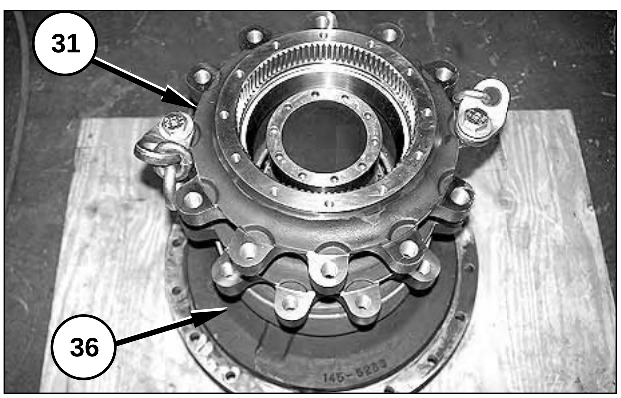
g. Use Tooling (D) to remove hub (31) with bearing (35).



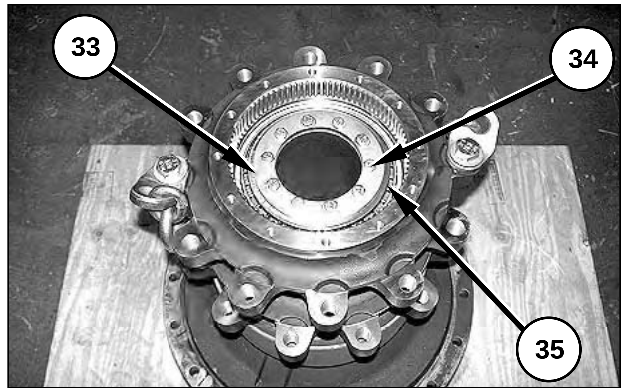
147. Install Duo-Cone Seal (39) into spindle (36) using Tooling (E). Refer to “Duo-Cone Seals” in this module.



148. Install Duo-Cone Seal (40) into hub (31), using Tooling (E). Refer to “Duo-Cone Seals” in this module.



149. Install hub (31) with the Duo-Cone Seal, onto spindle (36). Use Tooling (A) to lift the hub. The weight of the hub is **60 kg (132 lb)**.

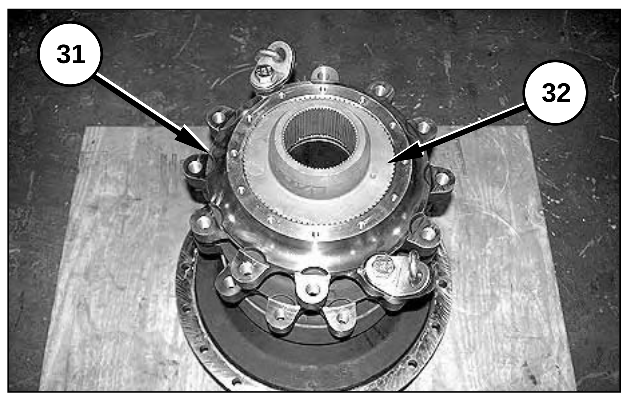


150. Heat bearing (35) to a temperature of **150°C (250°F),** and install the bearing in hub (31). If necessary, use a brass drift to tap the bearing into position.

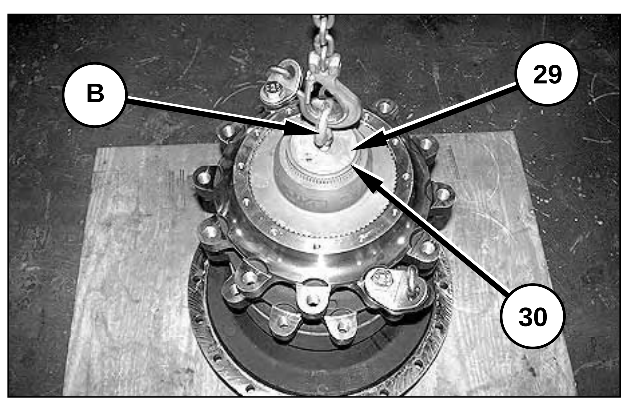
NOTICE

Do not overheat the bearing. If any part of the bearing starts to turn blue, replace the bearing.

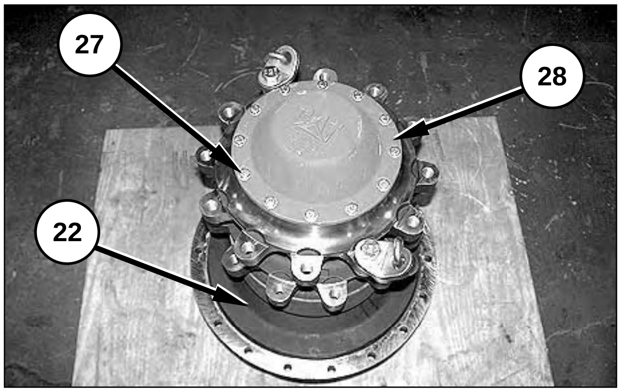
151. Quickly install ring (33) with ten bolts (34) with washers, and the correct amount of shims, as determined in Step146f. Fully tighten the bolts in a star pattern to seat bearing (35) while the bearing is still hot.



152. Install coupling (32) into hub (31).

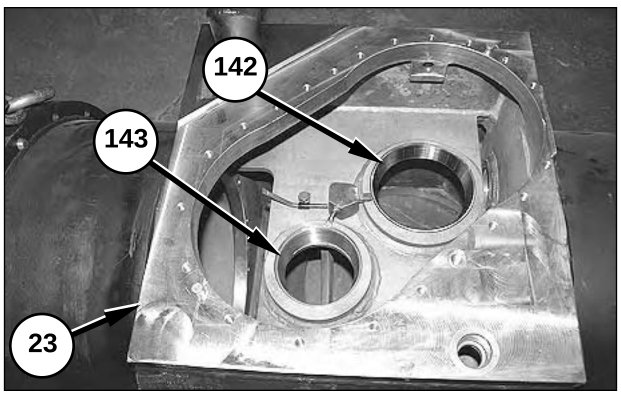


153. Use Tooling (B) to install drive shaft (29) and retainer clip (30).



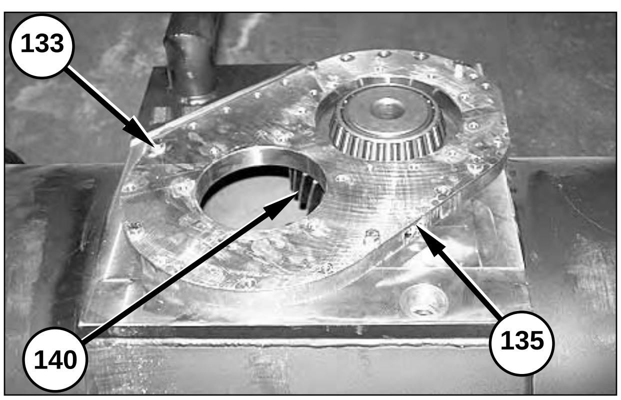
154. Install cover (28) with the O-ring, and 12 bolts (27) with washers.

155. Repeat Steps 146 through 154 for the second spindle assembly.

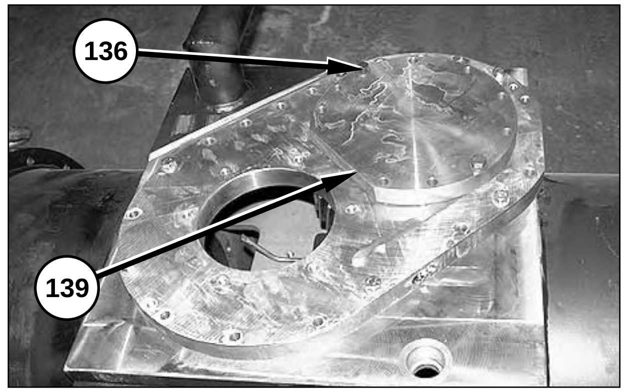


156. Chill bearing races (142) and (143) to **–100°C (–150°F),** and install the races in housing (23).

157. Set the bearing preload for gear assembly (140) as follows:



a. Install gear assembly (140) with plate (135) and at least four bolts (133) with washers.



b. Use two bolts (136) with washers to install cage assembly (139) with the O-ring seal and the bearing race. Tighten two bolts (136) to a torque of **1.1 N•m (10 lb in)**.

c. Spin gear assembly (140) three revolutions, and tighten two bolts (136) to a torque of **2.2 N•m (20 lb in)**.

d. Spin gear assembly (140) three revolutions, and tighten two bolts (136) to a torque of **3.4 N•m (30 lb in)**.

e. Loosen two bolts (136) and retighten the bolts to a torque of **0.34 N•m (3 lb in)**.

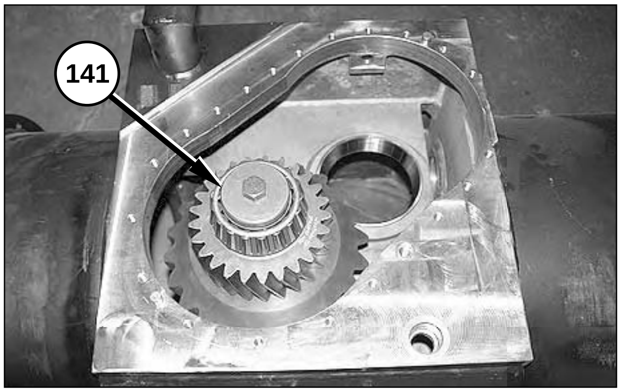
f. Measure the gap between the bottom of cage assembly (139) and plate (135) at the location of bolts (136).

NOTE: Ensure that no paint is present in the measured area.

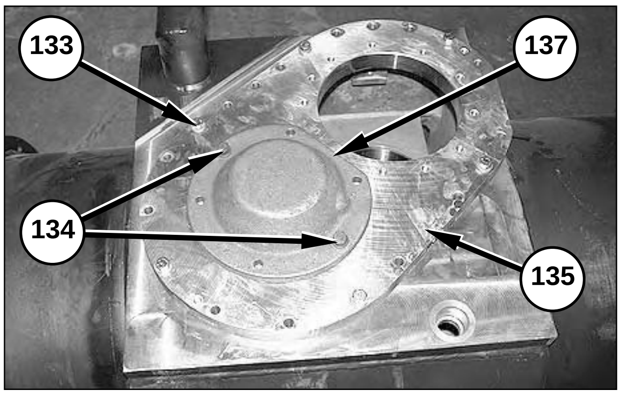
g. Calculate the average of the two readings from Step f. Add **0.1 mm (0.004 in)** to the average of the readings from Step f, to determine the thickness of shims to install with cage assembly (139).

h. Remove two bolts (136) with washers, cage assembly (139), plate (135) and gear assembly (140).

158. Set the bearing end play for pinion assembly (141) as follows:



a. Install pinion assembly (141).



b. Install plate (135) with four bolts (133) and washers, and use two bolts (134) and washers to install cage assembly (137) with the O-ring seal and bearing race. Tighten two bolts (134) to a torque of **1.1 N•m (10 lb in)**.

c. Spin pinion assembly (141) three revolutions, and tighten two bolts (134) to a torque of **2.2 N•m (20 lb in)**.

d. Spin pinion assembly (141) three revolutions, and tighten two bolts (134) to a torque of **3.4 N•m (30 lb in)**.

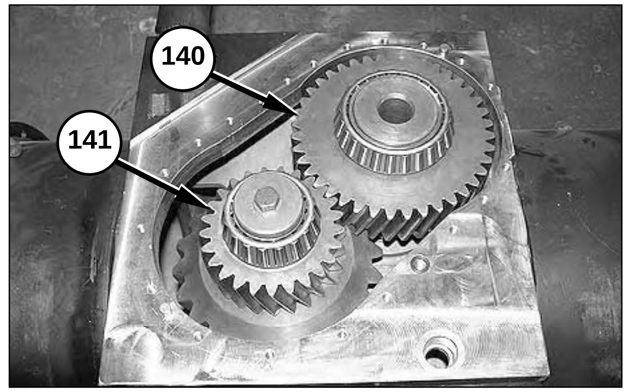
e. Loosen two bolts (134), and retighten the bolts to a torque of **0.34 N•m (3 lb in)**.

f. Measure the gap between the bottom of cage assembly (137) and plate (135), at the location of bolts (134).

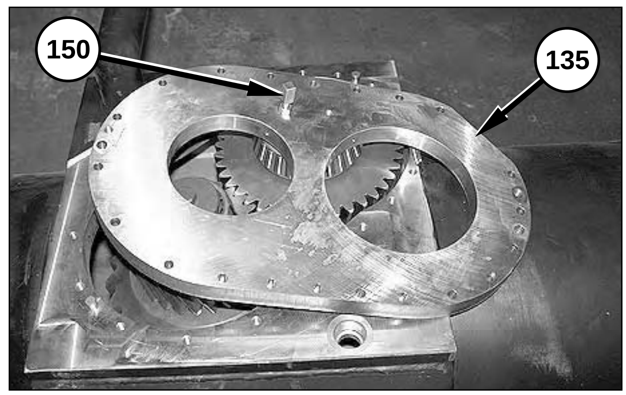
NOTE: Ensure that no paint is present in the measured area.

g. Calculate the average of the two readings from Step f. Add **0.1 mm (0.004 in)** to the average of the readings from Step f to determine the thickness of shims to install with cage assembly (137).

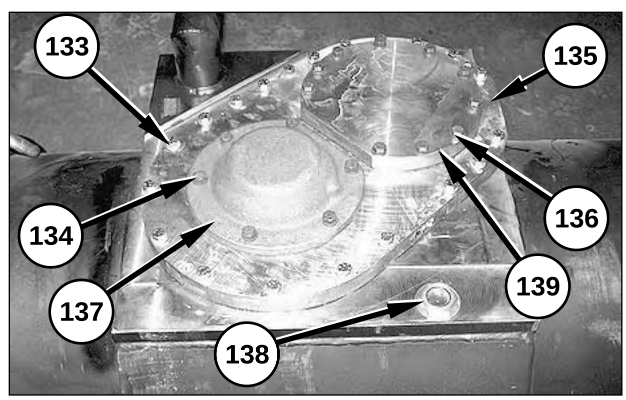
h. Remove two bolts (134) with washers, cage assembly (137), plate (135) and pinion assembly (141).



159. Install gear assembly (140) and pinion assembly (141).



160. Check the orientation of the oil spray holes on lubrication stud (150). The oil spray holes should be directed towards gear assembly (140) and pinion assembly (141) when plate (135) is installed.

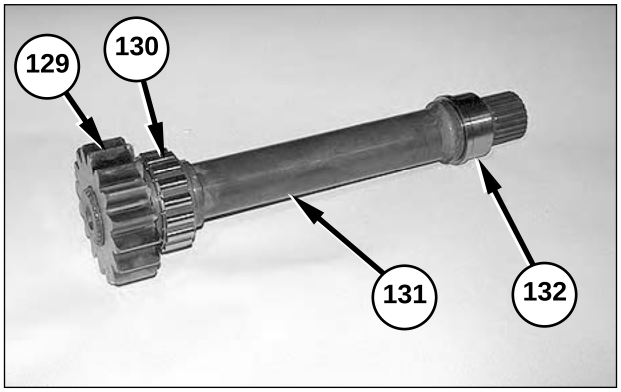


161. Apply **4C-9505 Gasket Maker (Form-A-Gasket™ #3)** to the mating surface between plate (135) and housing (23), and install the plate using 20 bolts (133) with washers.

162. Install cage assembly (137) with the correct thickness of shims, as determined in Step 154, and six bolts (134) with washers.

163. Install cage assembly (139) with the correct thickness of shims, as determined in Step 155, and ten bolts (136) with washers.

164. Install sight gauge (138) with O-ring seal, if necessary.

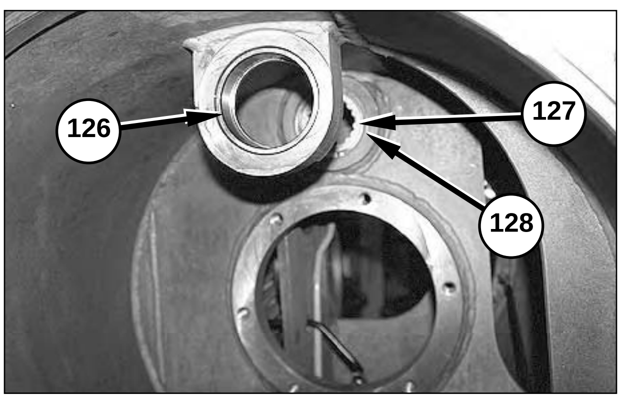


165. Heat bearing (130) and bearing race (132) to **120°C (250°F),** and install them on steering shaft (131).

NOTICE

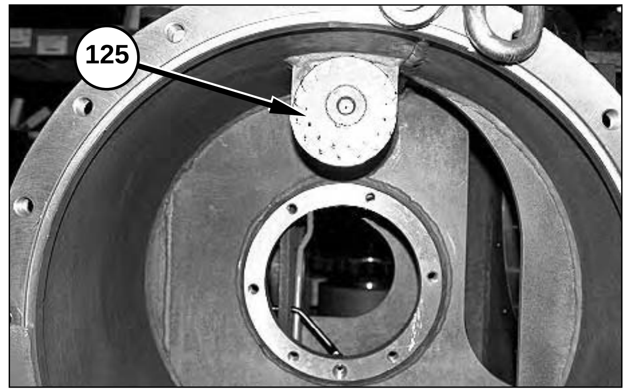
Do not overheat the bearing. If any part of the bearing starts to turn blue, replace the bearing.

166. Install steering gear (129) onto steering shaft (131).

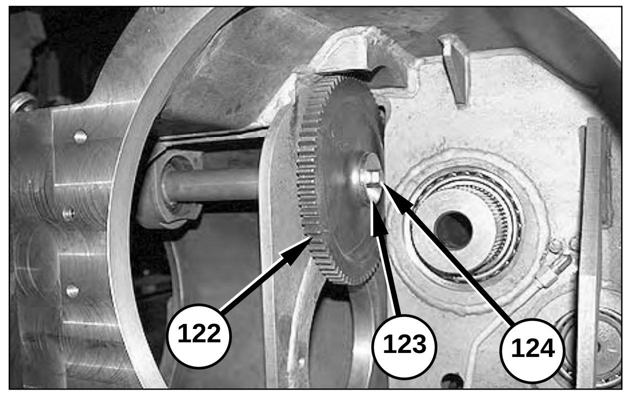


167. Install bearing (128) and snap ring (127).

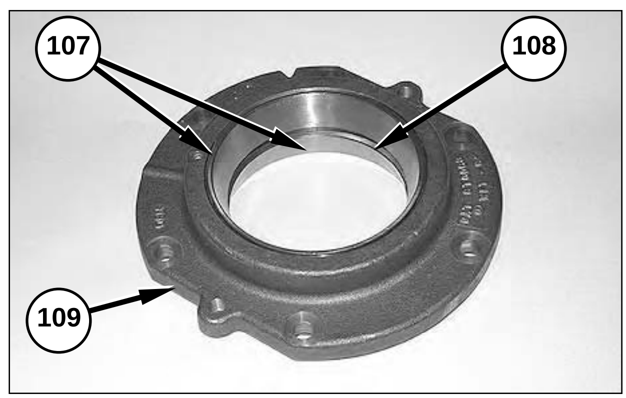
168. Chill bearing race (126) to a temperature of **-100°C (-150°F),** and install the race.



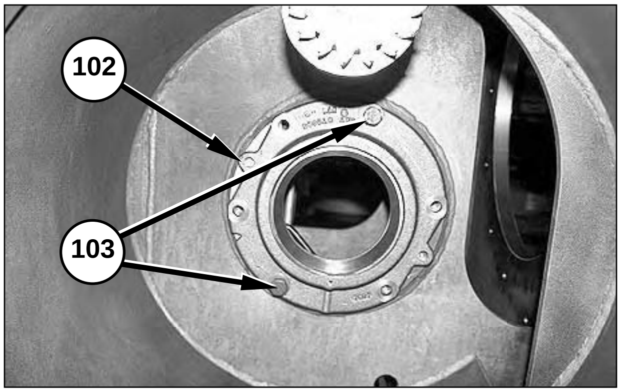
169. Install steering shaft assembly (125).



170. Install steering gear (122), washer (123) and bolt (124). Tighten the bolt to a torque of **135 ± 20 N•m (100 ± 15 lb ft)**.

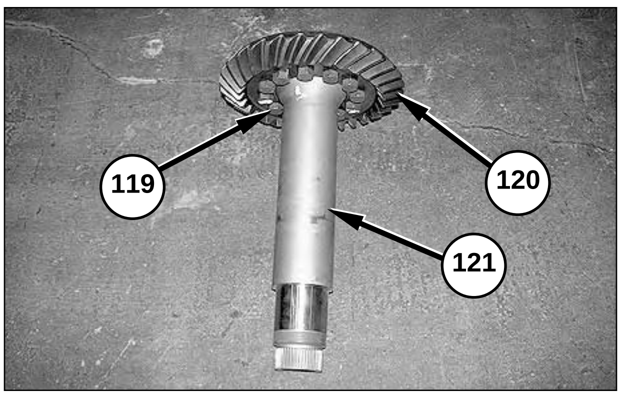


171. Chill two bearing races (107) to **–100°C (–150°F),** and install the races with spacer (108) in cage assembly (109).

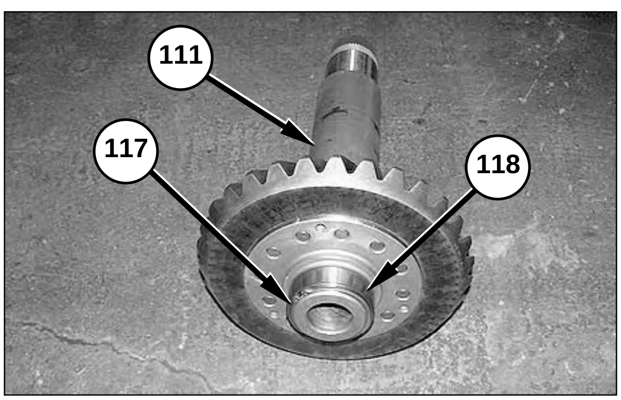


172. Install cage assembly (102) with two bolts (103) and washers.

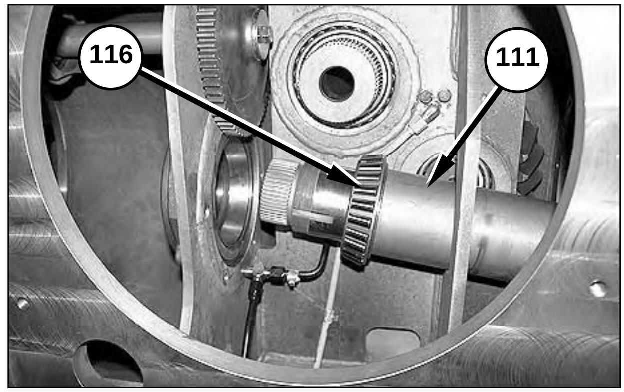
NOTE: Use only two bolts (103) at this time to set the bearing preload.



173. Install gear (120) to shaft (121) with 12 bolts (119). Tighten the bolts to a torque of **475 ± 60 N•m (350 ± 44 lb ft)**.

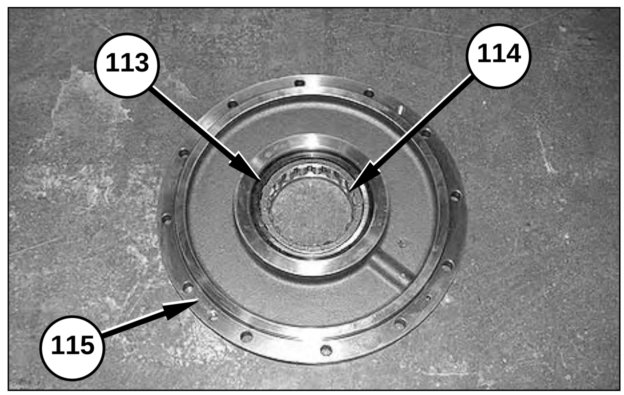


174. Install bearing race (118) onto shaft assembly (111) with snap ring (117).

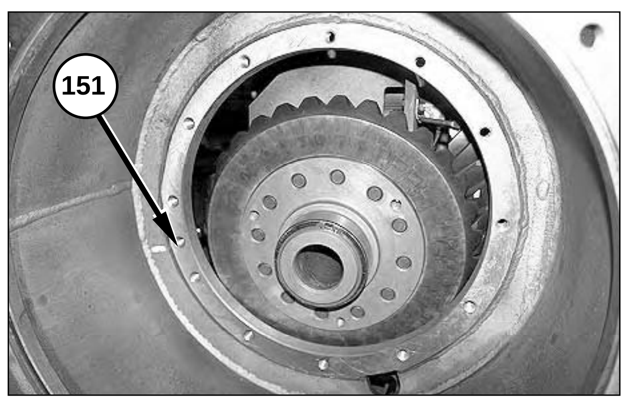


175. Use two people to install shaft assembly (111). The weight of the shaft assembly is approximately **30 kg (64 lb)**.

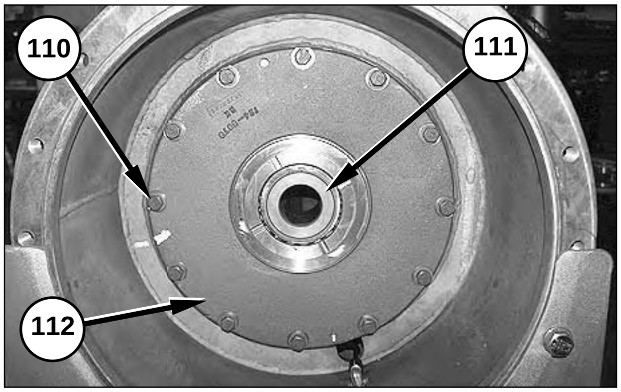
176. Install bearing (116) onto shaft assembly (111).



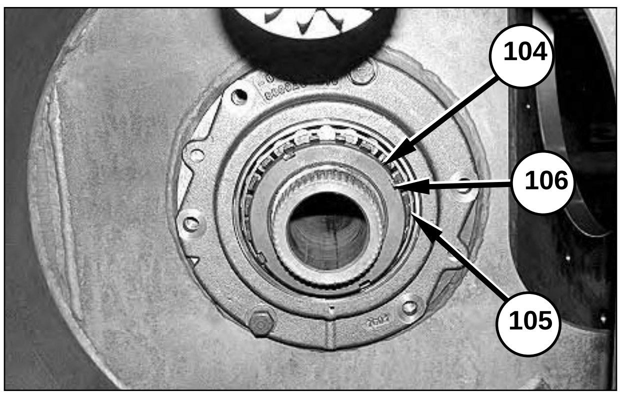
177. Install bearing (114) and snap ring (113) into cage assembly (115).



178. Make a mark to indicate the location of oil passage (151).



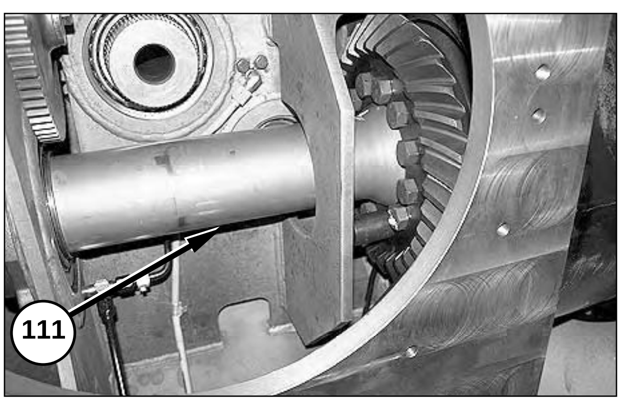
179. Lift shaft assembly (111) with a bar to align the shaft with cage assembly (112). Align the lubrication holes in the cage assembly with oil passage (151). Install the cage assembly with 12 bolts (110) and washers. Tighten the bolts to a torque of **135 ± 20 N•m (100 ± 15 lb ft)**.



180. Install bearing (105).

181. Install plate and lock washer (106).

182. Apply **4C-5598 Antiseize Compound** on the threads, and install nut (104) by hand.

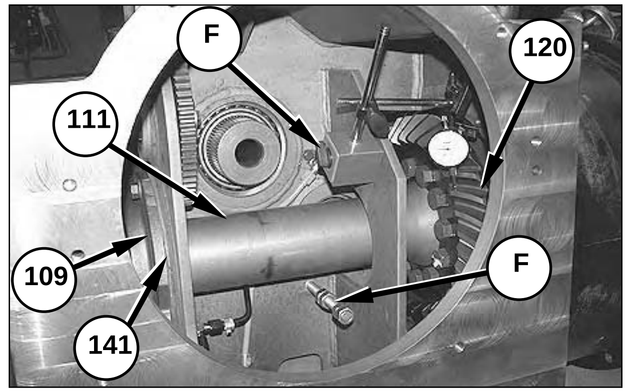


183. Install a **1.125 inch socket** on a bolt on shaft assembly (111) to keep the shaft assembly from rotating.

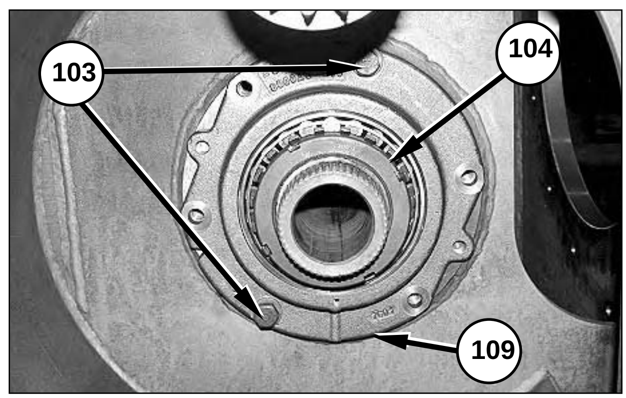
184. Use Tooling (C) to tighten nut (104) to a torque of **612 ± 68 N•m (451 ± 50 lb ft)**.

185. Bend at least one lock tang on lock washer (106) into a slot on nut (104). If a tang on the lock washer does not align with a slot on the nut, continue tightening until the tang aligns with a slot.

186. Remove the socket on the bolt on shaft assembly (111).



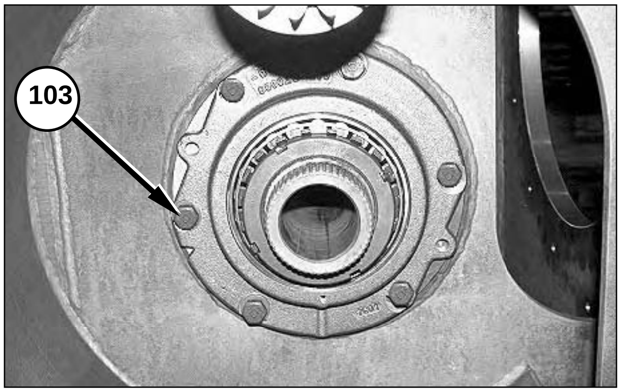
187. Install Tooling (F) to measure the backlash on gear (120). Install the threaded rod to stop the rotation of pinion assembly (141). Rotate shaft assembly (111) back and forth to determine the amount of backlash indicated on the dial gauge. Take backlash readings in four locations on gear (120), and average the results.



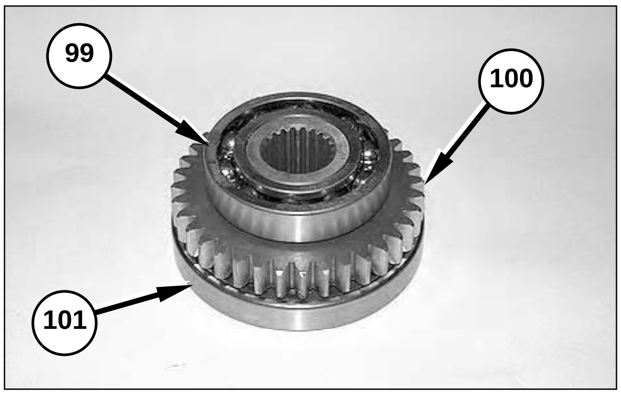
188. Loosen bolts (103), and add or subtract shims behind cage assembly (109) to achieve a backlash value of **0.36 ± 0.12 mm (0.014 ± 0.005 in)** on gear (120). Add shims to decrease the backlash. Remove shims to increase the backlash.

NOTE: The **9P-1478 Shim Pack** contains six shims of **0.05 mm (0.002 in)** thickness, six shims of **0.13 mm (0.005 in)** thickness, and two shims of **0.81 mm (0.032 in)** thickness. Jacking bolts can be used to add shims.

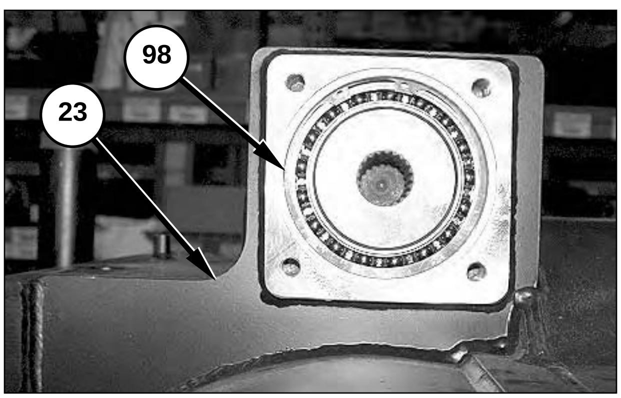
189. Remove Tooling (F).



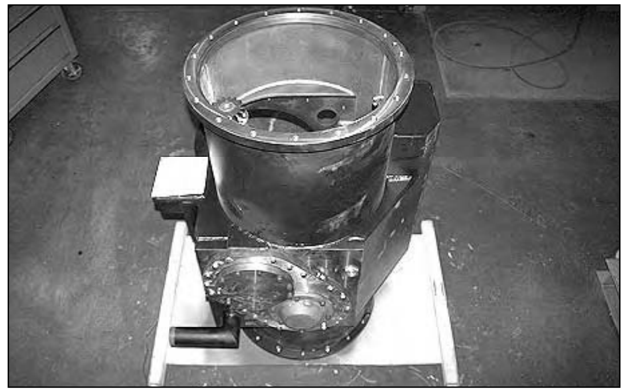
190. Install the remaining four bolts (103) with washers.



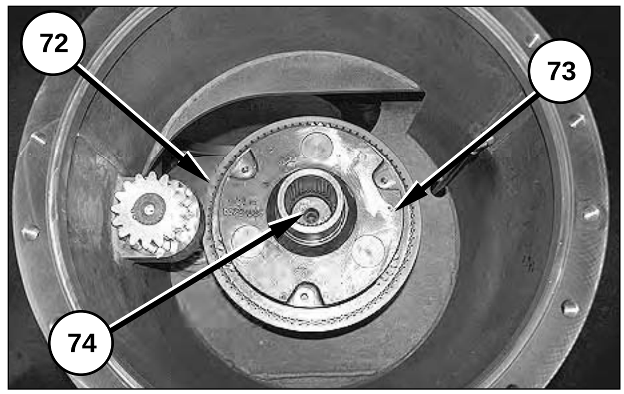
191. Install bearings (99) and (101) on steering gear (100).



192. Install steering gear assembly (98) with bearings into housing (23).

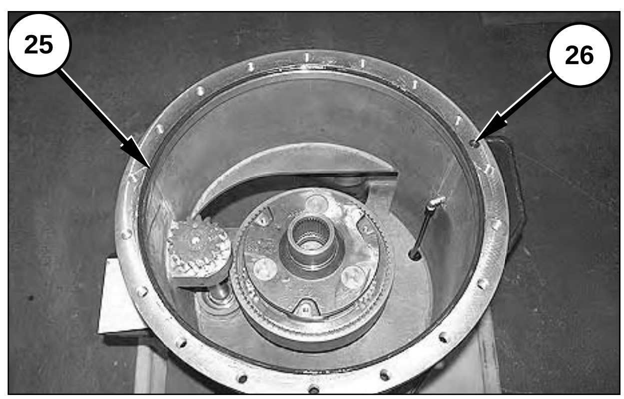


193. Use Tooling (A) and a hoist to position housing (23) with the right side up, as shown.

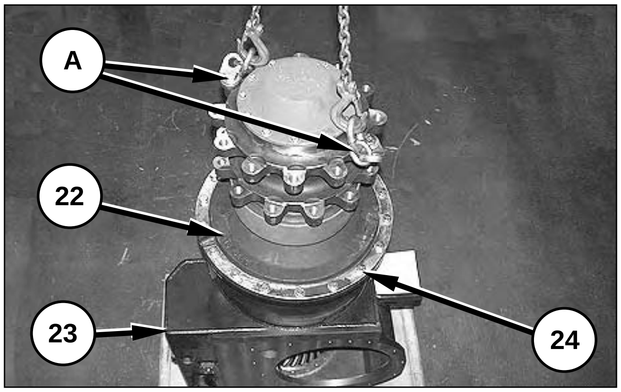


194. Install right inner planetary group (73) with right outer planetary group (72).

195. Install shaft (74).

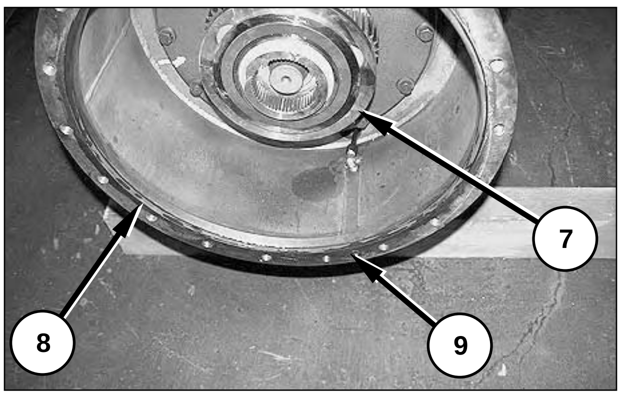


196. Install large O-ring seal (25) and small O-ring seal (26).



197. Use Tooling (A) and a hoist to install right spindle assembly (22) to housing (23). Align the lubrication passage in right spindle assembly (22) with the lubrication passage in housing (23).

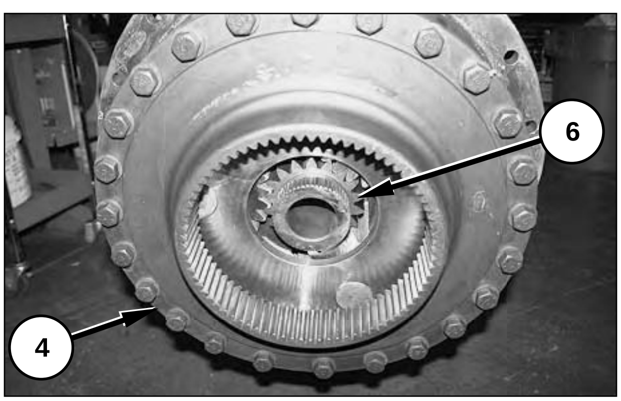
198. Install 18 bolts (24) with washers.



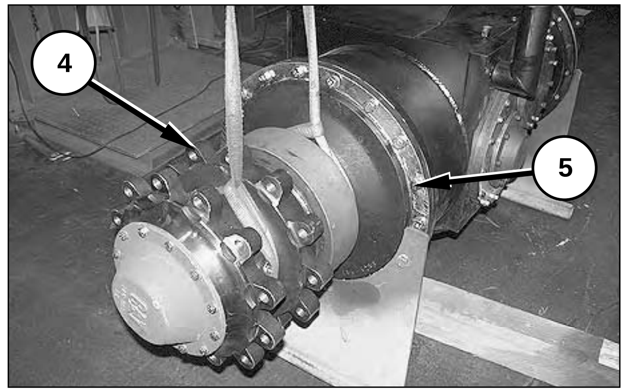
199. Use Tooling (A) and a hoist to position housing (23) horizontally, as shown.

200. Install left inner planetary group (7).

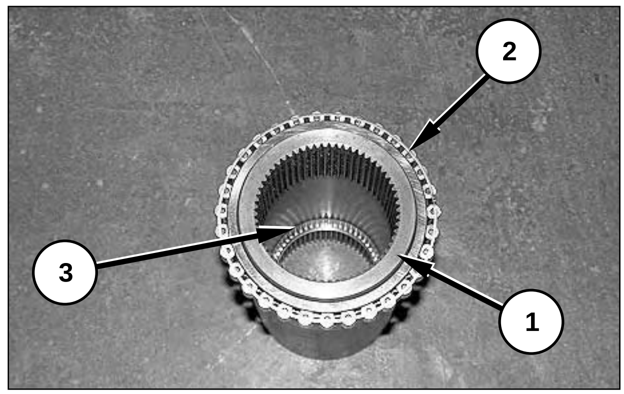
201. Install large O-ring seal (8) and small O-ring seal (9). Make note of the location of the lubrication port in which small O-ring seal (9) is installed.



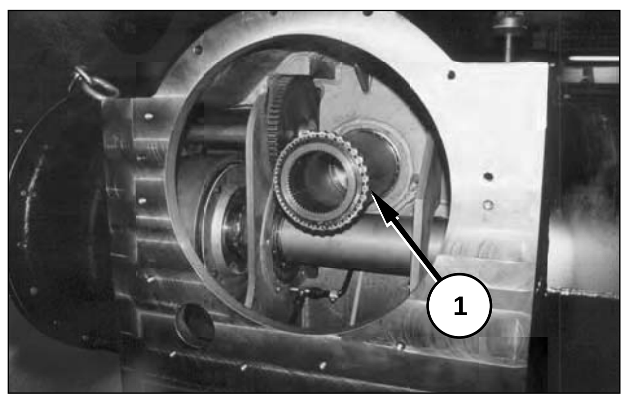
202. Install sun gear (6) into left spindle assembly (4).



203. Use a suitable lifting device, and install left spindle assembly (4) using 18 bolts (5) with washers. The weight of the spindle assembly is approximately **300 kg (661 lb)**.



204. Install bearing (2) and ring (3) onto input shaft (1).



205. Install input shaft (1) into housing (23).

NOTE: If the transmission and differential steering unit will be connected horizontally, place input shaft (1) and bearing (2) into the transmission.

End By:

a. Connect the transmission and differential steering unit.

b. Install the transmission and differential steering unit.

Drive Belt

Remove and Install

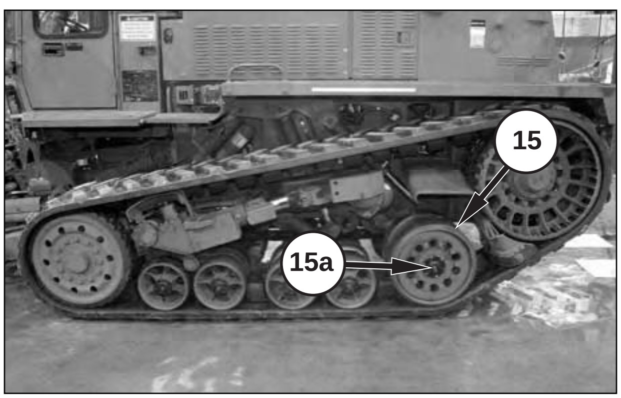
Tools Needed		A
8S-9906	Ratchet Puller (2000 lb capacity)	1

NOTE: Group numbers related to this procedure include 125-0110, 143-0837, and 144-7210.

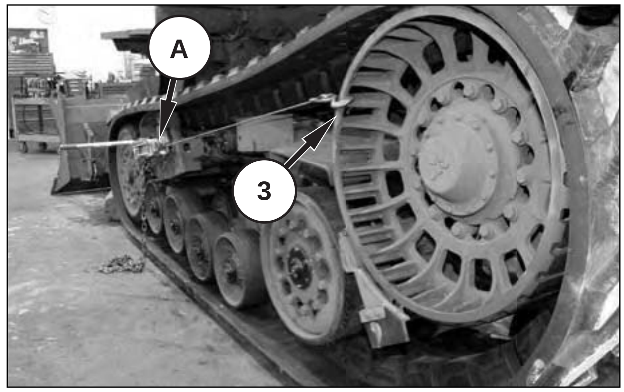
NOTE: The following procedure is for the component on the right side of the machine. The procedure for the component on the left side of the machine is the same.

1. Raise the machine so that the midrollers are off the ground at a height of approximately 200 mm (8 in). The midrollers should be clear of the belt guide blocks. Support the machine on suitable stands.

2. Release the drive belt tension. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage Steering and Brakes,* "Testing and Adjusting, Suspension System Procedures, Suspension Hydraulic Charging Procedure." Leave the undercarriage charging hose connected between the recoil cylinder port and the tank port on the remote tool manifold.

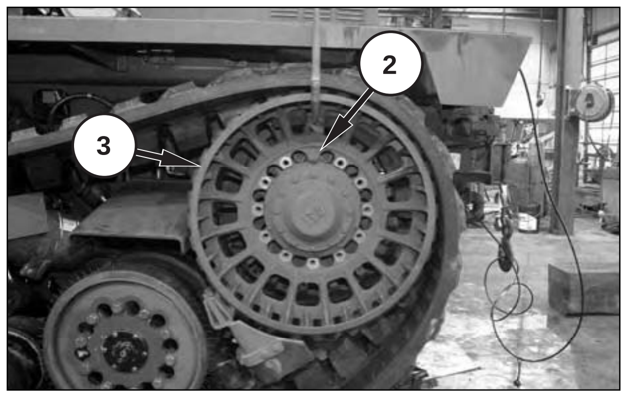


3. Use a floor jack to raise rear swing arm and idler (1).



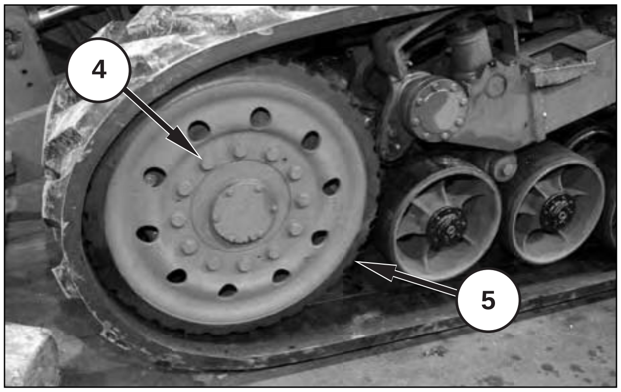
4. Fully retract the recoil cylinder. Use tooling (A), attached between tension assembly and drive wheel (3), to retract the recoil cylinder. When the recoil cylinder is fully retracted, remove tooling (A).

5. Remove 11 of 12 bolts (2) with washers. Leave one of the bolts near the top of drive wheel (3) to keep the wheel in place.



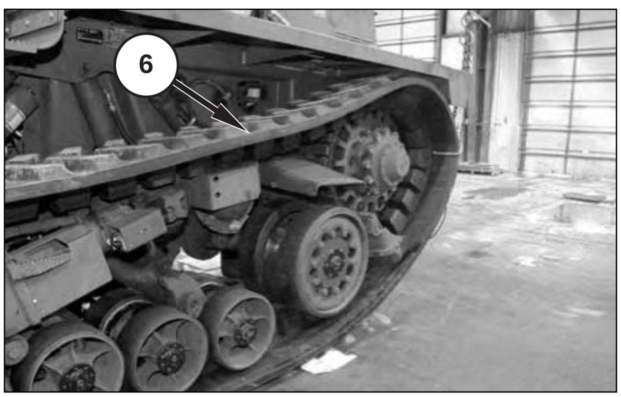
6. Use a forklift or other suitable lifting device to support outer drive wheel (3). Remove remaining bolt (2) with washer, and the outer drive wheel. The weight of the outer drive wheel is approximately **80 kg (166 lb)**. Upon installation, apply **154-9731 Thread Compound (Loctite™ 271)** to the threads of 12 new bolts (2), and tighten the bolts to a torque of **530 ± 70 N•m (391 ± 52 lb ft)**.

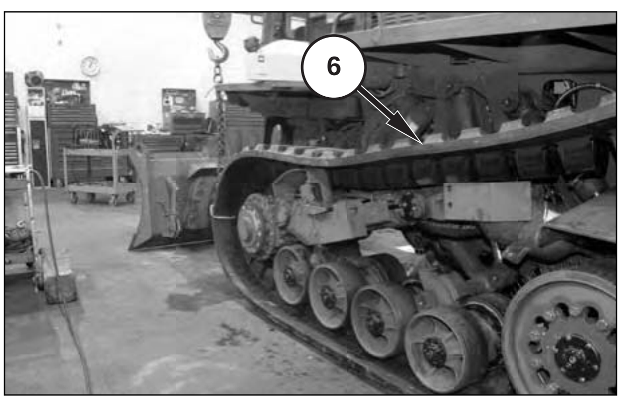
NOTE: Do not reuse bolts (2).



7. Remove 11 of 12 bolts (4) with washers from front idler (5). Leave one of the bolts near the top of the idler to keep the idler in place.

8. Use a chain hoist or other suitable lifting device to support front idler (5). Remove the remaining bolt (4) with washer, and remove the front idler. The weight of the front idler is approximately **73 kg (161 lb)**. Upon installation, apply **154-9731 Thread Compound (Loctite™ 271)** to the threads of 12 bolts (4), and tighten the bolts to a torque of **530 ± 70 N•m (391 ± 52 lb ft)**.





9. Use a chain hoist or other suitable lifting device to remove drive belt (6). The weight of the drive belt is approximately **471 kg (1036 lb)**.

NOTE: Reverse the removal steps to install the belt. When installing the belt, be sure to point the "V" of the grousers, on the top side of the belt, towards the front of the machine. Ensure that the pivot arm does not pivot over the center during this procedure. Reset the belt tension after the belt has been installed. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage Steering and Brakes,* "Testing and Adjusting, Suspension System Procedures, Suspension Hydraulic Charging Procedure."

Drive Hub

Remove and Install

Tools Needed	A	B	C
1P-2322 Puller	1		
1P-0524 Spacer Plate		1	
1U-6437 Seal Installer			1

NOTE: The following procedure is for the component on the left side of the machine. The procedure for the component on the right side of the machine is the same.

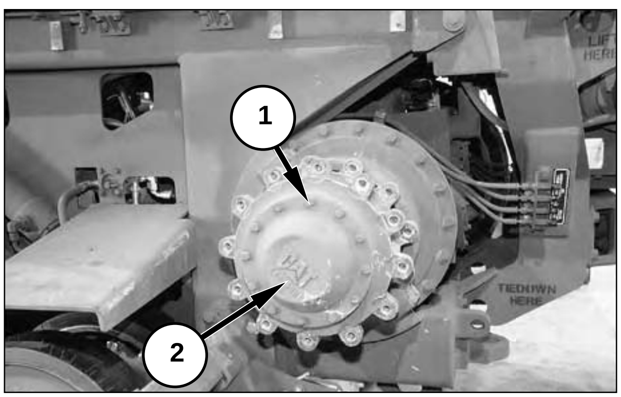
Start By:

a. Remove fender. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Machine Systems,* "Fender Group, Left" and "Fender Group, Left."

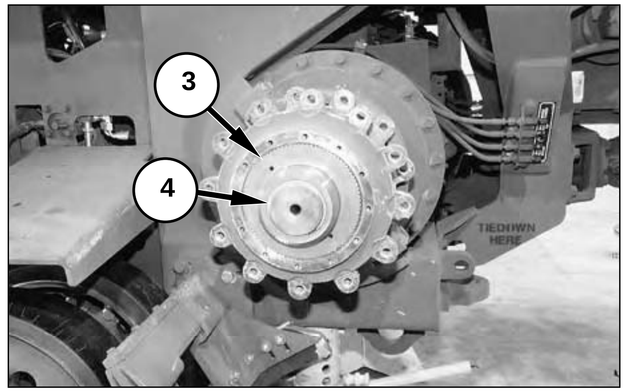
b. Remove drive belt.

c. Remove drive wheels.

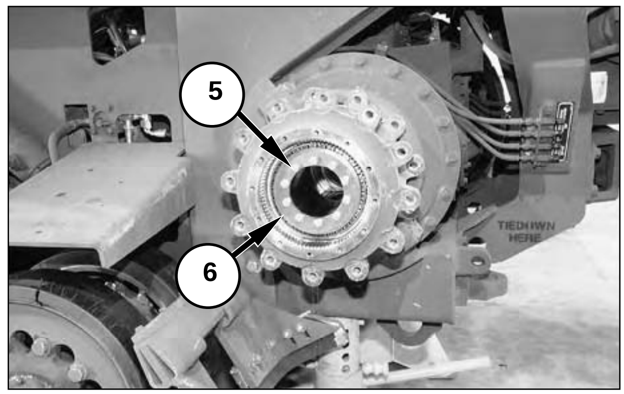
NOTE: The group number related to this procedure is 125-0110.



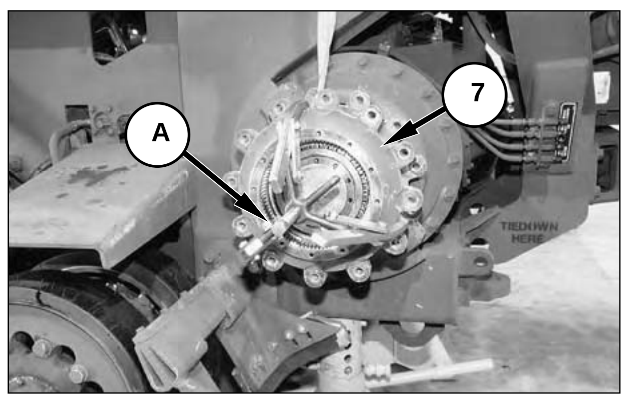
1. Remove 12 bolts (1) with washers, and cover (2) with the O-ring seal. Replace the O-ring seal if there is damage or wear.



2. Install a **20 mm bolt** in the puller hole of drive shaft (4), and use two people to remove the drive shaft and coupling (3) together. The combined weight of the drive shaft and coupling is **45 kg (100 lb).**

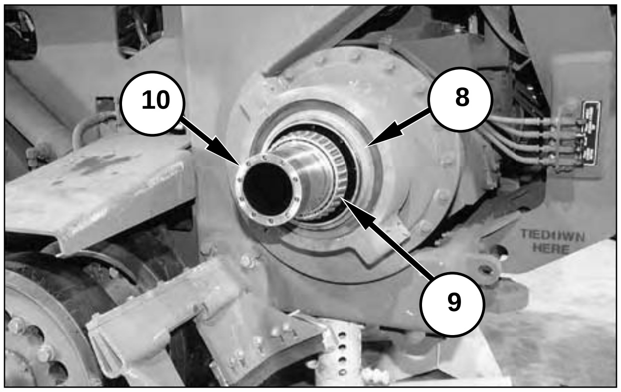


3. Remove 10 bolts (5) and ring (6) with shims. Note the location of the shims for reassembly.



4. Fasten a hoist to drive hub (7). The weight of the hub is **60 kg (132 lb).**

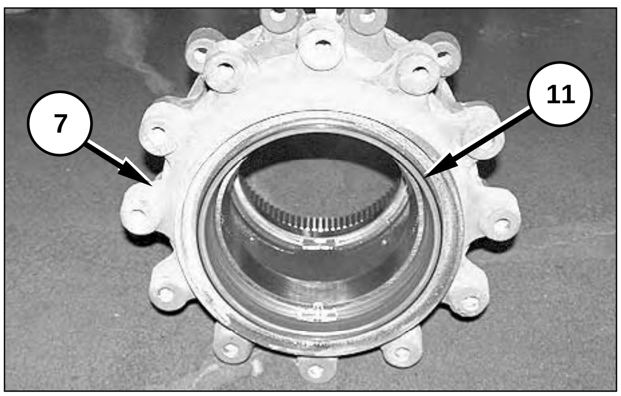
5. Use Tooling (A) to remove drive hub (7) with the bearing.



6. Use Tooling (B) to remove bearing (9) from spindle (10).

7. Remove Duo-Cone Seal (8). Replace the Duo-Cone Seal if there is damage or wear.

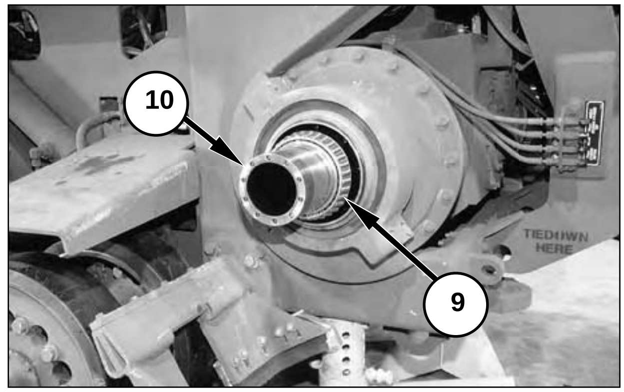
NOTE: Do not touch the polished sealing face of the Duo-Cone Seals if they will be reused.



8. Remove Duo-Cone Seal (11) from hub (7). Replace the Duo-Cone Seal if there is damage or wear.

NOTE: Replace both halves of the Duo-Cone Seal as a set. Do not touch the polished sealing face of the Duo-Cone Seals if they will be reused.

NOTE: The following steps are for installing the drive hub.

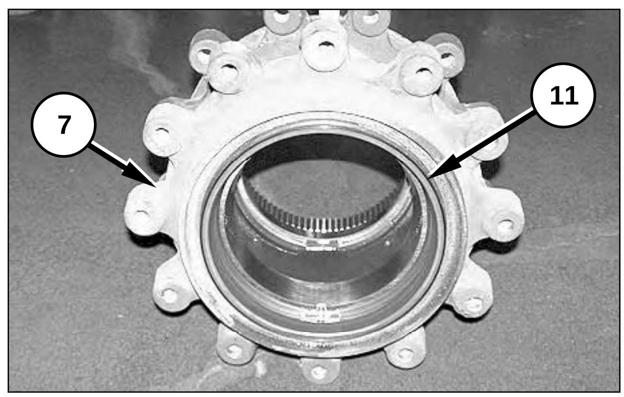


9. Heat bearing (9) to **120°C (250°F),** and install the bearing on spindle (10). Make sure there is no gap between the bearing and the shoulder in the spindle.

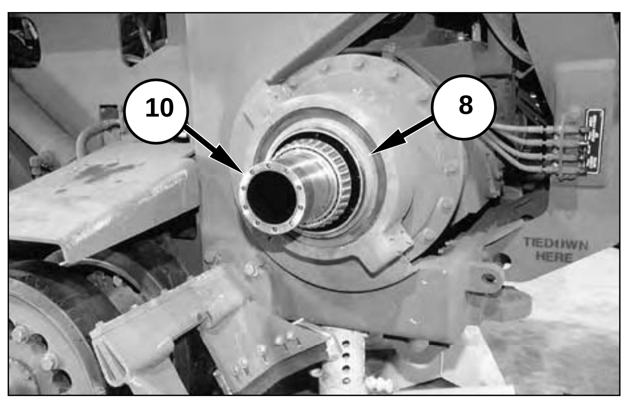
NOTICE

Do not overheat the bearing. If any part of the bearing starts to turn blue, replace the bearing. Do not heat the bearing with a torch.

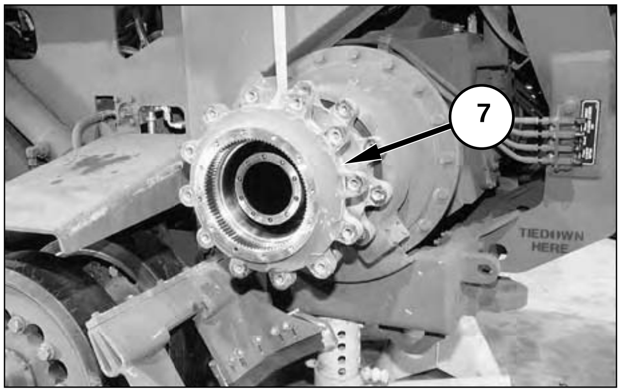
NOTE: If the hub was replaced, the bearing preload must be set. Refer to "Differential Steering Unit, Disassemble and Assemble."



10. Use Tooling (C) to install Duo-Cone Seal (11) in drive hub (7). Refer to "Duo-Cone Seal," in this module.

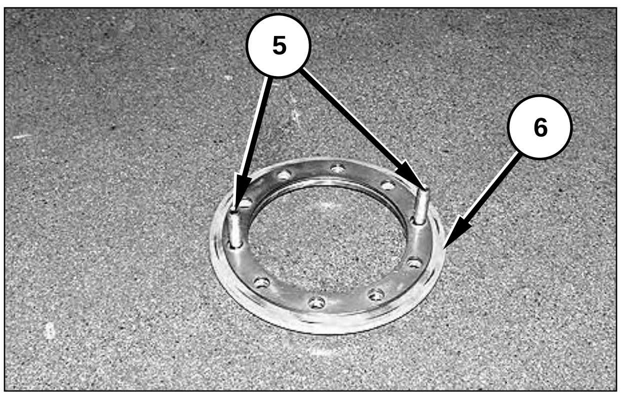


11. Use Tooling (C) to install Duo-Cone Seal (8) on spindle (10). Refer to "Duo-Cone Seals" in this module.



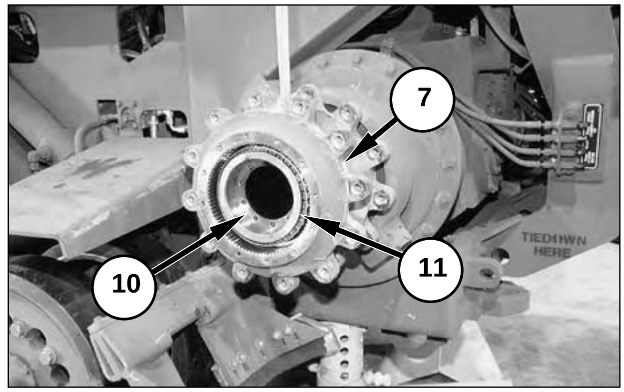
12. Carefully position hub (7) with the Duo-Cone Seals against each other in the spindle housing.

NOTE: Do not touch the Duo-Cone Seal sealing surface when positioning the hub on the spindle. A polished sealing surface that is scratched or damaged during installation will leak and must be replaced.



13. Install two **M10 X 40 mm bolts** into ring (6) with shims. The longer bolts will be used to draw the Duo-Cone Seals together.

NOTE: If the bearing preload was determined in Step 9 of this procedure, use the shim thickness determined in that step. If the hub was not replaced, use the shim combination which was removed in Step 3 of this procedure.



14. Heat bearing cone (11) to **120°C (250°F)**, and install the bearing cone into hub (7) and spindle (10). If necessary, use a brass drift to gently tap the bearing into position.

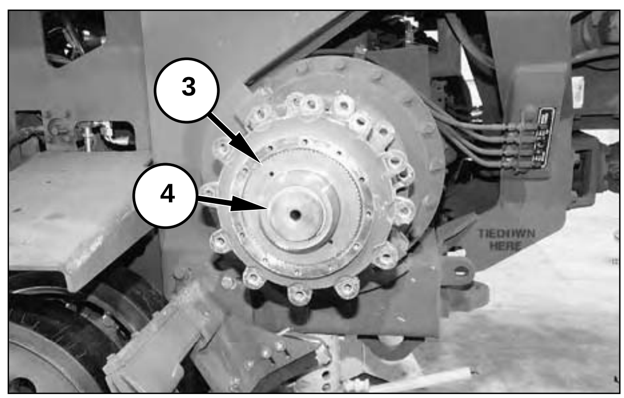
NOTICE

Do not overheat the bearing. If any part of the bearing starts to turn blue, replace the bearing.

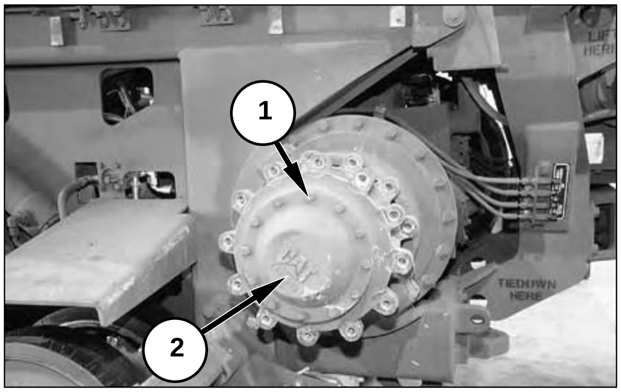
15. Quickly install ring (6) with shims and two long bolts.

16. Tighten the two long bolts to push the hub onto the spindle and compress the Duo-Cone Seals.

17. Install and tighten bolts (5). Remove the two long bolts after at least two of the standard bolts have been installed.



18. Install drive shaft (4) and coupling (3).



19. Install cover (2) with the O-ring seal and 12 bolts (1) with washers.

End By:

a. Install the drive wheels.

b. Install the drive belt.

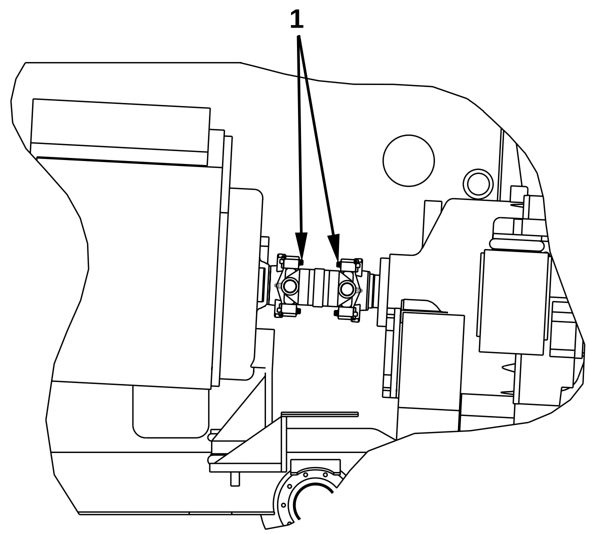
c. Install the fender.

Drive Shaft, Main

Remove and Install

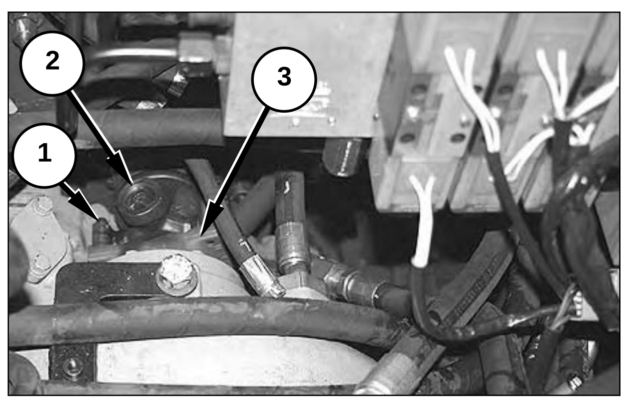
NOTE: The group number related to this procedure is 122-8643.

1. Raise the radiator. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Machine Features, Radiator Tilt."



2. Remove eight bolts (1).

NOTE: The rear bolts can be reached from under the machine when the rear bottom cover is removed.



3. Slide torque converter output coupler (3) into the torque converter to remove main drive shaft (2).

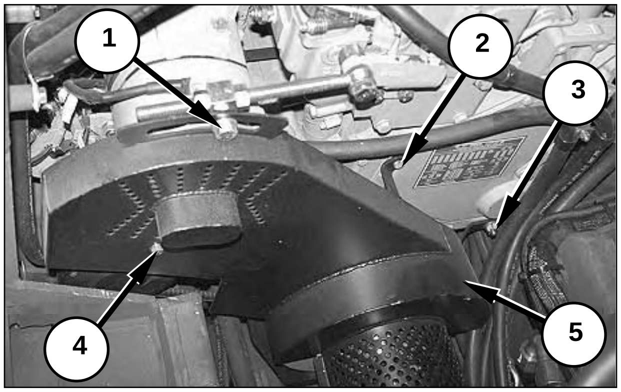
NOTE: To install the main drive shaft, reverse the removal steps.

Drive Shaft, Steering

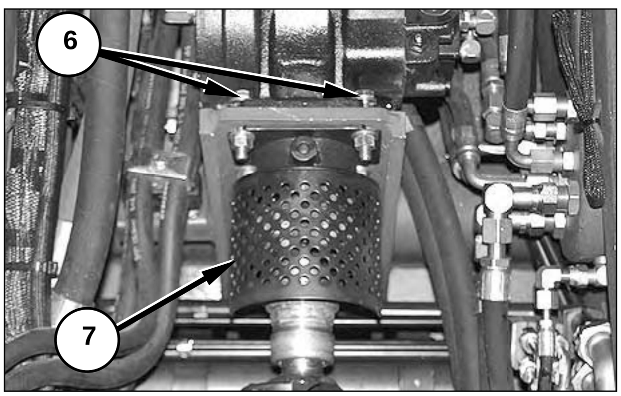
Remove and Install

NOTE: Group numbers related to this procedure include 112-5495, 125-6623, and 149-3203.

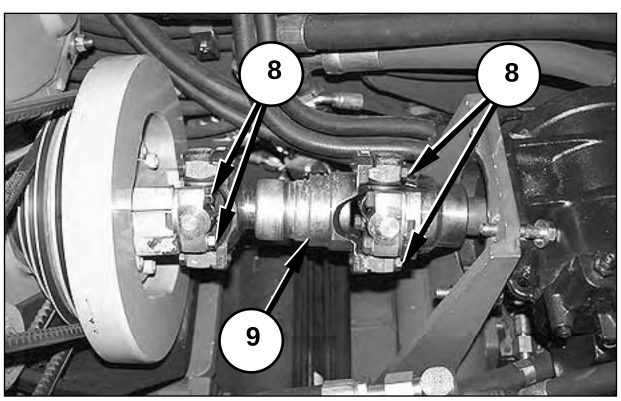
1. Raise the cab. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Machine Features, Cab Tilt."



2. Remove bolt (1) with washer, bolt (2), bolt (3) with nut and two washers, bolt (4) with washer, and cover (5).



3. Loosen two bolts (6) with nuts and washers, and remove guard (7).



4. Remove eight bolts (8, only four shown) with washers, and drive shaft (9).

NOTE: The bolts on the steering pump side are national fine (NF) thread and the bolts on the engine side are national course (NC) thread.

NOTE: The grease fitting on the steering drive shaft does not need to be greased.

NOTE: To install the steering drive shaft, reverse the removal steps.

Drive Wheels, Inner

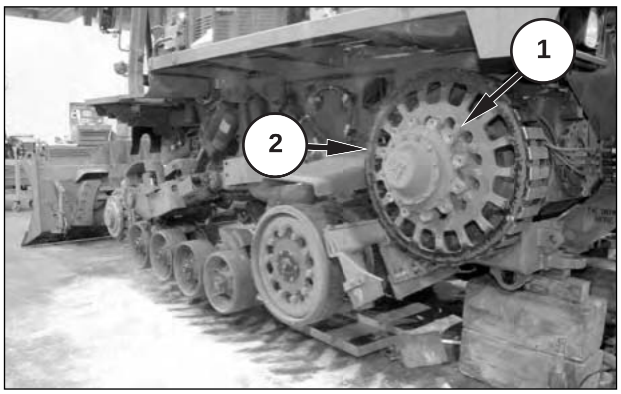
Remove and Install

NOTE: The following procedure is for the component on the left side of the machine. The procedure for the component on the right side of the machine is the same. The outer drive wheel is removed as part of the procedure to remove the drive belt.

Start By:

a. Remove the drive belt.

NOTE: The group number related to this procedure is 125-0110.



1. Remove twelve bolts (1) with washers, and use a suitable lifting device to remove inner drive wheel (2). The weight of the inner drive wheel is approximately **80 kg (176 lb).** Upon reassembly, apply **154-9731 Thread Compound (Loctite™ 271)** to the threads of the twelve bolts, and tighten the bolts to a torque of **530 ± 70 N•m (391 ± 52 lb ft)**.

NOTE: To install the drive wheels, reverse the removal steps.

End By:

a. Install the drive belt.

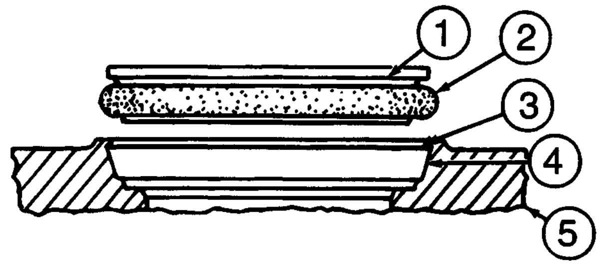
Duo-Cone Seals

Assembly and Installation

Introduction

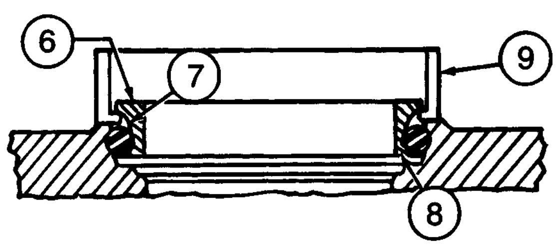
This procedure is for installing Duo-Cone Seals.

Correct assembly and installation procedures must be followed when Duo-Cone Seals are used. Many Duo-Cone Seal failures are the direct result of one or more mistakes made during the assembly or installation of the seal components.



C20391P1*

(1) Seal ring. (2) Rubber toric ring. (3) Housing retaining lip. (4) Housing ramp. (5) Seal ring housing.



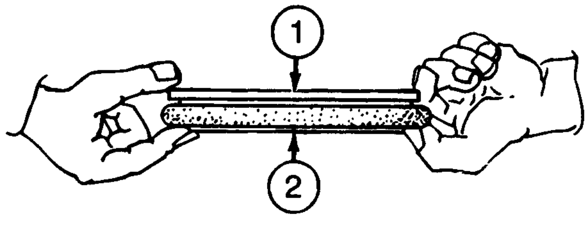
C20392P1*

(6) Seal ring face. (7) Seal ring ramp. (8) Seal ring retaining lip. (9) Installation tool.

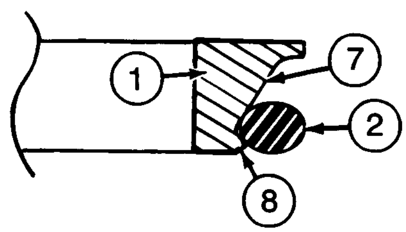
1. Remove any oil film, dust or other foreign matter from rubber toric ring (2) and from housing ramp (4), seal ring ramp (7), and housing retaining lip (3), and seal ring retaining lip (8) of both seal rings (1), and seal ring housing (5). Use **isopropyl alcohol** and a clean cloth or paper towels for wiping.

NOTICE

Never permit oil to get on the toric rings or ramps before both seal rings are put together in their final assembled position (Step 10).



C20393P1*

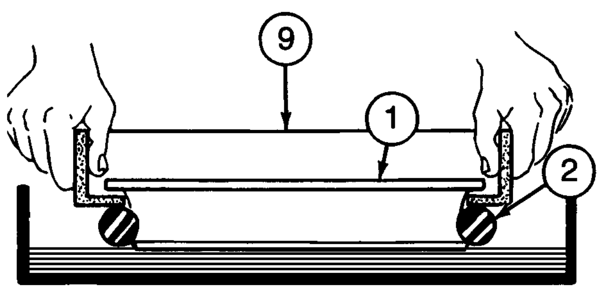


C20394P1*

2. Put rubber toric ring (2) on seal ring (1), at the bottom of seal ring ramp (7) and against seal ring retaining lip (8).

NOTICE

Make sure that rubber toric ring (2) is straight on seal ring (1) and is not twisted. Be careful when you work on the rubber toric ring. Nicks, cuts and scratches can cause leaks.



C20395P1*

3. Put installation tool (9) on seal ring (1) with rubber toric ring (2). Lightly dampen the lower half of the rubber toric ring with **isopropyl alcohol.**

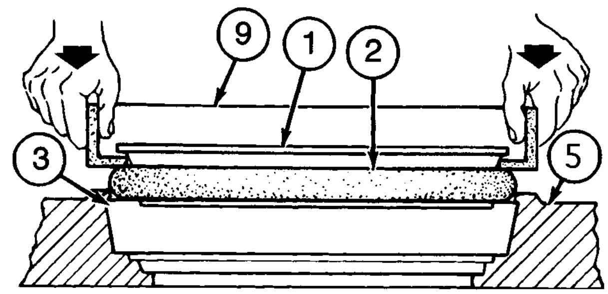
WARNING

Avoid prolonged skin contact with isopropyl alcohol. Avoid breathing the vapors in enclosed areas without adequate ventilation. Do not smoke. Do not use isopropyl alcohol near open flame or welding operations or other heated surfaces exceeding 482°C (900°F).

NOTE: A moist, lint-free towel can be used to dampen rubber toric ring (2), or the ring can be dipped in a container which contains a foam mat or lint free towels which have been saturated with **isopropyl alcohol.**

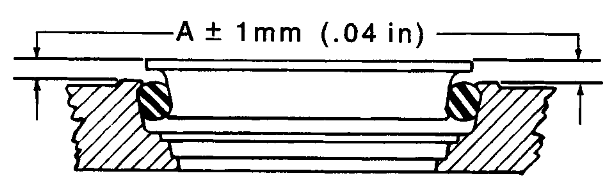
NOTICE

Do not use **Stanisol** or any other liquid that leaves an oil film or does not evaporate quickly.



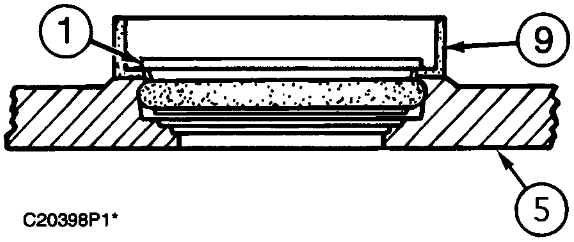
C20396P1*

4. With all surfaces of rubber toric ring (2) wet, use installation tool (9) to position seal ring (1) and the rubber toric ring squarely against housing (5), as shown. Use sudden and even pressure to pop (push) the rubber toric ring under retaining lip (3) of the seal ring housing.



C20397P1*

5. Check assembled height (A) in at least four places, **90 degrees apart.** The difference in height around the ring must not be more than **1 mm (0.04 in).**



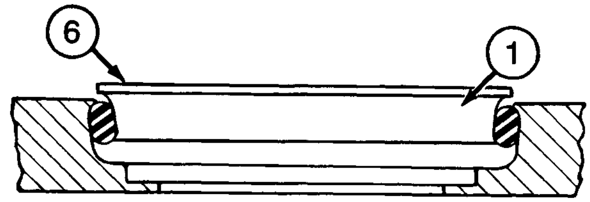
C20398P1*

6. If small adjustments are necessary, do not push directly on seal ring (1); use installation tool (9).

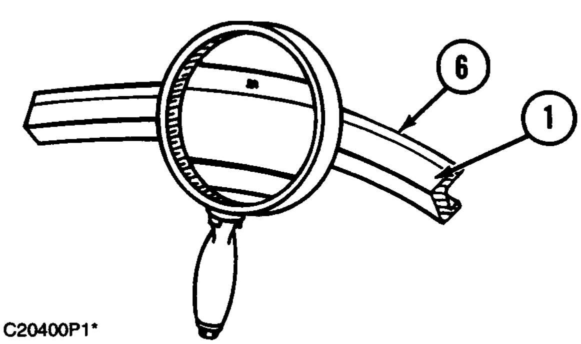
7. Rubber toric ring (2) can twist if the ring is not wet all around during installation, or if there are burrs or fins on retaining lip (3) of seal ring housing (5).

NOTICE
Misalignment, twists and bulges of the rubber toric ring will cause Duo-Cone Seal failures. If correct installation is not obvious, remove the seal from the housing and repeat Steps 3 through 6.

NOTICE
Rubber toric ring (2) must never slip on the ramps of either seal ring (1) or seal ring housing (5). To prevent slippage, wait a minimum of two minutes to let the isopropyl alcohol evaporate before further assembly. Once correctly in place, the rubber toric ring must roll on the ramps only.

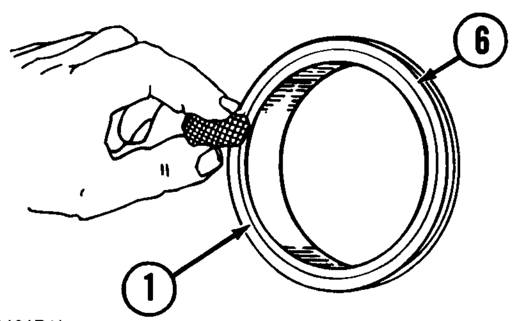


C20399P1*



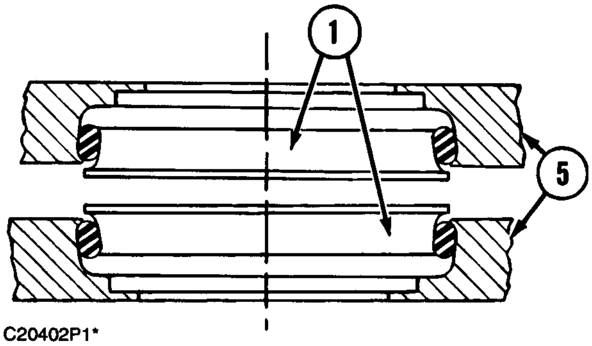
C20400P1*

8. Wipe seal ring face (6) of seal ring (1) clean. Use a lint free cloth or paper towel. No particles of any kind are permissible on the sealing surfaces. Even a small piece from a paper towel can hold the seal faces apart and cause leakage.



C20401P1*

9. Put a thin film of clean oil on the seal faces. Use an applicator, a disposable tissue or a clean finger to distribute the oil evenly. Be careful not to get any oil on the rubber toric rings.



10. Make sure both seal ring housings (5) are in correct alignment and are concentric. Move the parts slowly and carefully toward each other.

NOTICE

Do not slam the seals together. High impact can scratch or break the seal components.

Front Idler Group, Inner, Left and Right

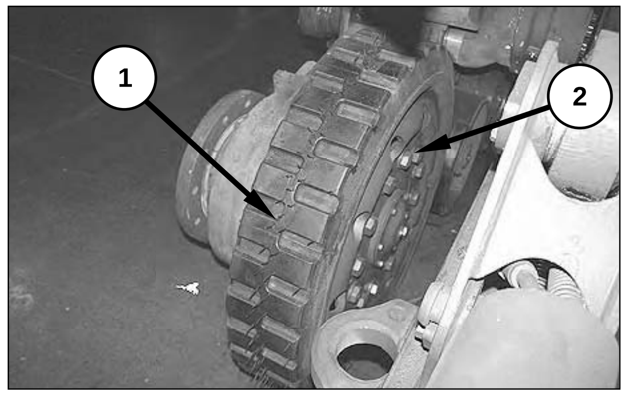
Remove and Install

NOTE: The group number related to this procedure is 143-0837.

NOTE: The following procedure is for the component on the right side of the machine. The procedure for the component on the left side of the machine is the same.

Start By:

a. Remove the drive belt.



1. Support the bottom of inner front idler (1), and remove 12 bolts (2) with washers. The weight of the inner front idler is approximately **73 kg (161 lb).** Upon installation, apply **154-9731 Thread Compound (Loctite™ 271)** to the threads of the 12 bolts, and tighten the bolts to a torque of **530 ± 70 N•m (391 ± 52 lb ft).**

2. Remove inner front idler (1).

NOTE: To install the inner front idler, reverse the installation steps.

End By:

a. Install the drive belt.

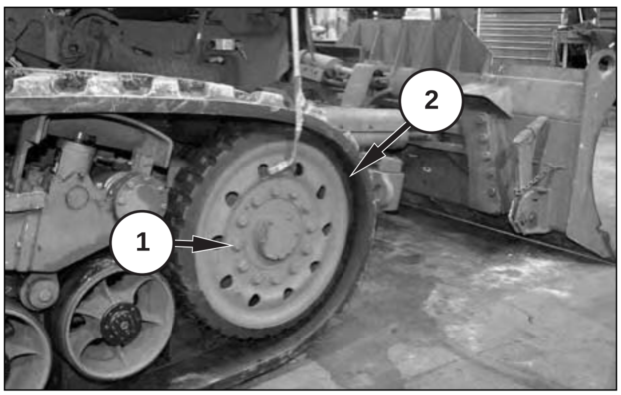
Front Idler Group, Outer, Left and Right

Remove and Install

NOTE: The following procedure is for the component on the right side of the machine. The procedure for the front idler group on the left side of the machine is the same.

NOTE: The group number related to this procedure is 143-0837.

1. Release the belt tension. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage Steering and Brakes,* "Testing and Adjusting, Suspension System Procedures, Suspension Hydraulic Charging Procedure."



NOTE: The machine is shown raised off the ground. This procedure can be performed with the machine on the ground.

2. Remove 11 of 12 bolts (1) with washers from outer front idler (2). Leave one of the bolts near the top of the idler to keep the idler in place.

3. Use a forklift or other suitable lifting device to support outer front idler (2). Remove remaining bolt (1) with washer, and remove the outer front idler. The weight of the front idler is approximately **73 kg (161 lb).** Upon installation, apply **154-9731 Thread Compound (Loctite™ 271)** to the threads of 12 bolts (1), and tighten the bolts to a torque of **530 ± 70 N•m (391 ± 52 lb ft).**

NOTE: To install the outer front idler, reverse the installation steps. Reset the belt tension. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage Steering and Brakes,* "Testing and Adjusting, Suspension System Procedures, Suspension Hydraulic Charging Procedure."

Front Suspension Cylinder

Remove and Install

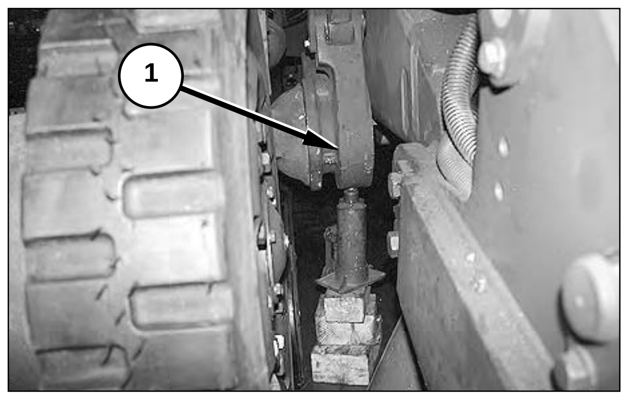
NOTE: The following procedure illustrates the removal of the right suspension cylinder. The removal of the left suspension cylinder is similar. Prior to removing the left suspension cylinder, disconnect or remove the kneeling switch. Refer to *Disassemble and Assembly, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* "Kneeling Limit Switch."

Start By:

a. Remove the right rear fender. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE),* Machine Systems, "Fender Group, Right."

b. Remove the right drive belt.

NOTE: The group number related to this procedure is 124-3842.

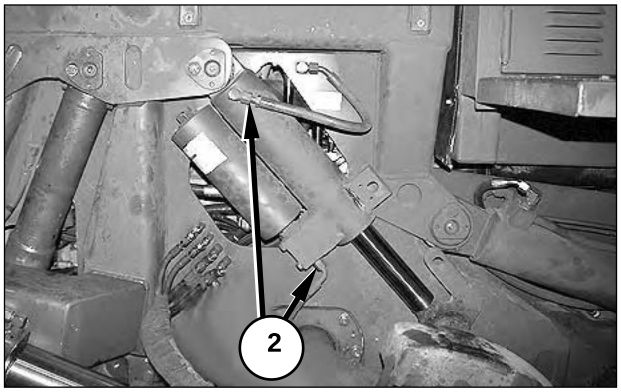


1. Support swing arm (1) with a jack or other suitable device.

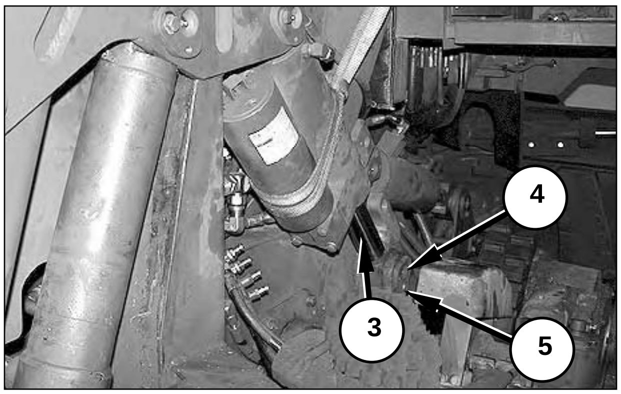
2. Remove the hydraulic pressure in the "Front Cylinder—Top" and "Front Cylinder—Bottom" suspension charging ports at the rear of the machine. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage Steering and Brakes,* "Testing and Adjusting, Suspension System Procedures, Suspension Hydraulic Charging Procedure."

⚠ WARNING

Do not remove any hydraulic line to the cylinder without first removing the hydraulic pressure from the accumulator circuit. Personal injury or death can result from a sudden release of high pressure oil.



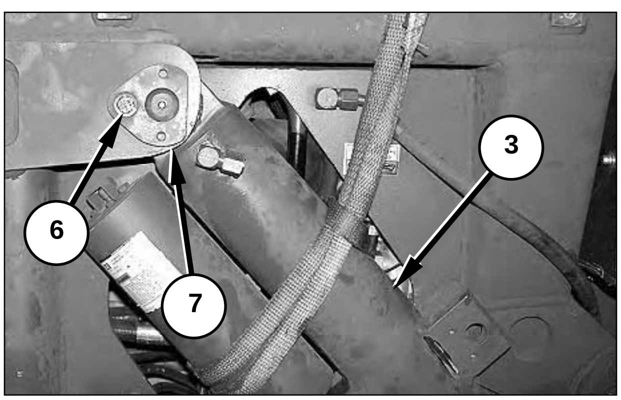
3. Disconnect, cap and plug two front cylinder lines (2).



4. Support front suspension cylinder (3) with a hoist, and remove bolt (5) with washer. Upon reassembly, apply **9S-3263 Thread Compound (Loctite™ 242)** to the threads.

NOTE: A spacer may be present behind bolt (5). The spacer can be used if the joint is worn.

5. Remove pin (4).



6. Remove bolt (6) with washer. Upon reassembly, apply **9S-3263 Thread Compound (Loctite™ 242)** to the threads.

7. Remove pin (7) with shims, and remove front suspension cylinder (3). The weight of the front suspension cylinder is **61 kg (135 lb).** Make note of the number and location of the shims for correct location during reassembly.

NOTE: Upon reassembly, shim the cylinder to the center of the pocket.

NOTE: To install the front suspension cylinder, reverse the removal steps.

End By:

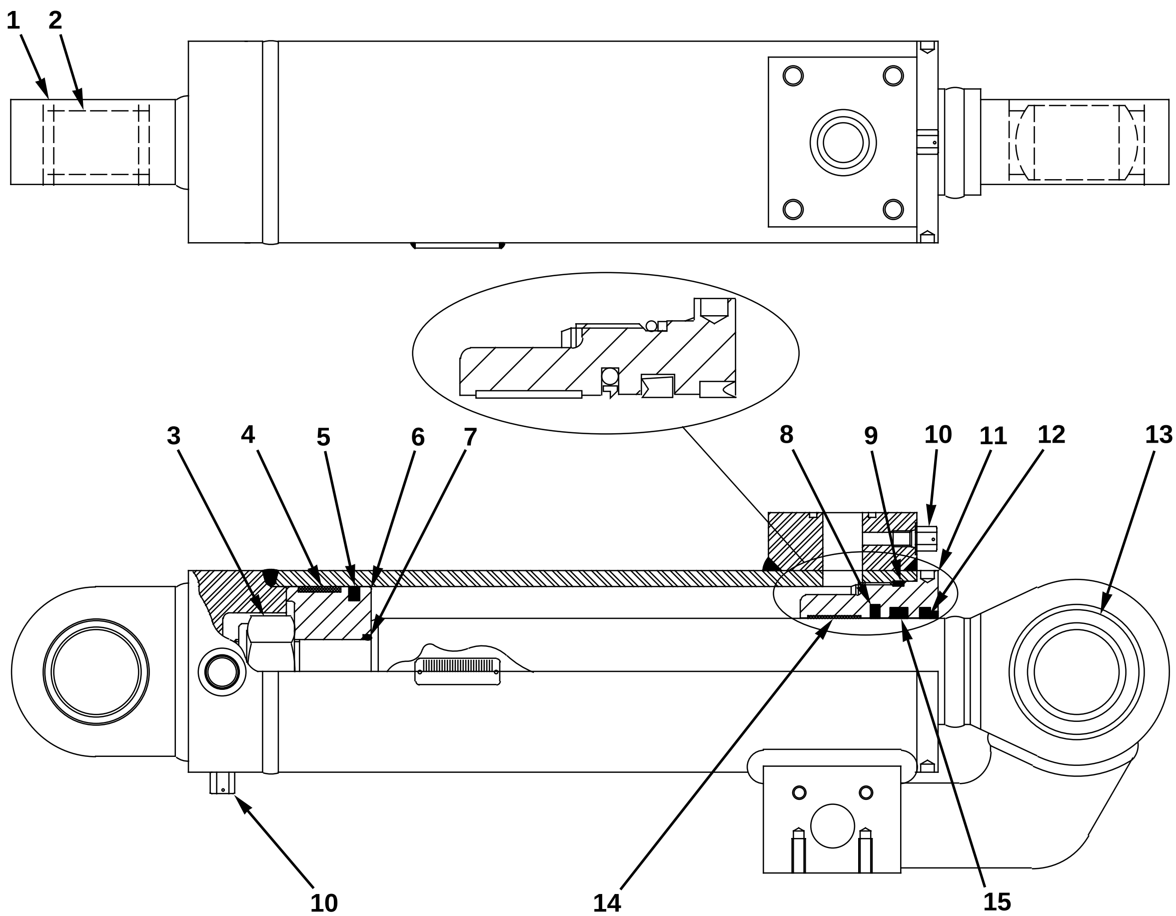
a. Install the right drive belt.

b. Install the right rear fender.

NOTE: Connect or install the kneeling limit switch if the left front suspension cylinder was removed.

Disassemble and Assemble

Tools Needed	A
124-3848 Spanner	1



(1) Seal. (2) Bearing. (3) Nut. (4) Wear ring. (5) Seal assembly. (6) Piston. (7) O-ring seal. (8) Seal assembly. (9) O-ring seal with backup ring. (10) Release valves. (11) Head. (12) Wiper seal. (13) Bearing. (14) Wear ring. (15) U-cup seal.

Start By:

a. Remove the front suspension cylinder.

NOTE: The group number related to this procedure is 124-3843.

1. Use Tooling (A) to loosen head (11). Upon reassembly, tighten the head to a torque of **408 N•m (300 lb ft)**.

2. Remove head (11) together with the rod and piston (6).

3. Remove nut (3) and piston (6). The nut must be replaced. Upon reassembly, tighten the new nut to a torque of **456 N•m (335 lb ft)**.

4. Remove wear ring (4), seal assembly (5) and O-ring seal (7); replace these components if they are damaged or worn. Upon reassembly and prior to installation, apply clean hydraulic oil to the wear ring, the seal assembly, and the O-ring.

NOTE: Seal assembly (5) is a two-piece seal.

5. Remove head (11) from the rod.

6. Remove seal assembly (8), O-ring seal with backup ring (9), wear ring (14), U-cup seal (15), and wiper seal (12) from head (11). Replace any of these components if they are damaged or worn. Upon reassembly, apply clean hydraulic oil to the seal assembly, the O-ring seal with backup ring, the wear ring, the U-cup seal, and the wiper seal.

7. Remove two seals (1).

8. If necessary, use a press to remove bearings (2) and (13).

9. If necessary, remove release valves (10).

NOTE: To assemble the front suspension cylinder, reverse the disassembly procedure.

End By:

a. Install the front suspension cylinder.

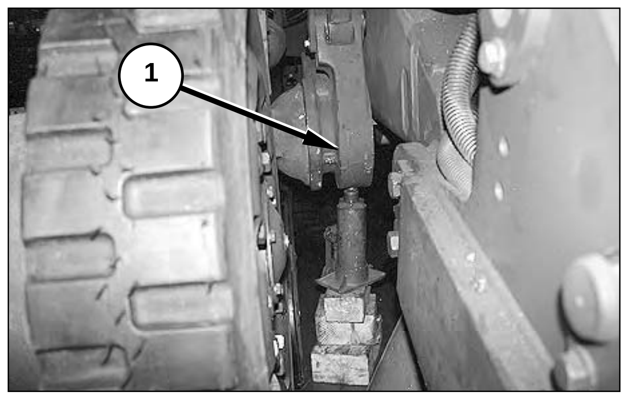
Front Suspension Accumulator, Bottom End, Left and Right

Remove and Install

NOTE: Group numbers related to this procedure include 124-3842 and 130-9240.

NOTE: The following procedure is for the component on the right side of the machine. The procedure for the component on the left side of the machine is the same.

1. Release the belt tension. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage Steering and Brakes,* "Testing and Adjusting, Suspension System Procedures, Suspension Hydraulic Charging Procedure."

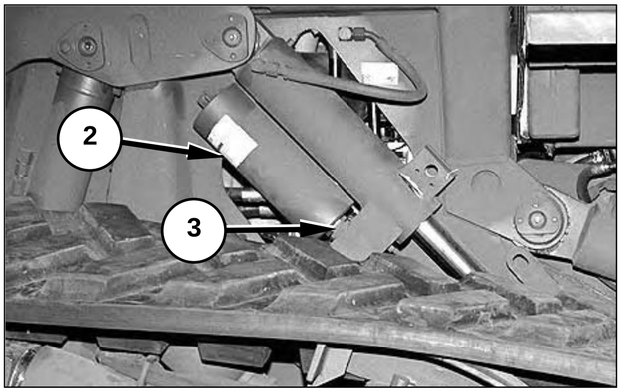


2. Support swing arm (1) with a floor jack or other suitable lifting device. Support the swing arm to release the pressure in the front suspension cylinder.

3. Remove the hydraulic pressure in the "Front Cylinder—Top" and "Front Cylinder—Bottom" suspension charging ports at the rear of the machine. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage Steering and Brakes,* "Testing and Adjusting, Suspension System Procedures, Suspension Hydraulic Charging Procedure."

WARNING

Do not remove any accumulator without first removing the hydraulic pressure from the accumulator circuit. Personal injury or death can result from a sudden release of high pressure oil.



4. Slowly turn union (3) counterclockwise to remove the union and accumulator (2) together.

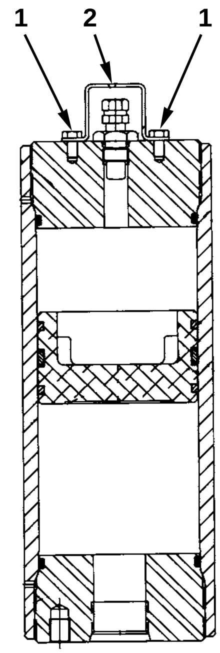
NOTE: To install the bottom end front suspension accumulator, reverse the removal steps. If a new accumulator is being installed, precharge the accumulator with nitrogen. Refer to *Specifications, Systems Operation, Testing and Adjusting,Deployable Universal Combat Earthmover (DEUCE), Undercarriage Steering and Brakes,* "Testing and Adjusting, Suspension System Procedures, Accumulator Charging Procedure."

Disassemble and Assemble

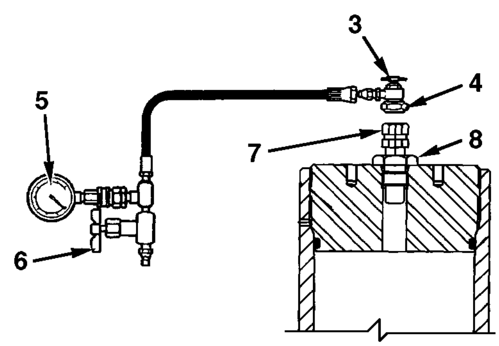
Tools Needed	
7S-5437 Nitrogen Charging Group	1

Start By:

a. Remove the front suspension accumulator, bottom end.



1. Remove bolts (1) and cover (2).



2. Install 8T-0857 Pressure Gauge (5) to the fitting on the 7S-5437 Nitrogen Charging Group.

3. Ensure that valve (6) is closed.

4. Attach connector (4) of the 7S-5437 Nitrogen Charging Group to gas valve (7) on the accumulator.

5. Turn valve (3) clockwise, until tight, and read the pressure which registers on pressure gauge (5).

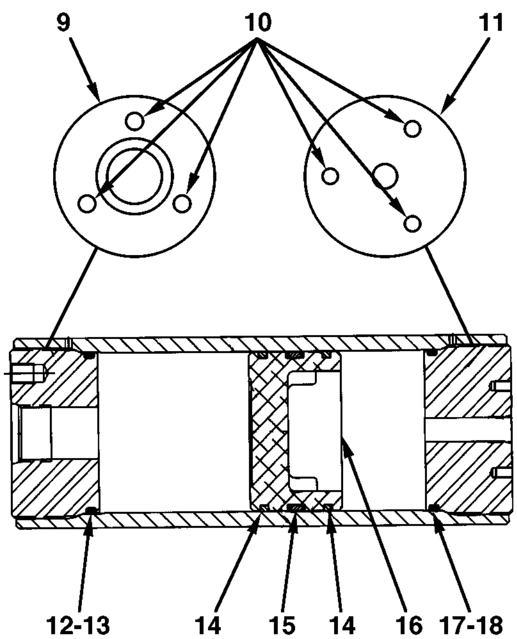
6. If the pressure is greater than 0 kPa (0 psi), open valve (6) slightly to slowly release the nitrogen gas. Direct the discharge of nitrogen away from personnel in the area. When the pressure on gauge (5) registers 0 kPa (0 psi), slowly open valve (6) completely to ensure that all of the nitrogen has been discharged from the accumulator.

7. Close valve (6), and remove connector (4) from gas valve (7).

8. Loosen nut (8), and remove gas valve (7) with the O-ring seal. Replace the O-ring seal if necessary.

WARNING

Do not remove gas valve (7) until all of the nitrogen gas has been removed from the accumulator.



9. Secure the accumulator with a strap wrench, or place the accumulator horizontally in a vise.

10. Remove gas end cap (11), and then remove hydraulic end cap (9).

NOTE: To remove end caps (9) and (11), place pins in holes (10), position a long bar between two of the pins, and use the bar and pins to unscrew the cap from the accumulator body.

11. Remove O-ring seal (17) and backup ring (18) from gas end cap (11).

12. Remove O-ring seal (13) and backup ring (12) from hydraulic end cap (9).

13. Use a bar to push piston (16) out of the accumulator housing.

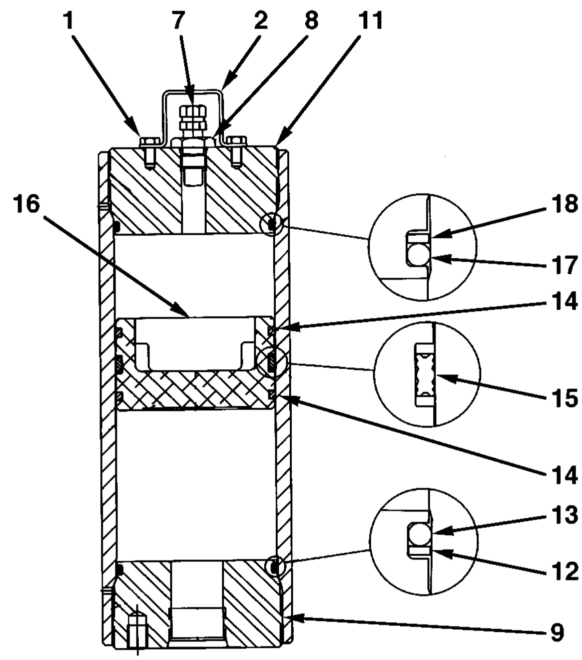
NOTE: Push on the hydraulic side of piston (16). The hydraulic side of the piston is flat and faces the end of the accumulator from which hydraulic end cap (9) was removed.

14. Remove wear rings (14) from piston (16).

15. Remove V-O-ring seal (15) with backup washers from piston (16).

NOTE: The following steps describe the procedure to assemble the accumulator.

NOTE: Ensure that all components are clean and dry. Coat internal parts with clean hydraulic oil before assembly.



16. Install V-O-ring seal (15) with backup washers on piston (16).

17. Install wear rings (14) on piston (16).

18. Place piston (16) in the accumulator housing with the flat end of the piston facing the hydraulic end of the accumulator. Ensure that the threads do not damage the V-O-ring.

19. Use a wood block and a hammer to tap piston (16) into the accumulator housing until the face of piston (16) is approximately **50 mm (2 in)** below the beginning of the honed bore in the accumulator housing.

NOTE: Install the piston slowly and ensure that the face of the piston remains square with the end of the accumulator housing. The piston fits snugly in the accumulator housing. As the piston is forced up the chamfer and into the housing, the V-O-ring seal compresses. To prevent the piston from springing out of the housing, constant force must be applied to the piston as the piston is forced up the chamfer.

20. Install backup ring (12), and then install O-ring seal (13) on hydraulic end cap (9).

21. Install hydraulic end cap (9) in the accumulator bore. Tighten the end cap until the face of end cap is **1.6 ± 0.8 mm (0.0625 ± 0.0313 in)** above the face of the accumulator housing.

NOTE: Ensure that the flat side of piston (16) is facing hydraulic end cap (9).

22. Install backup ring (18), and then install O-ring seal (17) on gas end cap (11).

23. Install gas end cap (11) in the accumulator bore. Tighten the end cap until the face of end cap is **1.6 ± 0.8 mm (0.0625 ± 0.0313 in)** above the face of the accumulator housing.

24. Install gas valve (7) with the O-ring seal. Tighten the gas valve to a torque of **1.4 ± 0.3 N•m (12.5 ± 2.5 lb in)**. Tighten nut (8) to a torque of **35 N•m (26 lb ft)** to secure the gas valve in gas end cap (11).

25. Charge the accumulator with nitrogen. For the charging procedure, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage, Steering and Brakes,* "Testing and Adjusting, Suspension System Procedures."

26. Place cover (2) over gas valve (7), and install bolts (1).

End By:

a. Install the front suspension accumulator, bottom end.

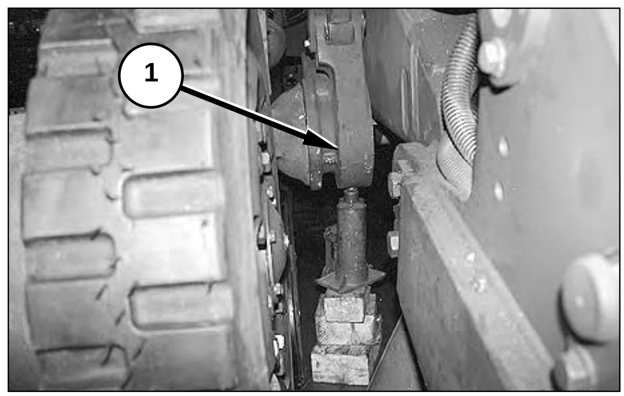
Front Suspension Accumulator, Top End, Right and Left

Remove and Install

NOTE: The group number related to this procedure is 126-6565.

NOTE: The following procedure is for the component on the right side of the machine. The procedure for the component on the left side of the machine is the same.

1. Release the belt tension. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage Steering and Brakes,* "Testing and Adjusting, Suspension System Procedures, Suspension Hydraulic Charging Procedure."

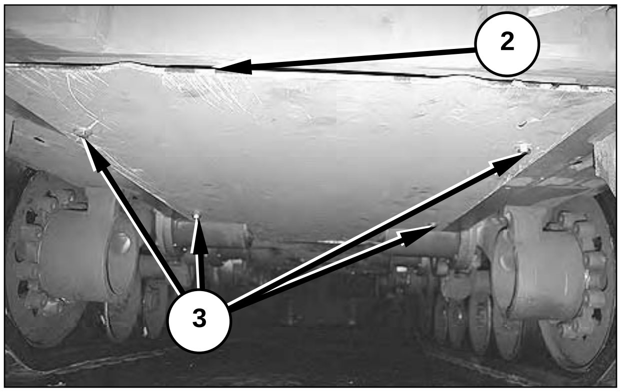


2. Support swing arm (1) with a floor jack or other suitable lifting device. Support the swing arm to release the pressure in the front suspension cylinder.

3. Remove the hydraulic pressure in the "Front Cylinder—Top" and "Front Cylinder—Bottom" suspension charging ports at the rear of the machine. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage Steering and Brakes,* "Testing and Adjusting, Suspension System Procedures, Suspension Hydraulic Charging Procedure."

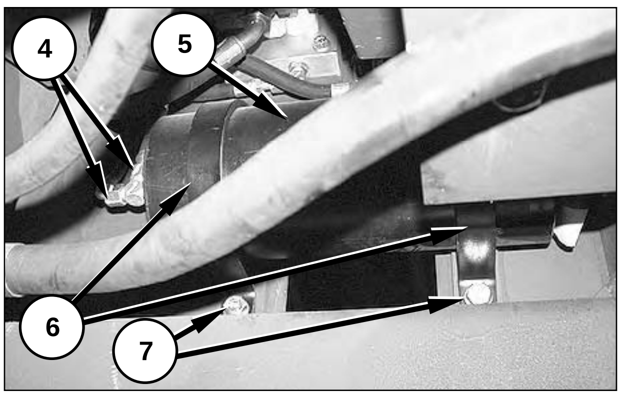
WARNING

Do not remove any accumulator without first removing the hydraulic pressure from the accumulator circuit. Personal injury or death can result from a sudden release of high pressure oil.



4. Remove four bolts (3) with washers, and bottom cover (2). The weight of cover (2) is **50.5 kg (111 lb).**

NOTE: If dirt or other debris has accumulated on the top side, the bottom cover may weigh more than **50.5 kg (111 lb)**. Use a suitable floor jack, or other tool, to support the bottom cover if there is a large amount of debris.



5. Slowly disconnect, cap and plug two lines (4).

6. Remove two bolts (7) with washers from the bottom of two brackets (6).

7. Support accumulator (5), and remove two bolts (7) with washers from the top end of two brackets (6).

NOTE: The bolts removed in Step 7 are not shown in the photograph. Bolt torque is 125±20 Nm (92±14 lb ft).

8. Remove two brackets (6) and accumulator (5).

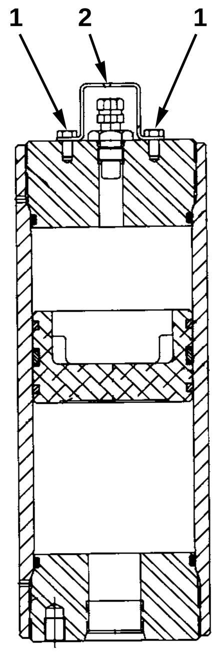
NOTE: To install the accumulator, reverse the removal steps. If a new accumulator is being installed, precharge the accumulator with nitrogen. Refer to *Specifications, Systems Operation, Testing and Adjusting,Deployable Universal Combat Earthmover (DEUCE), Undercarriage Steering and Brakes,* "Testing and Adjusting, Suspension System Procedures, Accumulator Charging Procedure."

Disassemble and Assemble

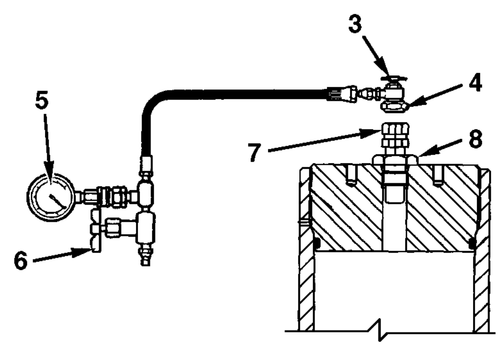
Tools Needed		
7S5437	Nitrogen Charging Group	1

Start By:

a. Remove the front suspension accumulator, top end.



1. Remove bolts (1) and cover (2).



2. Install 8T-0857 Pressure Gauge (5) to the fitting on the 7S-5437 Nitrogen Charging Group.

3. Ensure that valve (6) is closed.

4. Attach connector (4) of the 7S-5437 Nitrogen Charging Group to gas valve (7) on the accumulator.

5. Turn valve (3) clockwise, until tight, and read the pressure which registers on pressure gauge (5).

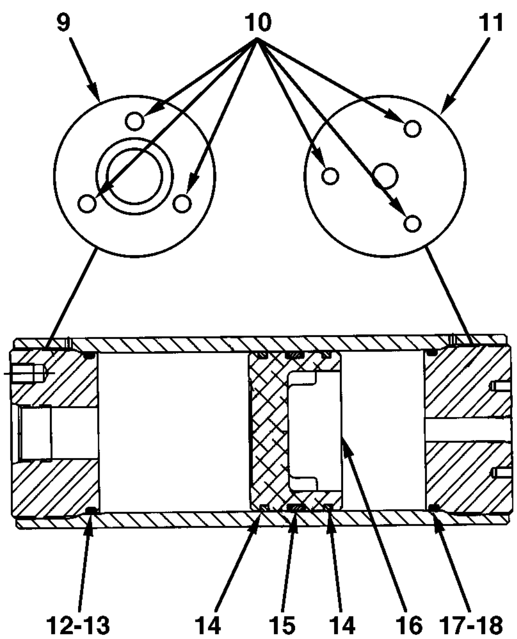
6. If the pressure is greater than 0 kPa (0 psi), open valve (6) slightly to slowly release the nitrogen gas. Direct the discharge of nitrogen away from personnel in the area. When the pressure on gauge (5) registers 0 kPa (0 psi), slowly open valve (6) completely to ensure that all of the nitrogen has been discharged from the accumulator.

7. Close valve (6), and remove connector (4) from gas valve (7).

8. Loosen nut (8), and remove gas valve (7) with the O-ring seal. Replace the O-ring seal if necessary.

WARNING

Do not remove gas valve (7) until all of the nitrogen gas has been removed from the accumulator.



9. Secure the accumulator with a strap wrench, or place the accumulator horizontally in a vise.

10. Remove gas end cap (11), and then remove hydraulic end cap (9).

NOTE: To remove end caps (9) and (11), place pins in holes (10), position a long bar between two of the pins, and use the bar and pins to unscrew the cap from the accumulator body.

11. Remove O-ring seal (17) and backup ring (18) from gas end cap (11).

12. Remove O-ring seal (13) and backup ring (12) from hydraulic end cap (9).

13. Use a bar to push piston (16) out of the accumulator housing.

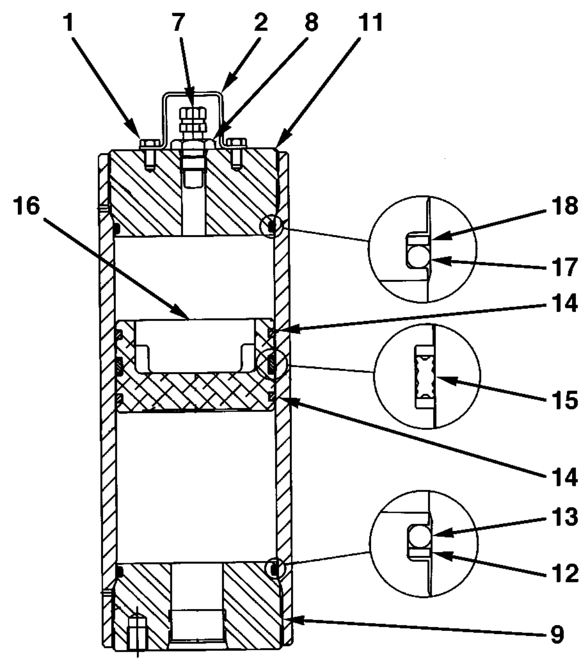
NOTE: Push on the hydraulic side of piston (16). The hydraulic side of piston (16) is flat and faces the end of the accumulator from which hydraulic end cap (9) was removed.

14. Remove wear rings (14) from piston (16).

15. Remove V-O-ring seal (15) with backup washers from piston (16).

NOTE: The following steps describe the procedure to assemble the accumulator.

NOTE: Ensure that all components are clean and dry. Coat internal parts with clean hydraulic oil before assembly.



16. Install V-O-ring seal (15) with backup washers on piston (16).

17. Install wear rings (14) on piston (16).

18. Place piston (16) in the accumulator housing with the flat end of the piston facing the hydraulic end of the accumulator. Ensure that the threads do not damage the V-O-ring.

19. Use a wood block and a hammer to tap piston (16) into the accumulator housing until the face of piston (16) is approximately **50 mm (2 in)** below the beginning of the honed bore in the accumulator housing.

NOTE: Install the piston slowly and ensure that the face of the piston remains square with the end of the accumulator housing. The piston fits snugly in the accumulator housing. As the piston is forced up the chamfer and into the housing, the V-O-ring seal compresses. To prevent the piston from springing out of the housing, constant force must be applied to the piston as the piston is forced up the chamfer.

20. Install backup ring (12), and then install O-ring seal (13) on hydraulic end cap (9).

21. Install hydraulic end cap (9) in the accumulator bore. Tighten the end cap until the face of end cap is **1.6 ± 0.8 mm (0.0625 ± 0.0313 in)** above the face of the accumulator housing.

NOTE: Ensure that the flat side of piston (16) is facing hydraulic end cap (9).

22. Install backup ring (18), and then install O-ring seal (17) on gas end cap (11).

23. Install gas end cap (11) in the accumulator bore. Tighten the end cap until the face of end cap is **1.6 ± 0.8 mm (0.0625 ± 0.0313 in)** above the face of the accumulator housing.

24. Install gas valve (7) with O-ring seal. Tighten the gas valve to a torque of **1.4 ± 0.3 N•m (12.5 ± 2.5 lb in)**. Tighten nut (8) to a torque of **35 N•m (26 lb ft)** to secure the gas valve in gas end cap (11).

25. Charge the accumulator with nitrogen. For the charging procedure, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage, Steering and Brakes,* "Testing and Adjusting, Suspension System Procedures."

26. Place cover (2) over gas valve (7), and install bolts (1).

End By:

a. Install the front suspension accumulator, top end.

Kneeling Solenoid Valve, Left and Right

Remove and Install

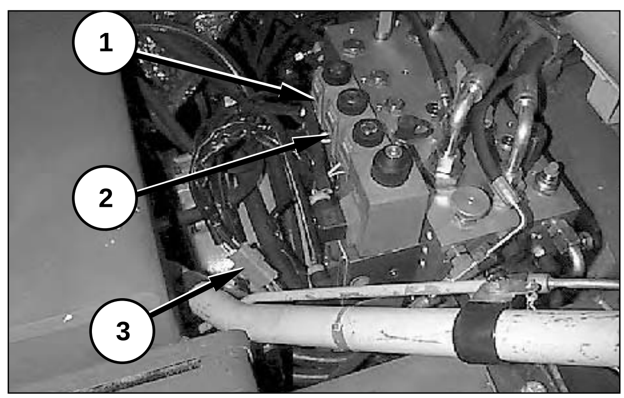
NOTE: The group number related to this procedure is 124-4624.

Start By:

1. Turn the main disconnect switch OFF. Refer to *Operation and Maintenance Manual, Deployable Universal Combat Earthmover (DEUCE), Operator's Manual,* "Operation Section, Machine Features, Main Disconnect Switch."

2. Raise the radiator. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Machine Features, Radiator Tilt."

3. Drain the hydraulic tank into a suitable container. The capacity of the hydraulic tank is approximately **72 L (19 U.S. gal).** Dispose of the oil according to local regulations. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Maintenance Intervals, Every 1000 Service Hours or One Year."



4. Disconnect connectors C202 and/or C204 (3), whichever corresponds to the solenoid valve that will be removed.

NOTE: There are two connectors (3); one is not visible in the photograph. Wires from connector C202 lead to the left kneeling solenoid and the winch solenoid. Wires from connector C204 lead to the right kneeling solenoid, the parking brake release solenoid, and the undercarriage charge solenoid.

5. Remove the connector pins which correspond to the wires leading to the solenoid valve that will be removed. Mark the wires and sockets to ensure correct connection during reassembly.

NOTE: The wires at connector C202 are: F885-PU at pin 1, 200-BK at pin 2, 200-BK at pin 3, and F886-PK at pin 4. The wires at connector C204 are: F885-PU at pin 3, F886-PK at pin 4, 200-BK at pin 5, and 200-BK at pin 6.

6. Remove four bolts from the front face of left kneeling solenoid valve (1), or right kneeling solenoid valve (2), and remove the kneeling solenoid valve. The four ports in each kneeling solenoid valve contain O-ring seals. Tighten the four bolts to a torque of **6 ± 1 N•m (53 ± 9 lb in).**

NOTE: To install the kneeling solenoid valve, reverse the removal steps.

Midroller Bogie Assembly

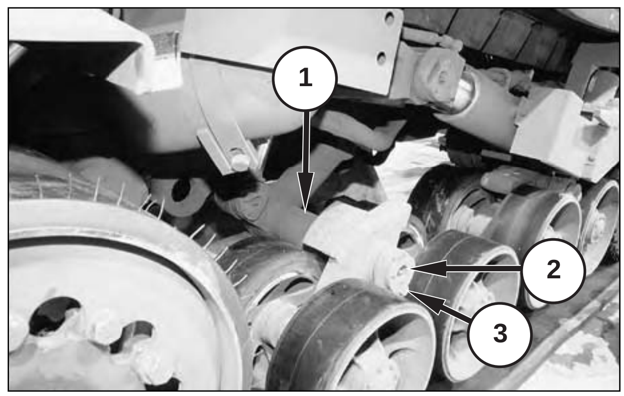
Remove and Install

Tools Needed	A
138-7575 Link Bracket	1

NOTE: Group numbers related to this procedure include 124-3840 and 124-3900.

NOTE: This procedure illustrates the removal of the midroller bogie assembly on the right side of the machine. The midroller bogie assembly on the left side of the machine can be removed in a similar manner.

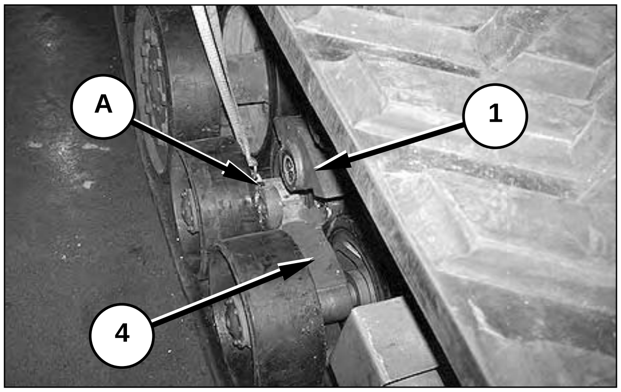
1. Release the belt tension. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage Steering and Brakes,* “Testing and Adjusting, Suspension System Procedures, Suspension Hydraulic Charging Procedure.”



2. Place a floor jack or other suitable lifting device beneath middle swing arm (1). Raise the floor jack until the jack begins supporting the weight of the swing arm.

3. Remove bolt (3) with washer. Upon reassembly, apply **154-9731 Thread Compound (Loctite™ 271)** to the threads of the bolt. Tighten the bolt to a torque of **300 N•m (220 lb ft)**.

4. Remove pin (2). There are two puller holes provided in the pin ear to help remove the pin. Upon reassembly, apply **129-1958 Multipurpose Lithium Complex** to pin (2).



5. Raise the floor jack to so that the pin boss in middle swing arm (1) clears the pin boss in midroller bogie assembly (4).

NOTICE

Do not raise middle swing arm (1) too high. The top of the swing arm may come into contact with the machine frame and cause damage.

6. Install Tooling (A), and attach midroller bogie assembly (4) to a hoist. The weight of the midroller bogie assembly is **160 kg (350 lb).**

7. Remove midroller bogie assembly (4) by lifting the assembly up and out between the recoil cylinder and middle swing arm (1). The weight of the midroller bogie assembly is **160 kg (350 lb).**

NOTE: The cover which is installed over the bogie accumulator can be removed if additional room is needed to remove the midroller bogie assembly.

NOTE: To install the midroller bogie assembly, reverse the disassembly steps and recharge the middle suspension cylinder. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage Steering and Brakes,* "Testing and Adjusting, Suspension System Procedures, Suspension Hydraulic Charging Procedure," to recharge the middle suspension cylinder.

Midroller Group

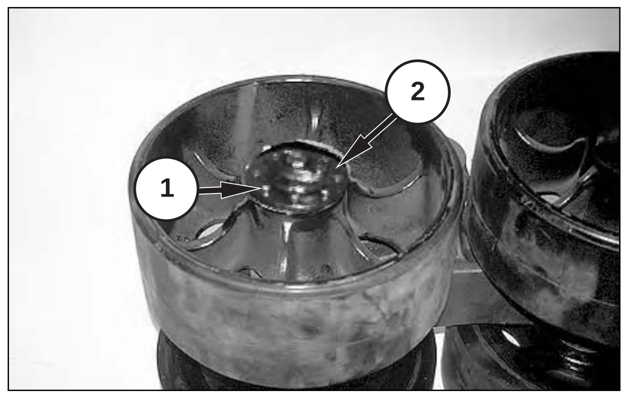
Disassemble and Assemble

Tools Needed	A	B
FT-1641 Spanner Wrench	1	
1U-8840 Seal Installer		1

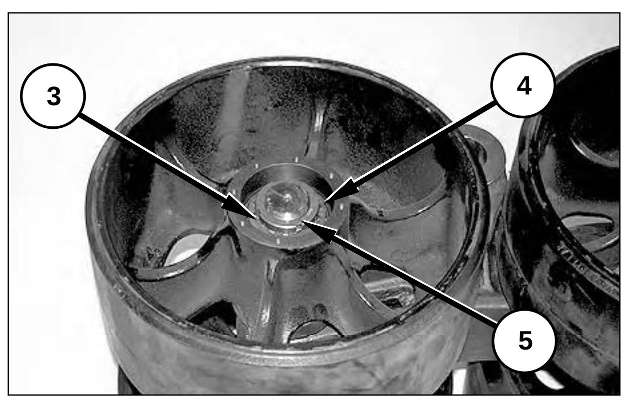
Start By:

a. Drain the oil from the midroller assembly. Dispose of the oil in accordance with local regulations. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Every 250 Service Hours or Three Months, Midrollers."

NOTE: The group number related to this procedure is 124-3840.

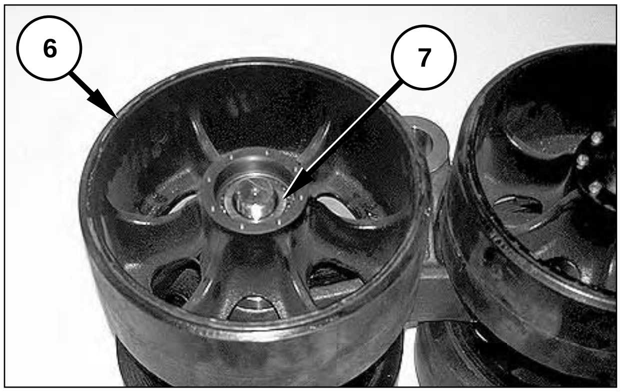


1. Remove eight bolts (1) with washers, and cover (2). Remove any sealant material remaining on the cover or on the mounting face of the midroller.

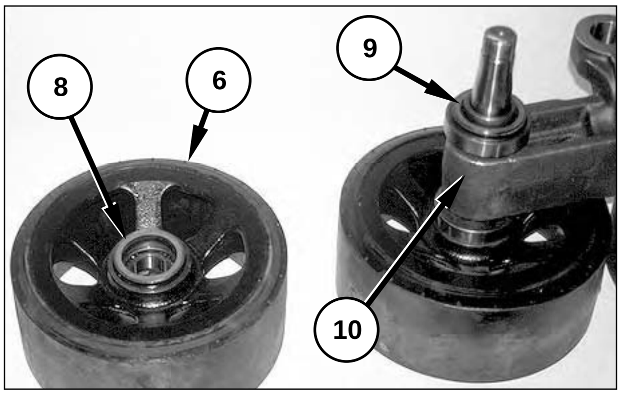


2. Bend the tabs of lock washer (3) down, and use Tooling (A) to remove lock nut (4).

3. Remove washer (5).



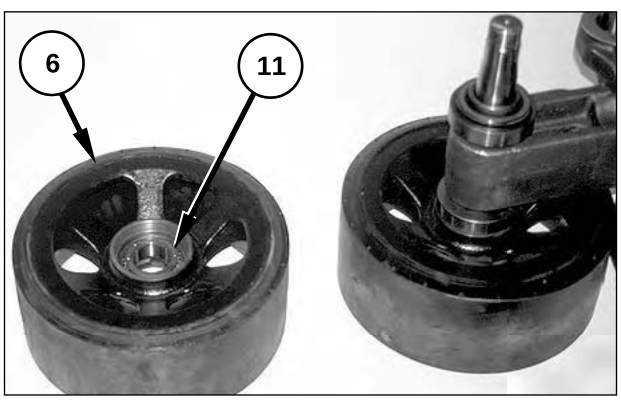
4. Remove midroller (6) with bearing cone (7).



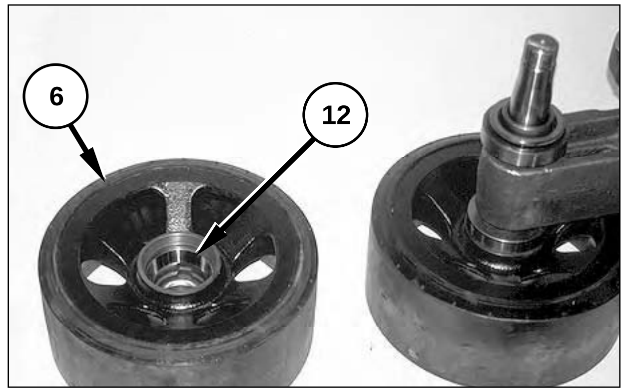
5. Remove Duo-Cone Seal (8) from midroller (6).

6. Remove Duo-Cone Seal (9) from midroller group (10).

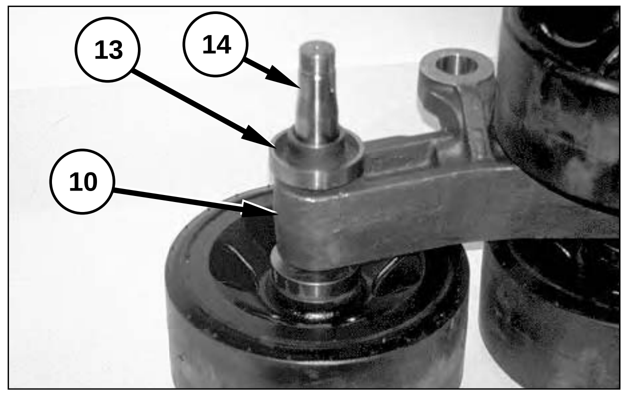
NOTE: Do not touch the polished sealing face of the Duo-Cone Seals if they will be reused.



7. Remove bearing (11) from midroller (6).



8. If necessary, use a suitable puller to remove two bearing races (12) from midroller (6).

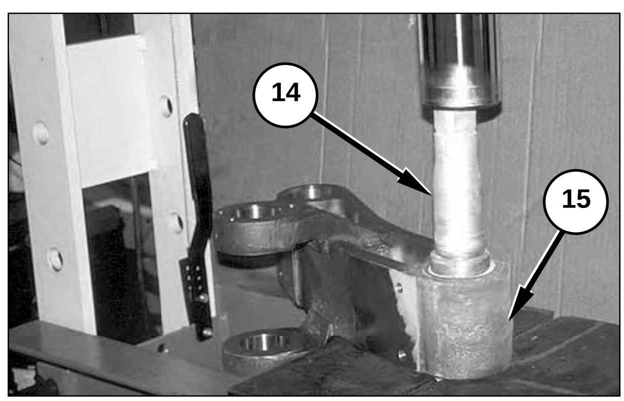


9. Use a suitable puller to remove Duo-Cone Seal retainer (13) from midroller group (10).

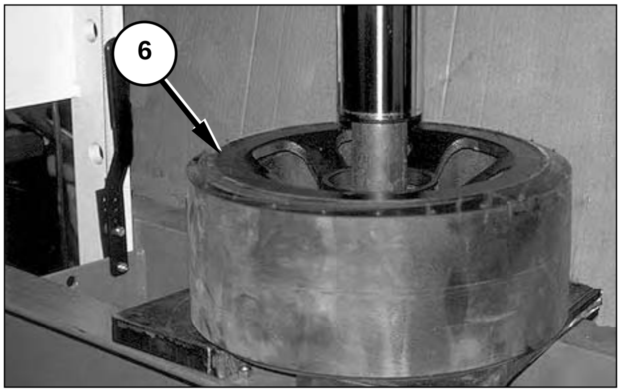
10. If necessary, repeat Steps 1 through 9 for the three remaining midrollers on midroller group (10).

11. If necessary, use a press to remove shaft (14).

NOTE: The following steps are for the assembly of the midroller group.

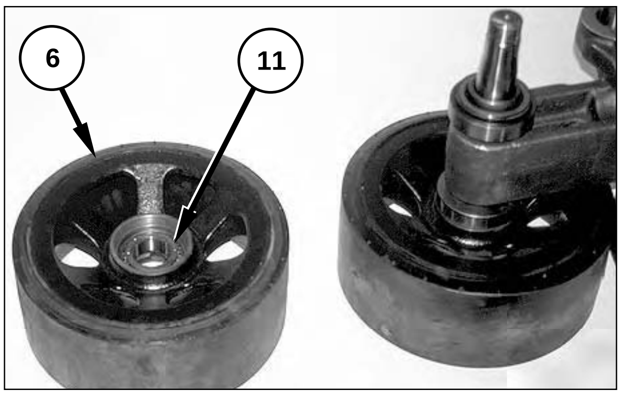


12. If necessary, chill shaft (14) to **–100°C (–150°F),** and press the shaft into minor bogie (15) until the step on the shaft is **14 ± 1 mm (0.55 ± 0.04 in)** from the edge of the minor bogie. Install Duo-Cone Seal retainer (13).

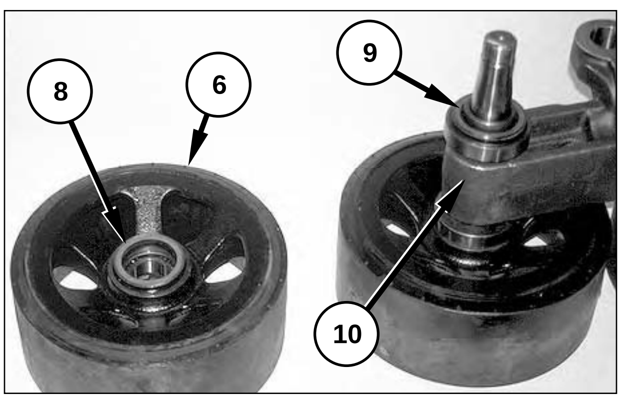


13. If necessary, chill bearing races (12) to **–100°C (–150°F),** and press the bearings into midroller (6).

NOTE: Refer to Step 8 for the location of bearing races (12).



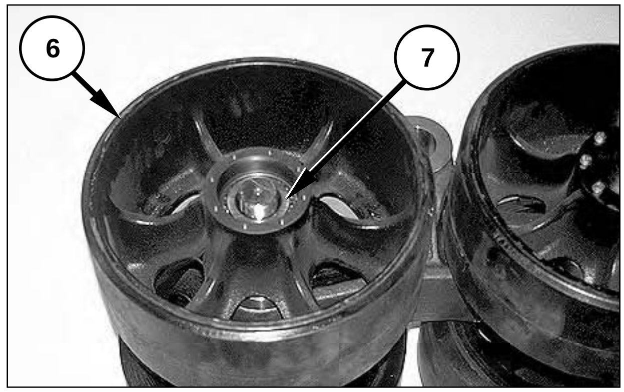
14. Install bearing (11) in midroller (6).



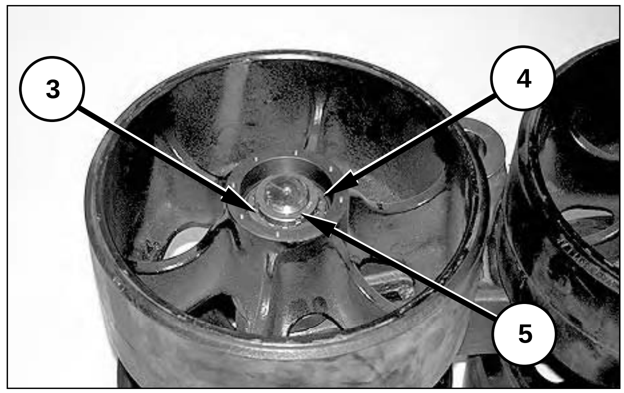
15. Use Tooling (B) to install Duo-Cone Seal (8) in midroller (6). Refer to “Duo-Cone Seals” in this module.

16. Use Tooling (B) to install Duo-Cone Seal (9) in midroller group (10). Refer to “Duo-Cone Seals” in this module.

NOTE: Do not touch the polished sealing face of the Duo-Cone Seals.

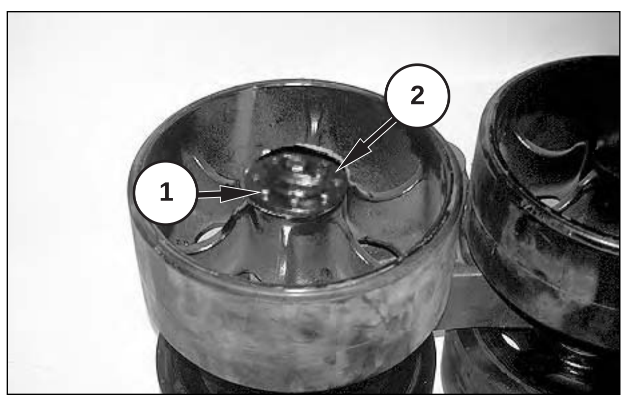


17. Install midroller (6) and bearing cone (7).



18. Install lock washer (3), and use Tooling (A) to install lock nut (4). Tighten the lock nut to a torque of **34 ± 7 N•m (25 ± 5 lb ft)** while rotating the midroller wheel.

19. Bend at least one tab on lock washer (3) into a locking groove on lock nut (4). If none of the grooves aligns with a tab, tighten the lock nut until the next groove aligns with a tab.



20. Apply **6V-5765 Sealant** (clear silicone) in a continuous bead on the sealing surface between cover (2) and the midroller wheel. Install the cover with eight bolts (1) and washers.

21. Refill the midroller assembly with the appropriate amount and type of oil. Refer to *Operator’s Manual, Deployable Universal Combat Earthmover (DEUCE),* “Maintenance Section, Lubricant Viscosities and Refill Capacities.”

Middle Suspension Cylinder, Left and Right

Remove and Install

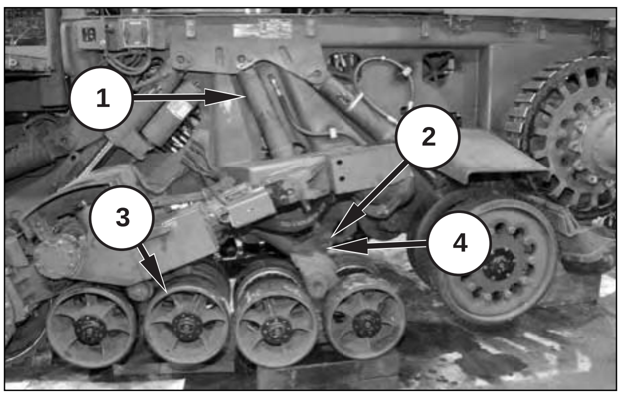
NOTE: The following procedure is for the component on the left side of the machine. The procedure for the component on the right side of the machine is the same.

Start By:

a. Remove the fender. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Machine Systems,* "Fender Group. Left" and "Fender Group, Right."

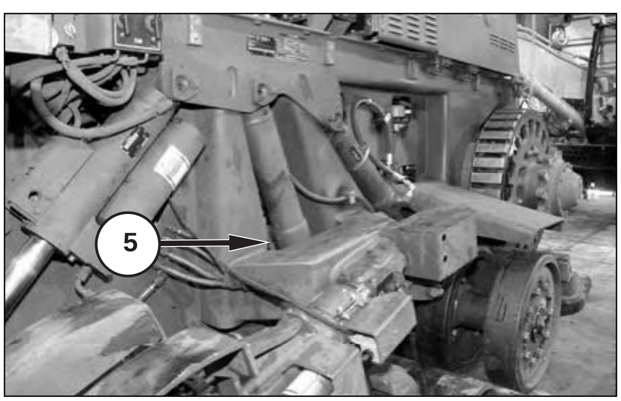
b. Remove the drive belt.

NOTE: Group numbers related to this procedure include 124-3848 and 124-3900.

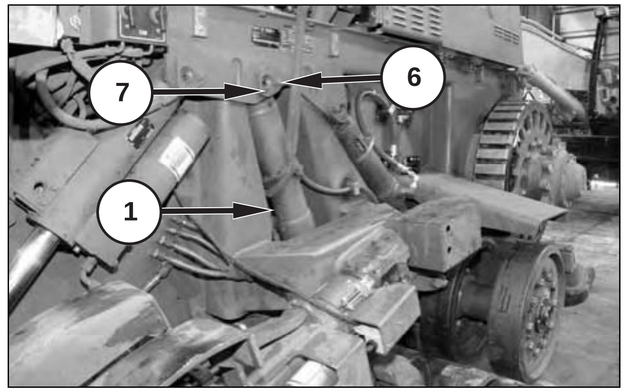


1. Support midroller assembly (3) with blocks.

2. Remove bolt (2) with washer and spacer, and remove pin (4). Upon reassembly, apply **9S-3263 Thread Compound (Loctite™ 242)** to the threads, and tighten the bolt to a torque of **120 ± 20 N•m (88 ± 15 lb ft).**



3. Disconnect and cap line (5). Remove the fitting from the cylinder, and plug the port.



4. Fasten a hoist to middle suspension cylinder (1), and support the cylinder. The weight of the middle suspension cylinder is **39 kg (85 lb).**

5. Remove bolt (6) with washer, and pin (7), with shims. Note the position of the shims for correct location upon reassembly. Upon reassembly, apply **9S-3263 Thread Compound (Loctite™ 242)** to the threads, and tighten the bolt to a torque of **120 ± 20 N•m (88 ± 15 lb ft).**

NOTE: The cylinder should be shimmed to the center of the pocket.

6. Remove middle suspension cylinder (1).

NOTE: To remove the cylinder, the bleed screw may have to be opened and the cylinder rod retracted. Use a suitable container to catch any hydraulic oil and dispose of the oil in accordance with local regulations.

NOTE: The cylinder can be removed out the top (by lifting) or out the bottom (by lowering).

NOTE: To install the middle suspension cylinder, reverse the removal steps.

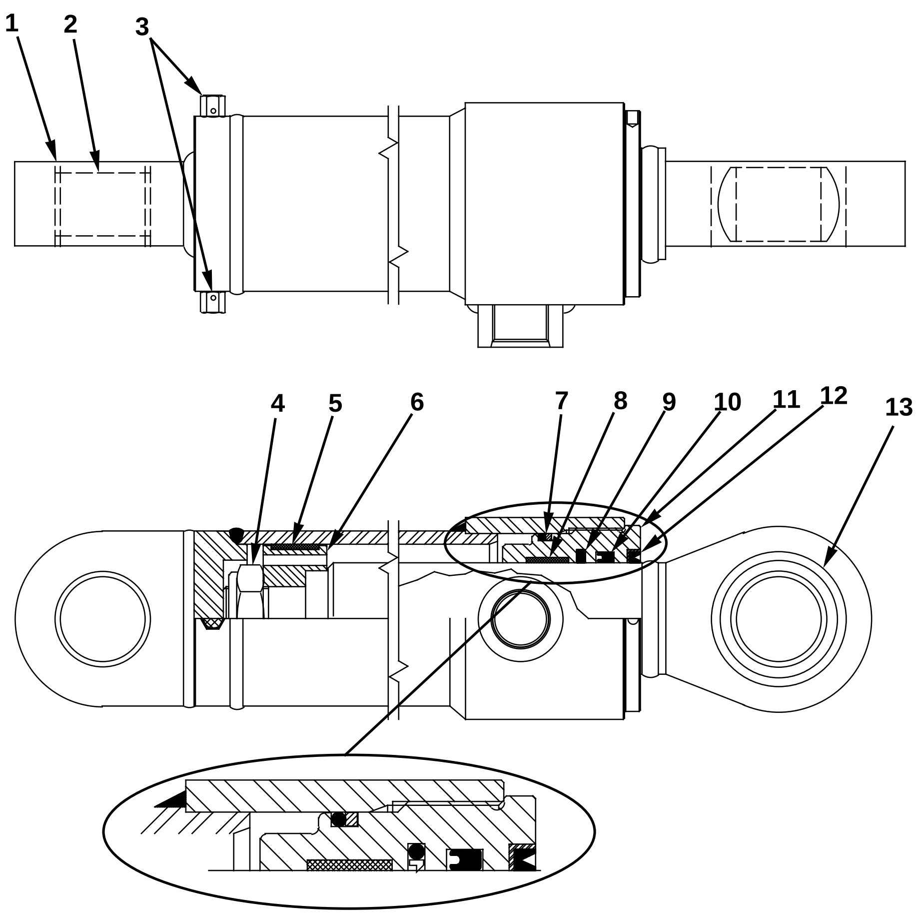
End By:

a. Install the drive belt.

b. Install the fender.

Disassemble and Assemble

Tools Needed	A
124-3848 Spanner	1



(1) Seals. (2) Bearing. (3) Release valves. (4) Nut. (5) Wear ring. (6) Piston. (7) O-ring seal with backup ring. (8) Wear ring. (9) Buffer ring. (10) Rod seal. (11) Head. (12) Rod wiper. (13) Bearing.

Start By:

a. Remove the middle suspension cylinder.

NOTE: The group number related to this procedure is 124-3848.

1. Use Tooling (A) to remove head (11) with the rod and piston (6). Upon reassembly, tighten head (11) to a torque of **340 N•m (250 lb ft)**.

2. Remove nut (4) and piston (6). Upon reassembly, replace the nut, and tighten the new nut to a torque of **388 N•m (285 lb ft)**.

3. Remove wear ring (5) from piston (6). Replace the wear ring if there is damage or wear. Upon reassembly and prior to installation, apply clean hydraulic oil to the wear ring.

4. Remove head (11) from the rod.

5. Remove O-ring seal with backup ring (7), wear ring (8), buffer ring (9), rod seal (10), and rod wiper (12) from head (11). Replace any of these components if they are damaged or worn. Upon reassembly and prior to installation, apply clean hydraulic oil to the backup ring, wear ring, buffer ring, rod seal, and rod wiper.

6. Remove two seals (1). Replace the seals if they are damaged or worn.

7. If necessary, use a press to remove bearings (2) and (13).

8. If necessary, remove release valves (3).

NOTE: To assemble the midroller bogie cylinder, reverse the disassembly steps.

End By:

a. Install the middle suspension cylinder.

Middle Suspension Cylinder Accumulator, Left

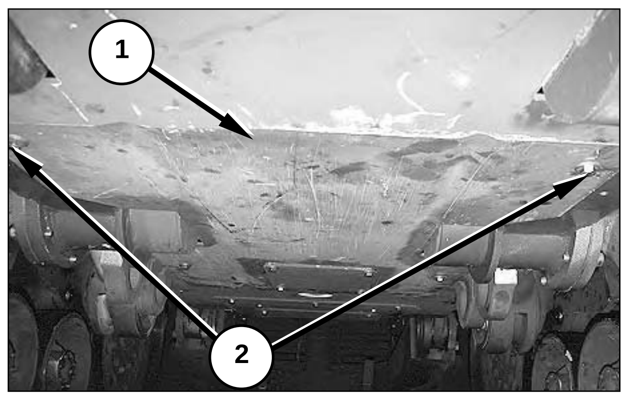
Remove and Install

NOTE: Group numbers related to this procedure include 126-6566 and 130-9240.

1. Release the hydraulic pressure from the left middle suspension cylinder. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage Steering and Brakes,* "Testing and Adjusting, Suspension System Procedures, Suspension Hydraulic Charging Procedure."

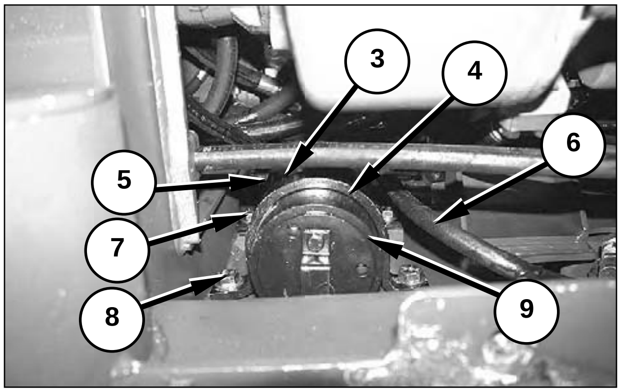
WARNING

Do not remove any accumulator without first removing the hydraulic pressure from the accumulator circuit. Personal injury or death can result from a sudden release of high pressure oil.



2. Remove two bolts (2) with washers, and allow bottom cover (1) to hang down. The weight of the cover is **50.5 kg (111 lb).**

NOTE: If dirt or other debris has accumulated on the top side, the bottom cover may weigh more than **50.5 kg (111 lb)**. Use a suitable floor jack or other tool to support the bottom cover if there is a large amount of debris.



3. Remove two bolts (7) and top clamp (3).

4. Loosen two bolts (8), and allow accumulator (9) to slide down and rest against the left frame rail.

5. Disconnect, cap and plug line (5), which goes to the charging valve at the rear of the machine.

6. Disconnect, cap and plug line (6), which goes to the left recoil cylinder.

7. Remove two bolts (8), top clamp (3) and accumulator (9).

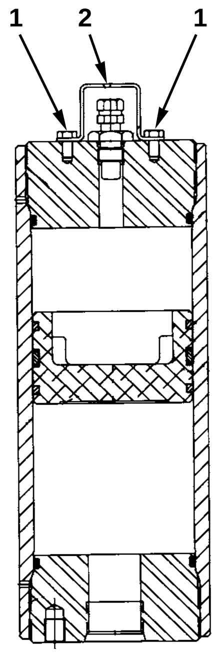
NOTE: To install the middle suspension cylinder accumulator, reverse the removal steps. Torque mounting bolts (8) to 125±20 Nm (92±14 lb ft). If a new accumulator is being installed, precharge the accumulator with dry nitrogen to the correct pressure. Refer to *“Specifications Systems Operation Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE),* Undercarriage Steering and Brakes, “Testing and Adjusting, Suspension System Procedures, Accumulator Charging Procedure.”

Disassemble and Assemble

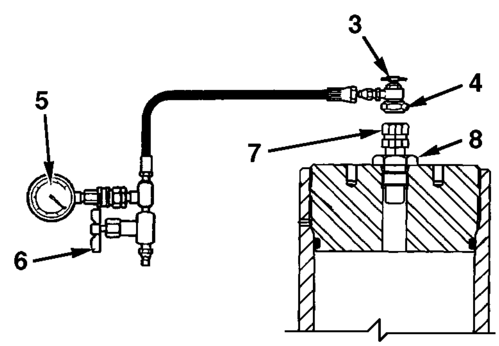
Tools Needed		
7S5437	Nitrogen Charging Group	1

Start By:

a. Remove the middle suspension accumulator, left side.



1. Remove bolts (1) and cover (2).



2. Install 8T-0857 Pressure Gauge (5) to the fitting on the 7S-5437 Nitrogen Charging Group.

3. Ensure that valve (6) is closed.

4. Attach connector (4) of the 7S-5437 Nitrogen Charging Group to gas valve (7) on the accumulator.

5. Turn valve (3) clockwise, until tight, and read the pressure which registers on pressure gauge (5).

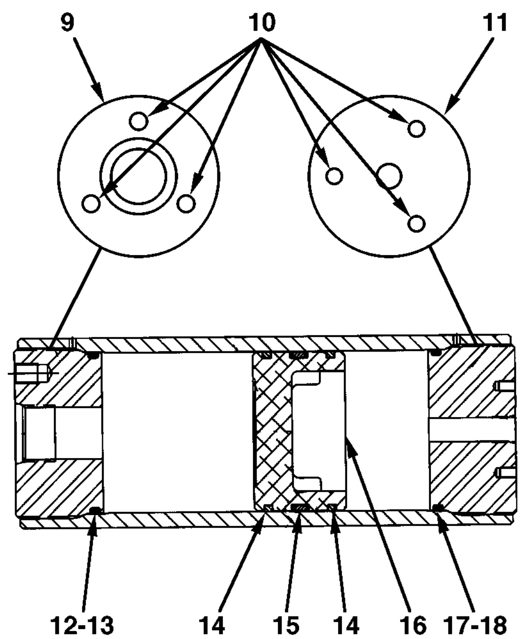
6. If the pressure is greater than 0 kPa (0 psi), open valve (6) slightly to slowly release the nitrogen gas. Direct the discharge of nitrogen away from personnel in the area. When the pressure on gauge (5) registers 0 kPa (0 psi), slowly open valve (6) completely to ensure that all of the nitrogen has been discharged from the accumulator.

7. Close valve (6), and remove connector (4) from gas valve (7).

8. Loosen nut (8), and remove gas valve (7) with the O-ring seal. Replace the O-ring seal if necessary.

WARNING

Do not remove gas valve (7) until all of the nitrogen gas has been removed from the accumulator.



9. Secure the accumulator with a strap wrench, or place the accumulator horizontally in a vise.

10. Remove gas end cap (11), and then remove hydraulic end cap (9).

NOTE: To remove end caps (9) and (11), place pins in holes (10), position a long bar between two of the pins, and use the bar and pins to unscrew the cap from the accumulator body.

11. Remove O-ring seal (17) and backup ring (18) from gas end cap (11).

12. Remove O-ring seal (13) and backup ring (12) from hydraulic end cap (9).

13. Use a bar to push piston (16) out of the accumulator housing.

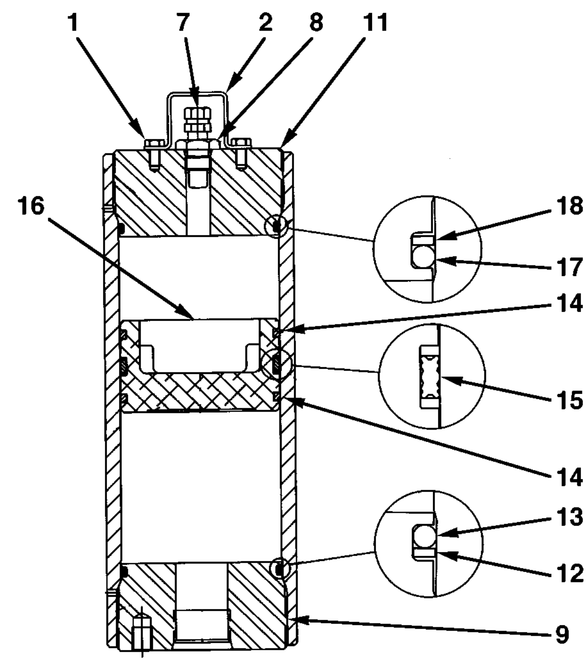
NOTE: Push on the hydraulic side of piston (16). The hydraulic side of the piston is flat and faces the end of the accumulator from which hydraulic end cap (9) was removed.

14. Remove wear rings (14) from piston (16).

15. Remove V-O-ring seal (15) with backup washers from piston (16).

NOTE: The following steps describe the procedure to assemble the accumulator.

NOTE: Ensure that all components are clean and dry. Coat internal parts with clean hydraulic oil before assembly.



16. Install V-O-ring seal (15) with backup washers on piston (16).

17. Install wear rings (14) on piston (16).

18. Place piston (16) in the accumulator housing with the flat end of the piston facing the hydraulic end of the accumulator. Ensure that the threads do not damage the V-O-ring.

19. Use a wood block and a hammer to tap piston (16) into the accumulator housing until the face of piston (16) is approximately **50 mm (2 in)** below the beginning of the honed bore in the accumulator housing.

NOTE: Install the piston slowly and ensure that the face of the piston remains square with the end of the accumulator housing. The piston fits snugly in the accumulator housing. As the piston is forced up the chamfer and into the housing, the V-O-ring seal compresses. To prevent the piston from springing out of the housing, constant force must be applied to the piston as the piston is forced up the chamfer.

20. Install backup ring (12), and then install O-ring seal (13) on hydraulic end cap (9).

21. Install hydraulic end cap (9) in the accumulator bore. Tighten the end cap until the face of end cap is **1.6 ± 0.8 mm (0.0625 ± 0.0313 in)** above the face of the accumulator housing.

NOTE: Ensure that the flat side of piston (16) is facing hydraulic end cap (9).

22. Install backup ring (18), and then install O-ring seal (17) on gas end cap (11).

23. Install gas end cap (11) in the accumulator bore. Tighten the end cap until the face of end cap is **1.6 ± 0.8 mm (0.0625 ± 0.0313 in)** above the face of the accumulator housing.

24. Install gas valve (7) with the O-ring seal. Tighten the gas valve to a torque of **1.4 ± 0.3 N•m (12.5 ± 2.5 lb in)**. Tighten nut (8) to a torque of **35 N•m (26 lb ft)** to secure the gas valve in gas end cap (11).

25. Charge the accumulator with nitrogen. For the charging procedure, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage, Steering and Brakes,* "Testing and Adjusting, Suspension System Procedures."

26. Place cover (2) over gas valve (7), and install bolts (1).

End By:

a. Install the middle suspension accumulator, left side.

Middle Suspension Cylinder Accumulator, Right

Remove and Install

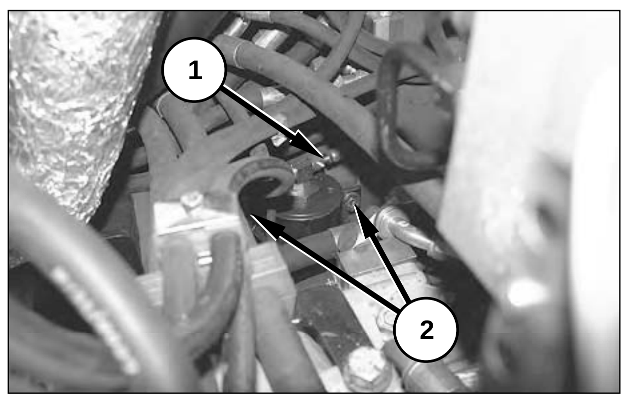
NOTE: Group numbers related to this procedure include 126-6566 and 130-9240.

1. Raise the radiator. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Machine Features, Radiator Tilt."

2. Release the hydraulic pressure from the middle suspension cylinder. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage Steering and Brakes,* "Testing and Adjusting, Suspension System Procedures, Suspension Hydraulic Charging Procedure."

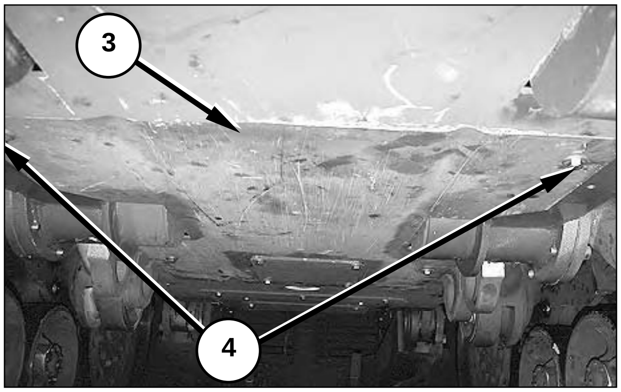
WARNING

Do not remove any accumulator without first removing the hydraulic pressure from the accumulator circuit. Personal injury or death can result from a sudden release of high pressure oil.



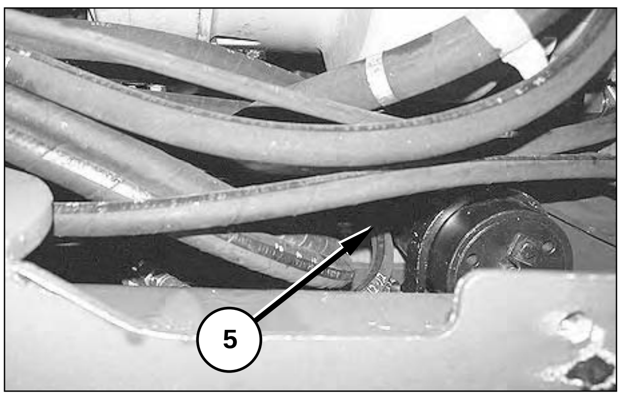
3. Disconnect, cap and plug line (1), which goes to the charging valve at the rear of the machine.

4. Loosen, but do not remove, two bolts (2).

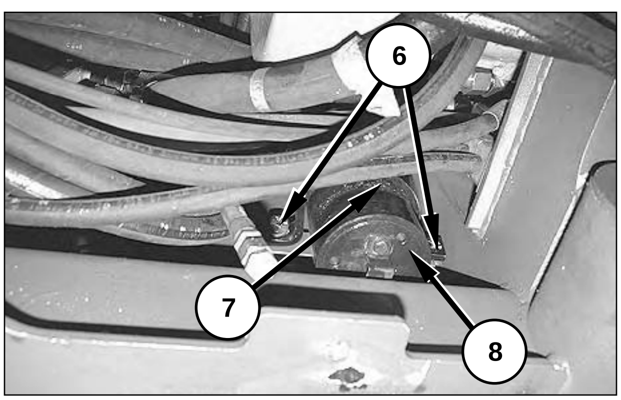


5. Remove two bolts (4) with washers, and allow bottom cover (3) to hang down. The weight of the cover is **50.5 kg (111 lb).**

NOTE: If dirt or other debris has accumulated on the top side, the bottom cover may weigh more than **50.5 kg (111 lb)**. Use a suitable floor jack, or other tool, to support the bottom cover if there is a large amount of debris.



6. Disconnect, cap and plug line (5) from the middle suspension cylinder.



7. Loosen two bolts (6), and allow accumulator (8) to slide down and rest on the right frame.

8. Remove two bolts (6) and clamp (7), and remove accumulator (8).

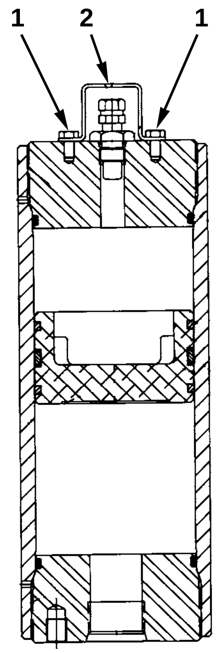
NOTE: To install the middle suspension cylinder accumulator, reverse the removal steps. If a new accumulator is being installed, precharge the accumulator with dry nitrogen to the correct pressure. Refer to *Specifications Systems Operation Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage Steering and Brakes,* “Testing and Adjusting,Suspension System Procedures, Accumulator Charging Procedure.”

Disassemble and Assemble

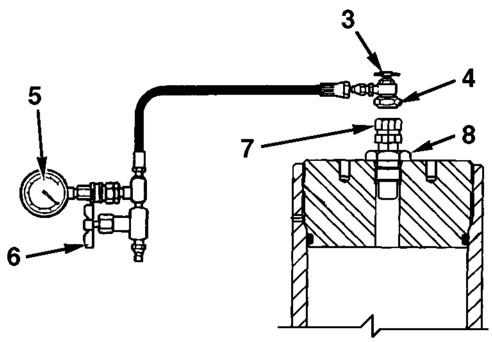
Tools Needed		
7S5437	Nitrogen Charging Group	1

Start By:

a. Remove the middle suspension accumulator, right side.



1. Remove bolts (1) and remove cover (2).



2. Install 8T-0857 Pressure Gauge (5) to the fitting on the 7S-5437 Nitrogen Charging Group.

3. Ensure that valve (6) is closed.

4. Attach connector (4) of the 7S-5437 Nitrogen Charging Group to gas valve (7) on the accumulator.

5. Turn valve (3) clockwise, until tight, and read the pressure which registers on pressure gauge (5).

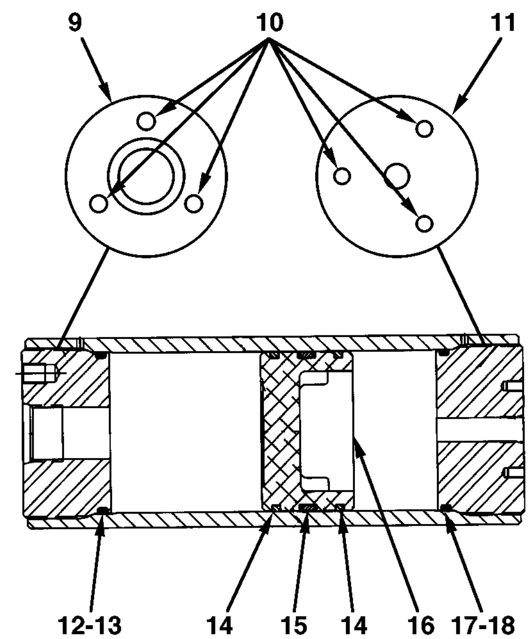
6. If the pressure is greater than 0 kPa (0 psi), open valve (6) slightly to slowly release the nitrogen gas. Direct the discharge of nitrogen away from personnel in the area. When the pressure on gauge (5) registers 0 kPa (0 psi), slowly open valve (6) completely to ensure that all of the nitrogen has been discharged from the accumulator.

7. Close valve (6), and remove connector (4) from gas valve (7).

8. Loosen nut (8), and remove gas valve (7) with the O-ring seal. Replace the O-ring seal if necessary.

WARNING

Do not remove gas valve (7) until all of the nitrogen gas has been removed from the accumulator.



9. Secure the accumulator with a strap wrench, or place the accumulator horizontally in a vise.

10. Remove gas end cap (11), and then remove hydraulic end cap (9).

NOTE: To remove end caps (9) and (11), place pins in holes (10), position a long bar between two of the pins, and use the bar and pins to unscrew the cap from the accumulator body.

11. Remove O-ring seal (17) and backup ring (18) from gas end cap (11).

12. Remove O-ring seal (13) and backup ring (12) from hydraulic end cap (9).

13. Use a bar to push piston (16) out of the accumulator housing.

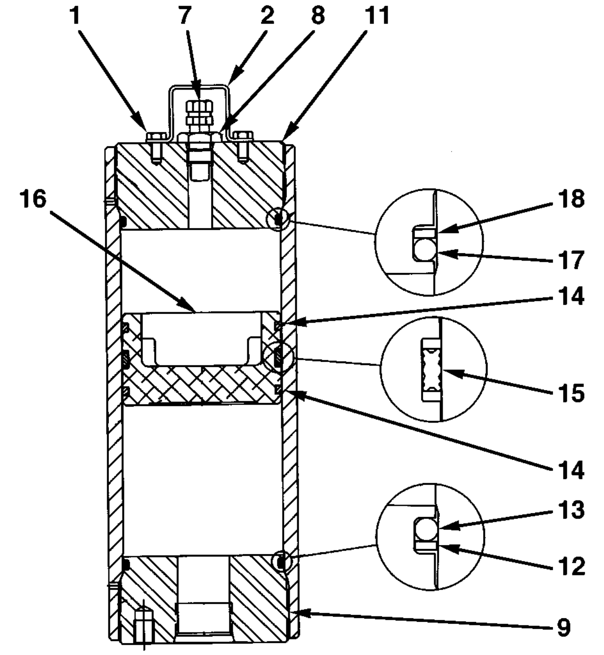
NOTE: Push on the hydraulic side of piston (16). The hydraulic side of the piston is flat and faces the end of the accumulator from which hydraulic end cap (9) was removed.

14. Remove wear rings (14) from piston (16).

15. Remove V-O-ring seal (15) with backup washers from piston (16).

NOTE: The following steps describe the procedure to assemble the accumulator.

NOTE: Ensure that all components are clean and dry. Coat internal parts with clean hydraulic oil before assembly.



16. Install V-O-ring seal (15) with backup washers on piston (16).

17. Install wear rings (14) on piston (16).

18. Place piston (16) in the accumulator housing with the flat end of the piston facing the hydraulic end of the accumulator. Ensure that the threads do not damage the V-O-ring.

19. Use a wood block and a hammer to tap piston (16) into the accumulator housing until the face of piston (16) is approximately **50 mm (2 in)** below the beginning of the honed bore in the accumulator housing.

NOTE: Install the piston slowly and ensure that the face of the piston remains square with the end of the accumulator housing. The piston fits snugly in the accumulator housing. As the piston is forced up the chamfer and into the housing, the V-O-ring seal compresses. To prevent the piston from springing out of the housing, constant force must be applied to the piston as the piston is forced up the chamfer.

20. Install backup ring (12), and then install O-ring seal (13) on hydraulic end cap (9).

21. Install hydraulic end cap (9) in the accumulator bore. Tighten the end cap until the face of end cap is **1.6 ± 0.8 mm (0.0625 ± 0.0313 in)** above the face of the accumulator housing.

NOTE: Ensure that the flat side of piston (16) is facing hydraulic end cap (9).

22. Install backup ring (18), and then install O-ring seal (17) on gas end cap (11).

23. Install gas end cap (11) in the accumulator bore. Tighten the end cap until the face of end cap is **1.6 ± 0.8 mm (0.0625 ± 0.0313 in)** above the face of the accumulator housing.

24. Install gas valve (7) with the O-ring seal. Tighten the gas valve to a torque of **1.4 ± 0.3 N•m (12.5 ± 2.5 lb in)**. Tighten nut (8) to a torque of **35 N•m (26 lb ft)** to secure the gas valve in gas end cap (11).

25. Charge the accumulator with nitrogen. For the charging procedure, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage, Steering and Brakes,* "Testing and Adjusting, Suspension System Procedures."

26. Place cover (2) over gas valve (7), and install bolts (1).

End By:

a. Install the front suspension accumulator, right side.

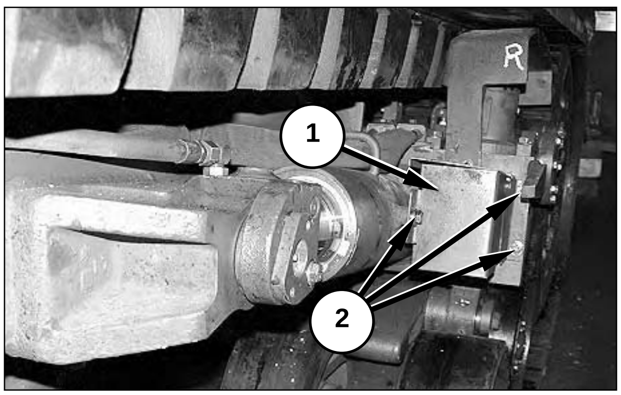
Minor Bogie Accumulator, Left and Right

Remove and Install

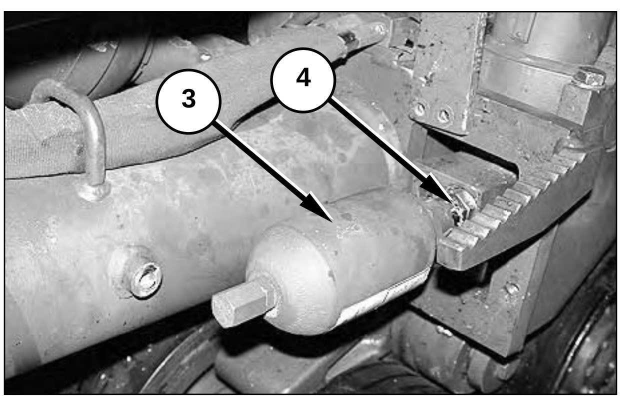
NOTE: Group numbers related to this procedure include 9T-6148, 124-3847, and 169-7416.

NOTE: The following procedure is for the component on the right side of the machine. The procedure for the component on the left side of the machine is the same.

1. Remove the hydraulic pressure in the minor bogie cylinder. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage Steering and Brakes,* "Testing and Adjusting, Suspension System Procedures, Suspension Hydraulic Charging Procedure."



2. Remove three bolts (2) with the washers, and cover (1).



3. Turn union fitting (4) counterclockwise, and remove the union fitting together with midroller bogie accumulator (3).

⚠ WARNING

Do not remove any accumulator without first removing the hydraulic pressure from the accumulator circuit. Personal injury or death can result from a sudden release of high pressure oil.

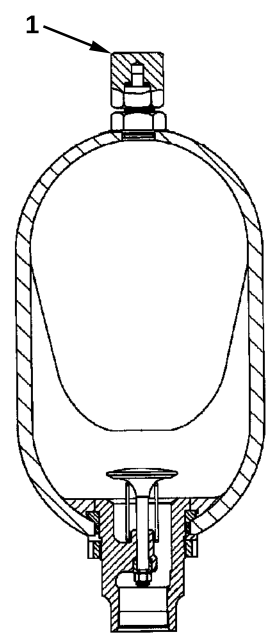
NOTE: To install the minor bogie accumulator, reverse the removal steps. If a new accumulator is being installed, precharge the accumulator with nitrogen. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage Steering and Brakes,* "Testing and Adjusting, Suspension System Procedures, Accumulator Charging Procedure."

Disassemble and Assemble

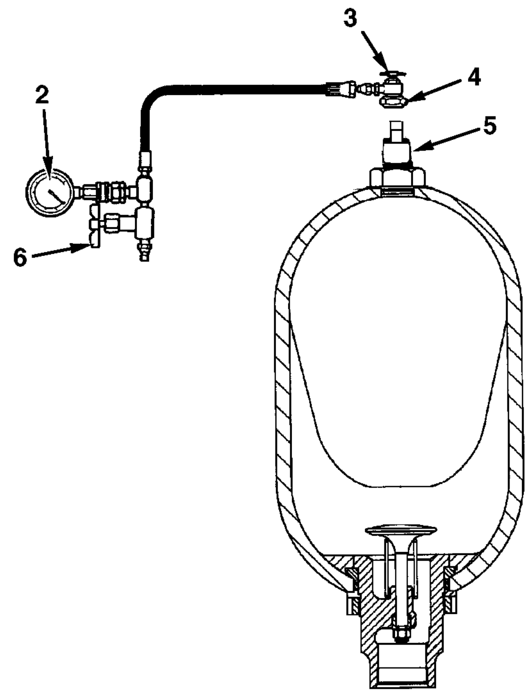
Tools Needed		
7S5437	Nitrogen Charging Group	1

Start By:

a. Remove the minor bogie accumulator.



1. Remove valve cover (1).



2. Install 7S-8712 Pressure Gauge (2) to the fitting on the 7S-5437 Nitrogen Charging Group.

3. Ensure that valve (6) is closed.

4. Attach connector (4) of the 7S-5437 Nitrogen Charging Group to gas valve (5) on the accumulator.

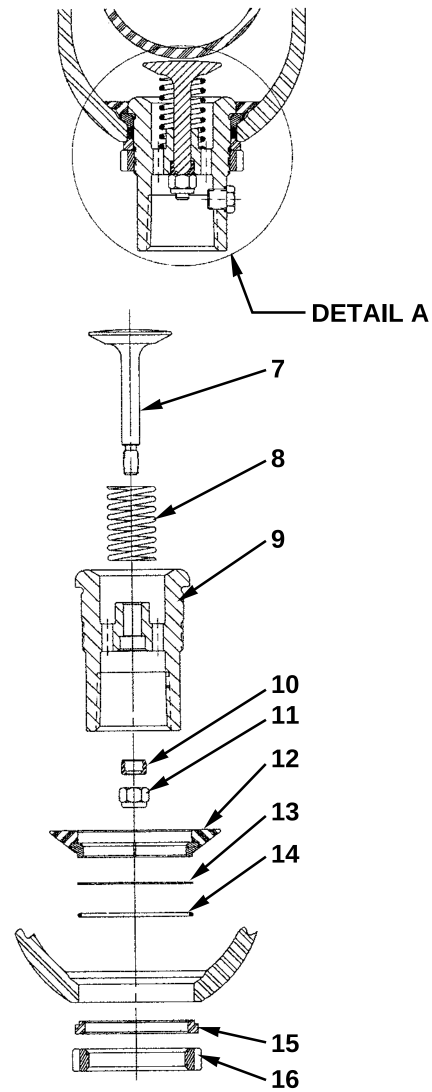
5. Turn valve (3) clockwise, until tight, and read the pressure which registers on pressure gauge (2).

6. If the pressure is greater than 0 kPa (0 psi), open valve (6) slightly to slowly release the nitrogen gas. Direct the discharge of nitrogen away from personnel in the area. When the pressure on gauge (2) registers 0 kPa (0 psi), slowly open valve (6) completely to ensure that all of the nitrogen has been discharged from the accumulator.

7. Close valve (6), and remove connector (4) from gas valve (5).

8. Secure the accumulator in a chain vise.

NOTE: If a chain vise is not available, a standard jaw vise with brass inserts can be used.



DETAIL A

9. Remove lock nut (16) and spacer (15).

⚠ WARNING

Only remove lock nut (16) if all of the nitrogen gas has been removed from the accumulator.

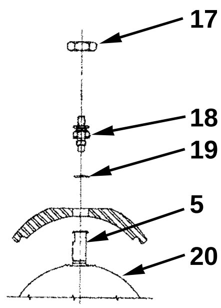
10. Push port assembly (9) into the accumulator housing.

11. Remove O-ring seal (14) and metal backup ring (13) from the accumulator housing.

12. Remove anti-extrusion ring (12) from port assembly (9), and then remove the anti-extrusion ring from the accumulator housing.

13. Remove port assembly (9) from the accumulator housing.

NOTE: If necessary, remove lock nut (11), poppet (10), valve (7), and spring (8) from port assembly (9).



14. Remove nut (17).

15. Remove valve core (18) and seal (19) from gas valve (5).

16. Remove bladder (20) from the accumulator housing.

NOTE: The following steps describe the assembly procedure.

17. Coat the inside of the accumulator housing with clean hydraulic oil.

18. Install bladder (20) in the accumulator housing.

NOTE: Collapse and fold bladder (20) lengthwise into a tight roll. A slight twisting of the bladder will assist with installation. A bladder pull rod (a rod with a threaded cap on the end which fits over the gas valve) can be fabricated and used to install the bladder.

19. Install nut (17) by hand. Tighten the nut to a torque of **76 N•m (56 lb ft)**.

20. Insert port assembly (9) into the accumulator housing with the threaded end facing out. Push the port assembly completely inside the accumulator housing.

NOTE: If lock nut (11), poppet (10), valve (7), and spring (8) were removed from port assembly (9) during disassembly, reinstall the components before the port assembly is inserted into the accumulator housing.

21. Install anti-extrusion ring (12) in the accumulator housing, and then install the anti-extrusion ring on port assembly (9).

NOTE: This step must be performed with anti-extrusion ring (12) and port assembly (9) inside of the accumulator housing.

22. Pull the threaded end of port assembly (9) through the port in the accumulator housing until the non-threaded end of the port assembly is seated against the inside of the accumulator housing

23. Install seal (19) and valve core (18) in gas valve (5). Tighten the valve core to a torque of **0.4 N•m (3.5 lb in)**.

24. Charge the accumulator with dry nitrogen until the pressure reaches approximately **276 to 345 kPa (40 to 50 psi)**. For the accumulator charging procedure, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage, Steering, and Brakes* “Testing and Adjusting, Suspension System Procedures.”

25. Install metal backup ring (13) so the ring is firmly seated against anti-extrusion ring (12).

26. Install O-ring seal (14).

27. Install spacer (15) with the smaller diameter of the shoulder facing the accumulator housing.

28. Install lock nut (16). Tighten the lock nut to a torque of **100 N•m (73 lb ft)**.

29. Pour approximately **47 mL (3 cu in)** of clean hydraulic oil into the accumulator.

30. Charge the accumulator with dry nitrogen to the specified pressure. For the accumulator charging procedure, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage, Steering, and Brakes* “Testing and Adjusting, Suspension System Procedures.”

31. Install valve cover (1). Tighten the valve cover to a torque of **19 N•m (14 lb ft)**.

End By:

a. Install the minor bogie accumulator.

Minor Bogie Cylinder, Left and Right

Remove and Install

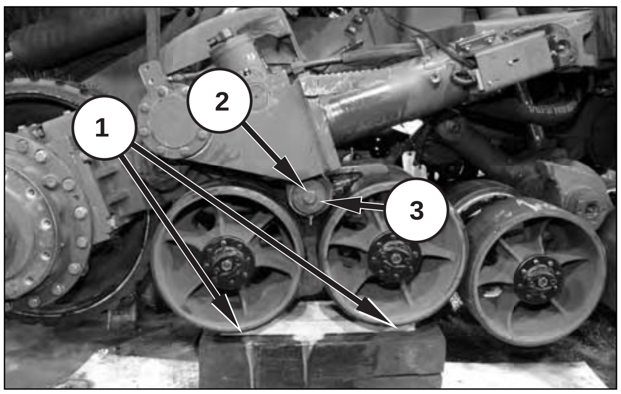
NOTE: Group numbers related to this procedure include 124-3847, 169-7416, and 169-7417.

NOTE: The following procedure is for the component on the right side of the machine. The procedure for the component on the left side of the machine is the same.

Start By:

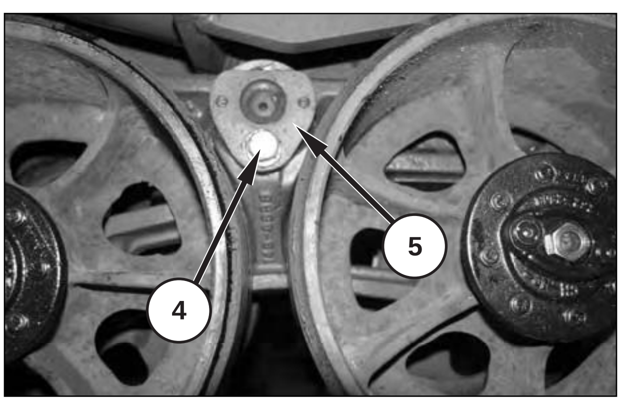
a. Remove the drive belt.

b. Remove the minor bogie accumulator.



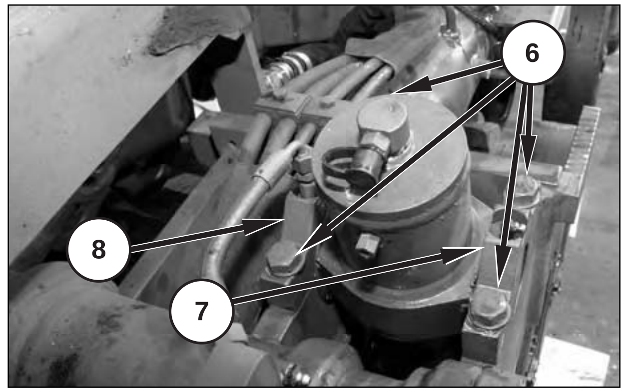
1. Add blocks beneath midrollers (1) to support them in position.

2. Remove bolt (3) and retainer (2) from the cylinder pin. Upon reassembly, apply **9S-3263 Thread Compound (Loctite™ 242)** to the threads of the bolt, and tighten the bolt to a torque of **570 ± 80 N•m (420 ± 59 lb ft).**



3. Remove bolt (4) with washer. Move pin (5) out until the rod eye of the minor bogie cylinder is free of the pin. Upon reassembly, apply **9S-3263 Thread Compound (Loctite™ 242)** to the threads, and tighten the bolt to a torque of **300 ± 40 N•m (222 ± 30 lb ft).**

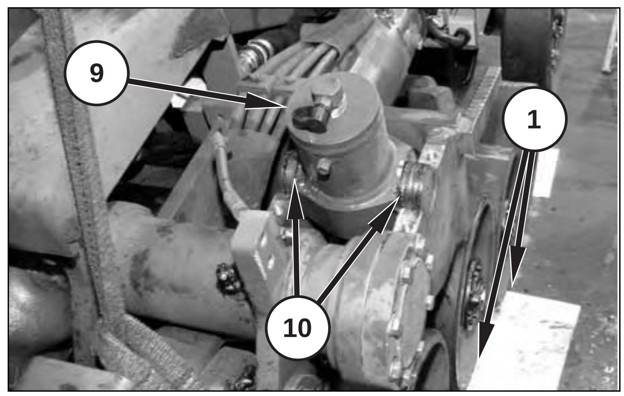
NOTE: Do not remove pin (5): the pin is necessary to retain the minor bogie assembly.



4. Remove four bolts (6) with washers.

5. Remove outer bearing cap (7).

6. Move aside inner bearing cap (8), with grease hose attached.



7. Reposition the blocks to allow the front set of midrollers (1) to hang down, with the rear set of midrollers supported by the blocks.

8. Remove minor bogie cylinder (9) with shims (10). If a new minor bogie cylinder is installed, add shims as necessary to remove any gap between the cylinder and the frame.

NOTE: To install the minor bogie cylinder, reverse the disassembly steps and recharge the cylinder. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage Steering and Brakes,* “Testing and Adjusting, Suspension System Procedures, Suspension Hydraulic Charging Procedure,” to recharge the minor bogie cylinder.

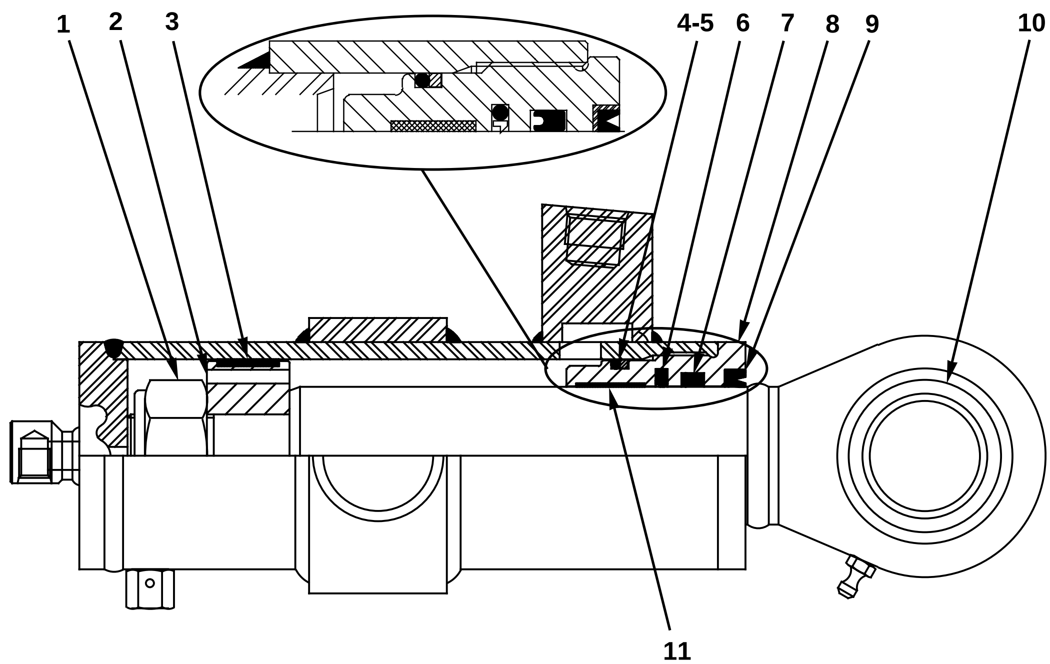
End By:

a. Install the minor bogie accumulator.

b. Install the drive belt.

Disassemble and Assemble

Tools Needed		A
124-3848	Spanner	1



Start By:

a. Remove the minor bogie cylinder

NOTE: The group number related to this procedure is 124-3844.

1. Use Tooling (A) to remove head (8) with rod and piston (2). Upon reassembly, tighten the head to a torque of **340 N•m (250 lb ft)**.

2. Remove nut (1) and piston (2). Upon reassembly, replace the nut, and tighten the new nut to a torque of **388 N•m (285 lb ft)**.

3. Remove wear ring (3) from piston (2). Replace the wear ring if there is damage or wear. Upon reassembly and prior to installation, apply clean hydraulic oil to the wear ring.

4. Remove head (8) from the rod.

5. Remove O-ring seal (4), backup ring (5), wear ring (11), buffer ring (6), rod seal (7), and rod wiper (9) from head (8). Replace any of these components that are damaged or worn. Upon reassembly and prior to installation, apply clean hydraulic oil to the backup ring, wear ring, buffer ring, rod seal, and rod wiper.

6. If necessary, remove and replace bearing (10).

NOTE: To assemble the minor bogie cylinder, reverse the disassembly steps.

End By:

a. Install the minor bogie cylinder.

Planetary Transmission

Disassemble

Tools Needed		A	B	C	D	E
138-7575	Link Bracket	3				
FT-0833	Pliers		1			
1P-1863	Pliers, Retaining Ring			1		
FT-0947	Pliers				2	
136-1452	Pliers, Retaining Ring					1
		F	G			
1P-0520	Driver Group	1				
2P-8312	Pliers, Snap Ring		1			

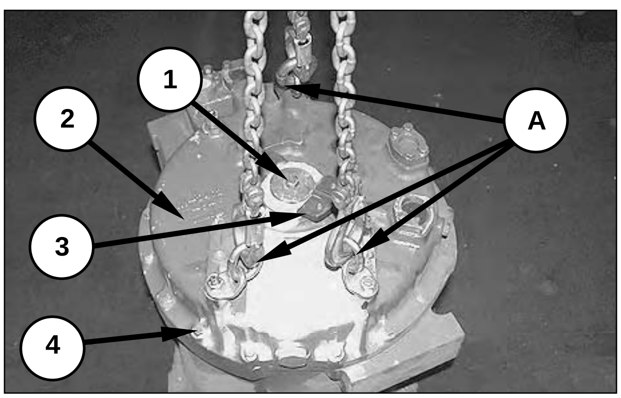
Start By:

a. Remove the transmission control valve.

b. Remove the differential steering unit and transmission.

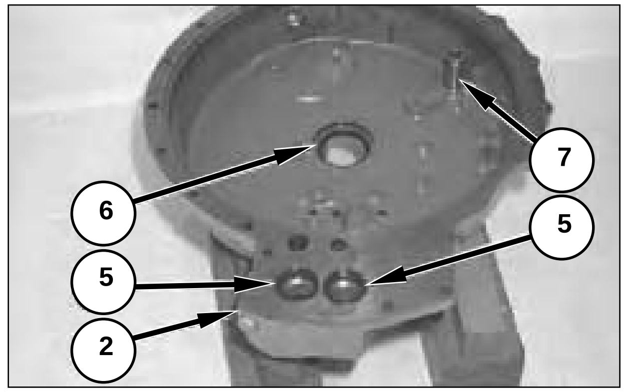
c. Separate the differential steering unit and transmission.

NOTE: Group numbers related to this procedure include 6I-9234 and 124-5269.

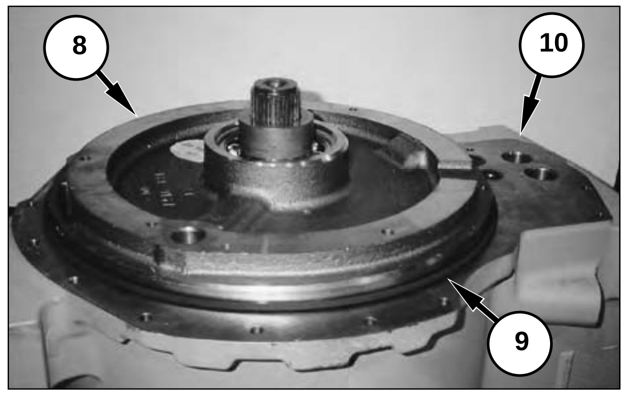


1. Remove bolt (1) and flange (3).

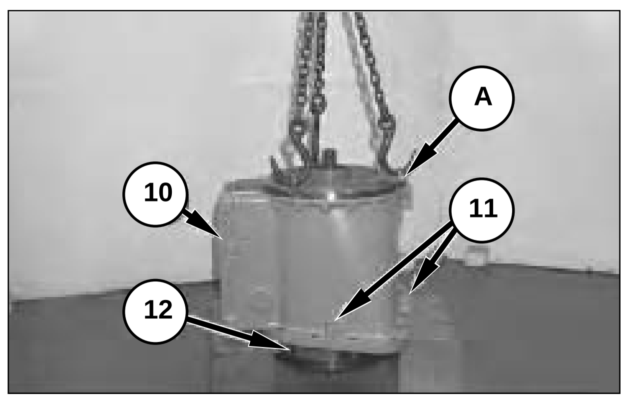
2. Connect cover (2) and Tooling (A) to a suitable lifting device. Remove 17 bolts (4), and remove the cover from the case. The weight of the cover is **52 kg (115 lb).**



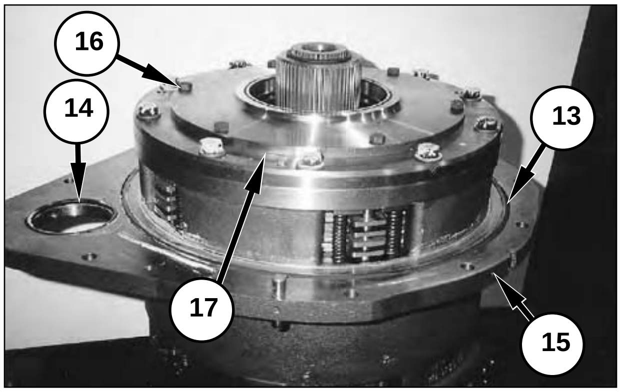
3. Remove two O-ring seals (5), lip seal (6) and sleeve (7) from transmission cover (2).



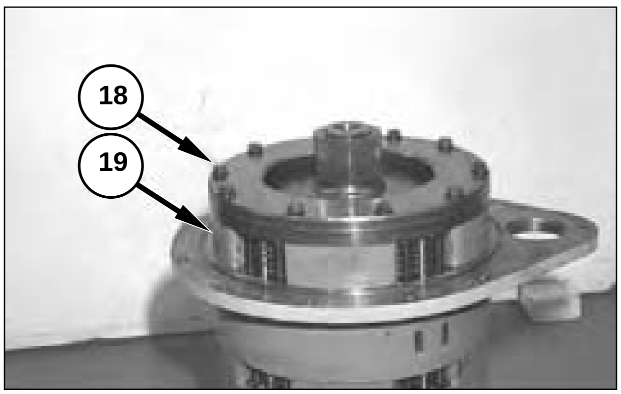
4. Remove spacer (8) and O-ring seal (9) from transmission case (10).



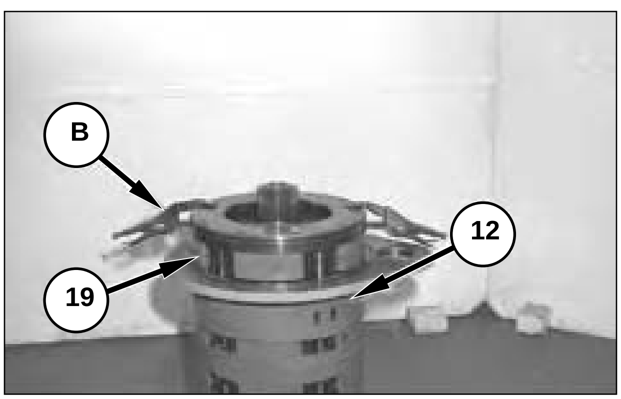
5. Attach Tooling (A) and a hoist to transmission case (10). Remove three bolts (11), and remove the transmission case from planetary group (12). The transmission case weighs approximately **100 kg (220 lb).**



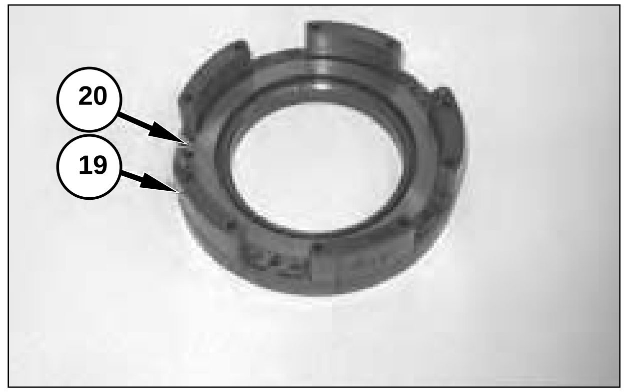
6. Turn the planetary group over. Remove O-ring seal (13) and (14) from manifold assembly (15). Remove six bolts (16) and cage bearing and race (17).



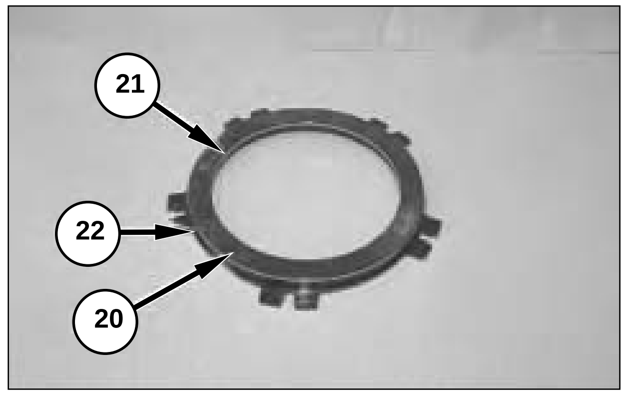
7. Remove ten bolts (18) and the washers from clutch housing (19).



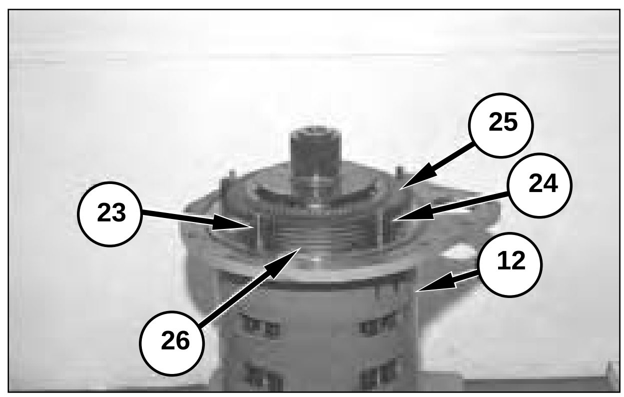
8. Use Tooling (B) to hold the piston into clutch housing (19). Use two persons to remove the clutch housing from planetary group (12). The clutch housing weighs approximately **28 kg (61 lb).**



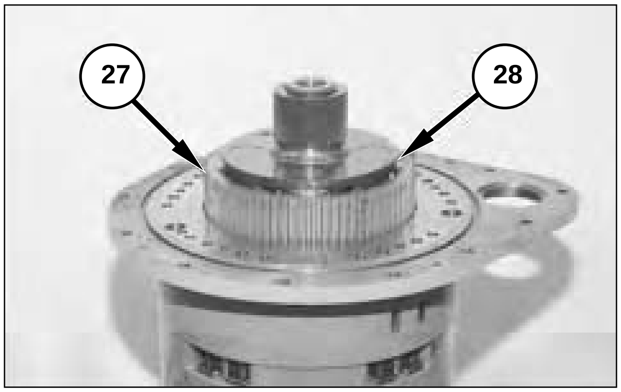
9. Remove piston (20) from clutch housing (19).



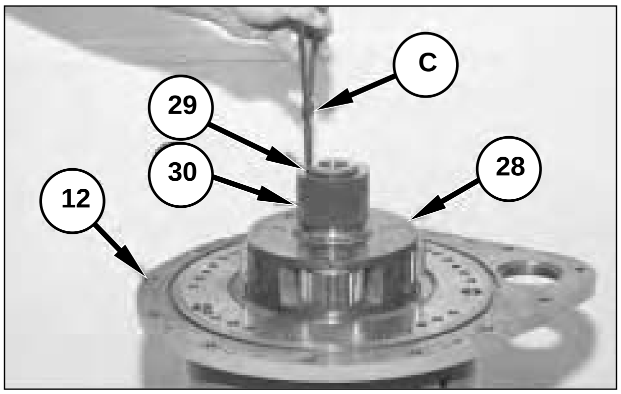
10. Remove O-ring seals (21) and (22) from piston (20).



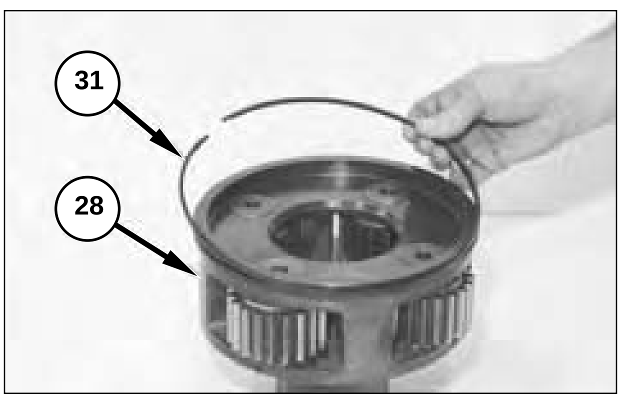
11. Remove five dowels (25), ten springs (26), five friction disks (27) and four clutch plates (28) from planetary group (12).



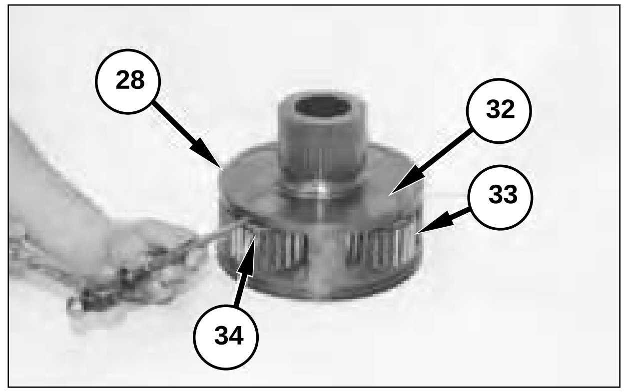
12. Remove ring gear (27) from carrier (28).



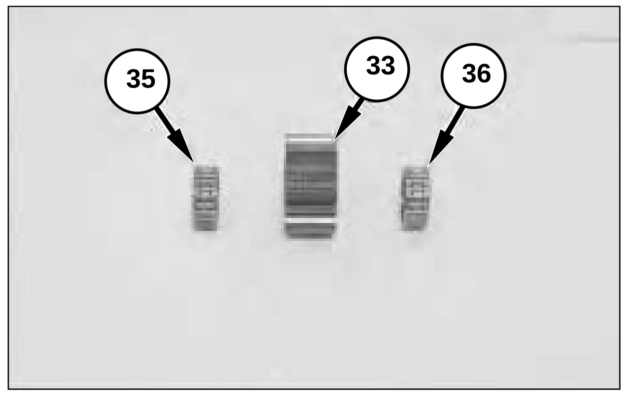
13. Use Tooling (C) to remove retaining ring (29) from output shaft (30). Remove carrier (28) from planetary group (12).



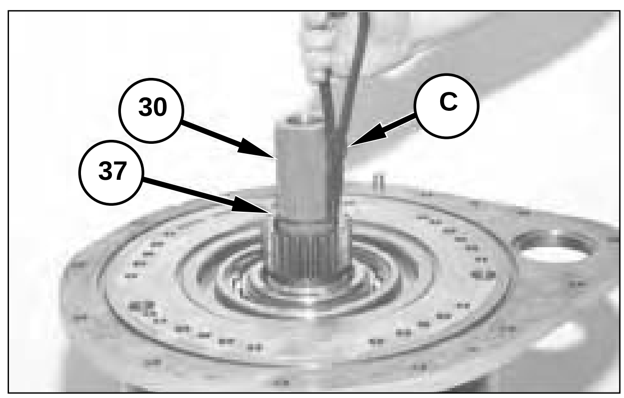
14. Remove seal ring (31) from carrier (28).



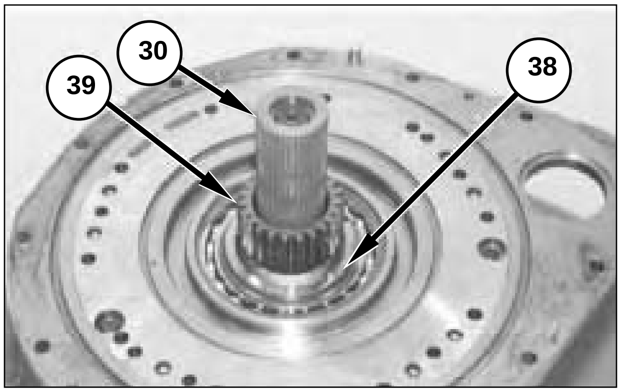
15. Use a hammer and a punch to remove the pins from four planet shafts (32). Remove the four planet shafts, four gear assemblies (33) and eight thrust disks (34) from carrier (28).



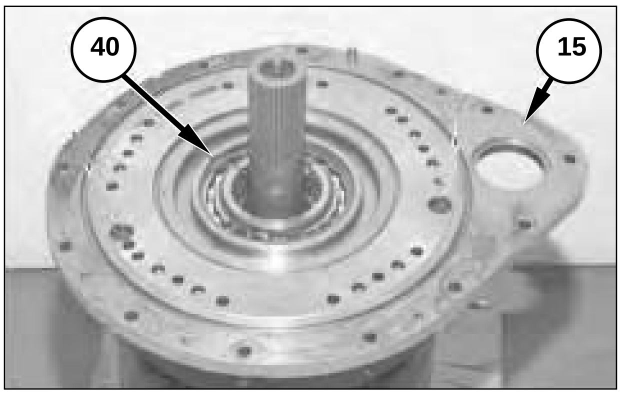
16. Remove bearings (35) and (36) from planet gear assembly (33).



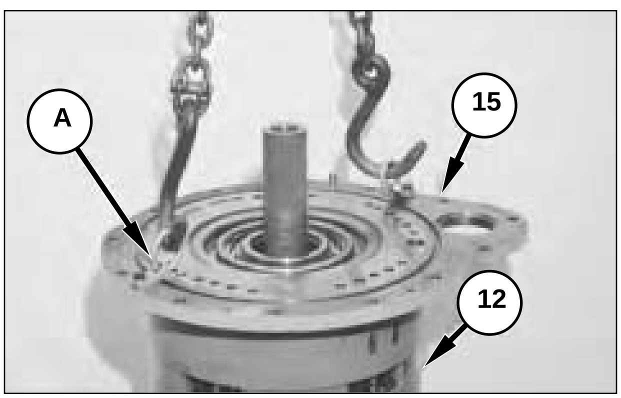
17. Use Tooling (C) to remove retaining ring (37) from output shaft (30).



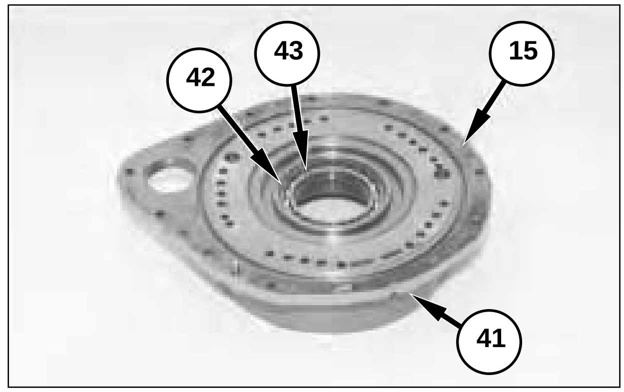
18. Remove retaining ring (38) and sun gear (39) from output shaft (30).



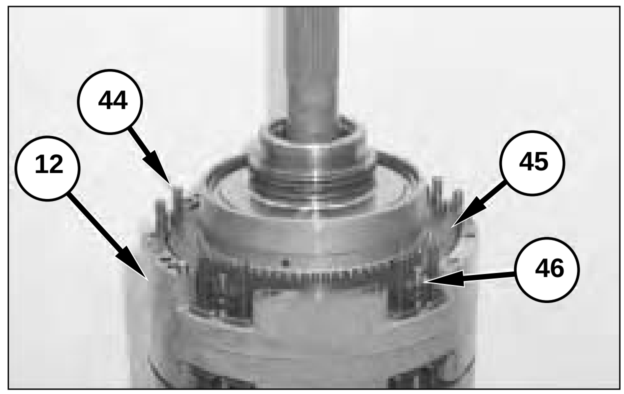
19. Use Tooling (E) to remove retaining ring (40) from manifold assembly (15).



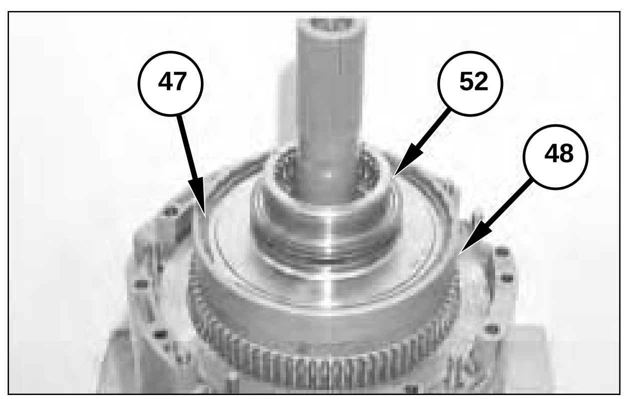
20. Attach Tooling (A) and a hoist to manifold assembly (15). Remove the manifold assembly from planetary group (12). The manifold assembly weighs approximately **61 kg (135 lb).**



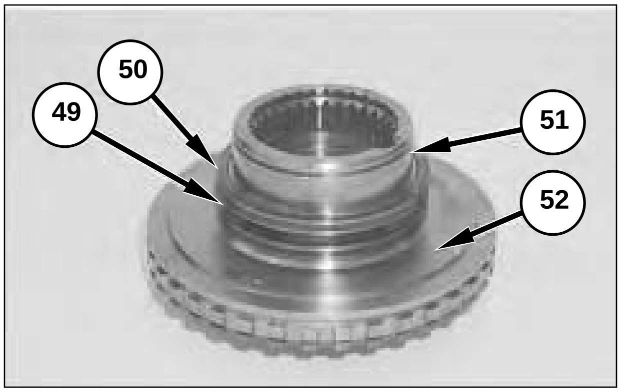
21. Use Tooling (E) to remove retaining ring (42), and remove bearing (43) from manifold assembly (15). Remove O-ring seal (41) from the manifold assembly.



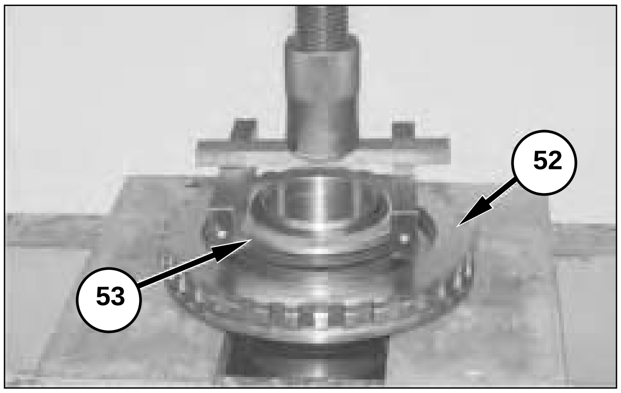
22. Remove ten springs (44), three friction disks (45) and two clutch plates (46) from planetary group (12).



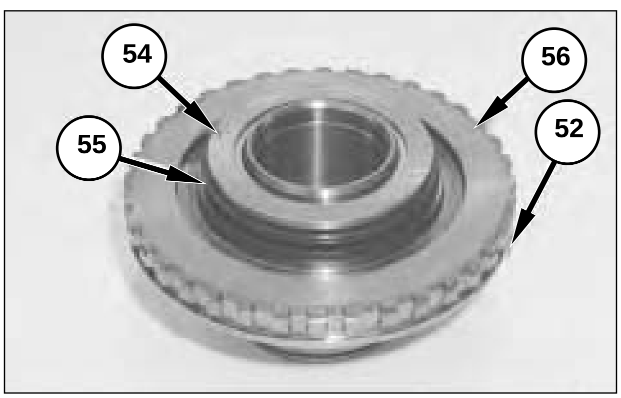
23. Remove retaining ring (47) and clutch housing (52) from ring gear (48).



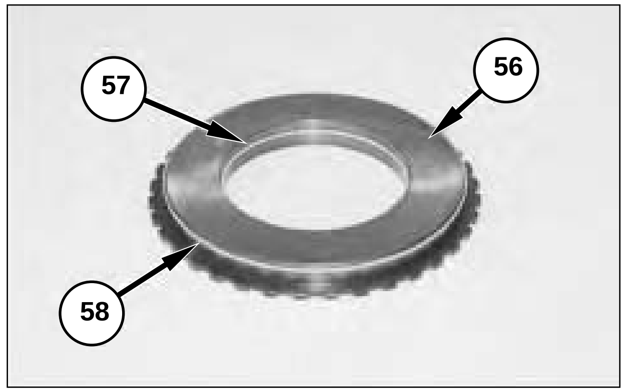
24. Remove seal ring (49) from carrier (50). Remove O-ring seal (51) from clutch housing (52).



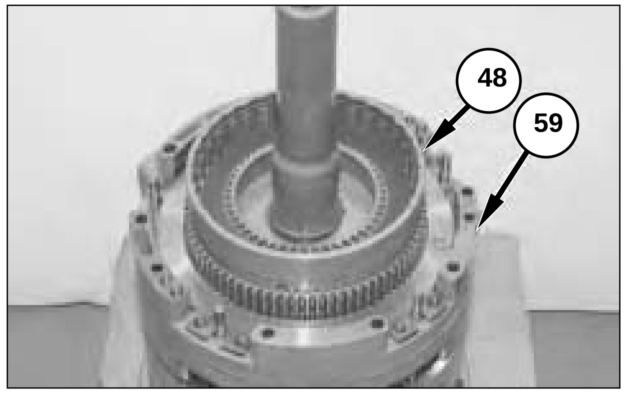
25. Use steel spacers and a press to remove retaining ring (53) from clutch housing (52). Compress the springs and remove the retaining ring with Tooling (G).



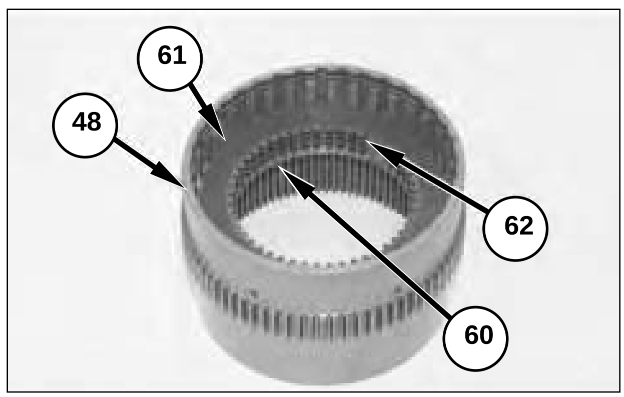
26. Remove plate (54), three springs (55) and piston (56) from clutch housing (52).



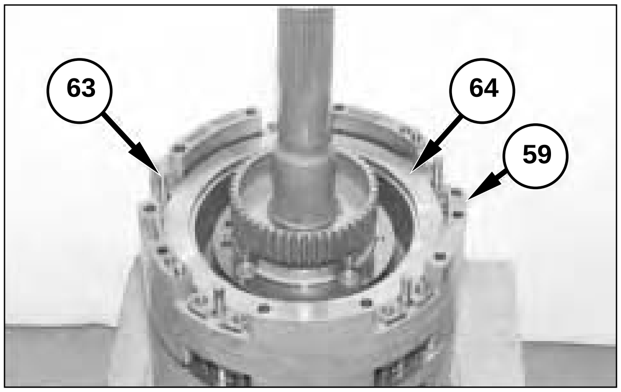
27. Remove seal ring (57) and ring seal (58) from piston (56).



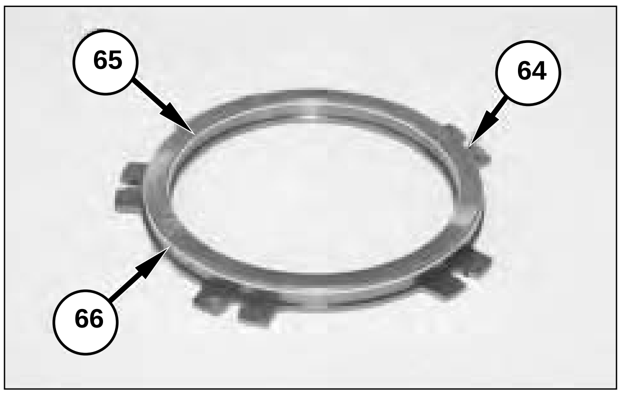
28. Remove ring gear (48) from clutch housing (59).



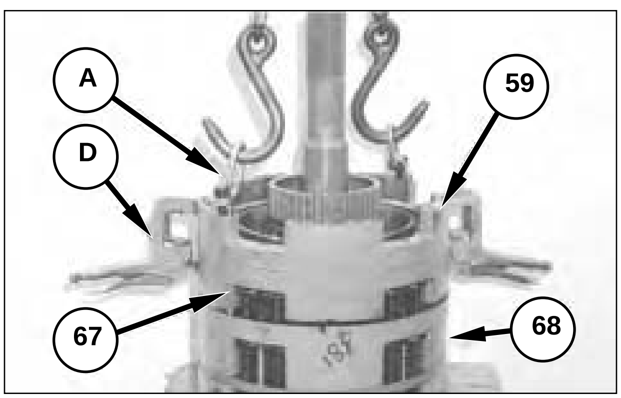
29. Remove four friction disks (61) and three clutch plates (62) from ring gear (48). Remove clutch plate (60).



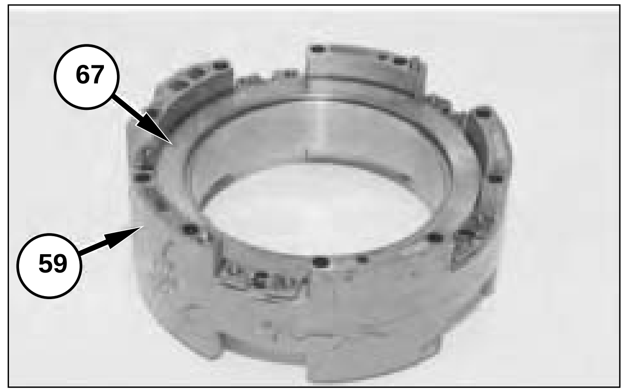
30. Remove four dowels (63) and piston (64) from clutch housing (59).



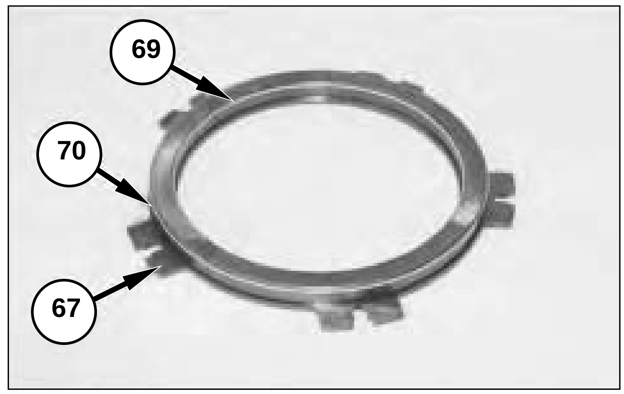
31. Remove seal ring (65) and seal ring (66) from piston (64).



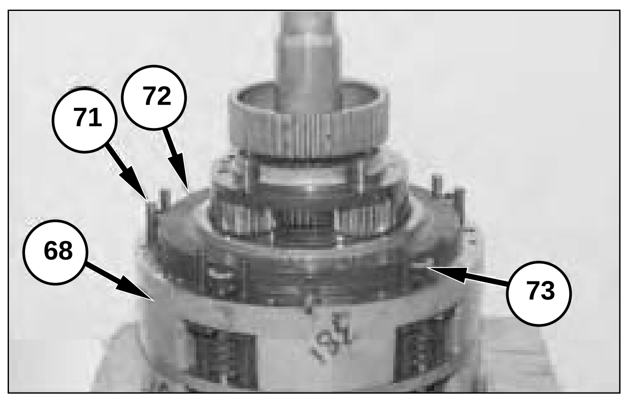
32. Attach Tooling (A) to clutch housing (59). Use Tooling (D) to hold piston (67) to clutch housing (59). Remove clutch housing (59) from clutch housing (68). The clutch housing weighs approximately **39 kg (85 lb).**



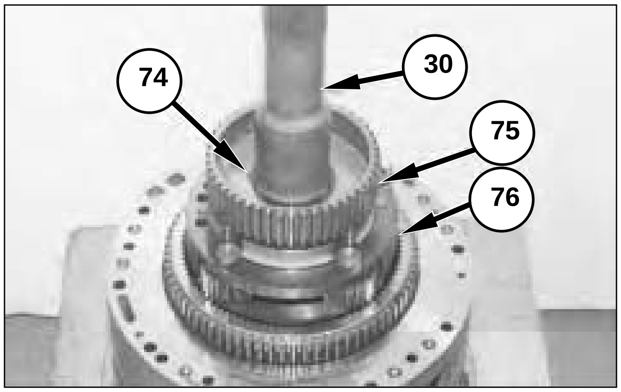
33. Remove piston (67) from clutch housing (59).



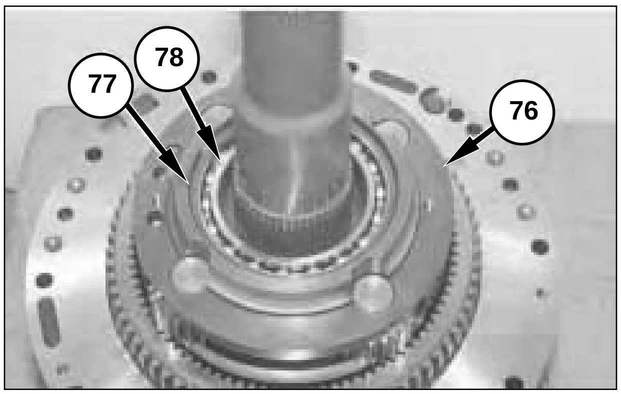
34. Remove seal ring (69) and seal ring (70) from piston (67).



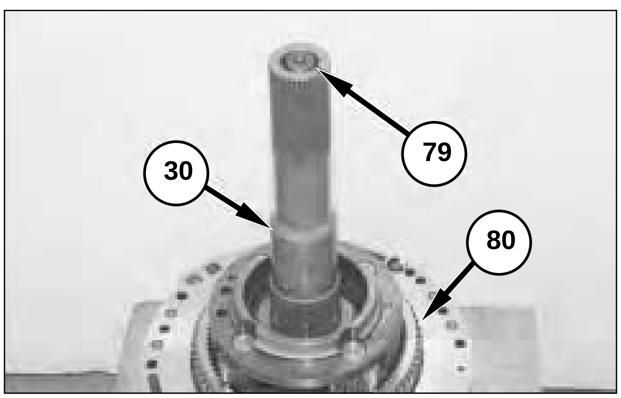
35. Remove ten springs (71), three friction disks (72) and two clutch plates (73) from clutch housing (68).



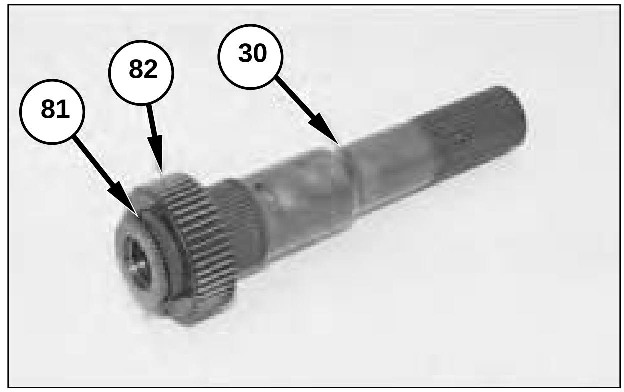
36. Use Tooling (C) to remove retaining ring (74) from output shaft (30). Remove rotating hub (75) from planet carrier (76).



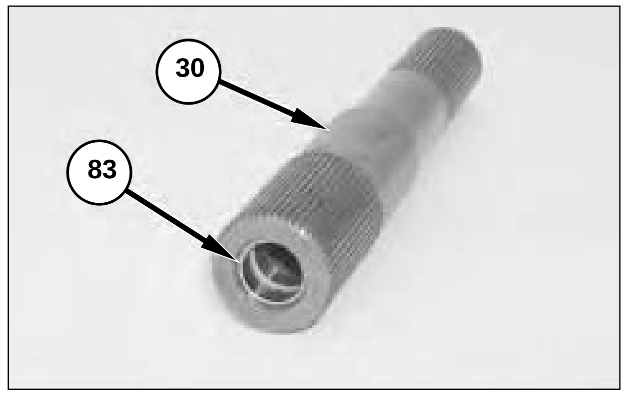
37. Remove retaining ring (77) and bearing (78) from planet carrier (76).



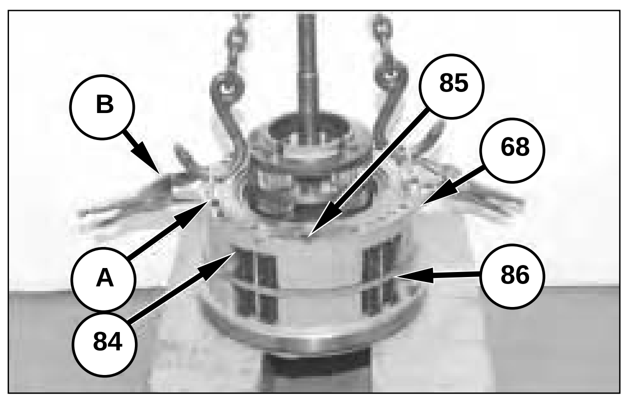
38. Remove output shaft (30) from input shaft (79). Remove ring gear (80).



39. Use Tooling (C) to remove retaining ring (81) from output shaft (30). Remove sun gear (82) from the output shaft.

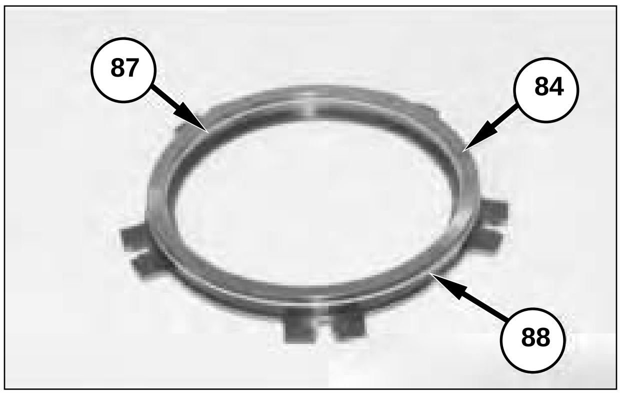


40. Remove sleeve bearing (83) from both ends of output shaft (30).

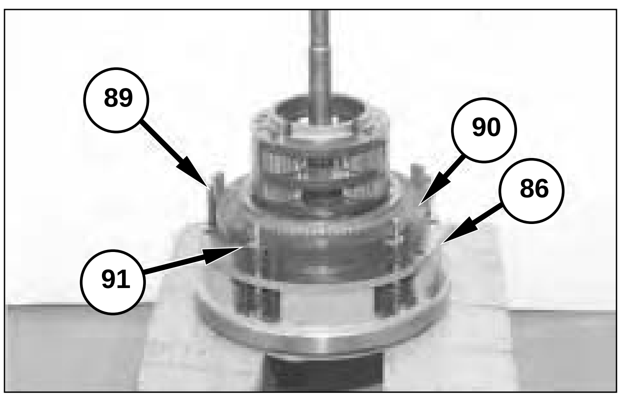


41. Install Tooling (A) and a hoist to clutch housing (68). Use Tooling (B) to hold piston (84) to the clutch housing. Remove two bolts (85) and the clutch housing from plate (86). The clutch housing weighs approximately **25 kg (55 lb).**

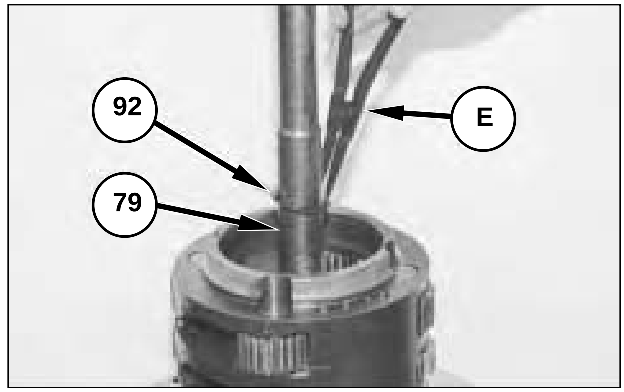
42. Remove piston (84) from clutch housing (68).



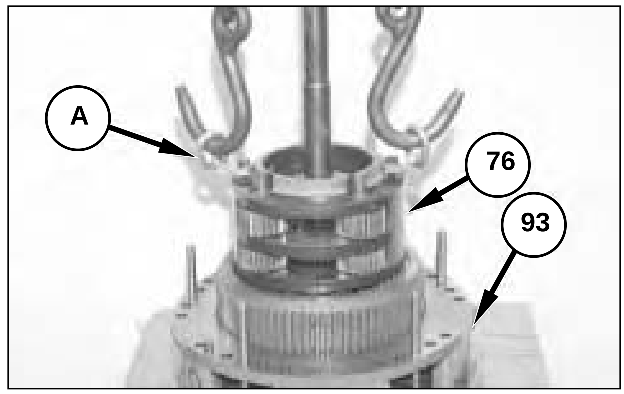
43. Remove seal rings (87) and (88) from piston (84).



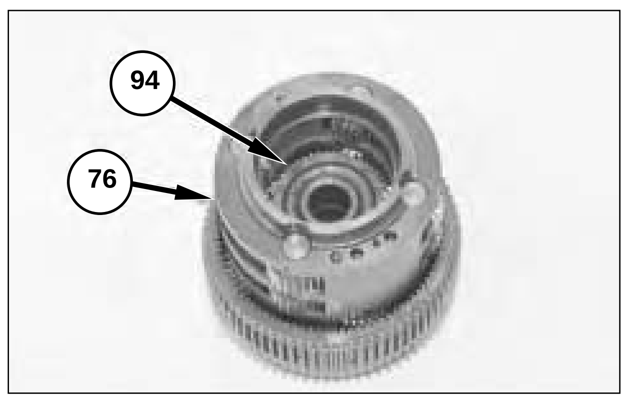
44. Remove ten springs (89), five friction disks (90) and four clutch plates (91) from plate (86).



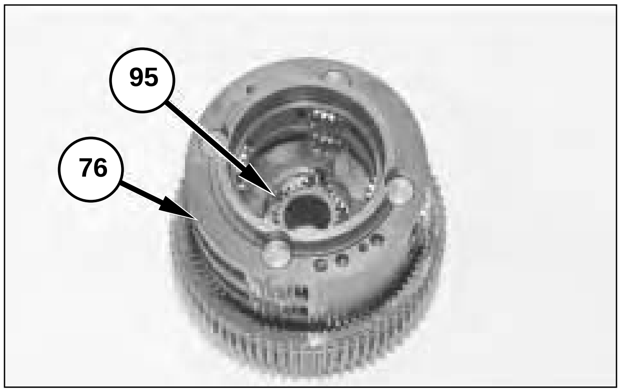
45. Use Tooling (E) to remove retaining ring (92) from input shaft (79).



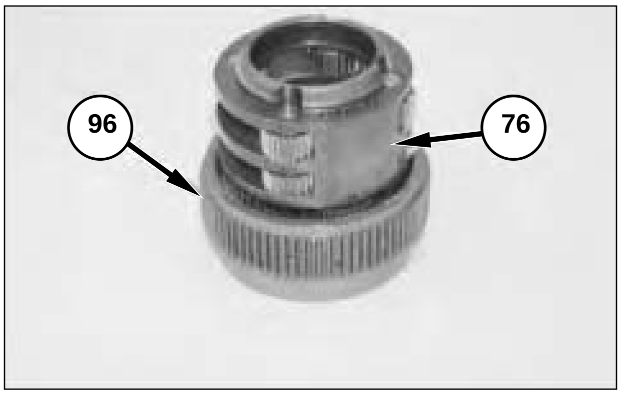
46. Install Tooling (A) and a hoist to remove planet carrier (76) from clutch housing (93). The carrier assembly weighs approximately **41 kg (90 lb).**



47. Remove sun gear (94) from planet carrier (76).

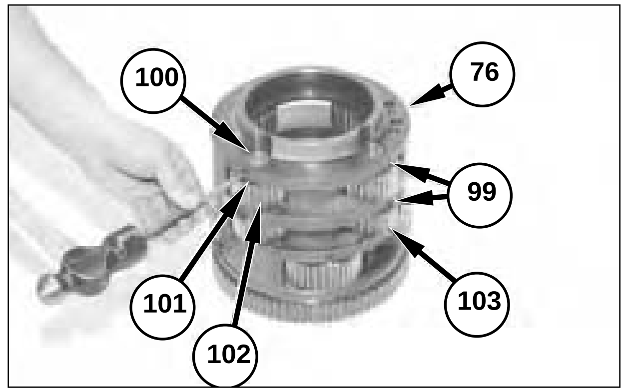


48. Remove sun gear (95) from planet carrier (76).

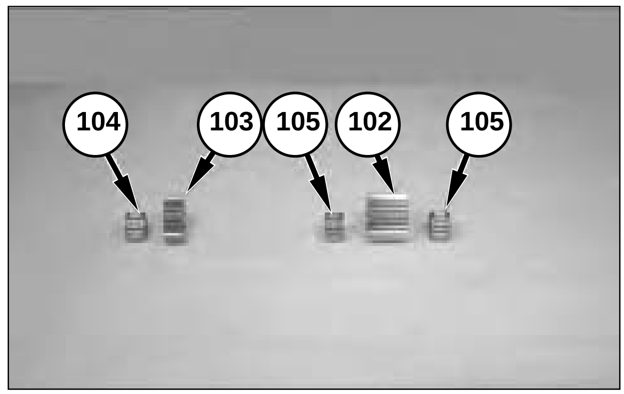


49. Remove ring gear (96) from planet carrier (76).

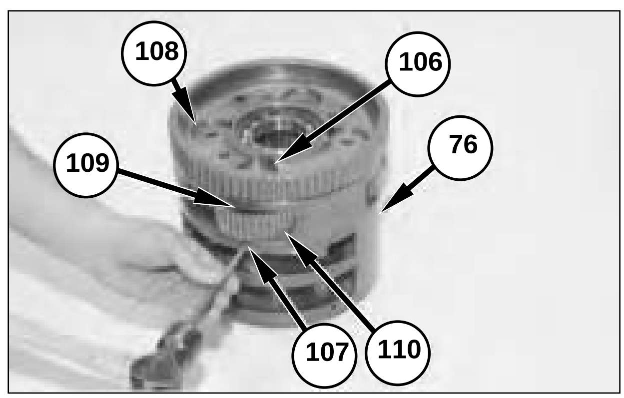
50. Place blocks under planet carrier (76). The blocks will allow ring gear (97) to be removed from planet carrier (76). Use two pin assemblies (98) with a diameter of **3.175 mm (0.125 in)** to compress the lock ring. The gear will fall from the carrier assembly.



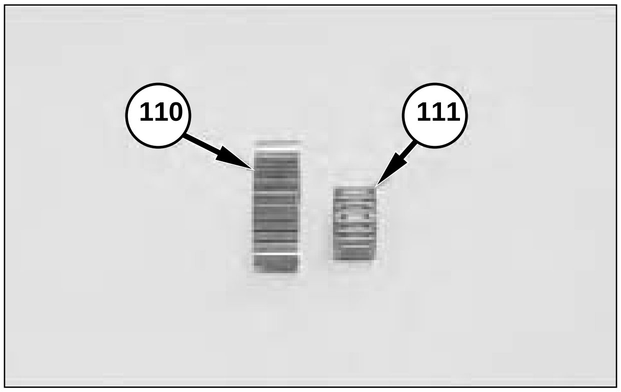
51. Use a hammer and a punch to push pins (99) into planet shafts (100). Remove four planet shafts (100), sixteen thrust disks (101), four planet gears (102) and four planet gears (103) from planet carrier (76).



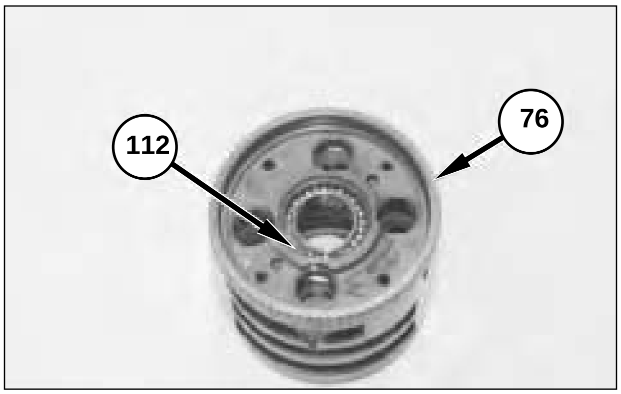
52. Remove bearing (104) from planet gear (103). Remove two bearings (105) from planet gear (102).



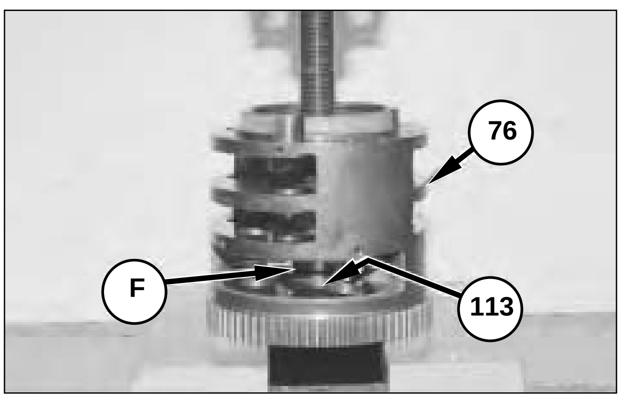
53. Use a hammer and a punch to push pins (107) into planet shafts (108). Remove four planet shafts (108), eight thrust disks (109), two tubes (106), and four planet gears (110) from planet carrier (76).



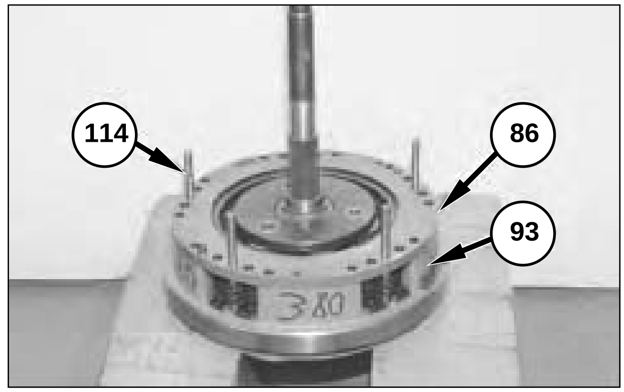
54. Remove bearing (111) from planet gear (110).



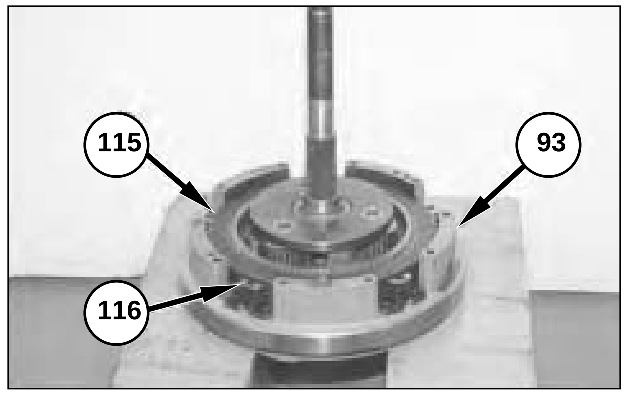
55. Use Tooling (E) and remove retaining ring (112) from planet carrier (76).



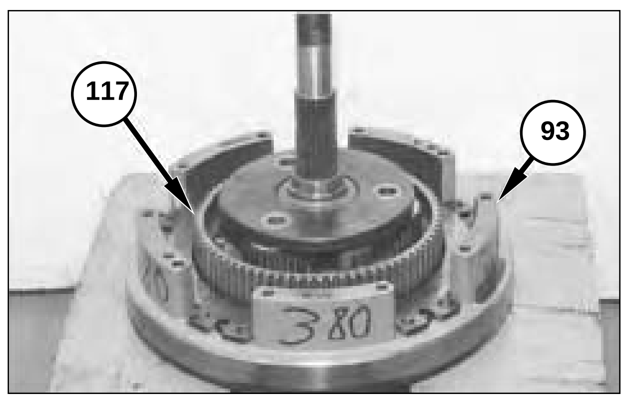
56. Use Tooling (F) and a press to remove bearing (113) from planet carrier (76).



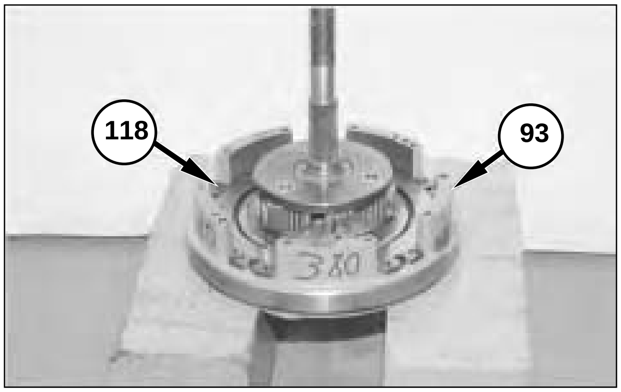
57. Remove five dowels (114) and plate (86) from clutch housing (93).



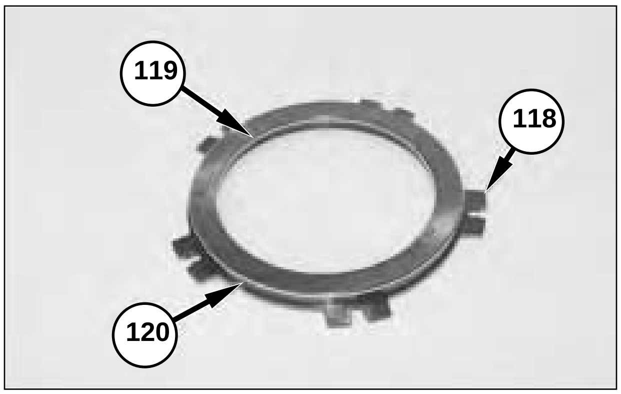
58. Remove four friction disks (115) and three clutch plates (116) from clutch housing (93).



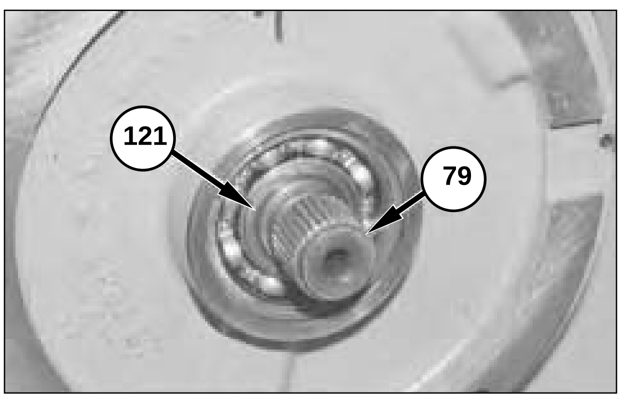
59. Remove coupling (117) from clutch housing (93).



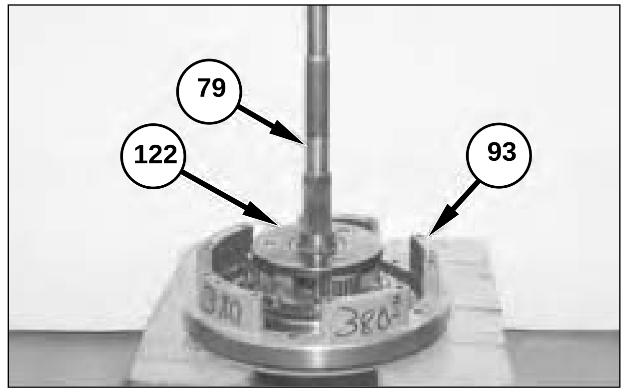
60. Remove piston (118) from clutch housing (93).



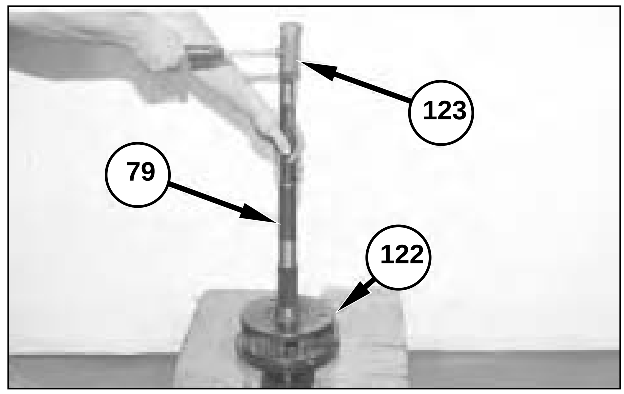
61. Remove seal rings (119) and (120) from piston (118).



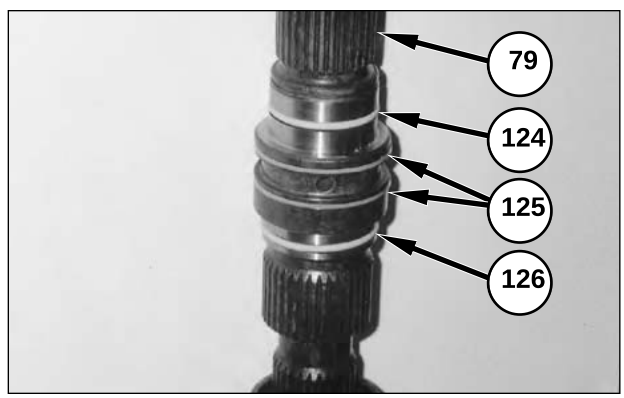
62. Use Tooling (G) to remove retaining ring (121) from input shaft (79).



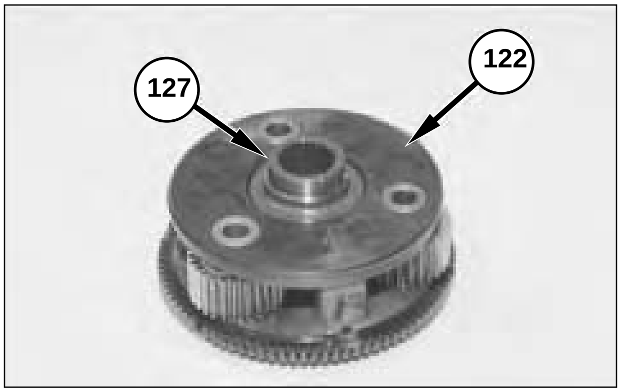
63. Remove input shaft (79) and planet carrier (122) from clutch housing (93).



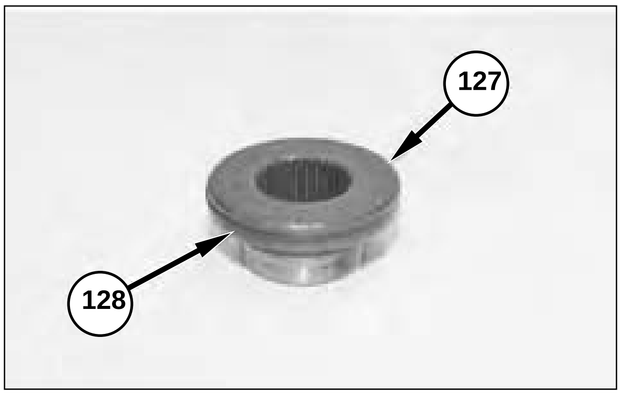
64. Use a soft-faced hammer (123) to remove input shaft (79) from planet carrier (122).



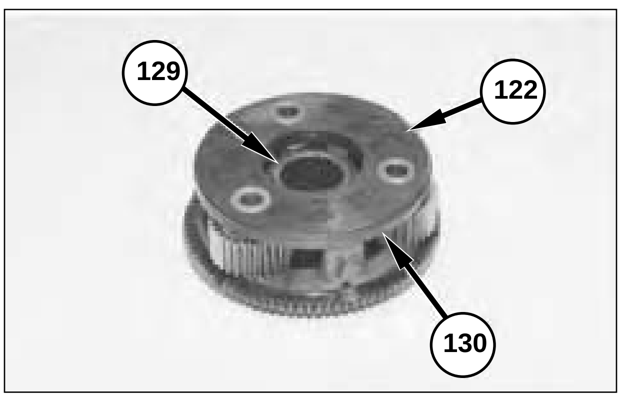
65. Remove O-ring seals (126) and (124), and remove ring seal (125) from input shaft (79).



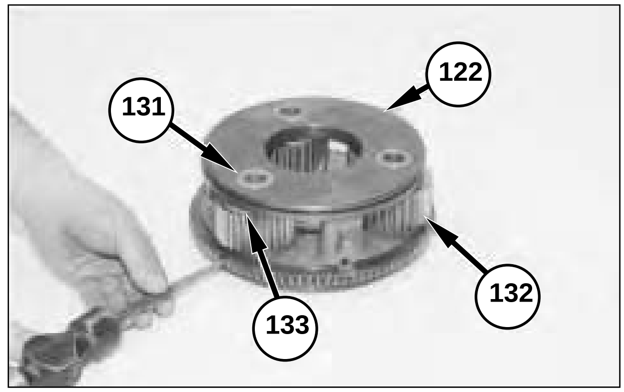
66. Remove ring carrier (127) from planet carrier (122).



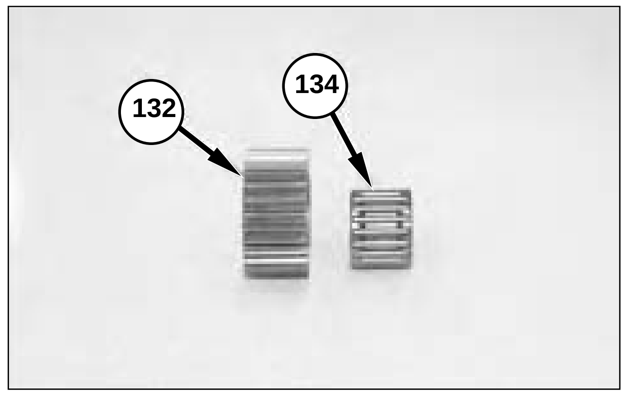
67. Remove metal seal ring (128) from ring carrier (127).



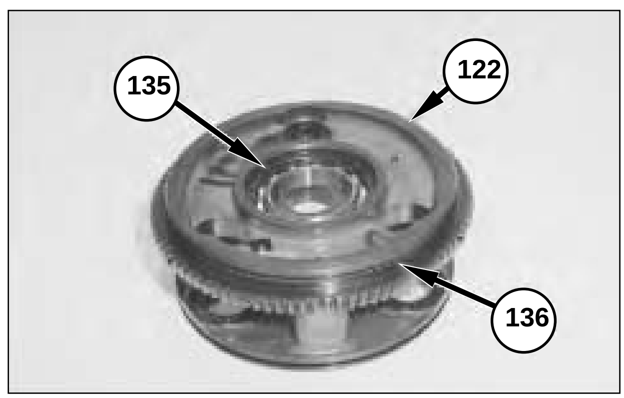
68. Remove sun gear (129) and seal ring (130) from planet carrier (122).



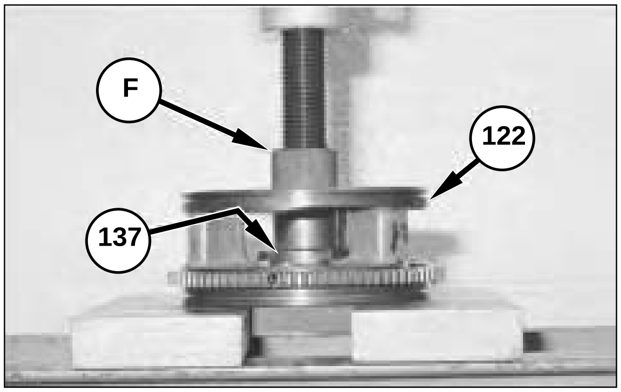
69. Use a hammer and a punch to push the pins into three planet shafts (131). Remove the three shafts, three planet gears (132) and six thrust disks (133) from planet carrier (122).



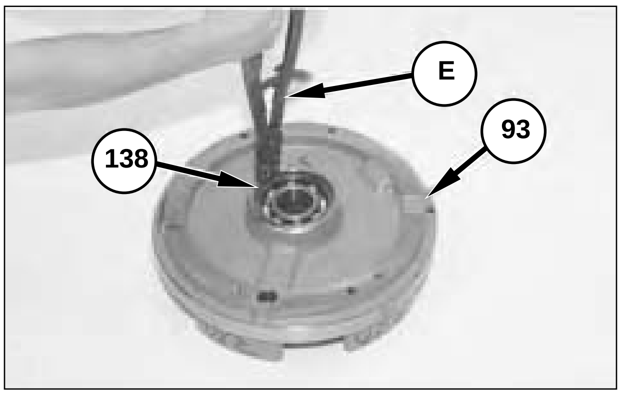
70. Remove bearing (134) from planet gear (132).



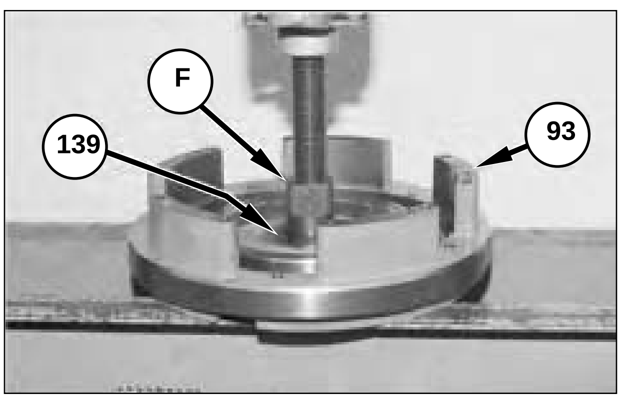
71. Use Tooling (E) to remove retaining ring (135) and seal ring (136) from planet carrier (122).



72. Use Tooling (F) and a press to remove bearing (137) from planet carrier (122).



73. Use Tooling (E) to remove retaining ring (138) from clutch housing (93).

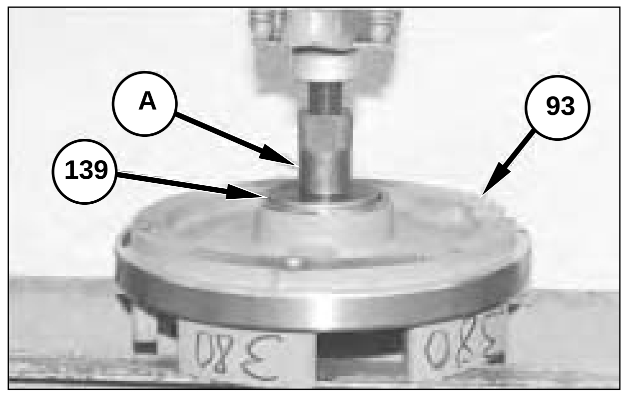


74. Use Tooling (F) and a press to remove bearing (139) from clutch housing (93).

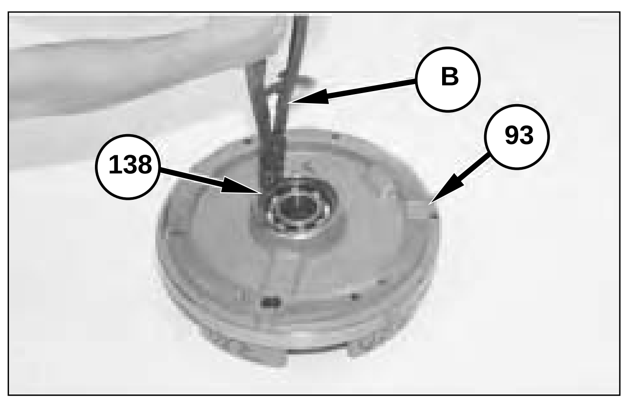
Assemble

Tools Needed	A	B	C	D	E
1P-0520 Driver Group	1				
136-1452 Pliers, Retaining Ring		1			
2P-8312 Pliers, Snap Ring			1		
138-7575 Link Bracket				3	
FT-0833 Pliers					1
	F	G	H		
1P-0510 Driver Group	1				
1P-1863 Pliers, Retaining Ring		1			
FT-0947 Pliers			2		

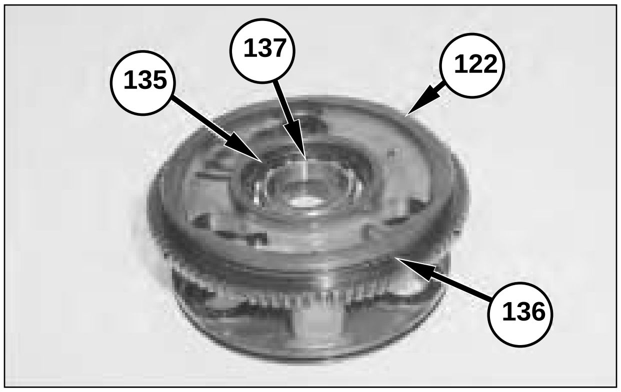
1. Clean and inspect all parts. If any parts are worn or damaged, use new Caterpillar parts for replacement.



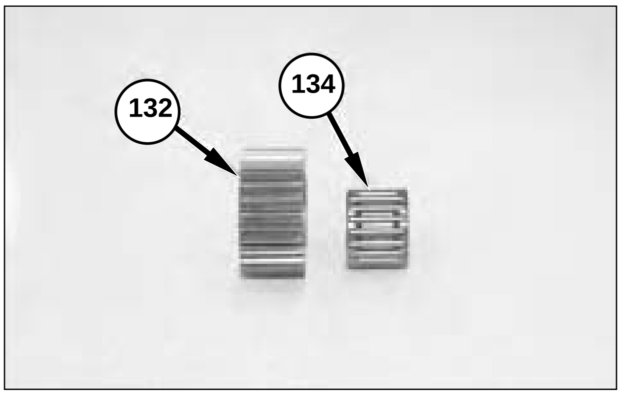
2. Use Tooling (A) and a press to install bearing (139) into clutch housing (93).



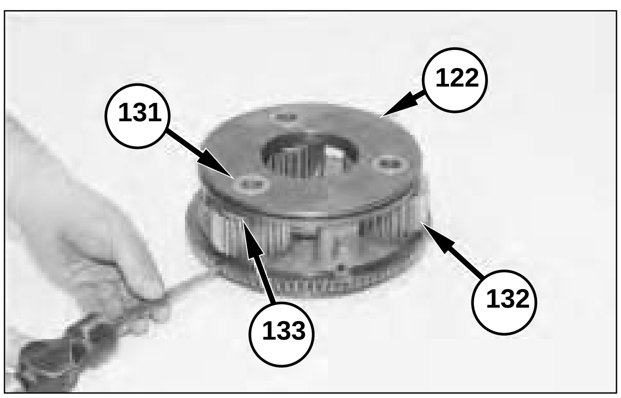
3. Use Tooling (B) to install retaining ring (138) into clutch housing (93).



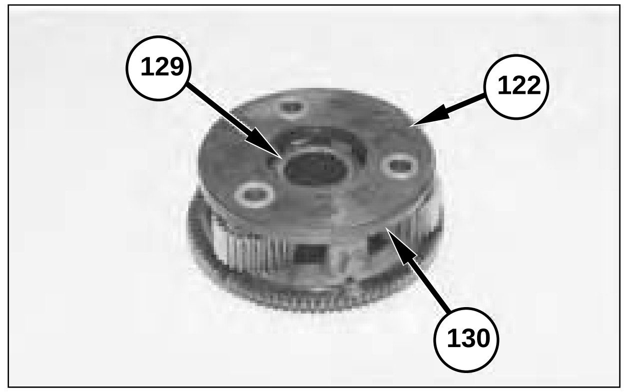
4. Use Tooling (A) and a press to install bearing (137) into planet carrier (122). Use Tooling (C) to install retaining ring (135) and seal ring (136) into the carrier.



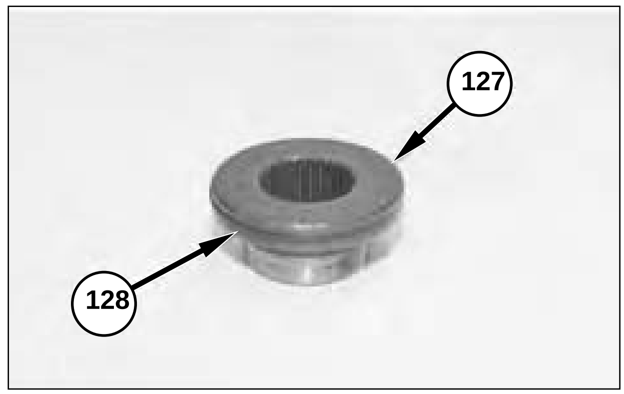
5. Install bearing (134) into planet gear (132). Apply a thin layer of **2S-3230 Grease** to the bearing prior to installation.



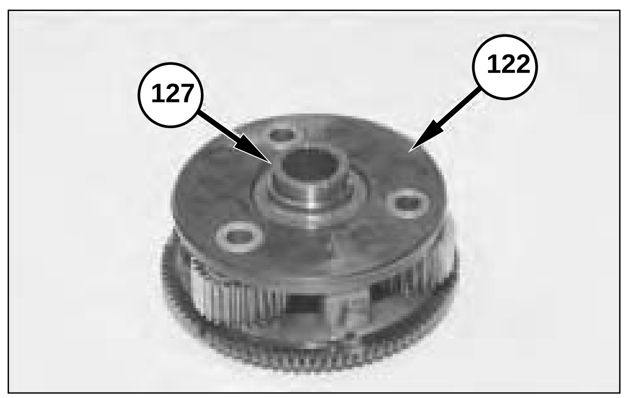
6. Position three planet gears (132) and six thrust disks (133) and install three planet shafts (131) into planet carrier (122). Use a hammer and a punch to install three pins that hold the shafts in place.



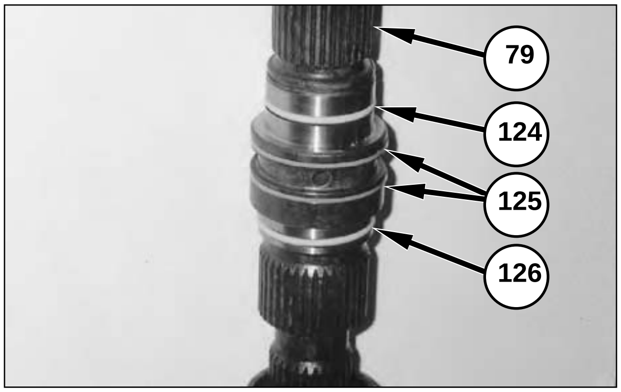
7. Install seal ring (130) and sun gear (129) into planet carrier (122).



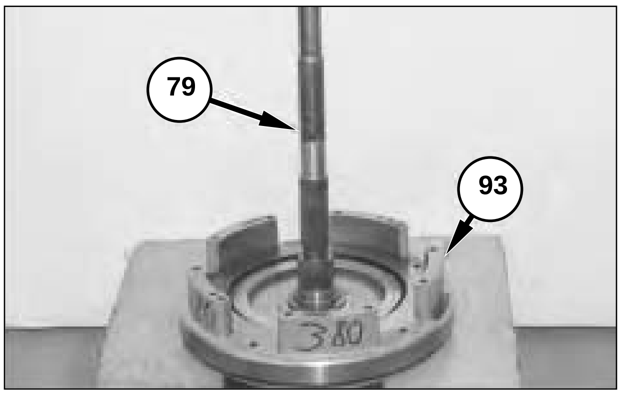
8. Install metal seal ring (128) onto ring carrier (127).



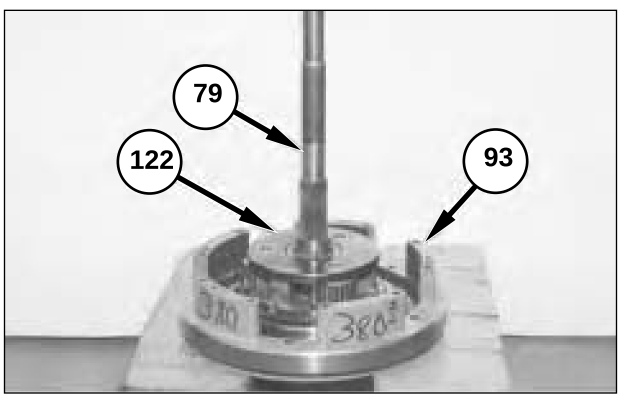
9. Install ring carrier (127) into planet carrier (122).



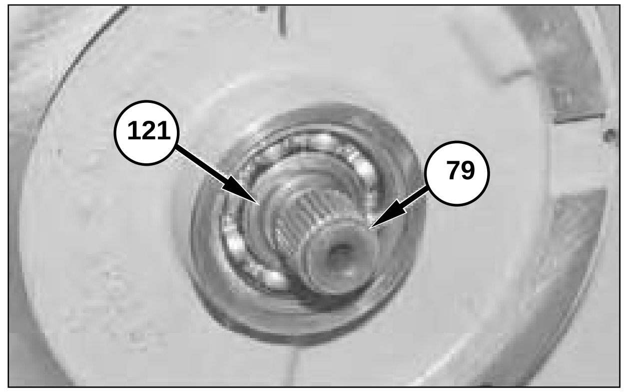
10. Install O-ring seals (126) and (124), and ring seal (125) on input shaft (79).



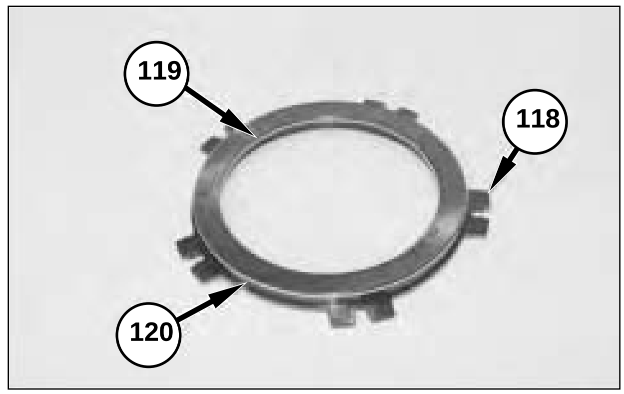
11. Install input shaft (79) into clutch housing (93).



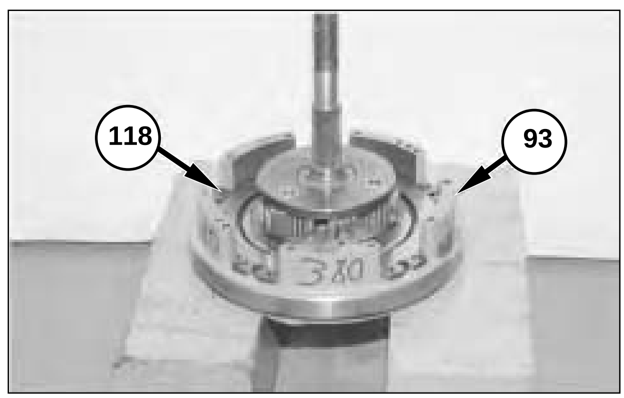
12. Install planet carrier (122) onto input shaft (79) and clutch housing (93).



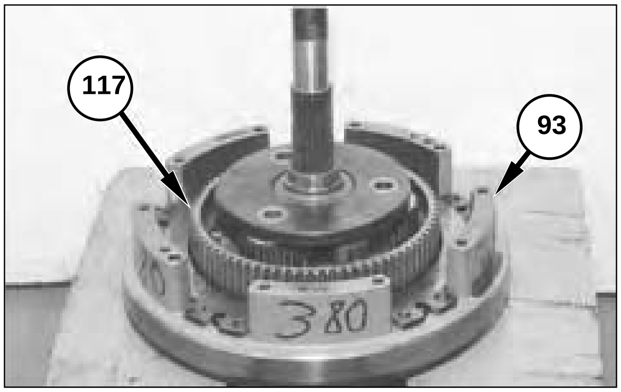
13. Use Tooling (C) to install retaining ring (121) onto input shaft (79).



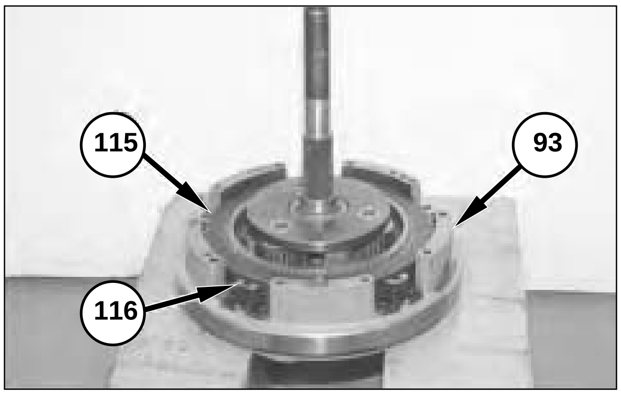
14. Install seal rings (119) and (120) onto piston (118).



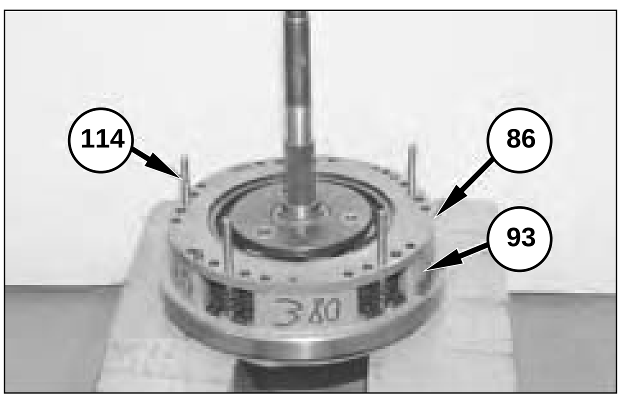
15. Install piston (118) into clutch housing (93).



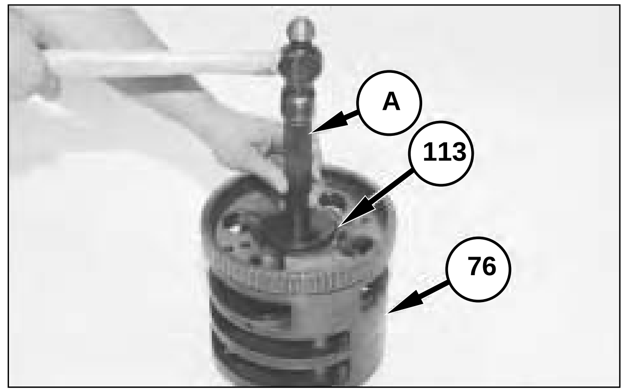
16. Install coupling (117) into clutch housing (93).



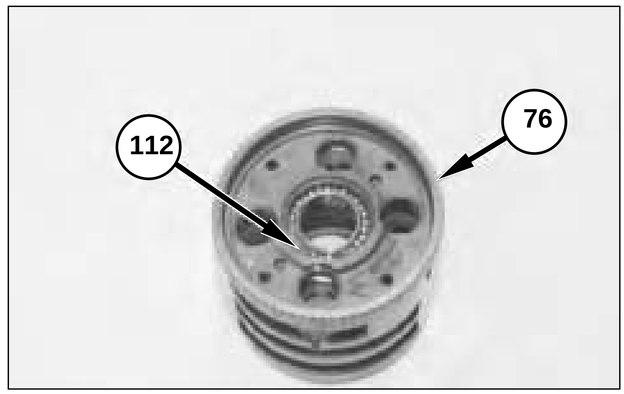
17. Install four friction disks (115) and three clutch plates (116) into clutch housing (93).



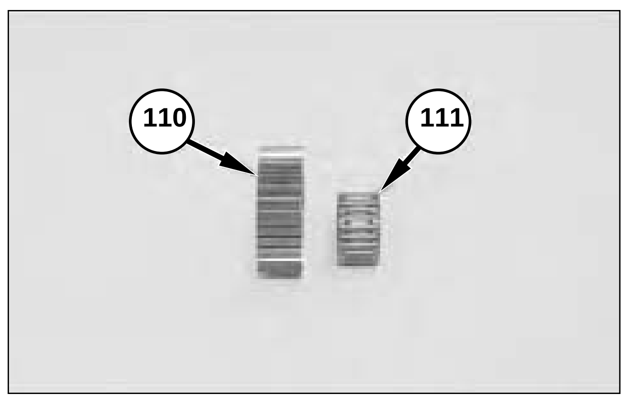
18. Install five dowels (114) and plate (86) onto clutch housing (93).



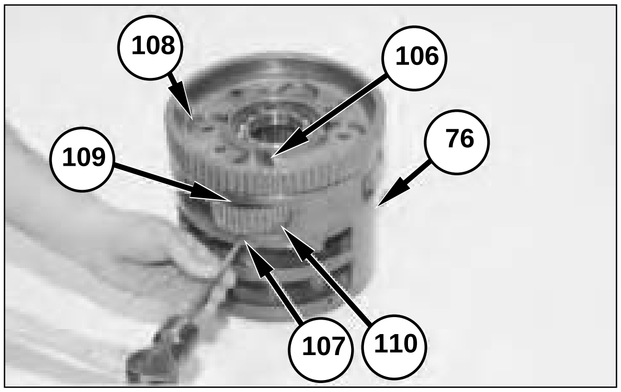
19. Use Tooling (A) to install bearing (113) into planet carrier (76).



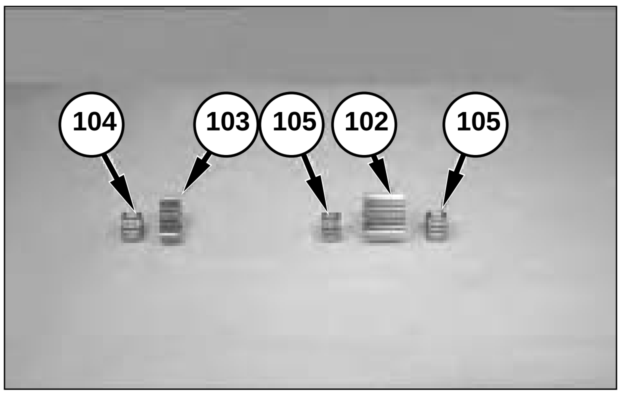
20. Use Tooling (B) to install retaining ring (112) into planet carrier (76).



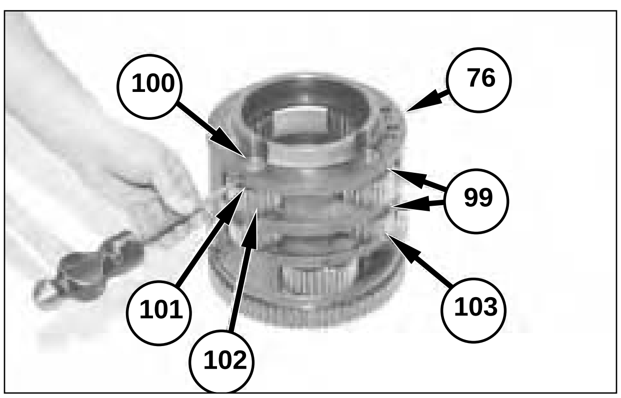
21. Install bearing (111) into planet gear (110).



22. Position two tubes (106), four planet gears (110), eight thrust disks (109), and four planet shafts (108) into carrier (76). Use a hammer and a punch to install pins (107) into planet carrier (76).

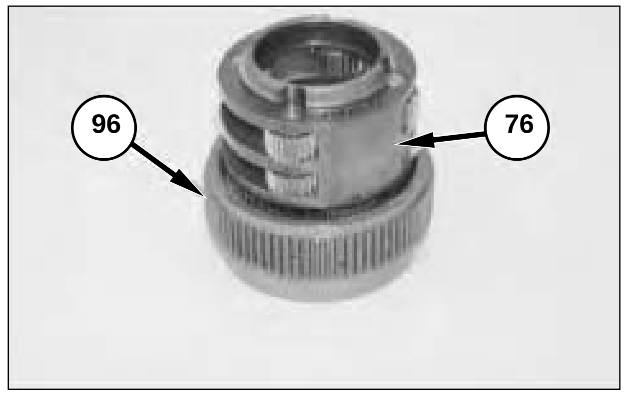


23. Install bearing (104) into planet gear (103). Install two bearings (105) into planet gear (102).

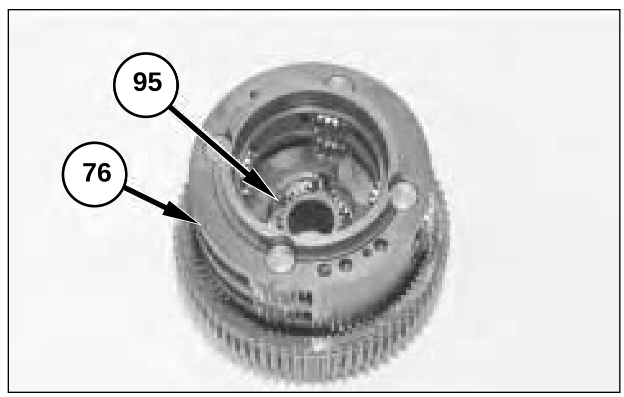


24. Position four planet gears (102), four planet gears (103), sixteen thrust disks (101) and four planet shafts (100) into planet carrier (76). Use a hammer and a punch to install pins (99) into planet carrier (76).

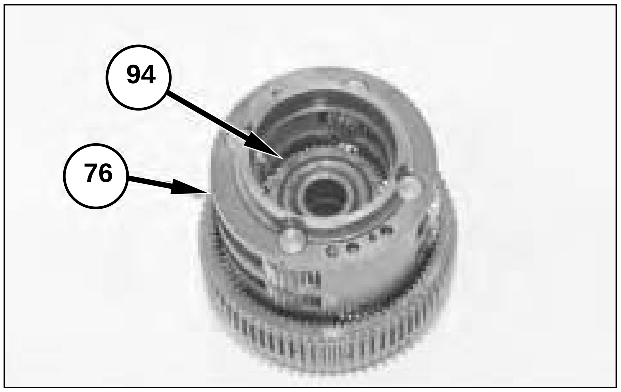
25. Install ring gear (97) onto planet carrier (76). Use two pin assemblies (98) with a diameter of **3.175 mm (0.125 inch)** to install the lock ring.



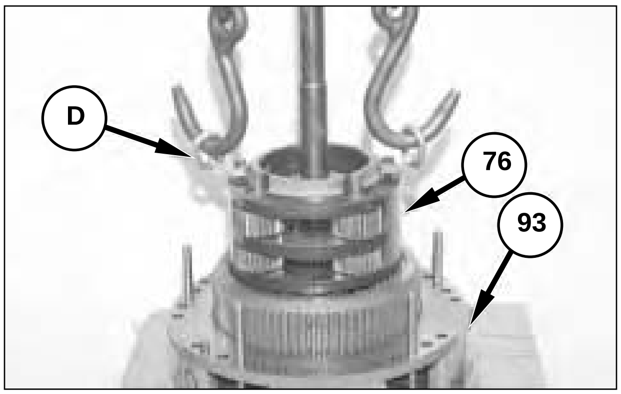
26. Install ring gear (96) onto planet carrier (76).



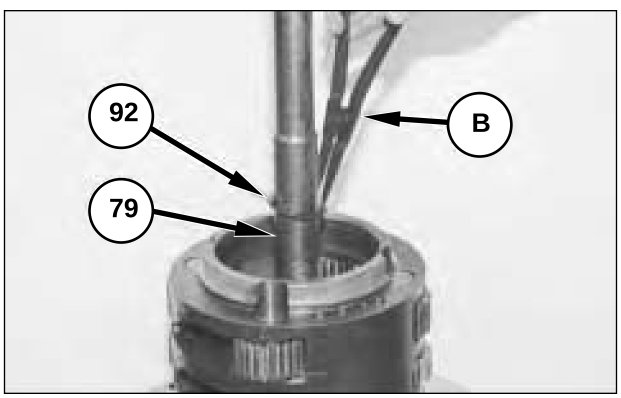
27. Install sun gear (95) into planet carrier (76).



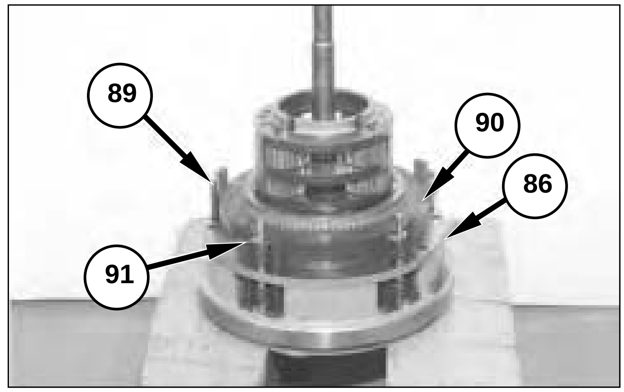
28. Install sun gear (94) into planet carrier (76).



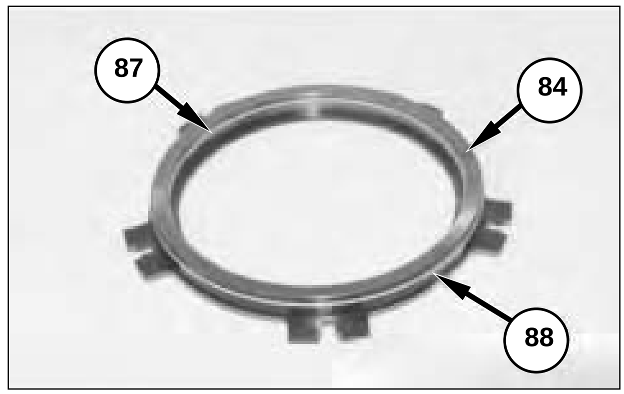
29. Use Tooling (D) and a hoist to position planet carrier (76) onto clutch housing (93). The carrier assembly weighs approximately **41 kg (90 lb).**



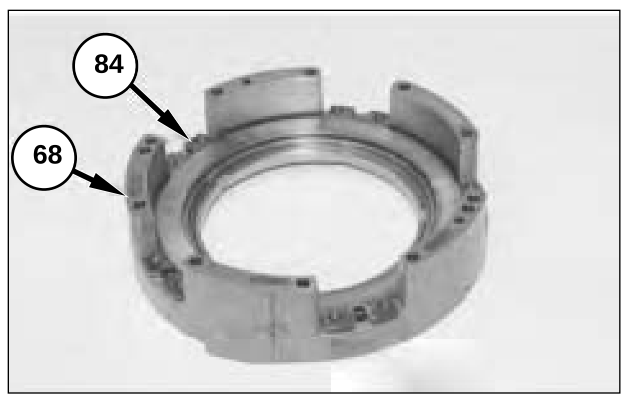
30. Use Tooling (B) to install retaining ring (92) onto input shaft (79).



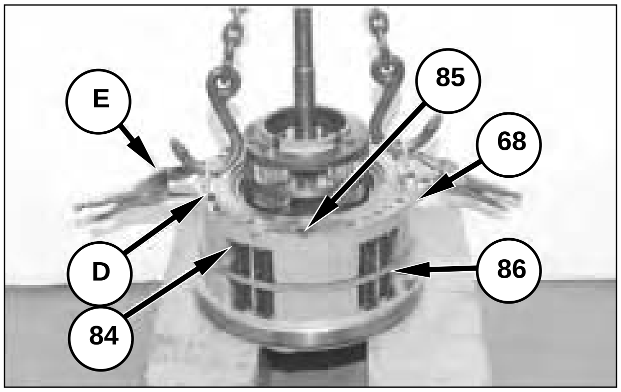
31. Install four clutch plates (91), five friction disks (90), and ten springs (89) onto plate (86).



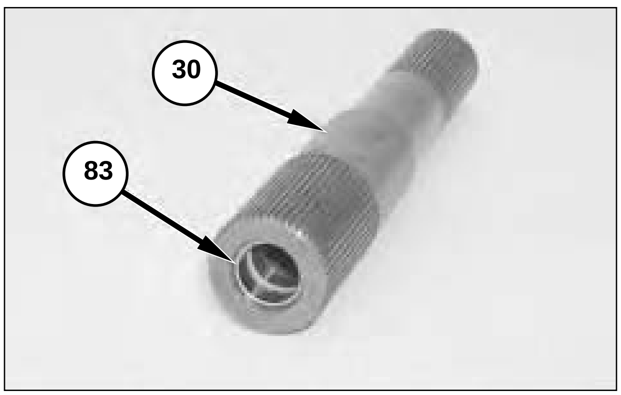
32. Install seal rings (87) and (88) onto piston (84).



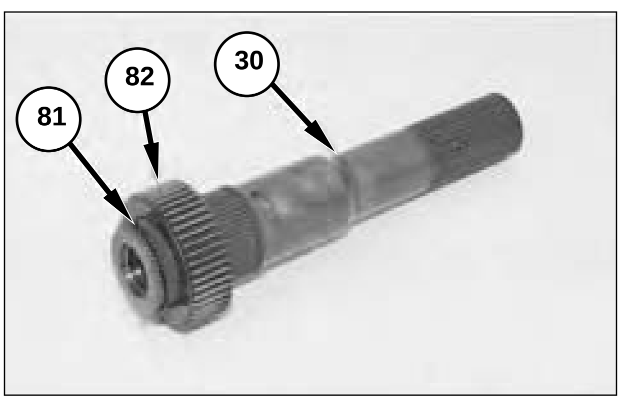
33. Install piston (84) into clutch housing (68).



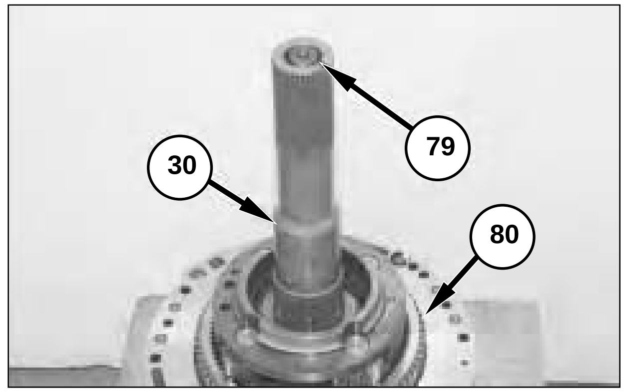
34. Use Tooling (E) to hold piston (84) onto clutch housing (68). Attach Tooling (D) and a hoist to the clutch housing, and position the clutch housing onto plate (86). The clutch housing weighs approximately **25 kg (55 lb).** Install two bolts (85) into the clutch housing.



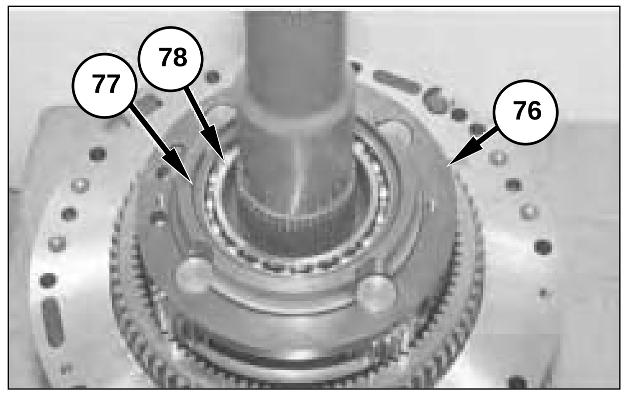
35. Use Tooling (F) to install sleeve bearing (83) into both ends of output shaft (30).



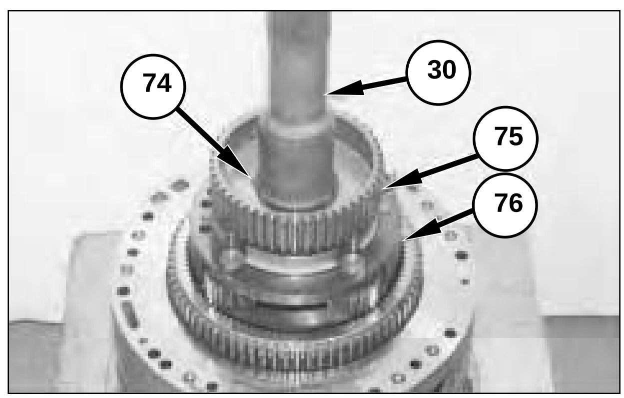
36. Install sun gear (82) onto output shaft (30). Use Tooling (G) to install retaining ring (81) onto output shaft (30).



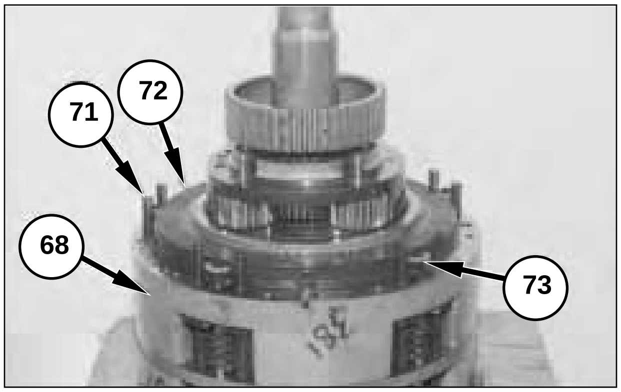
37. Install ring gear (80), and install output shaft (30) onto input shaft (79).



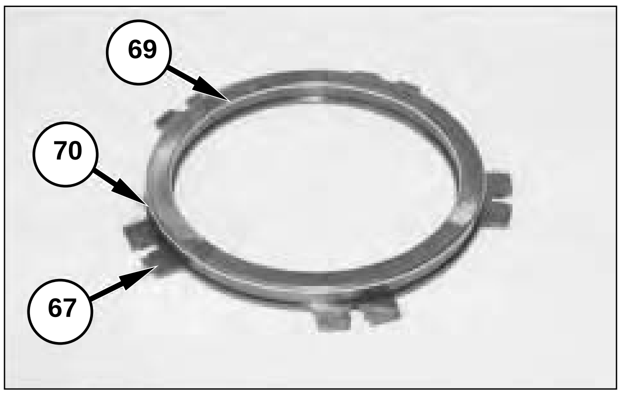
38. Install bearing (78) into planet carrier (76), and install retaining ring (77).



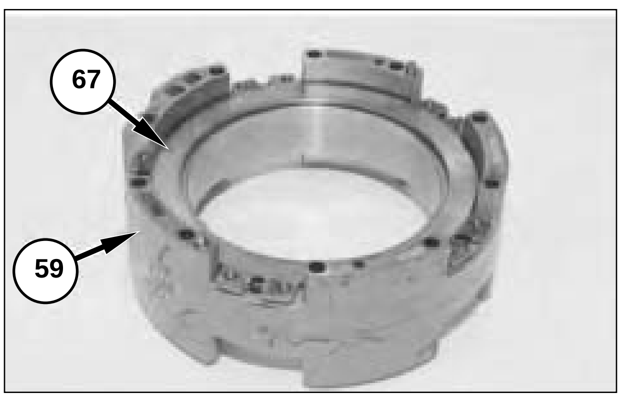
39. Install rotating hub (75) onto planet carrier (76). Use Tooling (B) to install retaining ring (74) onto output shaft (30).



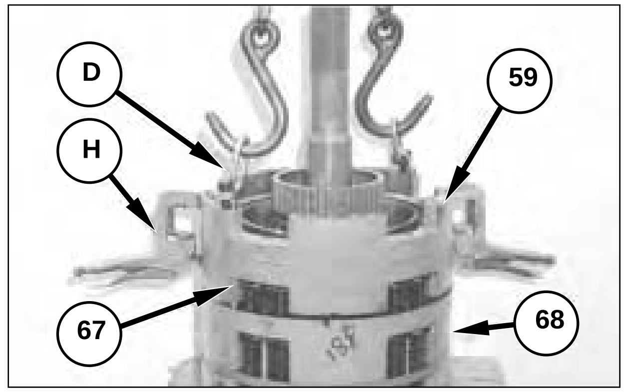
40. Install two clutch plates (73), three friction disks (72) and ten springs (71) onto clutch housing (68).



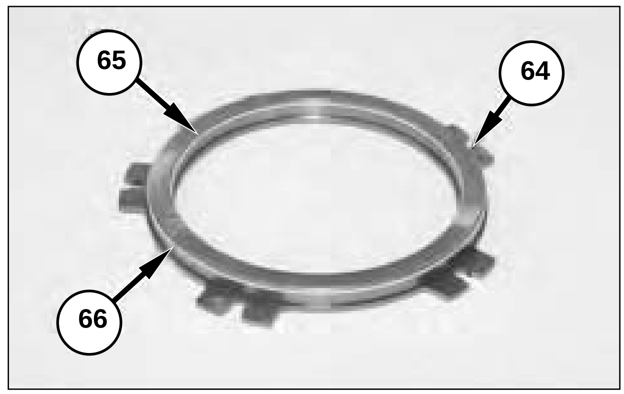
41. Install seal ring (69) and seal ring (70) onto piston (67).



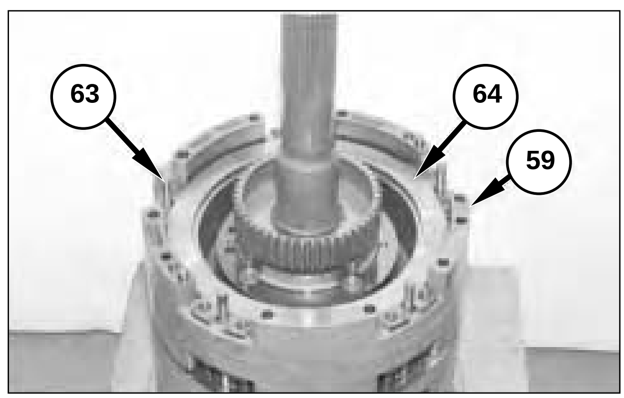
42. Install piston (67) into clutch housing (59).



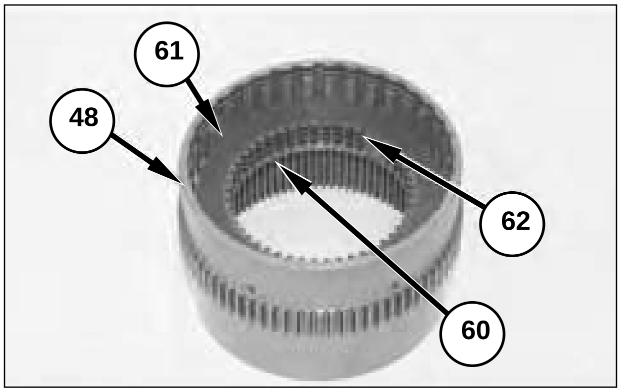
43. Use Tooling (H) to hold piston (67) to clutch housing (59). Attach Tooling (D) and position clutch housing (59) onto clutch housing (68). Clutch housing (59) weighs approximately **39 kg (85 lb).**



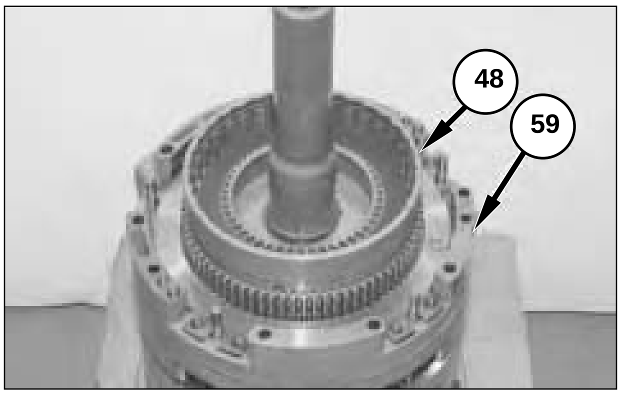
44. Install seal ring (65) and seal ring (66) onto piston (64).



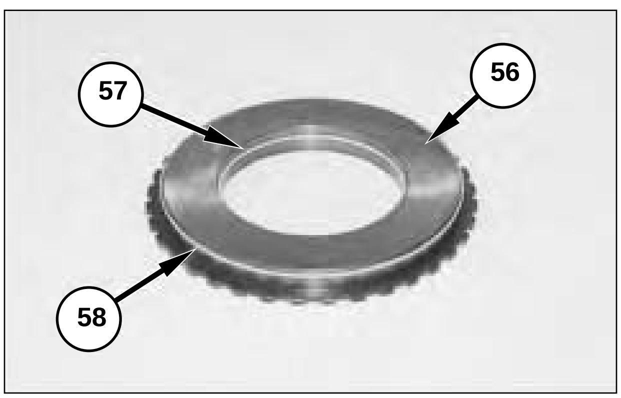
45. Install piston (64) and four dowels (63) onto clutch housing (59).



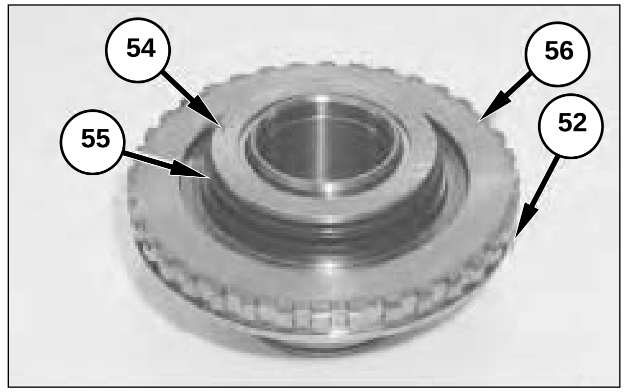
46. Install clutch plate (60), three clutch plates (62), and four friction disks (61) into ring gear (48).



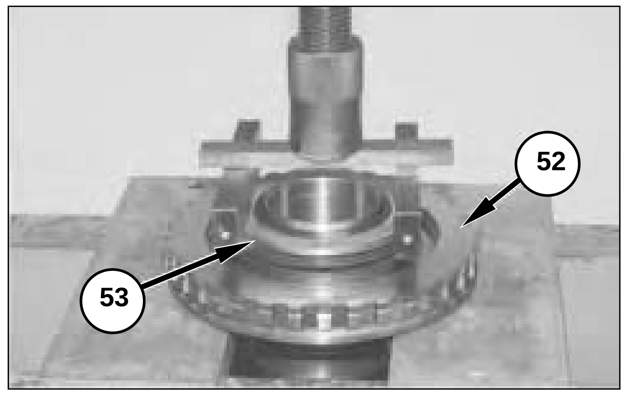
47. Install ring gear (48) into clutch housing (59).



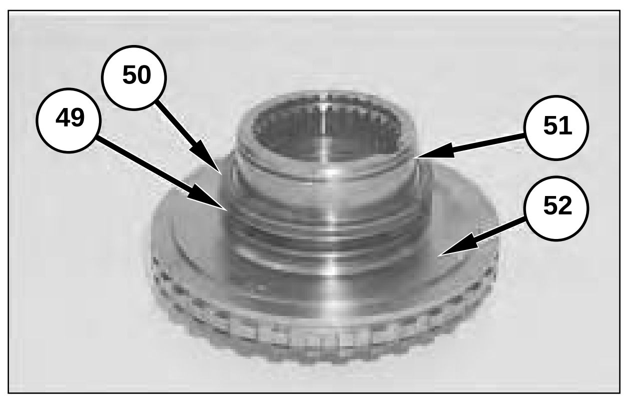
48. Install ring seal (58) and seal ring (57) onto piston (56).



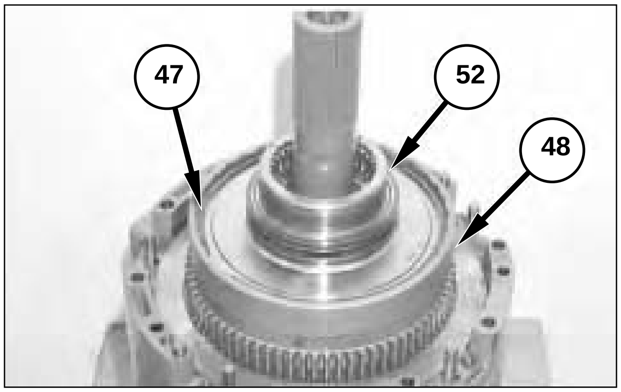
49. Install piston (56), three springs (55), and plate (54) onto clutch housing (52).



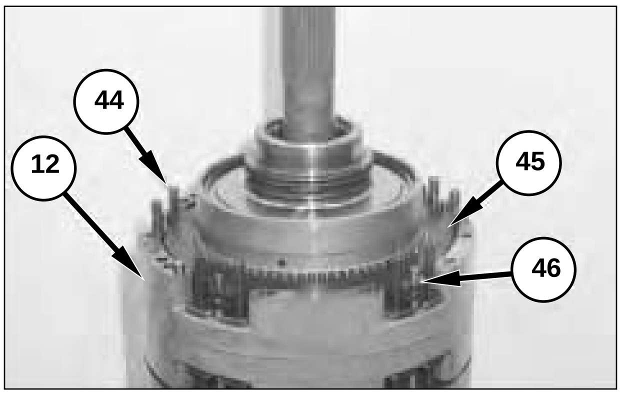
50. Use steel spacers and a press to install retaining ring (53). Compress the springs, and use Tooling (C) to install the ring onto clutch housing (52).



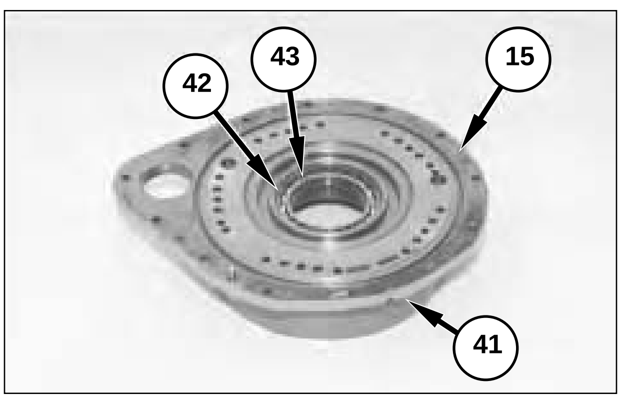
51. Install seal ring (49) onto carrier (50). Install O-ring seal (51) onto clutch housing (52).



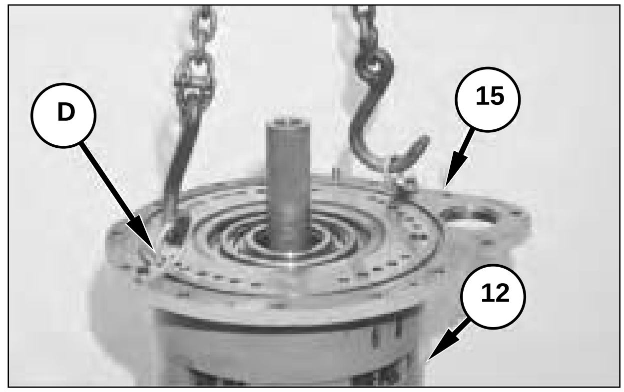
52. Install clutch housing (52) onto ring gear (48). Install retaining ring (47) into the gear.



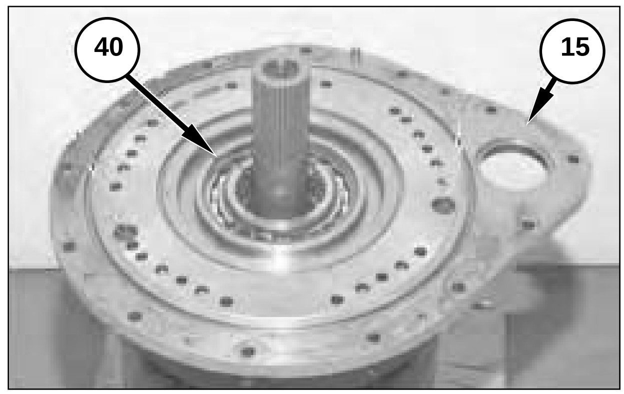
53. Install two clutch plates (46), three friction disks (45) and ten springs (44) onto planetary group (12).



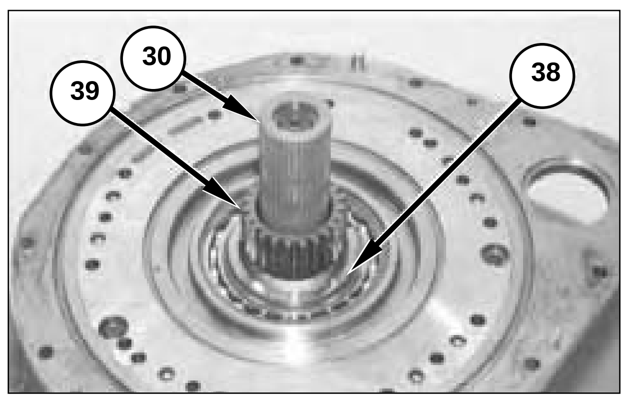
54. Use Tooling (A) and a press to install bearing (43) into manifold assembly (15). Use Tooling (B) to install retaining ring (42) into the manifold assembly. Install O-ring seal (41).



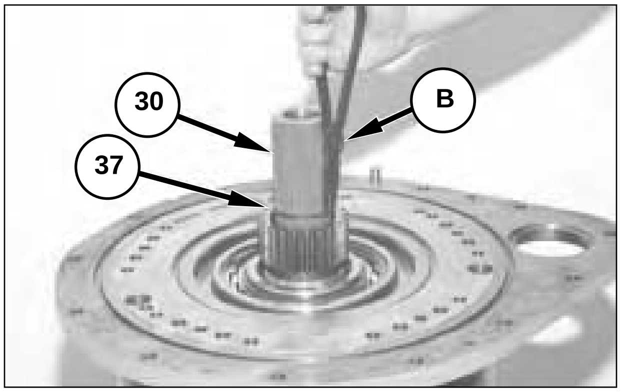
55. Use Tooling (D) and a hoist to position manifold assembly (15) onto planetary group (12). The manifold assembly weighs approximately **61 kg (135 lb).**



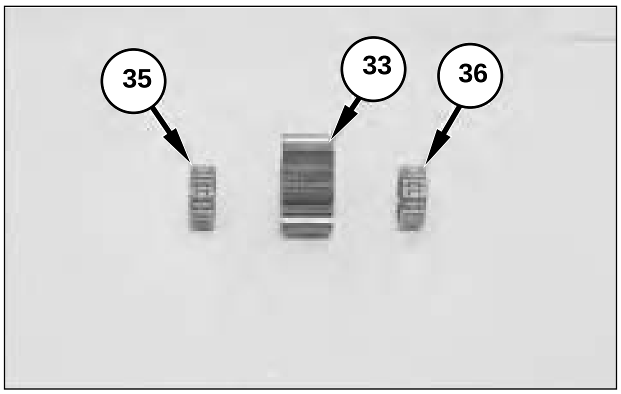
56. Use Tooling (B) to install retaining ring (40).



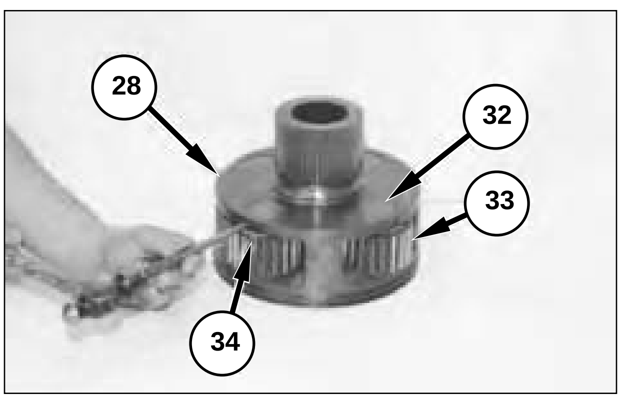
57. Use Tooling (B) to install retaining ring (38) and sun gear (39) onto output shaft (30).



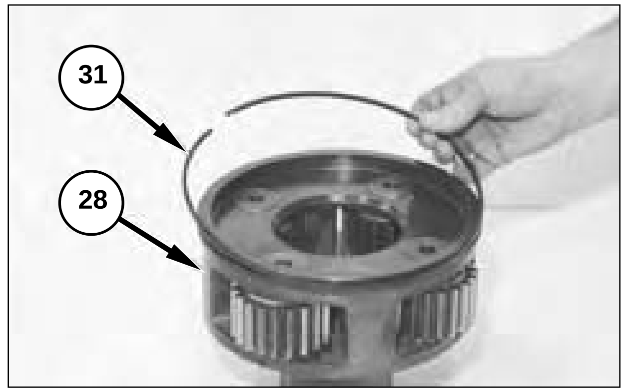
58. Use Tooling (B) to install retaining ring (37) onto output shaft (30).



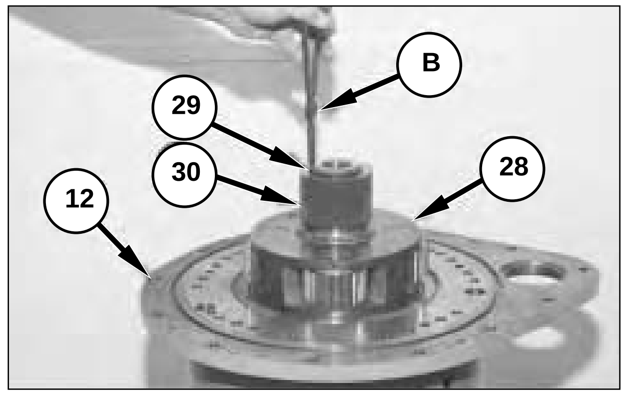
59. Install bearings (35) and (36) into planet gear assembly (33).



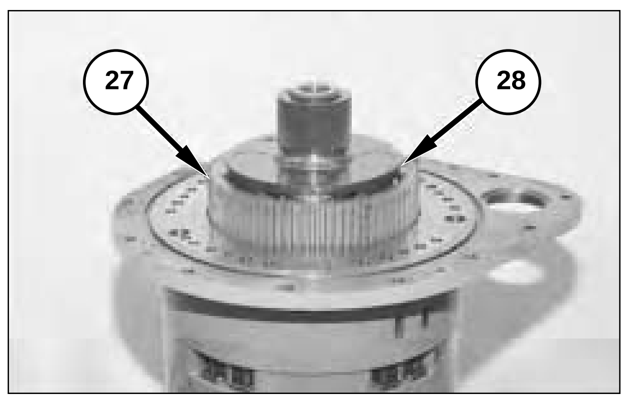
60. Position four gear assemblies (33) and eight thrust disks (34) in carrier (28). Install four planet shafts (32) into the carrier. Use a hammer and a punch to install the pins into the carrier.



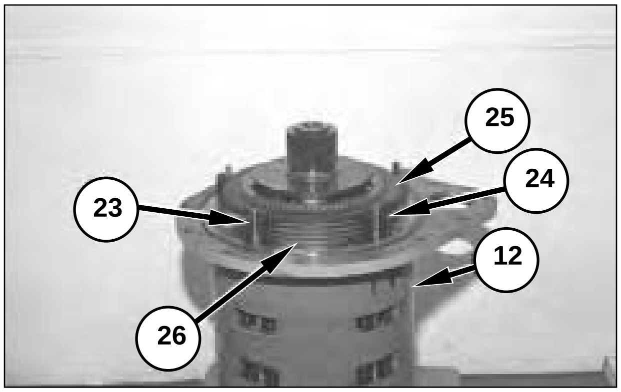
61. Install seal ring (31) onto carrier (28).



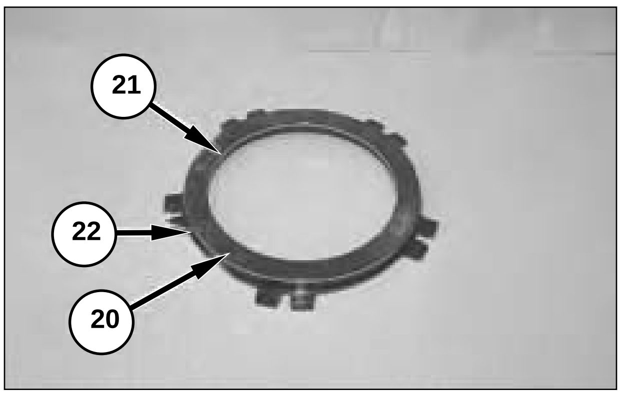
62. Install carrier (28) onto planetary group (12). Use Tooling (B) to install retaining ring (29) onto output shaft (30).



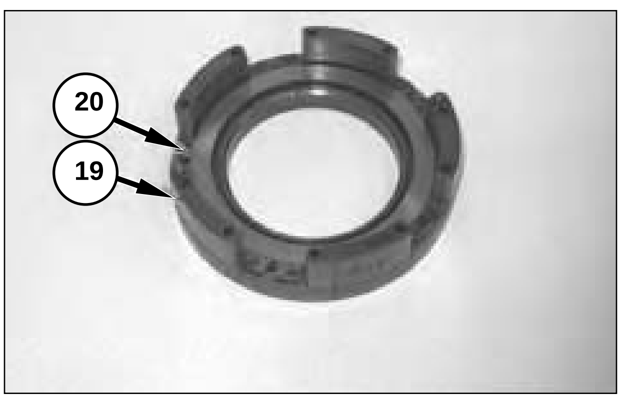
63. Install ring gear (27) onto carrier (28).



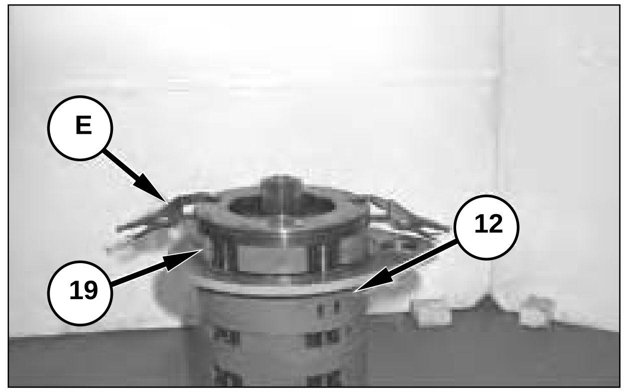
64. Install four clutch plates (26), five friction disks (25), ten springs (24) and five dowels (23) onto planetary group (12).



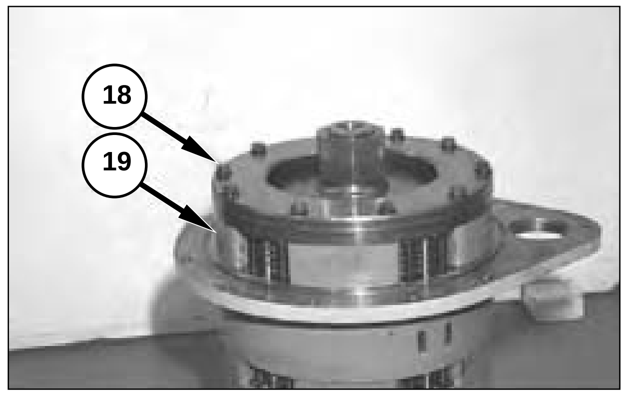
65. Install O-ring seals (21) and (22) onto piston (20).



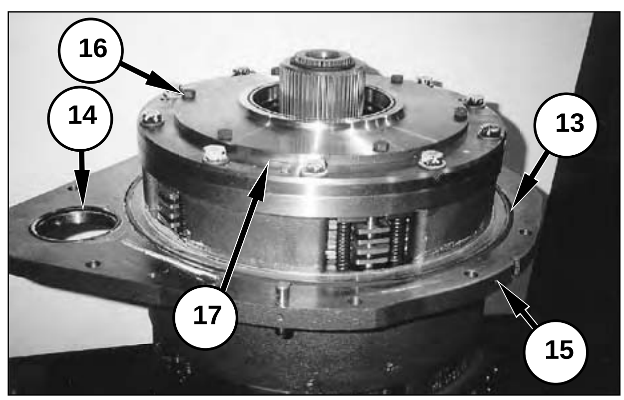
66. Install piston (20) onto clutch housing (19).



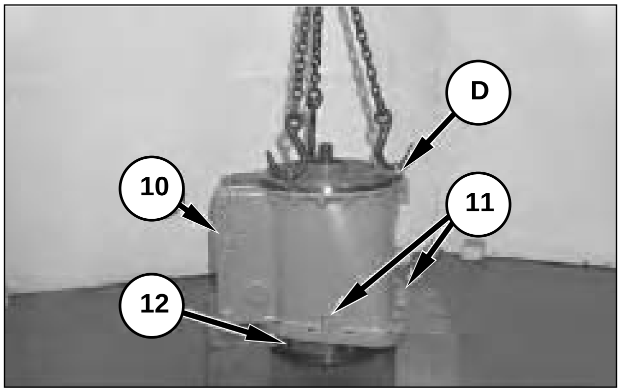
67. Use Tooling (E) to hold the piston into clutch housing (19). Use two people to install the clutch housing into planetary group (12). The clutch housing weighs approximately **28 kg (61 lb).**



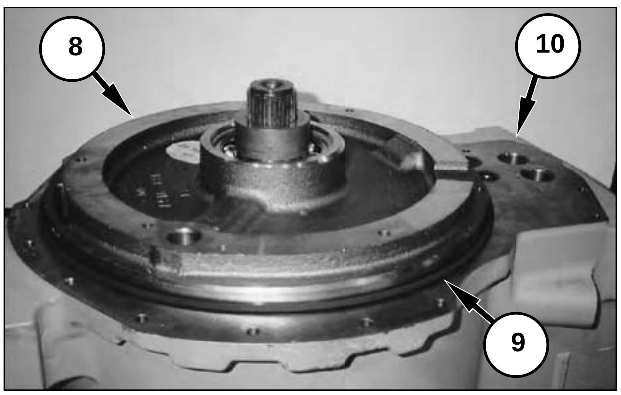
68. Install ten bolts (18) and the washers to clutch housing (19).



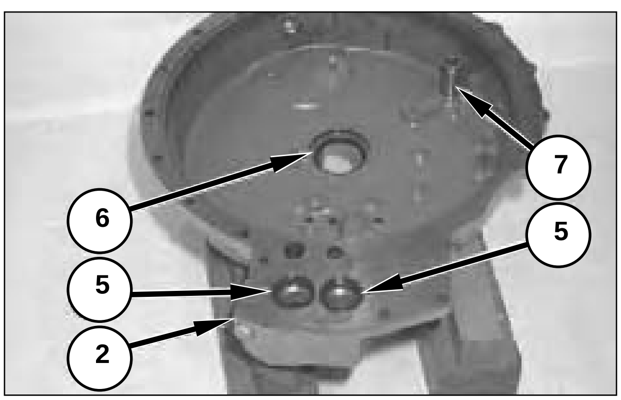
69. Install O-ring seal (13) and (14) in manifold assembly (15). Install cage bearing and race (17) and six bolts (16).

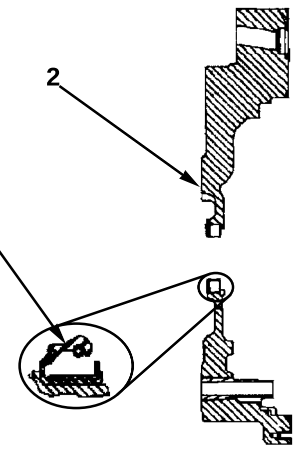


70. Use Tooling (D) to turn over the planetary group. Attach Tooling (D) and a hoist to transmission case (10). Position the transmission case onto planetary group (12), and install three bolts (11). The transmission case weighs approximately **100 kg (220 lb)**.



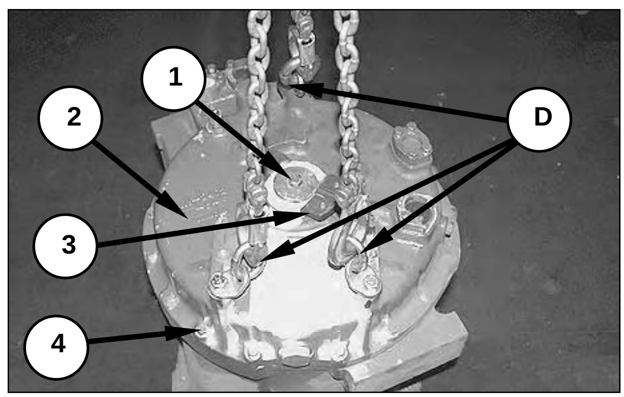
71. Install O-ring seal (9) and spacer (8) onto transmission case (10).





72. Install two O-ring seals (5), and sleeve (7) onto transmission cover (2).

73. Use Tooling (A) to install lip seal (6) so that the lip of the seal is toward the inside of the cover, as shown. Put clean transmission oil on the lip of the seal.



74. Install Tooling (D) and a hoist, and install cover (2) on the case, as shown. Install 17 bolts (4) to hold the cover.

75. Install flange (3) using bolt (1).

End By:

a. Connect the transmission and differential steering unit.

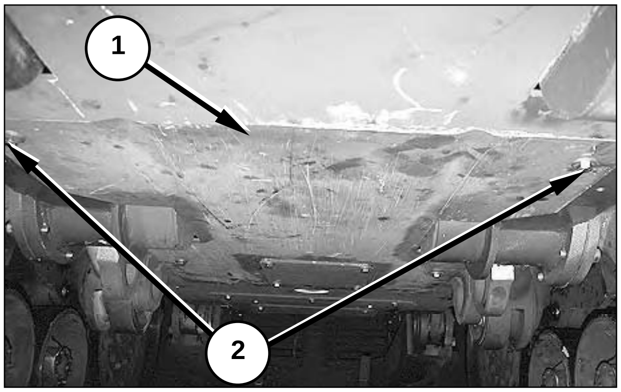
b. Install the differential steering unit and transmission.

c. Install the transmission hydraulic control valve.

Power Train Lubrication Pump

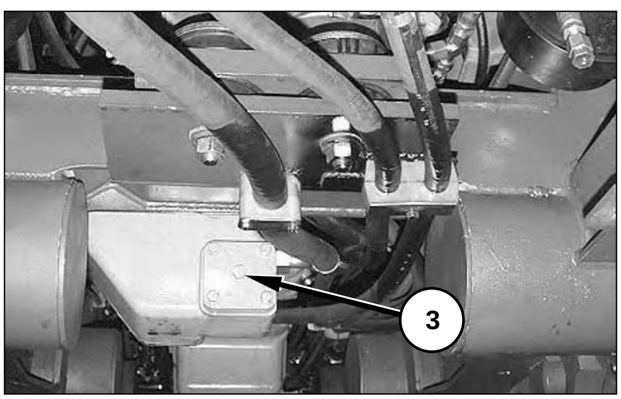
Remove and Install

NOTE: Group numbers related to this procedure include 124-9406 and 124-9407.

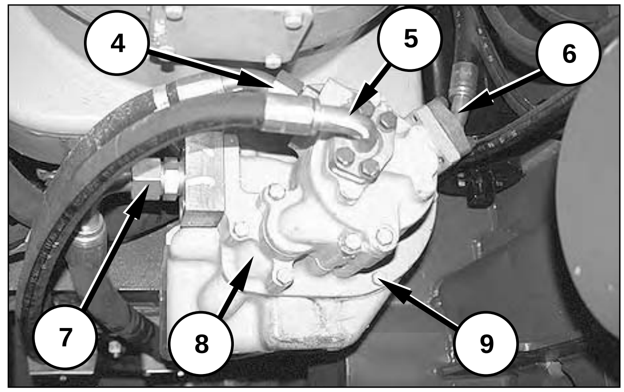


1. Remove two bolts (2) with washers, and allow bottom cover (1) to hang down.

2. Drain the power train oil system into a suitable container. The power train oil system contains approximately **152 L (40 U.S. gal).** Discard the oil according to local regulations. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Every 2000 Service Hours or Two Years, Power Train."



3. Remove plug (3) and allow the power train oil remaining in the torque converter housing to drain into a suitable container. The capacity of the torque converter housing is approximately **8 L (2 U.S. gal).** Discard the oil according to local regulations.



4. Disconnect lines (4), (5), (6), and (7). Mark the lines for correct connection during reinstallation.

5. Remove two long bolts and four short bolts (9) with washers.

6. Remove power train lubrication pump (8) with the O-ring seal. Replace the O-ring seal if the seal is damaged or worn.

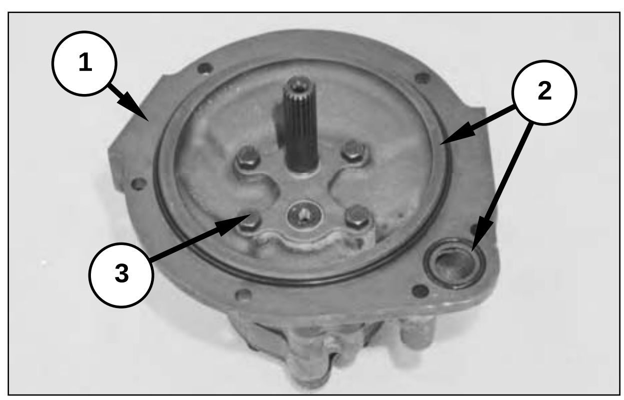
NOTE: To install the power train lubrication pump, reverse the removal steps.

Disassemble

Start By:

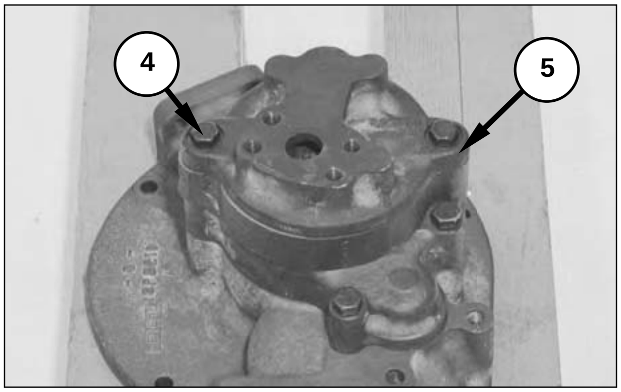
a. Remove the power train lubrication pump.

NOTE: For easier assembly, put a mark on the outer surface of each of the body assemblies of the pump, to show their original orientation.

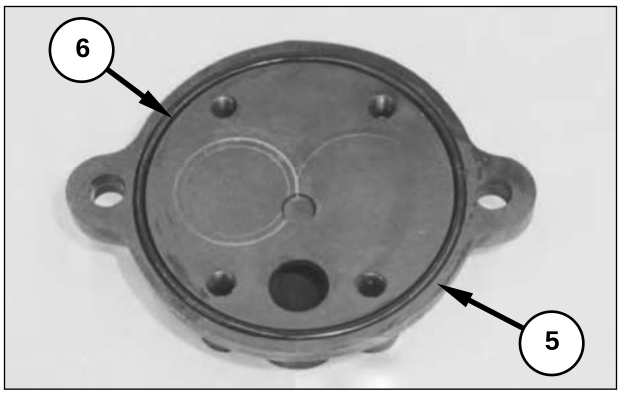


1. Remove seals (2) from manifold assembly (1).

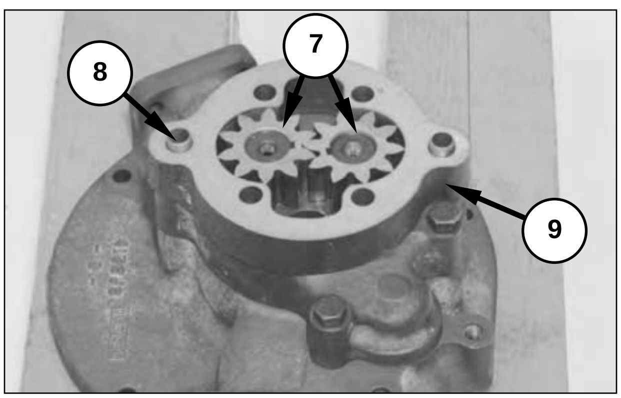
2. Remove four bolts (3) from manifold assembly (1).



3. Remove two bolts (4) and cover (5) from the pump.



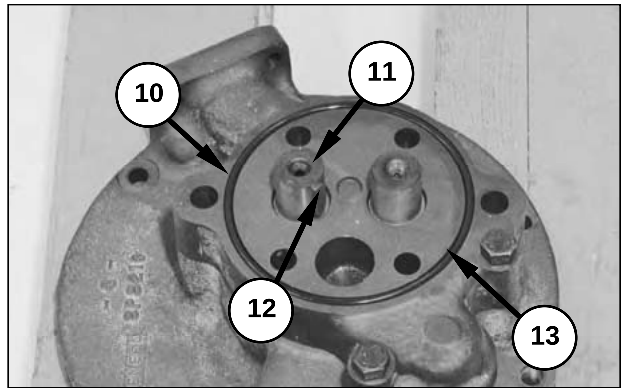
4. Remove seal (6) from cover (5).



5. Remove body (9) from the pump.

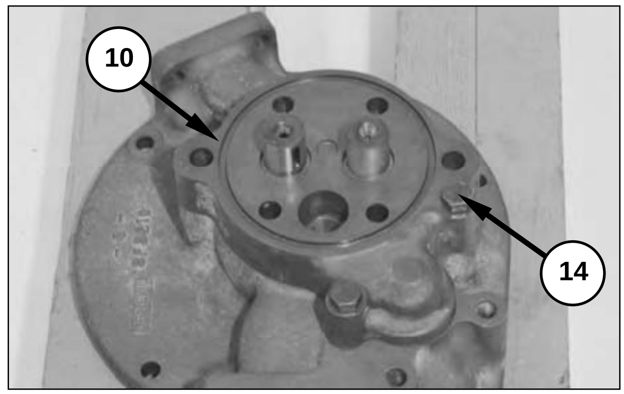
6. Remove dowels (8) from body (9).

7. For easier assembly, mark and remove gears (7) from the pump.

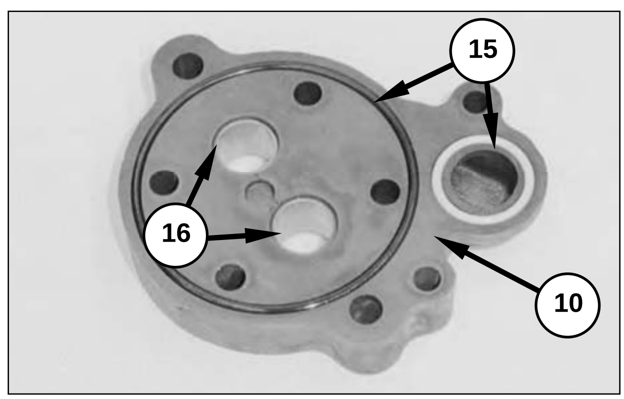


8. Remove key (12) from driving gear assembly (11).

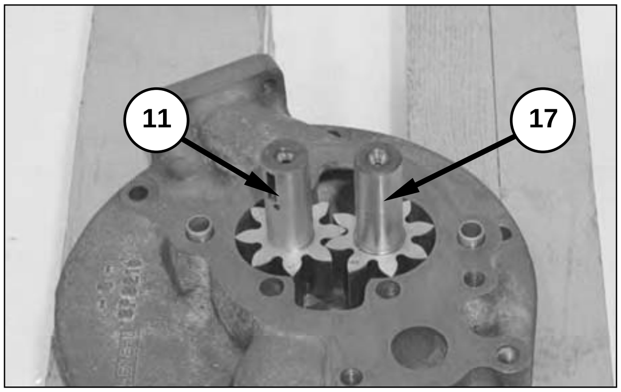
9. Remove seal (13) from cover assembly (10).



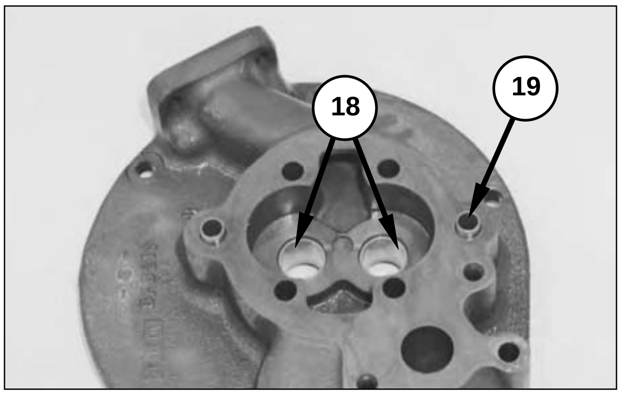
10. Remove bolts (14) and cover assembly (10) from the pump.



11. Remove seals (15) and bearings (16) from cover assembly (10).



12. For easier assembly, make note of the locations of driving gear assembly (11) and driven gear assembly (17), and remove them from the manifold assembly.

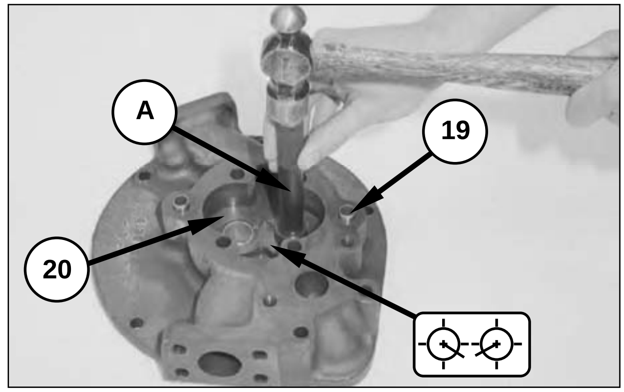


13. Remove bearings (18) and dowels (19) from the manifold assembly.

Assemble

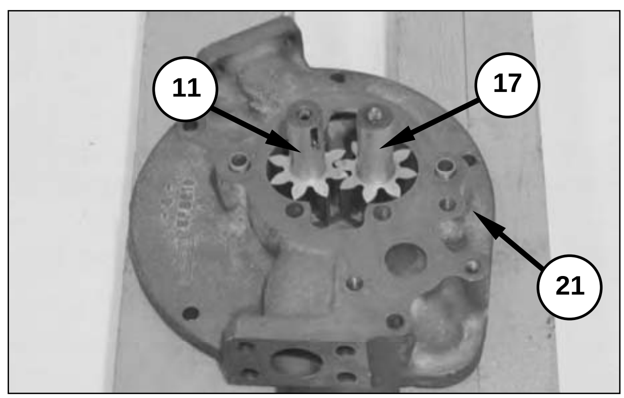
Tools Needed		
1P-0510	Driver Group	1

NOTE: Clean and put clean transmission oil on all the parts before assembly.



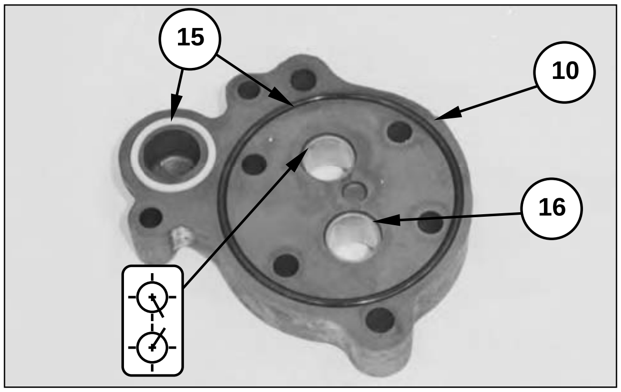
1. Install dowels (19) **5.0 ± 0.5 mm (0.197 ± 0.020 in)** above the manifold's outside surface.

2. Use Tooling group (A) and install bearings (18) in the manifold **1.52 ± 0.25 mm (0.060 ± 0.010 in)** below surface (20). Make sure the bearing joints are **30° ± 15°** from the centerline and toward the oil passage, as shown.



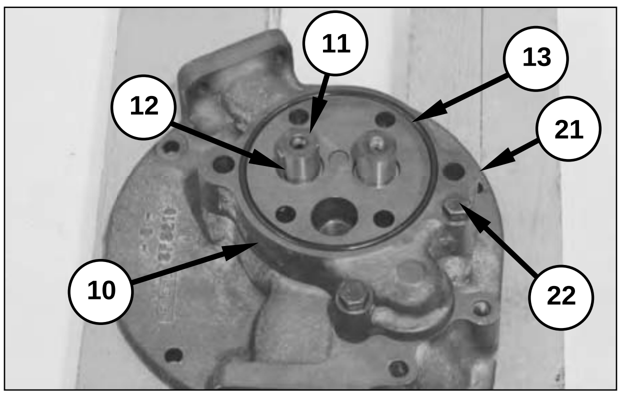
3. Install driving gear assembly (11) in manifold (21), as shown. Make sure the slot in the shaft is up, as shown.

4. Install driven gear assembly (17) in manifold (21) as shown. Make sure that after the driven gear assembly is installed the assembly is even with the bottom of the outside surface of the manifold.



5. Use Tooling group (A) to install bearings (16) in cover assembly (10) until they are **1.575 mm (0.062 in)** below the outside surface. Make sure the bearing joints are **30° ± 15°** from the centerline, toward the oil passage, as shown.

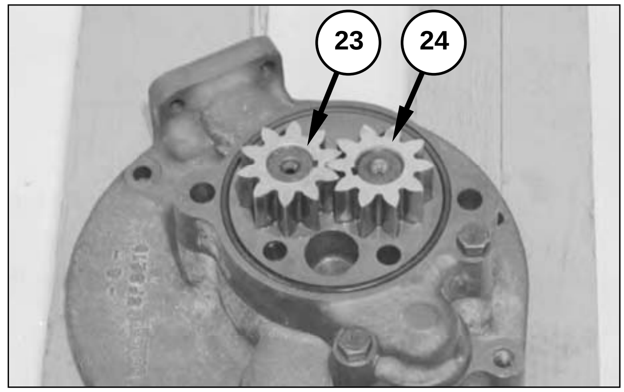
6. Install seals (15) on cover assembly (10).



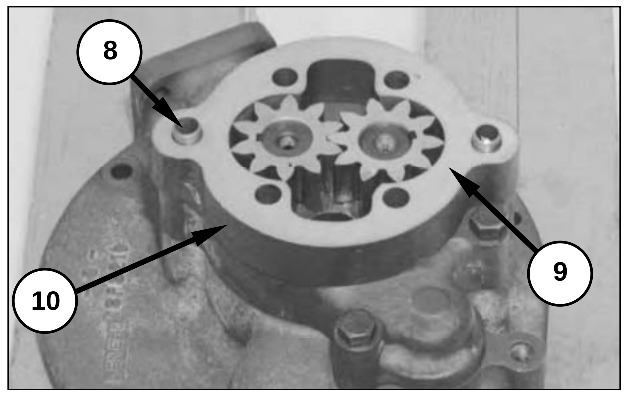
7. Put cover assembly (10) in position on manifold (21), as shown. Install bolts (22) but do not tighten them at this time.

8. Install seal (13) on cover assembly (10).

9. Put key (12) in the slot of the driving gear assembly (11), as shown.

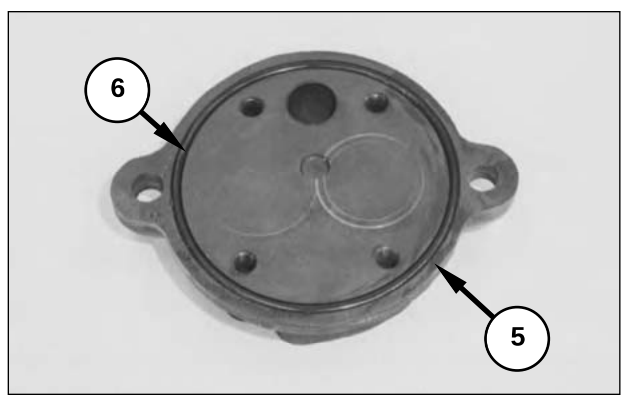


10. Install gears (23) and (24) on the driving and driven gear assemblies, as shown. Make sure the slot in gear (23) is in alignment with the key on the shaft of driving gear assembly (11).

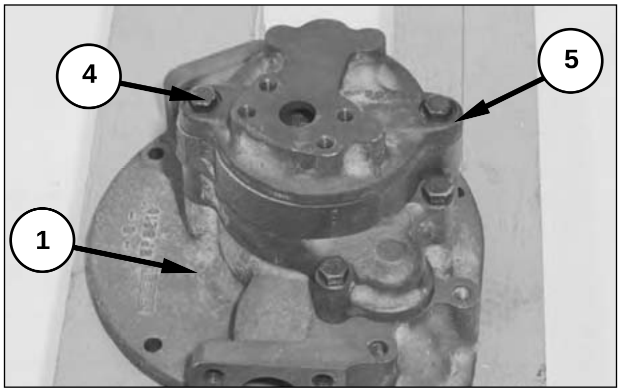


11. Install dowels (8) in body (9) so that the dowels extend **4.83 mm (0.19 in)** from the outside surfaces of both sides of body (9).

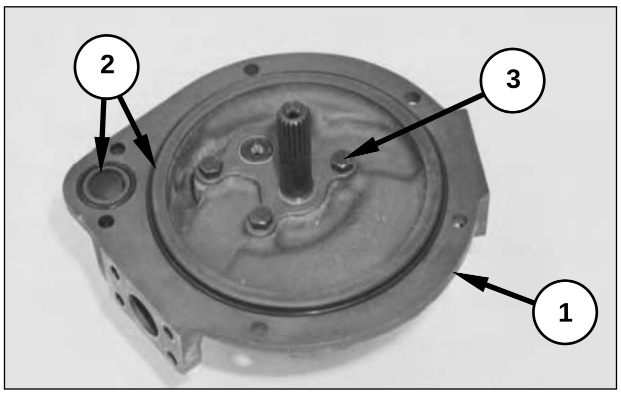
12. Install body (9) on cover assembly (10), as shown.



13. Install seal (6) on cover (5).



14. Put cover (5) in position on the body assembly, as shown. Note the locations of the oil ports on cover (5) and manifold assembly (1) for the correct installation. Install bolts (4) and tighten the remaining bolts.



15. Install bolts (3) in manifold assembly (1), as shown.

NOTICE
Pump gears must turn freely by hand before it is installed.

16. Install seals (2) on manifold assembly (1), as shown.

End By:

a. Install the power train lubrication pump.

Priority Valve

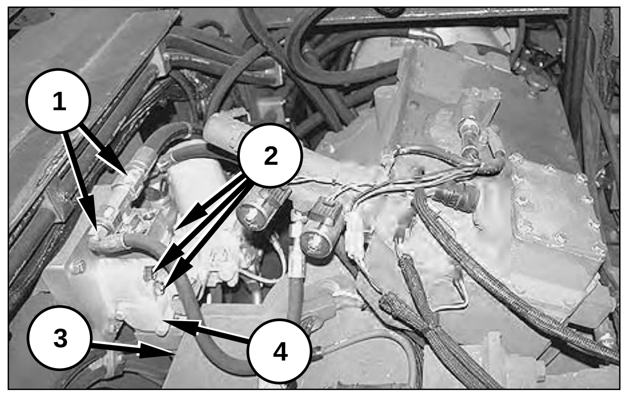
Remove and Install

Tools Needed		A
1U-5429	Snap Ring Pliers	1

Start By:

a. Remove the fuel tank. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Machine Systems,* "Fuel Tank."

NOTE: Group numbers related to this procedure include 118-3531 and 126-6629.



1. Disconnect cap and plug lines (1) and (3). Mark the lines for correct connection during reinstallation.

NOTE: Oil may drain out of the lines. Catch the oil in a suitable container, and dispose of the oil according to local regulations.

2. Remove four bolts (2) (three shown) with washers.

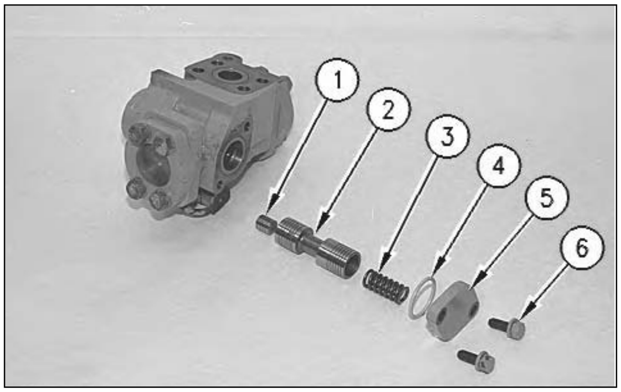
3. Remove priority valve (4).

NOTE: To install the priority valve, reverse the removal steps.

Disassemble and Assemble

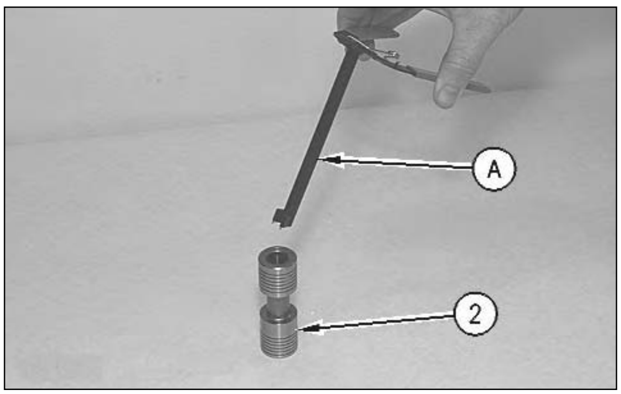
Start By:

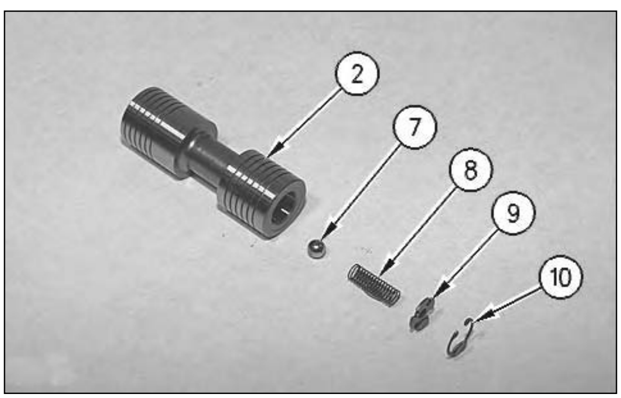
a. Remove the priority valve.



1. Remove two bolts (6) and washers and cover (5). Remove O-ring seal (4) from the cover.

2. Remove spring (3), spool (2) and slug (1) from the valve body.



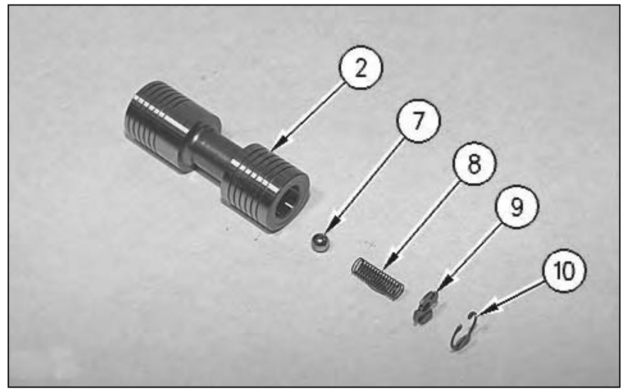


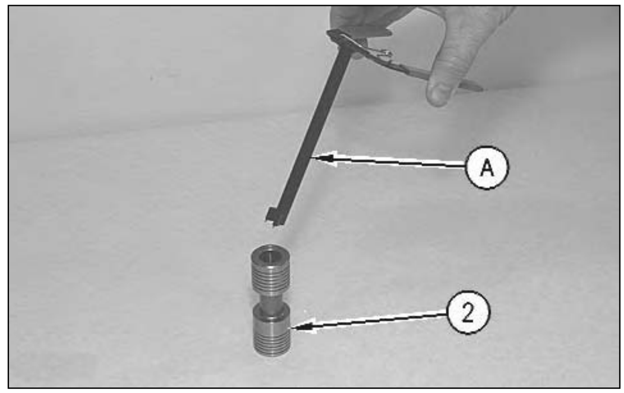
3. Use Tooling (A) to remove snap ring (10) from spool (2).

4. Remove retainer (9), spring (8) and ball (7) from spool (2). Inspect the parts for damage. If damage is found, replace the spool.

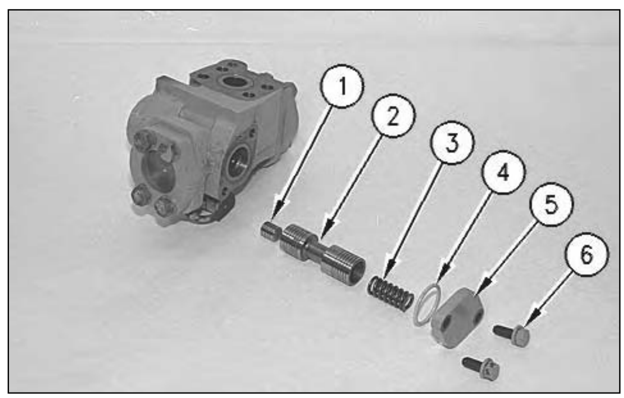
NOTE: The following steps are for the assembly of the transmission priority valve.

NOTE: Clean thoroughly, and put a thin coat of clean oil on all parts before assembly.





5. Put ball (7), spring (8) and retainer (9) in position in spool (2). Install snap ring (10) using Tooling (A).



6. Put slug (1) in position in spool (2). Put the spool in position in the valve body.

7. Put spring (3) in position in the end of spool (2).

8. Put O-ring seal (4) in position in cover (5). Put cover (5) in position on the valve body. Install two bolts (6) and washers.

End By:

a. Install the priority valve.

Rear Idler Hub

Remove and Install

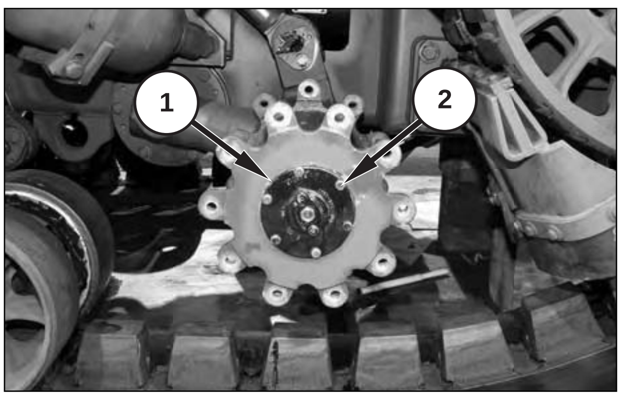
Tools Needed		A
4C-9527	Seal Installer	1

Start By:

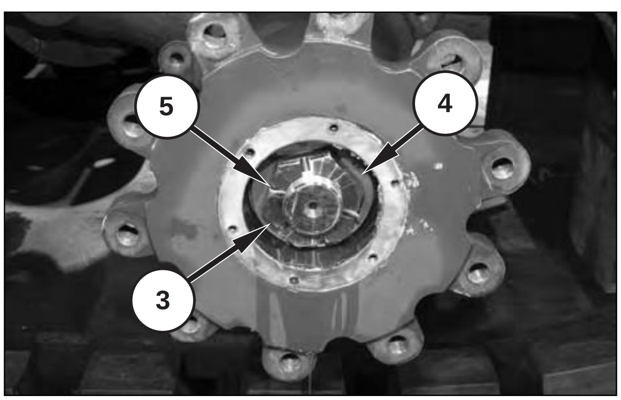
a. Remove rear idler wheels.

NOTE: Group numbers related to this procedure include 142-0065 and 142-0066.

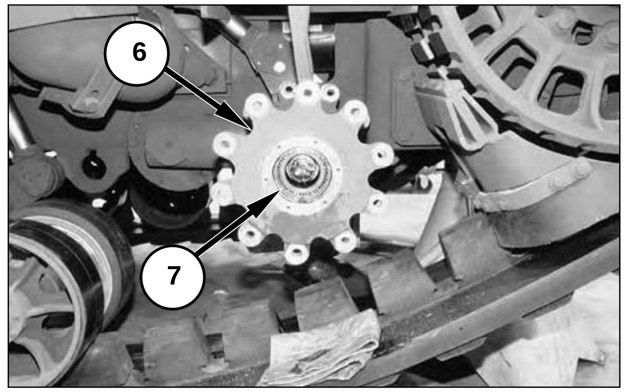
1. Drain the oil from the rear idler hub. The rear idler hub contains approximately **1.5 L (0.4 U.S. gal)** of oil. Dispose of the oil in accordance with local regulations. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Every 250 Service Hours or Three Months, Rear Idlers."



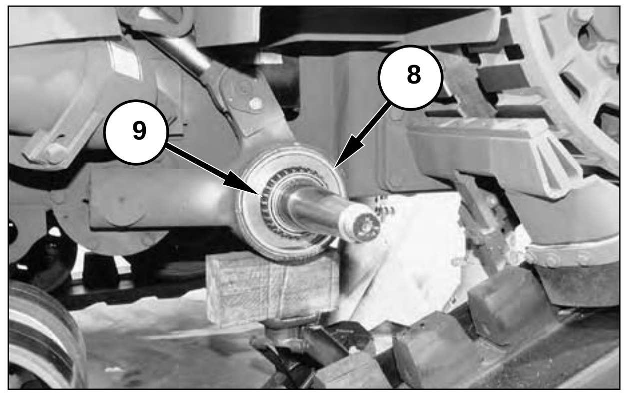
2. Remove six bolts (2) with washers, and cover (1). Remove any remaining sealant on the cover and the mating surface.



3. Remove cotter pin (5), nut (3), and thrust plate (4).

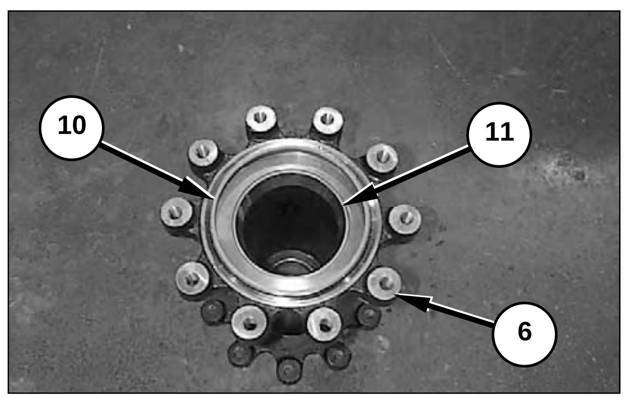


4. Fasten a hoist to rear idler hub (6), and remove bearing (7) and the hub. The weight of the hub is **47 kg (105 lb).**

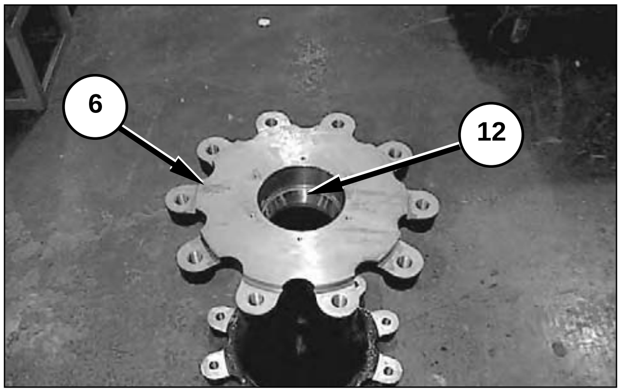


5. If necessary, use a suitable puller to remove bearing (9).

6. Remove Duo-Cone Seal (8).

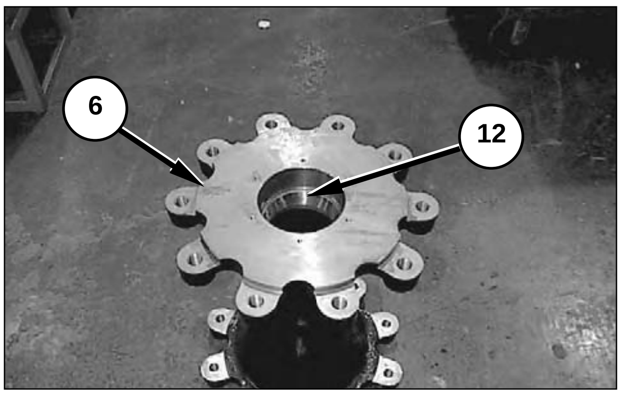


7. Remove Duo-Cone Seal (10) and bearing race (11) from rear idler hub (6).

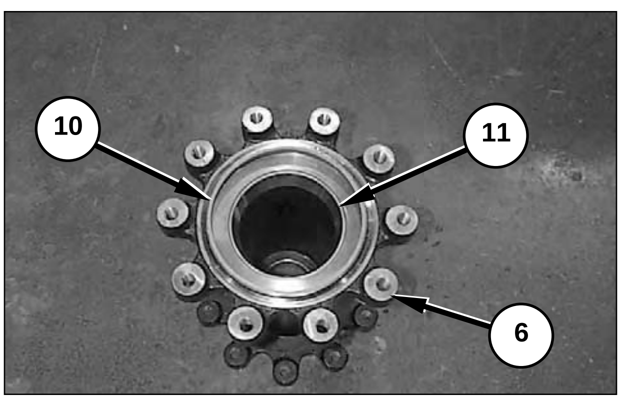


8. Remove bearing race (12) from rear idler hub (6).

NOTE: Follow the steps below to reinstall rear idler hub (6).

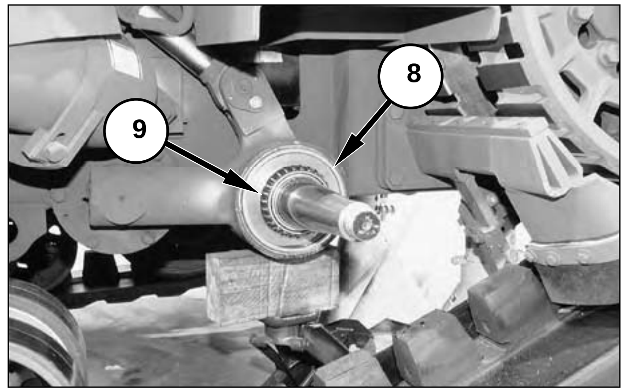


9. Chill bearing race (12) to **–100°C (–150°F),** and install the race in rear idler hub (6).



10. Chill bearing race (11) to **–100°C (–150°F)**, and install the race into rear idler hub (6).

11. Use Tooling (A) to install Duo-Cone Seal (10) into rear idler hub (6). Refer to “Duo-Cone Seals,” in this module.

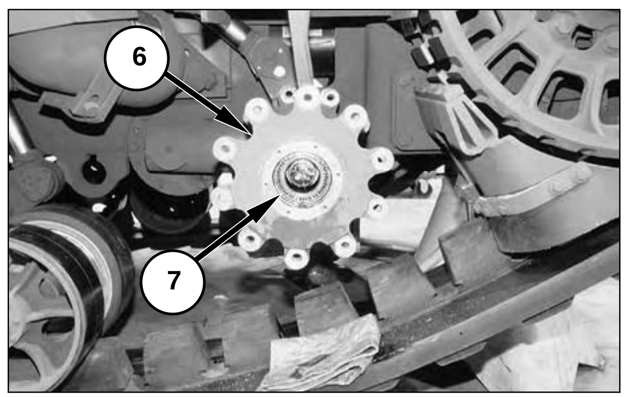


12. Use Tooling (A) to install Duo-Cone Seal (8) on the rear swing arm. Refer to “Duo-Cone Seals, Assembly and Installation,” in this module.

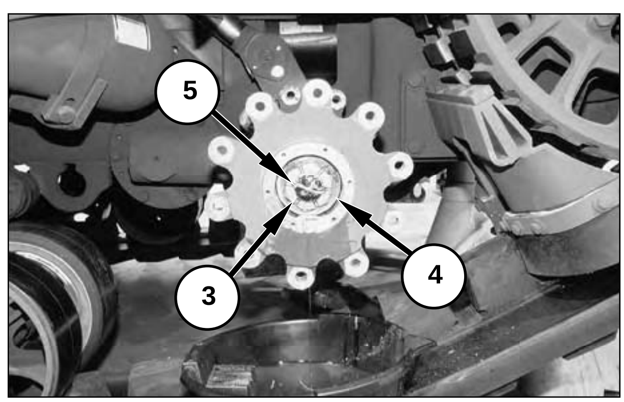
13. If bearing (9) has been removed, heat the new bearing to **107°C (225°F)**, and install the bearing on the rear swing arm.

NOTICE

Do not overheat the bearing. If any part of the bearing starts to turn blue, replace the bearing.

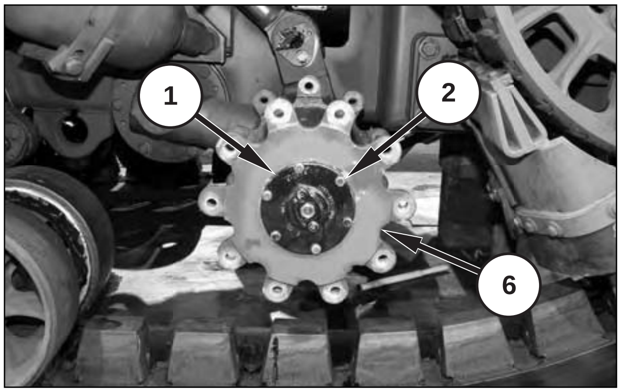


14. Install rear idler hub (6) and bearing (7) on the rear swing arm.



15. Install thrust plate (4) and nut (3). Tighten the nut to **405 N•m (300 lb ft).**

16. Install cotter pin (5) through the hole in the swing arm shaft and the slots in nut (3). If the slots in the nut do not line up with the hole in the swing arm shaft, tighten the nut until the next slot and hole line up.



17. Apply **6V-5765 Sealant** (clear silicone) in a continuous bead on the sealing surface between cover (1) and rear idler hub (6). Install the cover with six bolts (2) and washers.

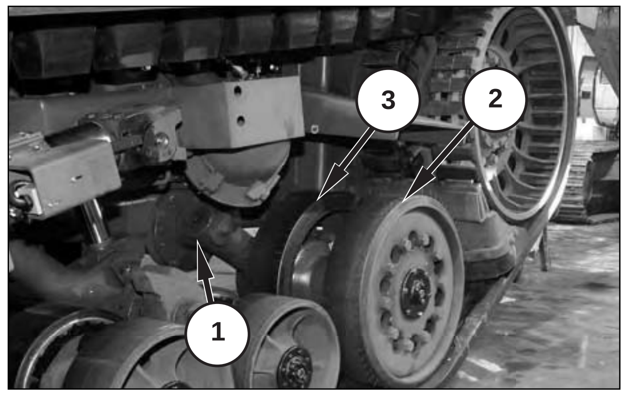
18. Refill the rear idler hub with the appropriate amount and type of oil. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Every 250 Service Hours or Three Months, Rear Idlers" and *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Lubricant Viscosities and Refill Capacities."

Rear Idler Wheel

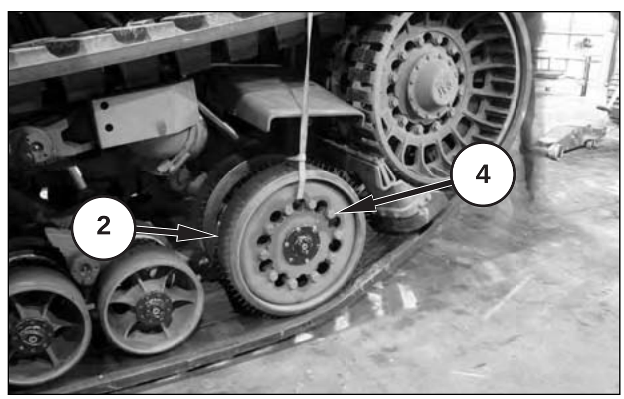
Remove and Install

NOTE: Group numbers related to this procedure include 142-0065 and 142-0066.

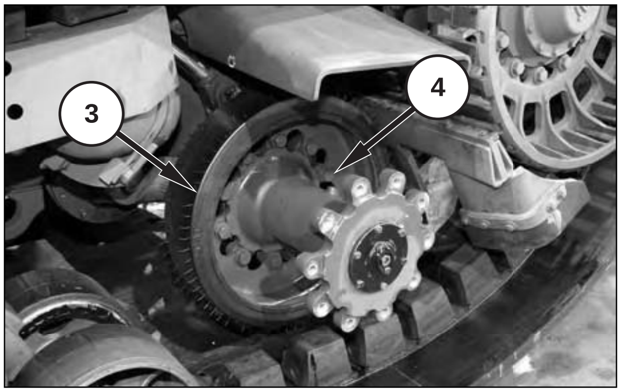
1. Release the track tension and keep the "recoil cylinder" charging port connected to the "T-IN" port on the remote tool manifold. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage Steering and Brakes,* "Testing and Adjusting, Suspension System Procedures, Suspension Hydraulic Charging Procedure."



2. Use a floor jack to raise rear swing arm (1) until idler wheels (2) and (3) are clear of the drive belt.



3. Use a hoist to support outer idler wheel (2) and remove 10 bolts (4) with washers, and then remove the outer idler. The weight of the outer idler is approximately **73 kg (161 lb).** Upon reassembly, apply **154-9731 Thread Compound (Loctite™ 271)** to the threads of the bolts, and tighten the bolts to a torque of **460 ± 60 N•m (360 ± 44 lb ft).**



4. Remove 10 bolts (4) with washers, and use a hoist to remove inner idler (3). The weight of the inner idler is approximately **73 kg (161 lb).** Upon reassembly, apply **154-9731 Thread Compound (Loctite™ 271)** to the threads of the bolts, and tighten the bolts to a torque of **460 ± 60 N•m (360 ± 44 lb ft).**

NOTE: Swing arm (1) may need to be raised higher to allow inner idler (3) to clear the guide blocks on the drive belt.

NOTE: To install rear idler wheels, reverse the removal steps.

Rear Suspension Cylinder, Left and Right

Remove and Install

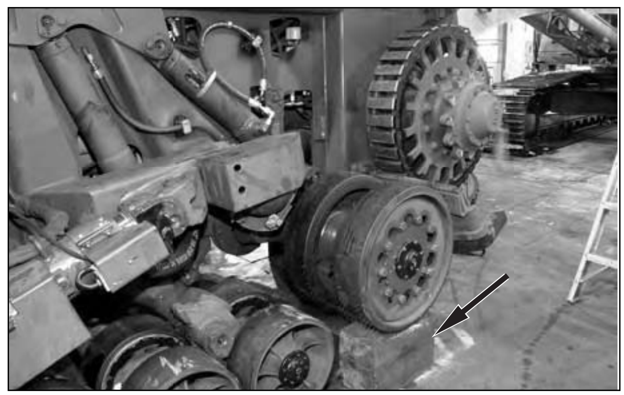
Start By:

a. Remove the fender. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Machine Systems,* "Fender Group, Left" and/or "Fender Group, Right."

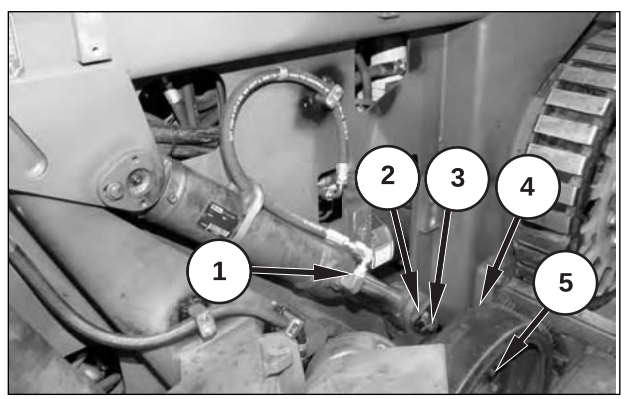
b. Remove the drive belt.

c. Remove the suspension cover group.

NOTE: The group number related to this procedure is 124-3901.



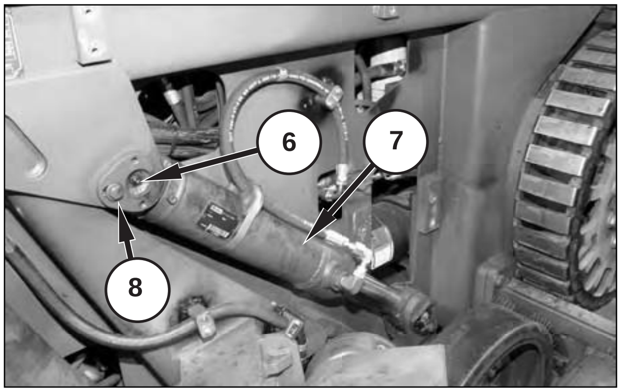
1. Block the rear idler.



2. Disconnect, cap and plug suspension line (1).

3. Remove 10 bolts (5) with washers, and allow inner idler (4) to move out onto the hub. Upon reassembly, apply **154-9731 Thread Compound (Loctite™ 271)** to the threads of the bolts, and tighten the bolts to a torque of **460 ± 60 N•m (360 ± 44 lb ft).**

4. Remove the pin retaining bolt (3) with washer and spacer (if present), and remove pin (2). Upon reassembly, apply **9S-3263 Thread Compound (Loctite™ 242)** to the threads, and tighten the pin retaining bolt to a torque of **120 ± 20 N•m (88 ± 15 lb ft).**



5. Support rear suspension cylinder (7) with a hoist, and remove bolt (8) with washer and spacer (if present). The weight of the rear suspension cylinder is approximately **43 kg (94 lb)**. Upon reassembly, apply **9S-3263 Thread Compound (Loctite™ 242)** to the threads of the bolt, and tighten the bolt to a torque of **120 ± 20 N•m (88 ± 15 lb ft).**

6. Remove pin (6) with shims, and remove rear suspension cylinder (7). Note the position of the shims. If new shims are used during reassembly, install shims to align the upper lug to within **1.5 mm (0.06 in)** of the centerline of the swing arm lug.

NOTE: To install the rear suspension cylinder, reverse the removal steps. Bleed the air from the cylinder after installation. Refer to *Systems Operations, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage, Steering and Brakes,* “Testing and Adjusting, Suspension System Procedures, Suspension Hydraulic Charging Procedure.”

End By:

a. Install the suspension cover group.

b. Install the drive belt.

c. Install the fender.

Disassemble and Assemble

NOTE: The rear suspension cylinder is the same as the middle suspension cylinder. Refer to “Middle Suspension Cylinder, Left and Right, Disassemble and Assemble,” in this module, to disassemble and assemble the rear suspension cylinder.

Recoil Accumulator

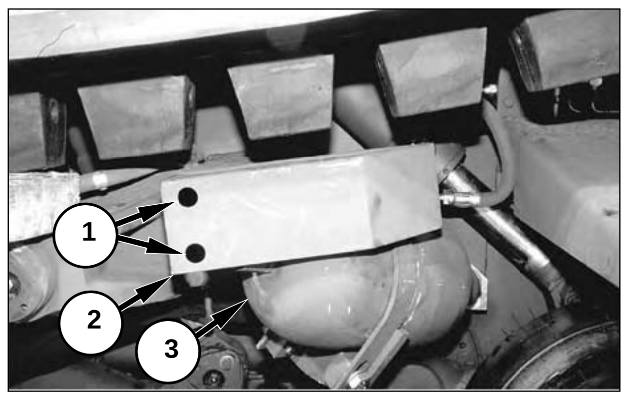
Remove and Install

NOTE: Group numbers related to this procedure include 168-0239 and 169-7418.

1. Release the belt tension. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage Steering and Brakes,* “Testing and Adjusting, Suspension System Procedures, Suspension Hydraulic Charging Procedure.”

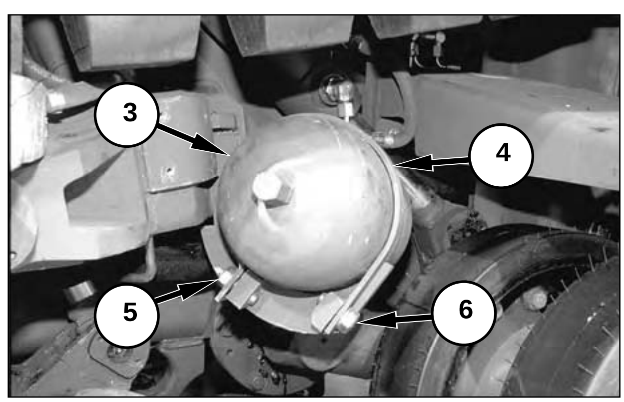
WARNING

Do not remove the accumulator without first removing the hydraulic pressure from the accumulator circuit. Personal injury or death can result from a sudden release of high pressure oil.



2. Remove three bolts with washers, and remove cover (2).

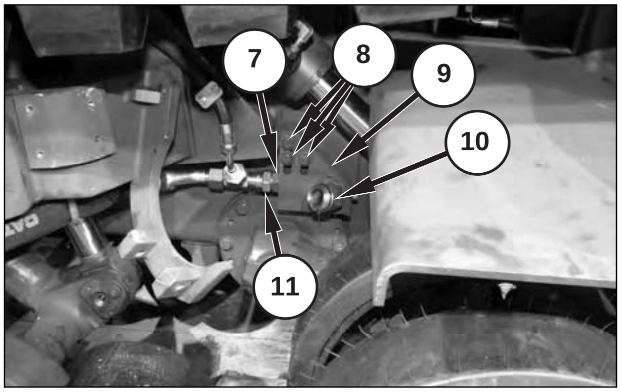
NOTE: Two of the bolts can be reached through holes (1) in the cover, and the third bolt can be reached from the back side of the cover, between accumulator (3) and the cover.



3. Remove bolts (5) and (6) with washers, and remove clamp (4).

4. Remove recoil accumulator (3).

NOTE: Oil may drain out of the accumulator. Catch the oil in a suitable container, and dispose of the oil according to local regulations.



5. Remove hose (11) from fitting (7). Cap the hose to prevent contamination. If necessary, remove the opposite end of the hose from the recoil cylinder, cut hose ties and remove the hose from the machine.

NOTE: Oil may drain out of hose (11). Catch the oil in a suitable container, and dispose of the oil according to local regulations.

6. Remove three bolts (8) with washers, and remove manifold (9).

7. Place manifold (9) in a vise, and remove fitting (7) with O-ring seal and fitting (10) with two O-rings. Make note of the approximate angle of the fitting for reinstallation.

NOTE: The following steps describe the installation procedure.

8. Install fitting (7) with O-ring.

9. Install fitting (10) with two O-rings. Tighten fitting (10) finger tight.

10. Use three bolts (8) with washers to install manifold (9). Tighten the bolts finger tight

11. Install accumulator (3) on manifold (9). Tighten the accumulator hand tight. Adjust the accumulator so that the accumulator fits in the center of the saddle.

12. Tighten three bolts (8).

13. Tighten the nut which secures fitting (10) to manifold (9).

14. Tighten accumulator (3) on fitting (10).

15. Connect hose (11) to fitting (7).

NOTE: If hose (11) was removed from the machine during disassembly, reconnect the hose to the recoil cylinder, and replace the hose ties which were cut.

16. Use bolts (5) and (6) with washers to install clamp (4).

17. Use three bolts with washers to install cover (2).

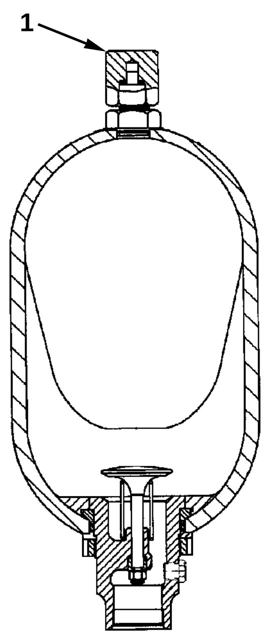
Disassemble and Assemble

Tools Needed	
7S-5437 Nitrogen Charging Group	1

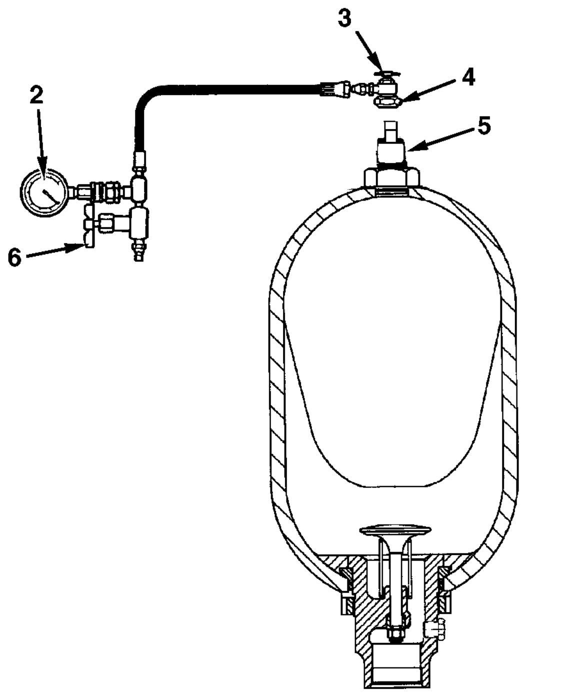
Start By:

a. Remove the recoil accumulator.

NOTE: The group number related to this procedure is 169-6876.



1. Remove valve cover (1).



2. Install **7S-8712 Pressure Gauge** (2) to the fitting on the **7S-5437 Nitrogen Charging Group**.

3. Ensure that valve (6) is closed.

4. Attach connector (4) of the **7S-5437 Nitrogen Charging Group** to gas valve (5) on the accumulator.

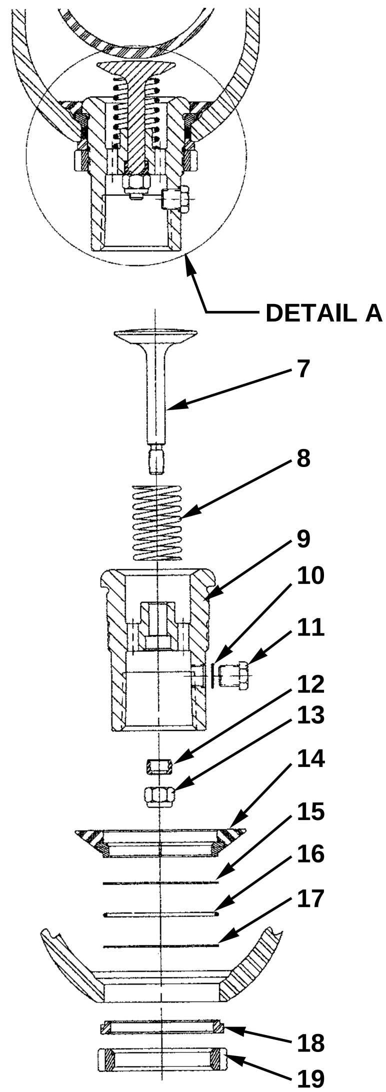
5. Turn valve (3) clockwise, until tight, and read the pressure which registers on pressure gauge (2).

6. If the pressure is greater than 0 kPa (0 psi), open valve (6) slightly to slowly release the nitrogen gas. Direct the discharge of nitrogen away from personnel in the area. When the pressure on gauge (2) registers 0 kPa (0 psi), slowly open valve (6) completely to ensure that all of the nitrogen has been discharged from the accumulator.

7. Close valve (6), and remove connector (4) from gas valve (5).

8. Secure the accumulator in a chain vise.

NOTE: If a chain vise is not available, a standard jaw vise with brass inserts can be used.



DETAIL A

9. Remove bleed plug (11) with O-ring seal (10). If necessary, replace the O-ring.

10. Remove lock nut (19), and remove spacer (18).

WARNING

Only remove lock nut (19) if all of the nitrogen gas has been removed from the accumulator.

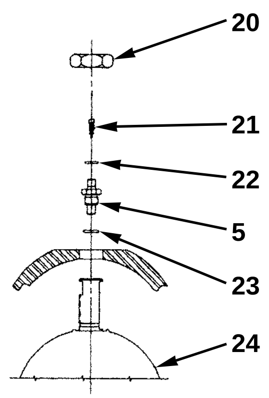
11. Push port assembly (9) into the accumulator housing.

12. Remove backup ring (17), O-ring seal (16), and metal backup ring (15) from the accumulator housing.

13. Remove anti-extrusion ring (14) from port assembly (9), and then remove the anti-extrusion ring from the accumulator housing.

14. Remove port assembly (9) from the accumulator housing.

NOTE: If necessary, remove lock nut (13), poppet (12), valve (7), and spring (8) from port assembly (9).



15. Remove nut (20).

16. Remove valve core (21) and seal (22) from gas valve (5).

NOTE: If necessary, remove gas valve (5) and O-ring seal (23) from bladder (24).

17. Remove bladder (24) from the accumulator housing.

NOTE: The following steps describe the assembly procedure.

18. Coat the inside of the accumulator housing with clean hydraulic oil.

19. Install bladder (24) in the accumulator housing.

NOTE: Collapse and fold bladder (24) lengthwise into a tight roll. A slight twisting of the bladder will assist with installation. A bladder pull rod (a rod with a threaded cap on the end which fits over the gas valve) can be fabricated and used to install the bladder.

NOTE: If gas valve (5) and O-ring seal (23) were removed from bladder (24), reinstall the components before the bladder is inserted into the accumulator housing.

20. Install nut (20) by hand. Tighten nut (20) to a torque of **76 N•m (56 lb ft)**.

21. Insert port assembly (9) into the accumulator housing with the threaded end facing out. Push the port assembly completely inside the accumulator housing.

NOTE: If lock nut (13), poppet (12), valve (7), and spring (8) were removed from port assembly (9) during disassembly, reinstall the components before the port assembly is inserted into the accumulator housing.

22. Install anti-extrusion ring (14) in the accumulator housing, and then install the anti-extrusion ring on port assembly (9).

NOTE: This step must be performed with anti-extrusion ring (14) and port assembly (9) inside of the accumulator housing.

23. Pull the threaded end of port assembly (9) through the port in the accumulator housing until the non-threaded end of the port assembly is seated against the inside of the accumulator housing.

24. Install seal (22) and valve core (21) in gas valve (5). Tighten the valve core to a torque of **0.4 N•m (3.5 lb in)**.

25. Fill bladder (24) with dry nitrogen until the pressure reaches approximately **276 to 345 kPa (40 to 50 psi)**. For the accumulator charging procedure, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage, Steering, and Brakes* “Testing and Adjusting, Suspension System Procedures.”

26. Install metal backup ring (15) so the ring is firmly seated against anti-extrusion ring (14).

27. Install O-ring seal (16) and backup ring (17).

28. Install spacer (18) with the smaller diameter of the shoulder facing the accumulator housing.

29. Install lock nut (19). Tighten the lock nut to a torque of **372 N•m (275 lb ft)**.

30. Install bleed plug (11) with O-ring seal (10). Tighten the bleed plug to a torque of **13.6 N•m (10 lb ft)**.

31. Pour approximately **0.95 L (0.25 U.S. gal)** of clean hydraulic oil into the accumulator.

32. Charge the accumulator with dry nitrogen to the specified pressure. For the accumulator charging procedure, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage, Steering, and Brakes* “Testing and Adjusting, Suspension System Procedures.”

33. Install the valve cover (1). Tighten valve cover (1) to a torque of **19 N•m (14 lb ft)**.

End By:

a. Install the recoil accumulator.

Recoil Cylinder

Disassemble and Assemble

Start By:

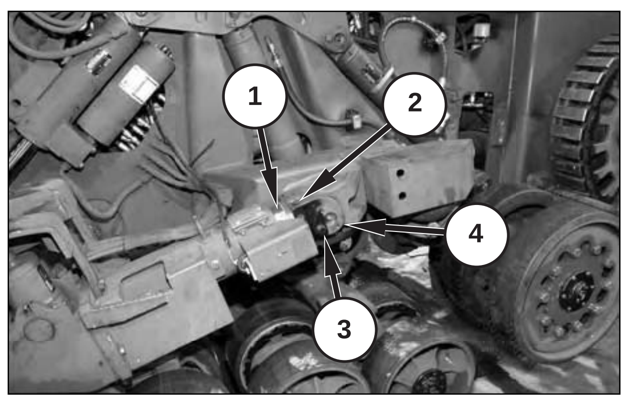
a. Remove the rear fender. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Machine Systems,* "Fender Group, Left" and/or "Fender Group, Right."

b. Remove the drive belt.

c. Remove the suspension cover group.

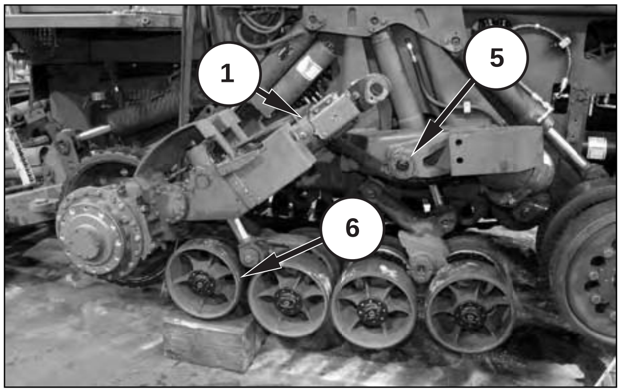
NOTE: Group number related to this procedure include 169-7416 and 169-7417.

1. Support the front half of the tension assembly with a hoist.



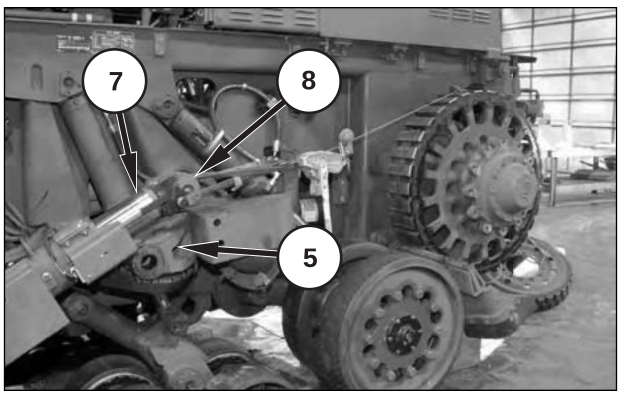
2. Remove bolt (2). Leave the fitting on recoil cylinder (1) open.

3. Remove bolt (3) with washer, and pin (4). Upon reassembly, apply **9S-3263 Thread Compound (Loctite™ 242)** to the threads of the bolt, and tighten the bolt to a torque of **300 ± 40 N•m (220 ± 30 lb ft).**



4. Block the bottom of midrollers (6), and lower the hoist to raise recoil cylinder (1) until the cylinder is clear of cylinder mount (5) on the machine frame.

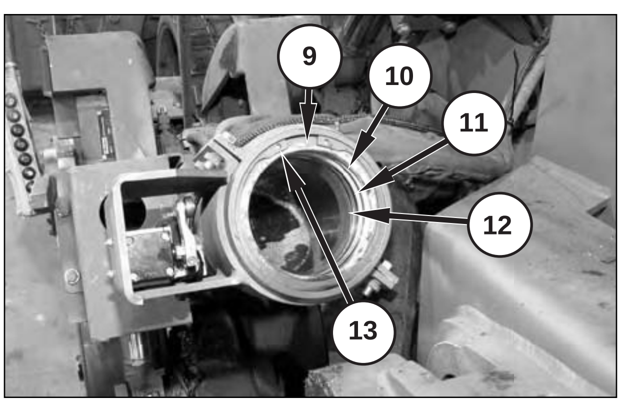
NOTE: Do not allow the pivot arm to go over center.

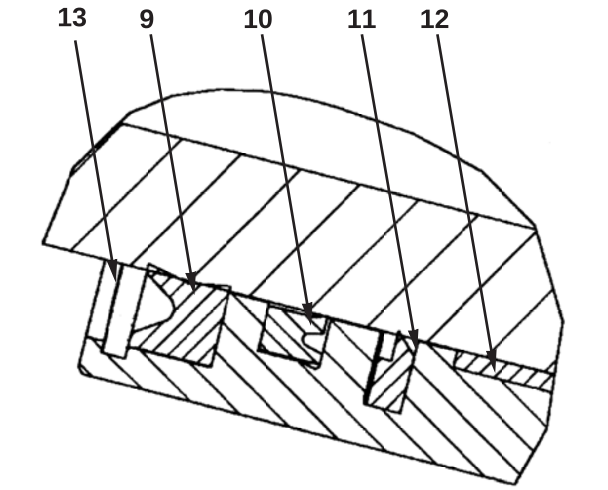


5. Install pin (8) and a hand winch.

6. Use the hand winch to remove cylinder rod (7). Use two people to support the rod during removal. The weight of the cylinder rod is **27 kg (60 lb).** Prevent the cylinder rod from coming into contact with cylinder mount (5).

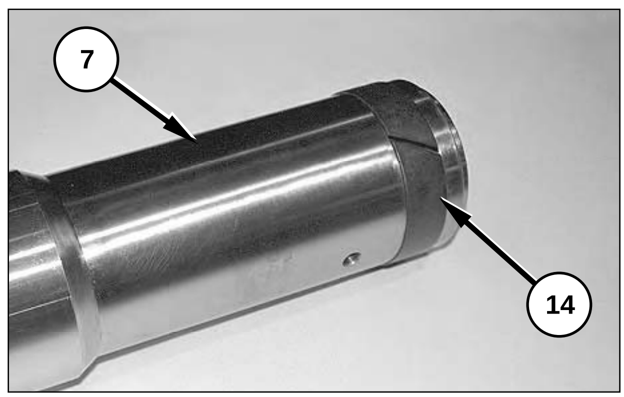
NOTE: When hand winch is attached, it may be necessary to block the front idler to prevent it from rotating beyond top center.





7. Remove snap ring (13).

8. If necessary, remove seals (9) through (12). The seals are flexible and can be twisted for removal and installation. Replace the seals if they are worn or damaged.



9. If necessary, remove seal (14) on cylinder rod (7).

NOTE: To install the recoil cylinder, reverse the disassembly steps.

End By:

a. Install the drive belt.

b. Install the rear fender.

c. Install the suspension cover group.

Recoil Alarm Switch Plate

Replace

NOTE: The group number related to this procedure is 144-7169.

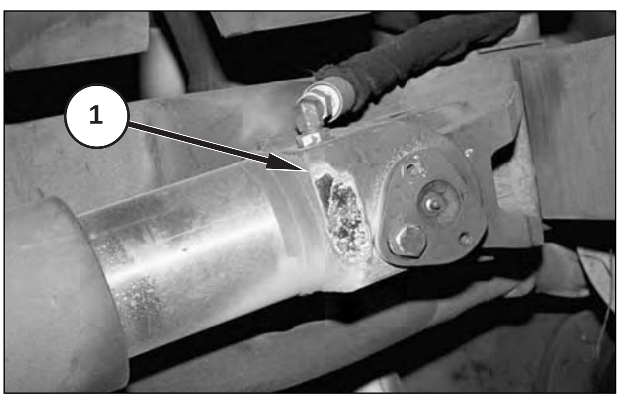
NOTE: The following procedure is for the component on the right side of the machine. The procedure for the component on the left side of the machine is the same.

Start By:

a. Remove recoil alert cover. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Electrical System* “Recoil Alert Cover.”

WARNING

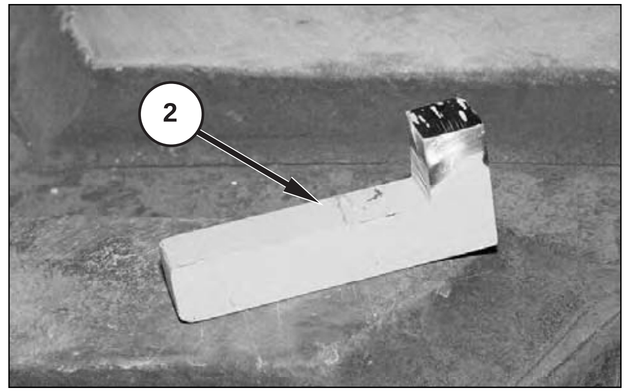
Prior to welding hose clamp plates on any CARC painted surface, remove the paint no less than six inches in all directions from the proposed weldment area. You must use a NIOSH certified respirator that protects against exposure to weld fumes that contain chromium. If any grinding on the painted surface is done in conjunction with the welding activity, the respirator must be NIOSH certified for dust, fume and mists.



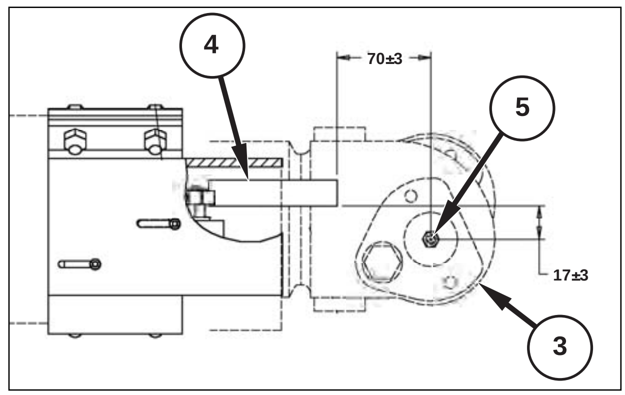
1. Place a fire blanket over the exposed recoil cylinder rod.

2. Remove the existing recoil alarm switch plate.

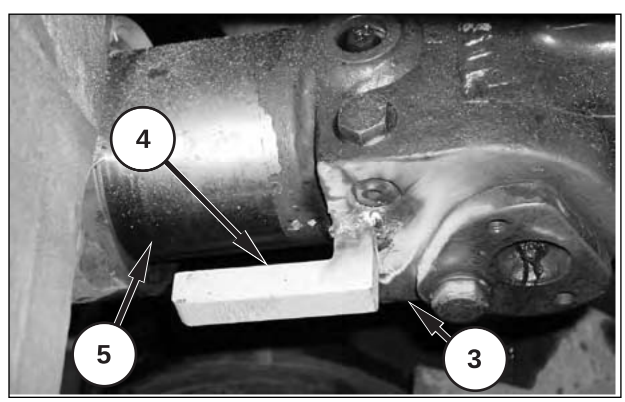
3. Remove the CARC paint finish from the rod end of recoil cylinder (1) where the recoil alarm switch plate is to be welded.



2. If necessary, remove the paint finish from the surface of recoil alarm switch plate (2) that will contact the rod end of the recoil cylinder.



3. Locate the position of recoil alarm switch plate (4) on the rod end of recoil cylinder (3). The bottom edge of the plate should be located **20 ± 3 mm (0.79 ± 0.12 in)** above the center of rod pin grease fitting (44). The back edge of the plate should be **70 ± 3 mm (2.75 ± 0.12 in)** in front of rod pin grease fitting (5). The bottom edge of the plate should be parallel to the center line of the recoil cylinder.



4. Weld recoil alarm switch plate (4) to the rod end of recoil cylinder (3).

5. After welding, touch-up all exposed metal surfaces with **Yellow Primer Paint 4C-4205** or the equivalent, and paint the surface with a flat green enamel paint.

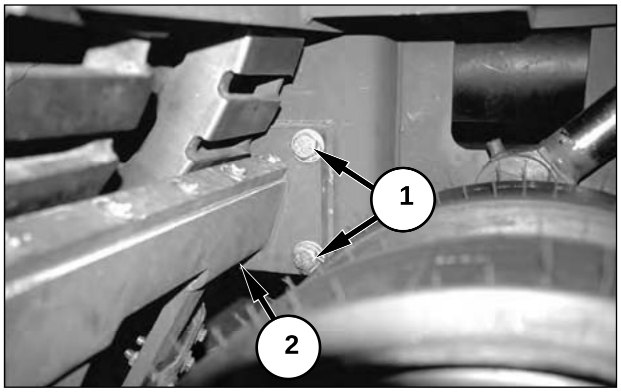
End By:

a. Install recoil alert cover.

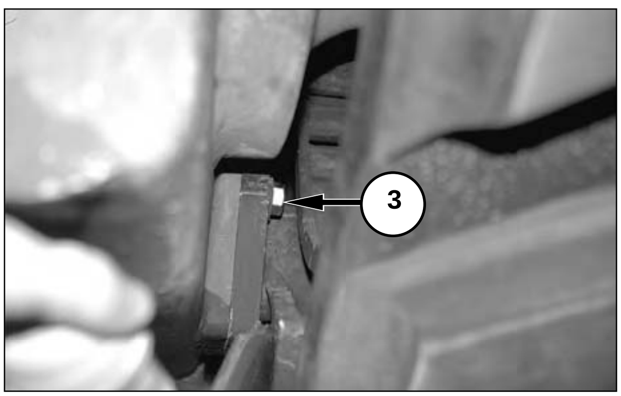
Scraper Group, Idler

Remove and Install

NOTE: The group number related to this procedure is 165-0540.



1. Remove two bolts (1) with washers which hold idler scraper group (2) to the machine frame. Upon reassembly, apply **9S-3263 Thread Compound (Loctite™ 242)** to the threads of the bolts.



2. Loosen but do not remove bolt (3). Upon reassembly, apply **9S-3263 Thread Compound (Loctite™ 242)** to the threads of the bolt.

3. Attach an appropriate lifting devise to scraper group (2). The weight of the scraper group is approximately **57 kg (125 lb)**. Slide the scraper group forward and off of bolt (3).

4. Remove scraper group (2). The weight of the idler scraper group is approximately **57 kg (125 lb)**.

NOTE: During the installation procedure, install the scraper group so that the rubber piece is within **1.5 ± 0.5 mm (0.06 ± 0.02 in)** of the drive belt, and the top edge of the scraper is **3 ± 1 mm (0.12 ± 0.04 in)** from the drive wheel.

NOTE: The right side shown; the left side is a mirror image.

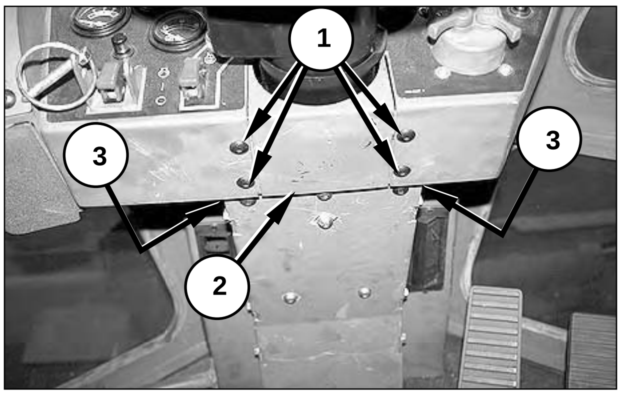
NOTE: To install the scraper group, reverse the removal steps.

Steering Column

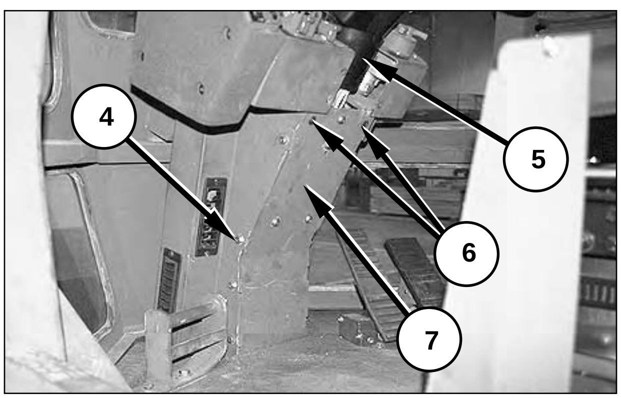
Remove and Install

NOTE: The group number related to this procedure is 145-0426.

1. Turn the main disconnect switch OFF. Refer to *Operation and Maintenance Manual, Deployable Universal Combat Earthmover (DEUCE), Operator's Manual,* "Operation Section, Machine Features, Main Disconnect Switch."



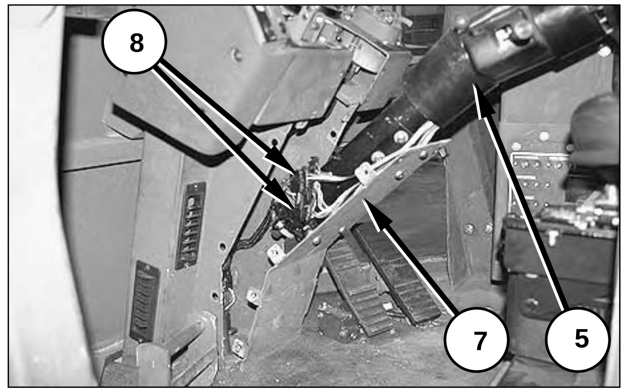
2. Remove four screws (1), two bolts (3) with washers, and cover (2).



3. Remove the remaining four bolts (4) on both sides of the column, and remove two screws (6) from the front of the column.

NOTE: The fourth bolt from the bottom, on the left side of the column, has a larger washer and a cable.

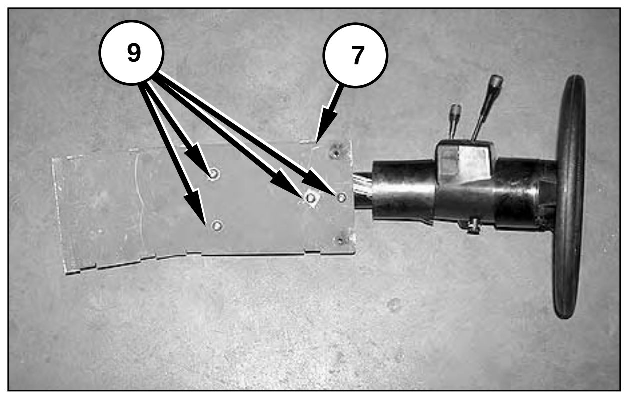
4. Allow cover (7), together with steering column (5), to fold down towards the seat.



5. Disconnect connectors C122 and C132 (8).

6. Lift steering column (5) to disengage the splines on the steering control drive shaft. Remove the steering column and cover (7) as a unit.

NOTE: Upon reassembly, ensure that the steering wheel is straight before installing the column on the steering control drive shaft.



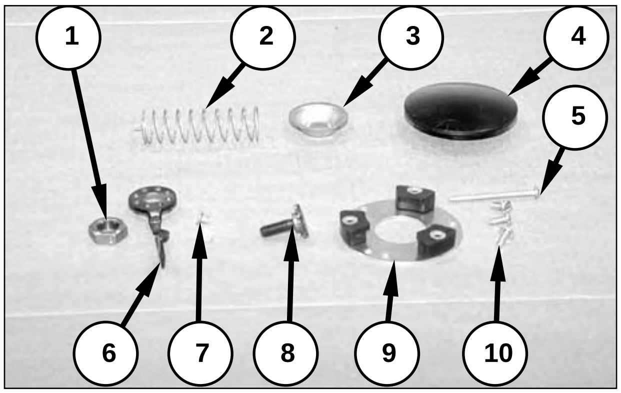
7. Remove four screws (9) with washers and cover (7).

NOTE: To install the steering column, reverse the removal steps.

Disassemble and Assemble

Tools Needed	A
145-5242 Puller Kit	1

NOTE: Tooling A does not include two **1/4-28 x 101.6 mm (4 in) bolts** with two flat washers which are necessary to pull the steering wheel.



1. Pry cover (4) off the center of the steering wheel, and remove retainer (3) and spring (2).

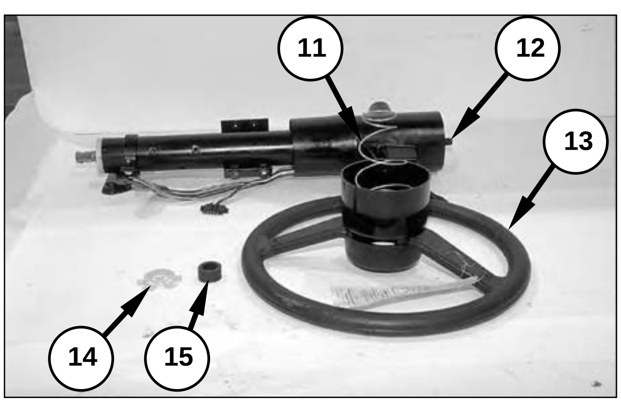
2. Remove three short screws (10) and one long screw (5) from contact plate (9).

3. Remove two screws (7) from telescoping lever (6). Remove the telescoping lever from the steering wheel.

4. Remove sprocket head bolt (8).

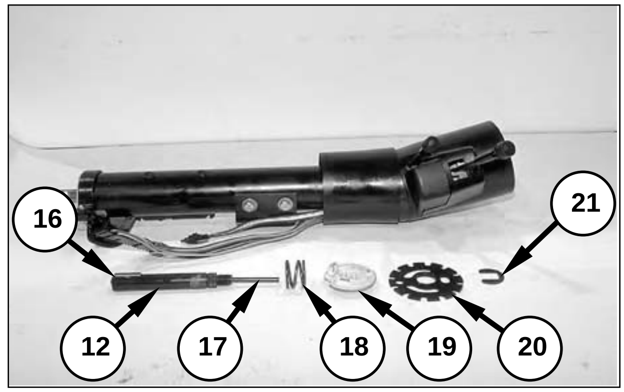
NOTE: Upon reassembly, install sprocket head bolt (8) until the bolt hits bottom. At this point, the wheel will not telescope. Loosen the sprocket head bolt until the wheel just begins to telescope. Swing telescoping lever (6) counterclockwise against the stop. Replace two screws (7) in the holes which align with the sprocket.

5. Remove steering wheel retaining nut (1).



6. Use Tooling A to remove steering wheel (13) with spring (11) from telescoping shaft (12).

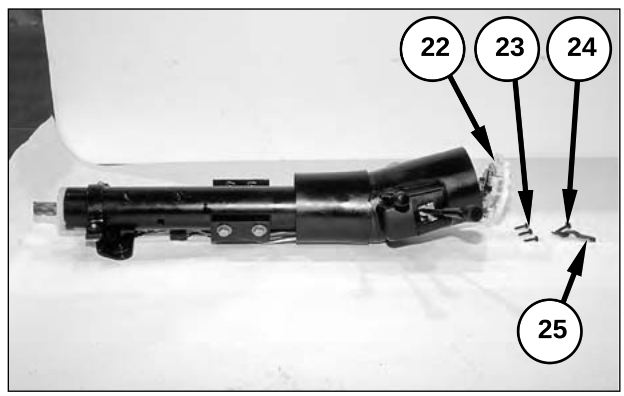
7. Remove rubber cushion (15) and plastic cover (14) from telescoping shaft (12).



8. Use Tooling A to remove retaining clip (21).

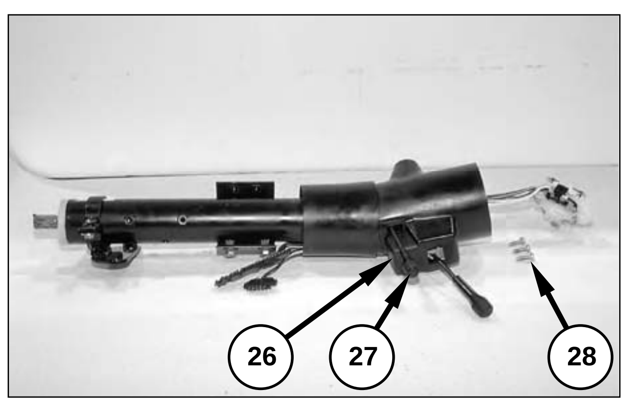
9. Remove metal plate (20) with plastic contact plate (19) and remove spring (18) from telescoping shaft (12).

10. Remove telescoping shaft (12) with rod (17) and key way (16) from the column.



11. Remove screw (24) and cam (25).

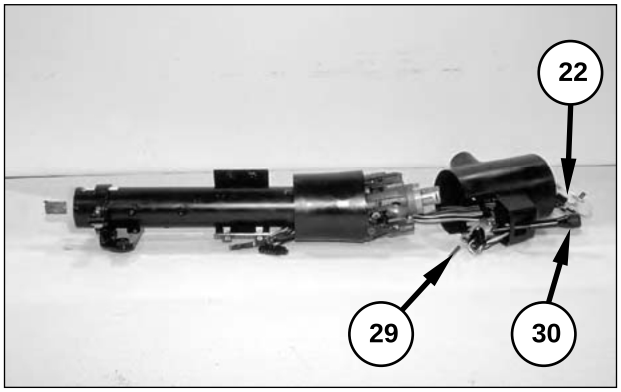
12. Remove three screws (23) and slide turn signal switch (22) out of the column.



13. Remove three screws (28) which hold the top of the steering column on.

14. Unscrew and remove tilt lever (27). Upon reassembly, tighten the tilt lever to a torque of **3.4 ± 0.6 N•m (30.3 ± 5 lb in)**.

15. Slide the top of the steering column up, and remove plastic cover (26).



16. Remove turn signal switch (22) with the harness, through the top of the steering column.

17. Remove pin (29) from turn and wiper lever (30). The pin must be pushed from the top for removal. Use a long skinny punch or pencil to push the pin out of the mount.

18. Push turn and wiper lever (30) through the hole, and remove the turn and wiper lever with the wiper switch from the column.

19. Remove the wiper harness through the top of the steering column.

NOTE: To assemble the steering column, reverse the removal steps.

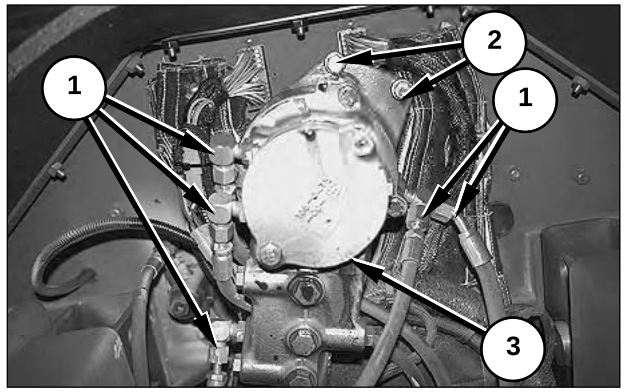
Steering Control Valve

Remove and Install

Start By:

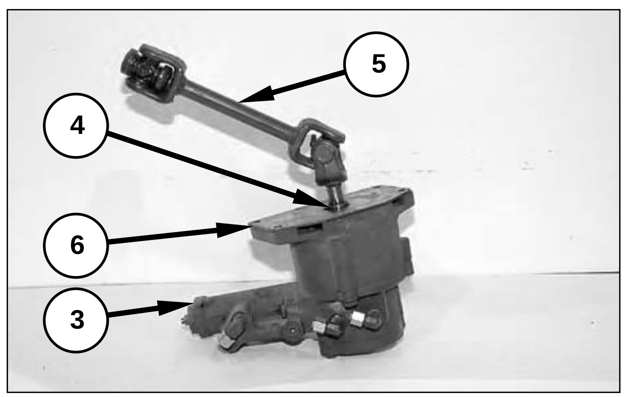
a. Remove the steering column.

NOTE: Group numbers related to this procedure include 135-7462 and 147-0746.



1. Disconnect, cap and plug five lines (1). Mark the lines for correct connection at reassembly.

2. Support the steering control unit, and remove four bolts (2, two shown) with washers, and steering control unit (3) with the steering column drive shaft. Upon reassembly, tighten the bolts to a torque of **59.6 ± 5.4 N•m (44 ± 4 lb ft).**



3. Use a punch to remove roll pin (4), and remove steering column drive shaft (5) from steering control unit (3).

4. Remove seal retention plate (6).

NOTE: To install the steering control valve, reverse the removal steps.

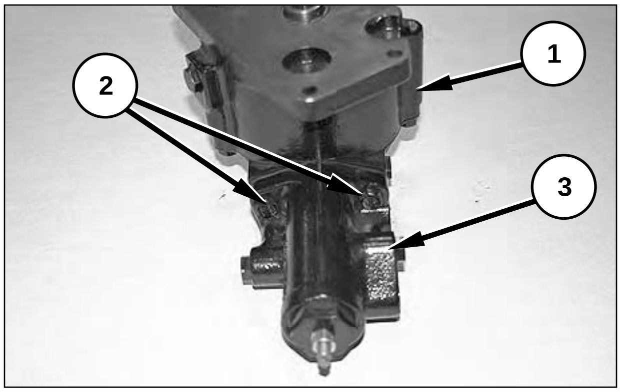
End By:

a. Install the steering column.

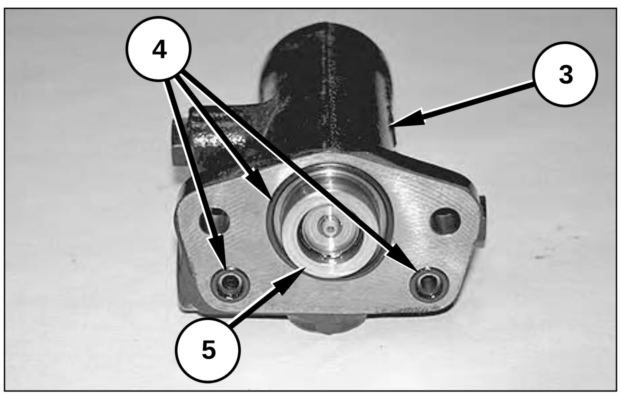
Disassemble and Assemble

Start By:

a. Remove the steering control valve.

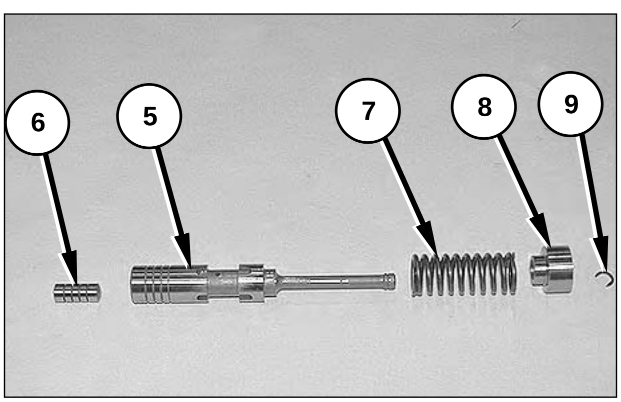


1. Remove two bolts (2), and separate housing (3) from housing (1).



2. Remove three O-ring seals (4) from housing (3). Replace the O-ring seals if they are worn or damaged.

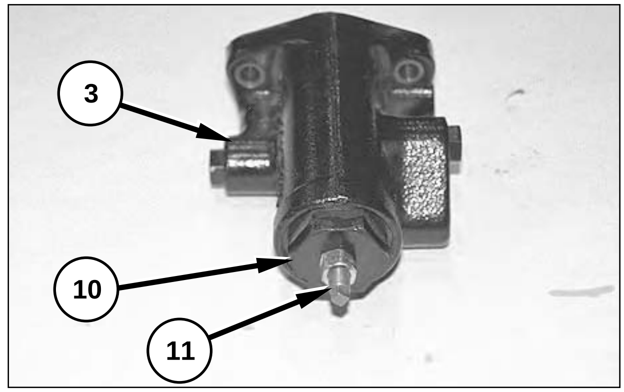
3. Remove spool (5) from housing (3).



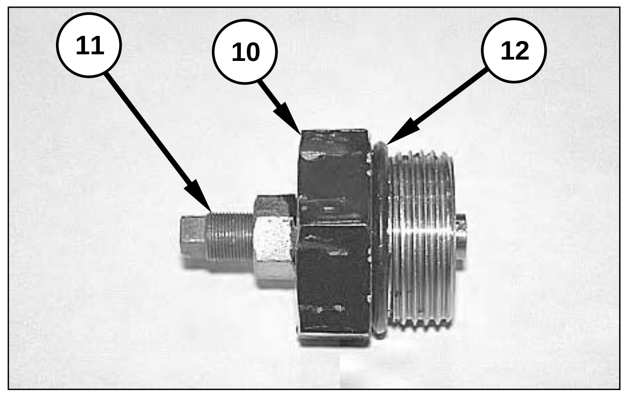
4. Remove snap ring (9) from spool (5).

5. Remove spring retainer (8) and spring (7) from spool (5).

6. Remove spool (6) from spool (5).



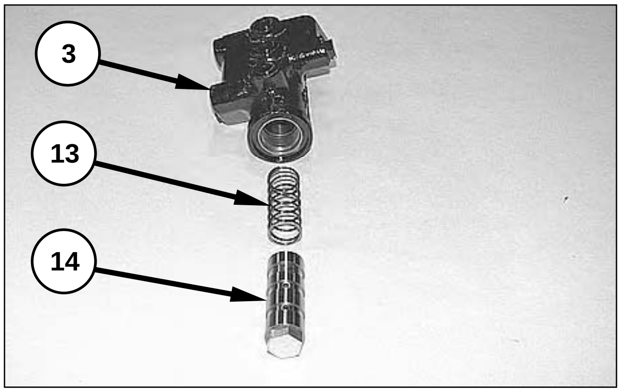
7. Remove end cap (10) with the lock nut and adjustment screw (plunger) (11) from housing (3). Upon reassembly, tighten the end cap to a torque of **80 ± 7 N•m (59.2 ± 9.5 lb ft).**



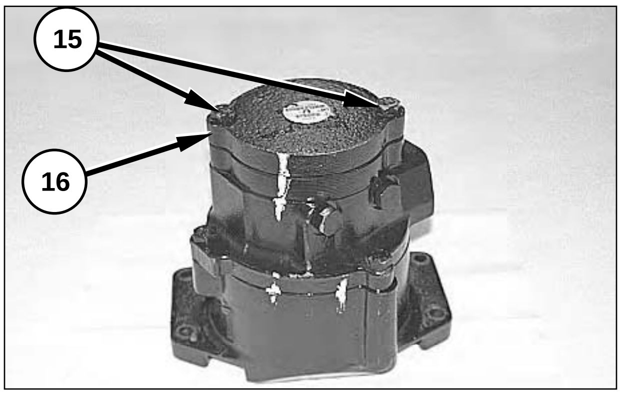
8. Remove O-ring seal (12) from end cap (10). Replace the O-ring seal if there is wear or damage.

9. If necessary, remove adjustment screw (plunger) (11) and the lock nut from end cap (10).

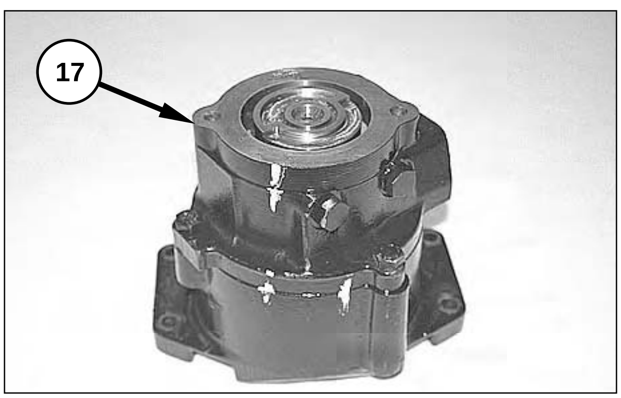
NOTE: Do not disturb lock nut and adjustment screw (plunger) (11), unless necessary. If the lock nut and screw are disturbed, perform the procedure given in *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage Steering, and Brakes,* “Testing and Adjusting, Steering System Procedures, Steering Control Valve Pressure Test.”



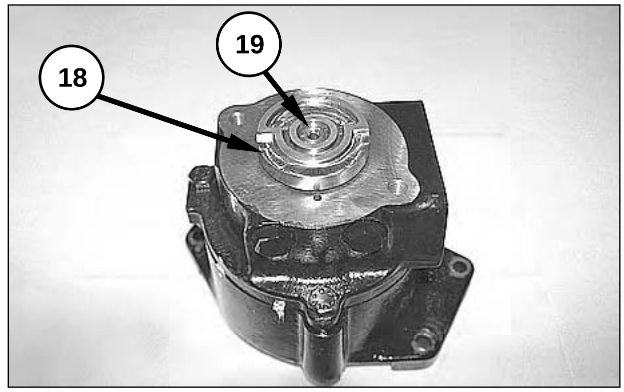
10. Remove spring (13) and sleeve spool (14) from housing (3).



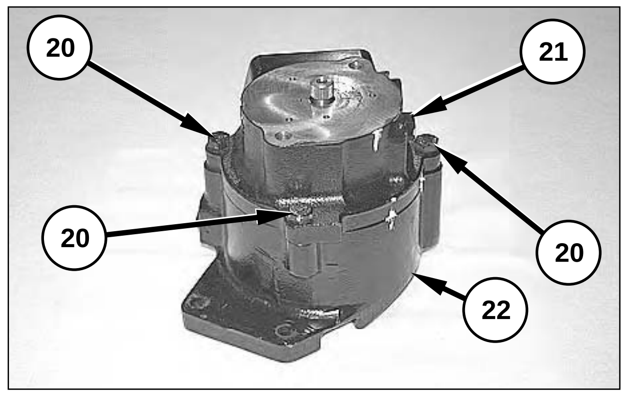
11. Remove two bolts (15) and end plate (16) with the O-ring seal. Mark the components for correct orientation upon reassembly. Replace the O-ring seal if there is wear or damage.



12. Remove ring (17) with the O-ring seal.

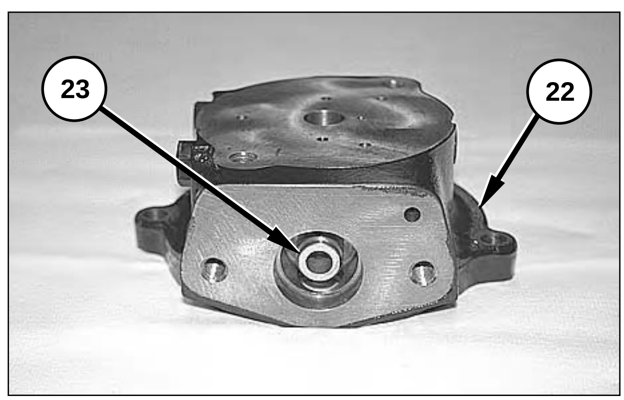


13. Make note of the orientation of the timing mark on shaft (19) and valve plate (18). Align the marks on the valve plate and the shaft in the same orientation upon reassembly.

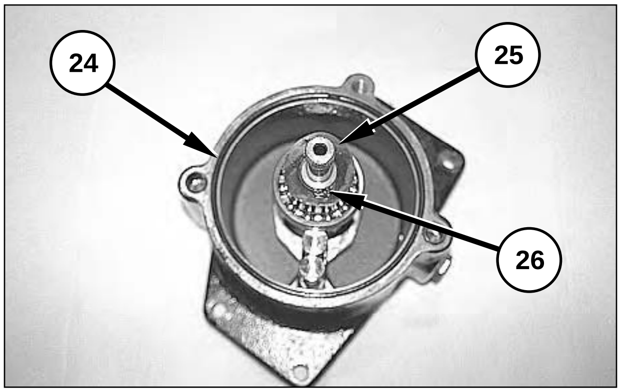


14. Remove three bolts (20), and housing (21) from housing (22).

NOTE: If necessary, loosen a fitting before removing one of the bolts from the housing.

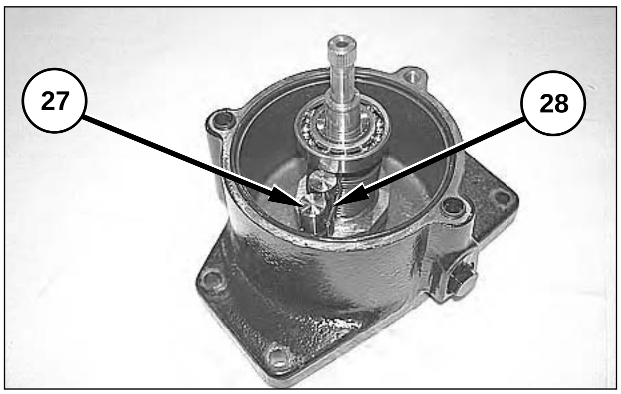


15. Remove follower (23) from housing (22).

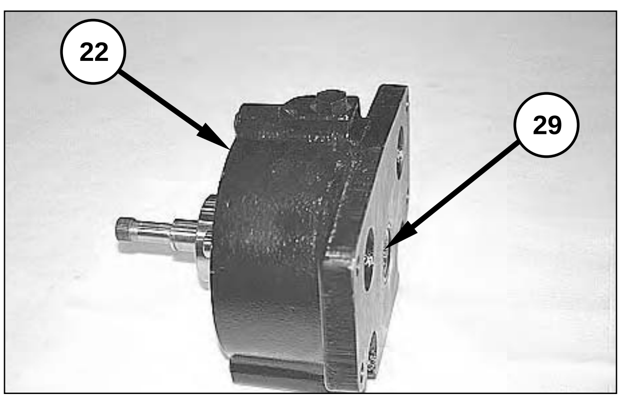


16. Remove O-ring seal (24). Replace the O-ring seal if there is damage or wear.

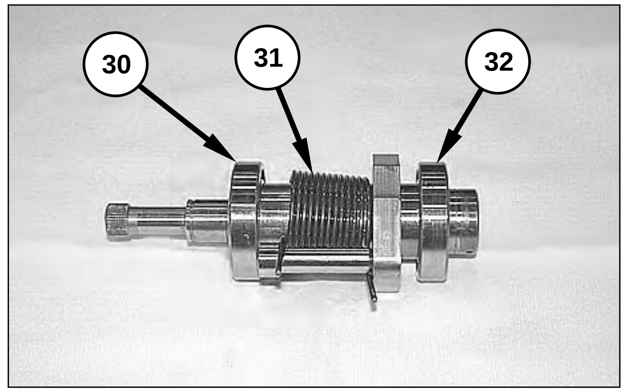
17. Remove snap ring (26) and cam (25).



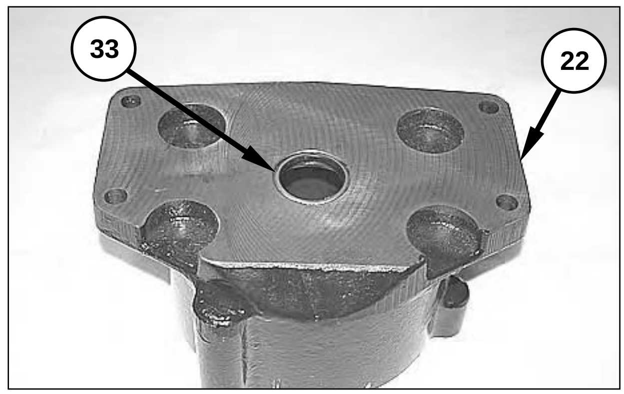
18. Move the end of spring (28) out of the groove in spring support (27).



19. Push on the end of shaft assembly (29) to remove the assembly from housing (22).



20. Use a suitable puller to remove bearing (30), bearing (32) and spring (31).



21. If necessary, remove and replace shaft seal (33) in housing (22).

NOTE: To assemble the steering control valve, reverse the disassembly steps.

End By:

a. Install the steering control valve.

Steering Pump

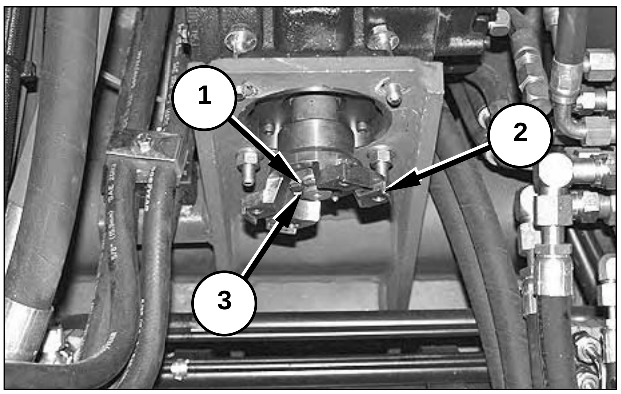
Remove and Install

Start By:

a. Remove the steering pump drive shaft.

NOTE: Group numbers related to this procedure include 124-3868, 126-6623, and 144-8605.

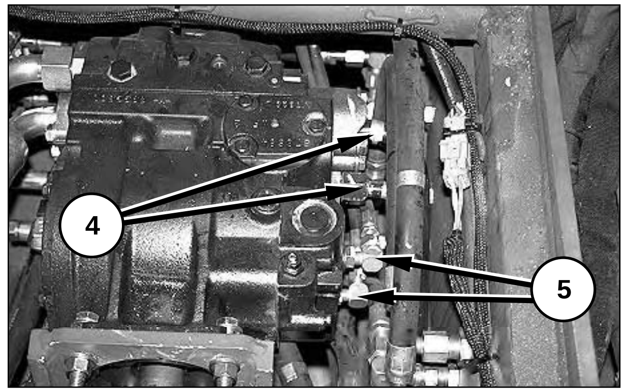
1. Drain the hydraulic tank. The capacity of the hydraulic tank is approximately **72 L (19 U.S. gal)**. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* “Maintenance Section, Maintenance Intervals, Every 1000 Service Hours or One Year,” “Hydraulic System.”



2. Remove cotter pin (1), nut (3), yoke (2), and the Woodruff key from the steering pump input shaft.

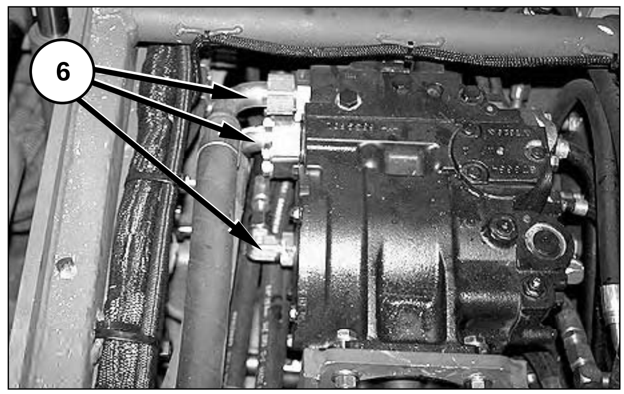
NOTE: Upon reassembly, apply a thin film of hydraulic oil to the threads of nut (3) and the shaft. Tighten the nut to a torque of **520 ± 13.5 N•m (385 ± 10 lb ft)**. If necessary, continue to tighten the nut until the cross drilled holes in the shaft are aligned with a slot in the nut and then install cotter pin (1). Install the steering pump drive shaft.

NOTE: If necessary, use a puller to remove yoke (3) from the steering pump input shaft.

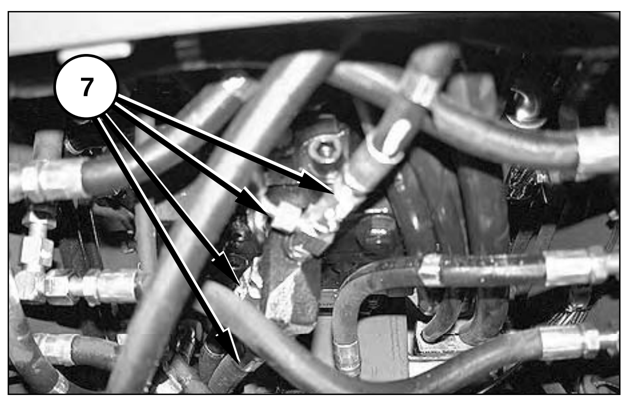


3. Disconnect, cap and plug two hard lines (4).

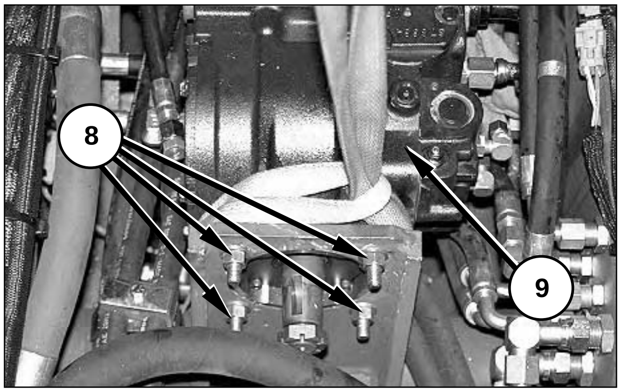
4. Disconnect, cap and plug two hoses (5). Mark the hoses for correct location at reassembly.



5. Disconnect, cap and plug three hoses (6). Mark the hoses for correct location at reassembly.



6. Disconnect, cap and plug four lines (7), on the bottom of the steering pump. Mark the hoses for correct connection at reassembly.



7. Attach a hoist to pump assembly (9). The weight of the pump assembly is **77 kg (170 lb)**.

8. Remove four nuts, bolts and washers (8), and remove pump assembly (9).

NOTICE

Do not damage the heating and air conditioning lines on the back of the cab while lifting the pump.

NOTE: To install the steering pump, reverse the removal steps. Two people may be required to position the pump during installation.

End By:

a. Install the steering pump drive shaft.

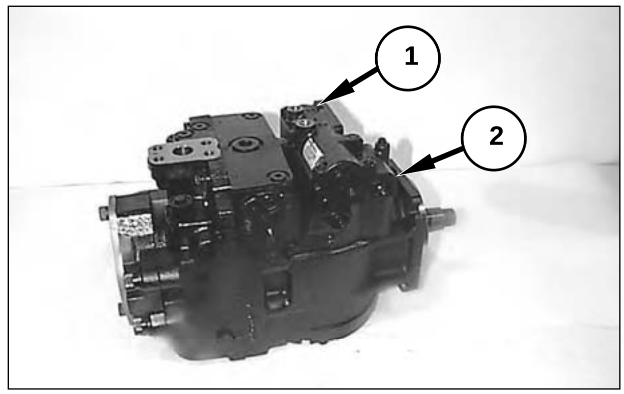
Disassemble and Assemble

Tools Needed	A
1P-1864 Pliers	1

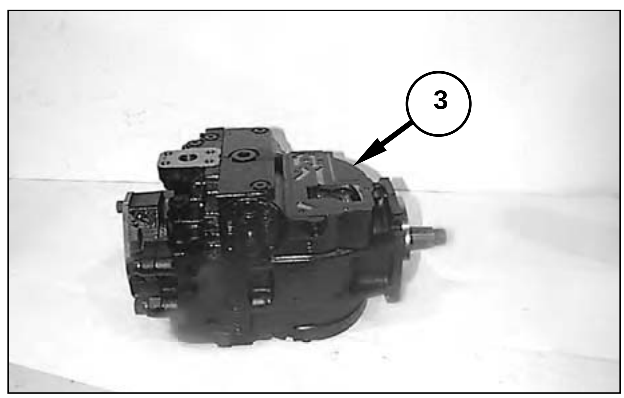
Start By:

a. Remove the steering pump.

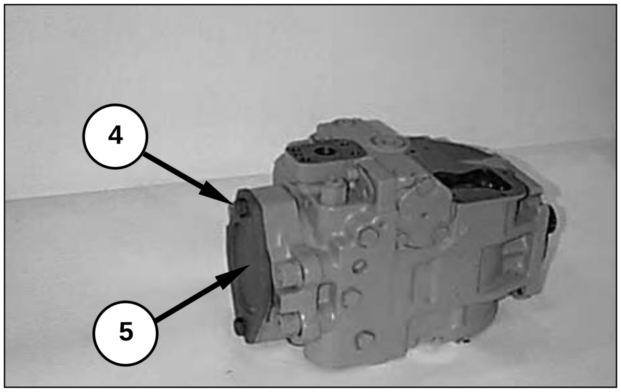
NOTE: The group number related to this procedure is 124-3868.



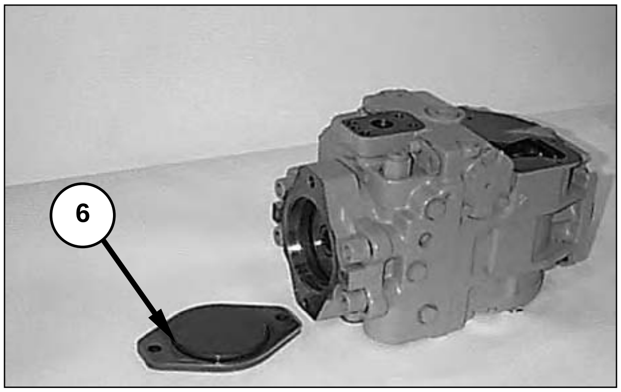
1. Remove six bolts (1), and remove displacement control valve (2). Upon reassembly, tighten the bolts to a torque of **16 N•m (12 ft lb).**



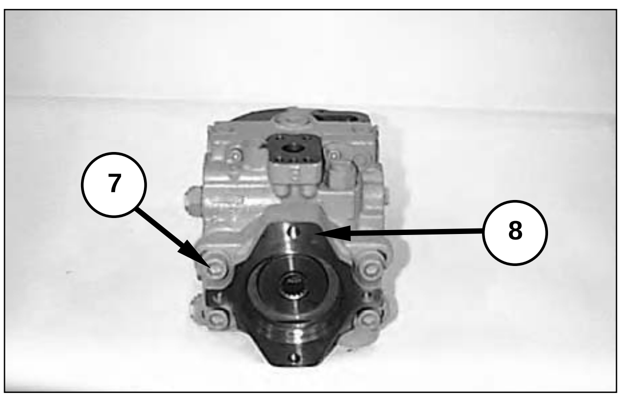
2. Remove gasket (3). Check the gasket for wear or damage, and replace it if necessary.



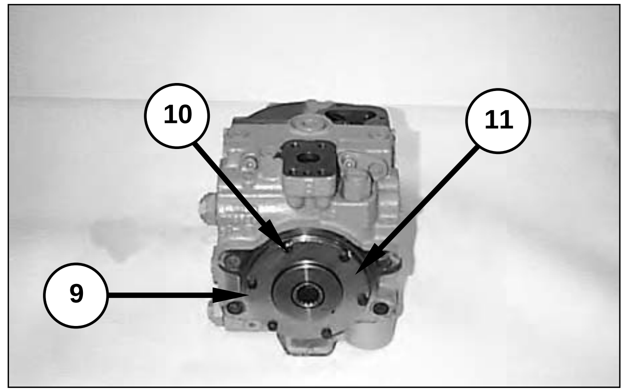
3. Remove two bolts (4) and cover (5).



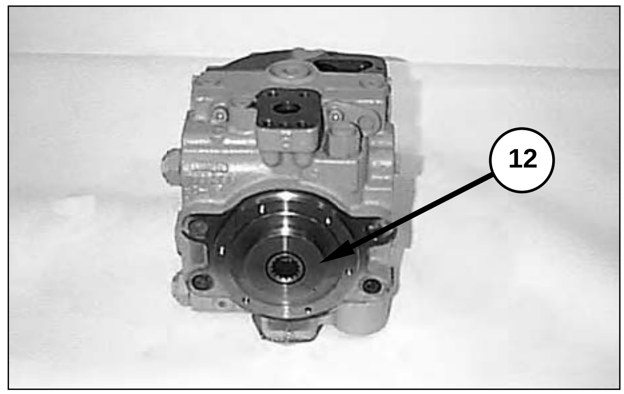
4. Remove O-ring seal (6) from cover (5). Check the O-ring seal for wear or damage, and replace it if necessary.



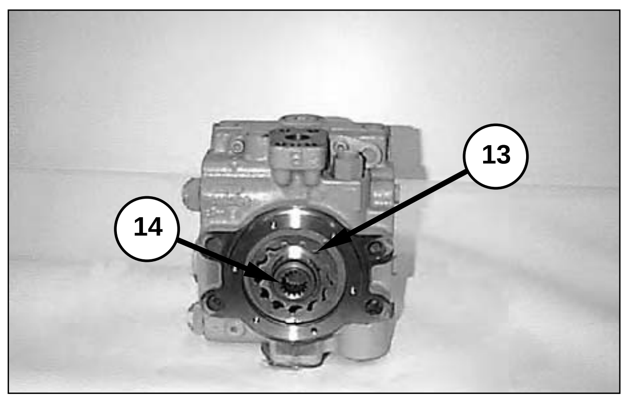
5. Remove four bolts (7) with washers, and remove flange (8). Upon reassembly, tighten the bolts to a torque of **105 N•m (75 lb ft).**



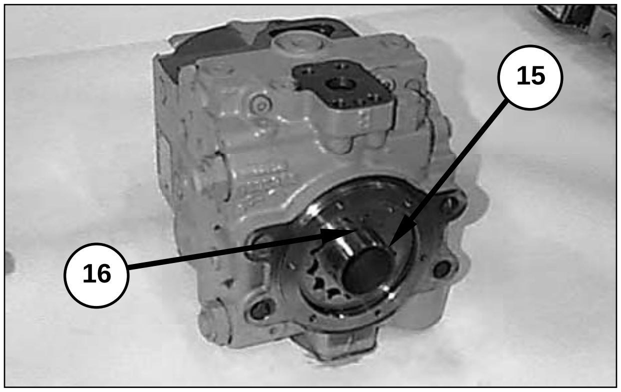
6. Remove O-ring seal (9), six bolts (10), and retaining plate (11). Check the O-ring seal for wear or damage, and replace it if necessary. Upon reassembly, tighten the bolts to a torque of **256 N•m (189 ft lb).**



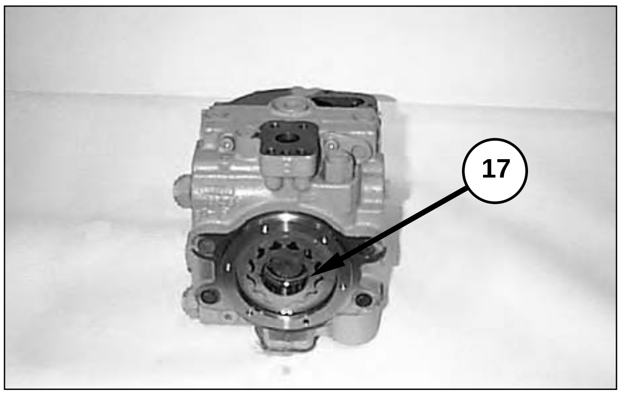
7. Remove charge cover (12) with the bushing. Use a press to remove the bushing if necessary.



8. Mark the case to locate pin (13) for reassembly. Remove coupling (14).

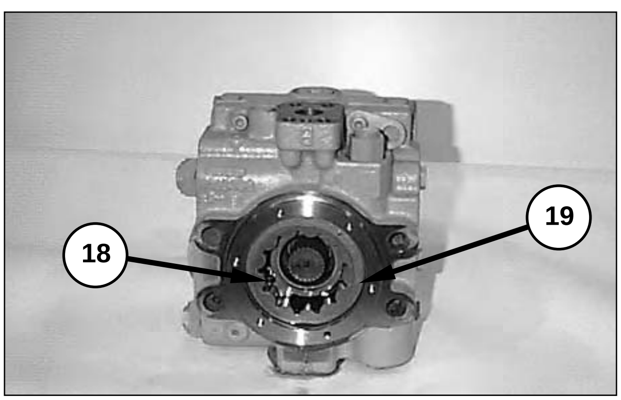


9. Remove charge shaft (15) with key (16).



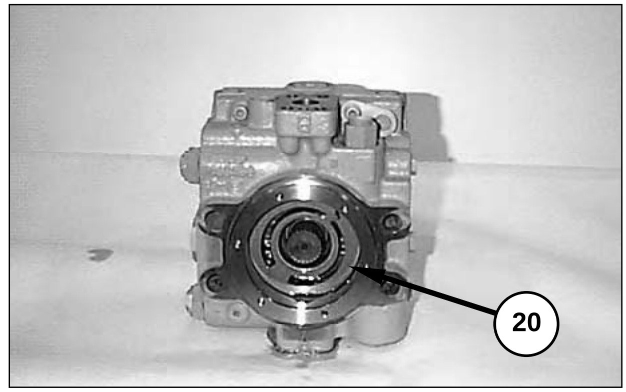
10. Remove gerotor (17).

NOTE: Gerotor (17) is not serviced separately. If the gerotor is damaged or worn, the charge pump must be replaced.



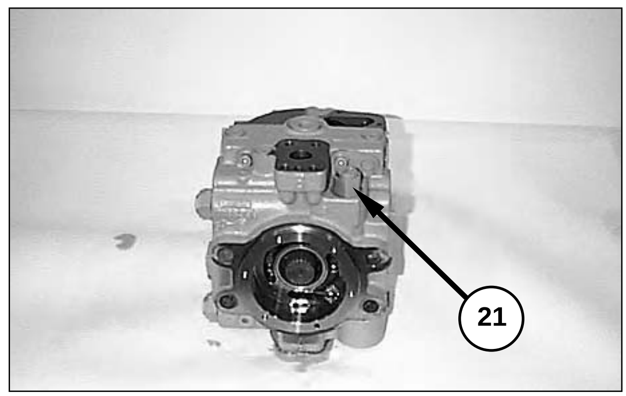
11. Remove gerotor ring (18) and eccentric ring (19).

NOTE: Gerotor ring (18) and eccentric ring (19) are not serviced separately. If these components are damaged or worn, the charge pump must be replaced.

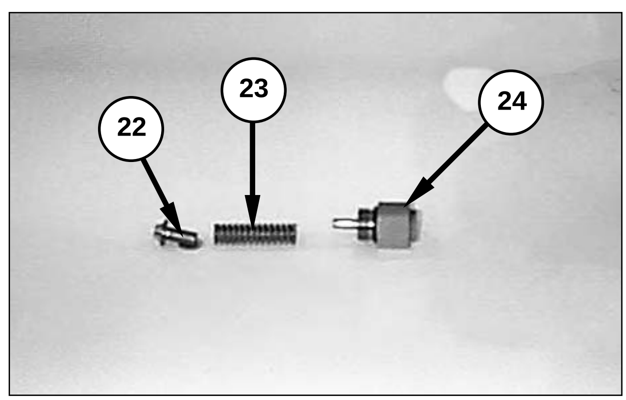


12. Remove port plate (20). Upon reassembly, place the beveled edge of the port plate toward the pump housing.

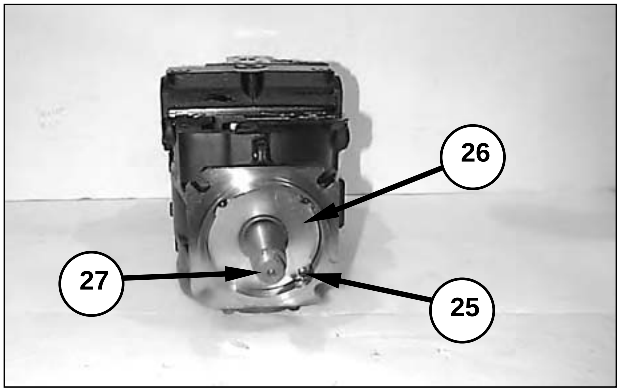
NOTE: Port plate (20) is not serviced separately. If the port plate is damaged or worn, the charge pump must be replaced.



13. Remove charge relief valve (21).

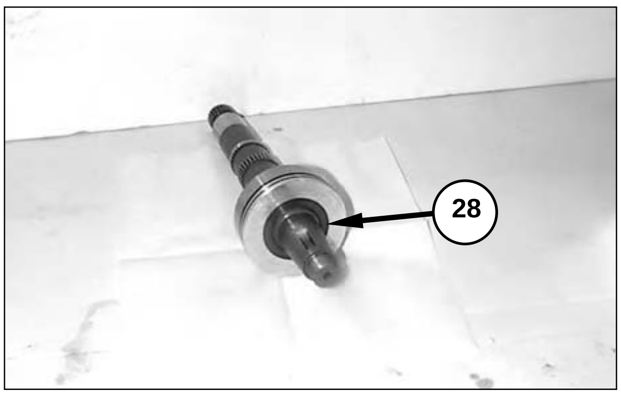


14. Charge relief valve (21) consists of: poppet (22), spring (23), and plug with O-ring seal and nut (24).



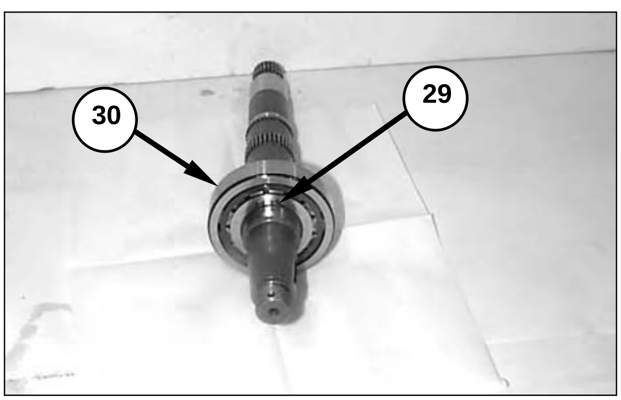
15. Remove four bolts (25) and retainer plate (26).

16. Use a soft hammer to tap on the charge-pump end of main shaft (27). Remove the main shaft.

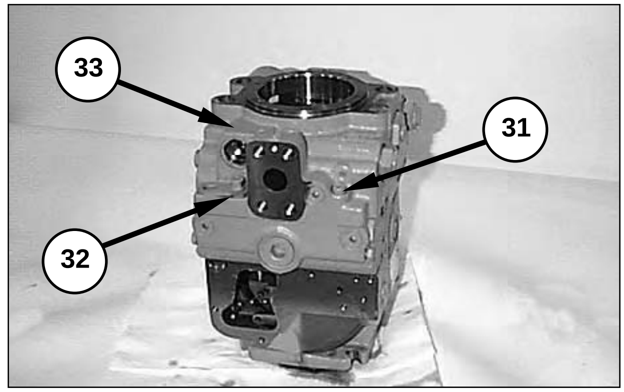


17. Remove seal carrier (28). Inspect the seal carrier for wear or damage, and replace it if necessary.

NOTE: Seal carrier (28) includes an O-ring seal and a lip seal.

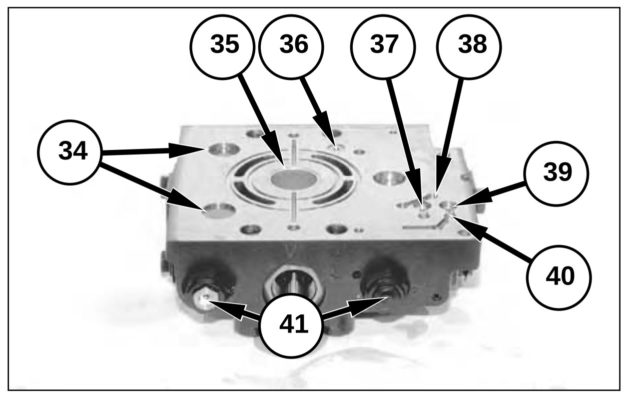


18. Use Tooling (A) to remove retaining ring (29) and bearing (30). Inspect the bearing for wear or damage, and replace it if necessary.



19. Stand the pump on end, with the charge-pump end facing up. Remove two bolts (31), bolt (32) with the washer, lifting bracket, and spacer, and remove end cap (33). Upon reassembly, tighten the bolts to a torque of **13.5 N•m (10 ft lb).**

NOTE: End cap (33) is not serviced separately.



20. Shims (34) must be kept in the same location on end cap (33).

21. Remove two multifunction valves (41) with four O-ring seals. Check the O-ring seals for wear or damage, and replace them if necessary.

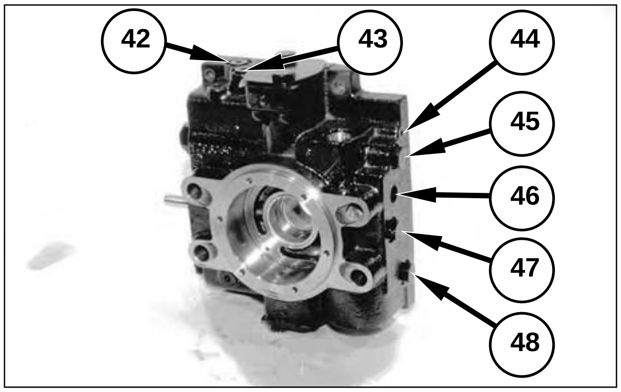
NOTE: Multifunction valves (41) are not serviced separately.

22. Remove check valves (37) and (39).

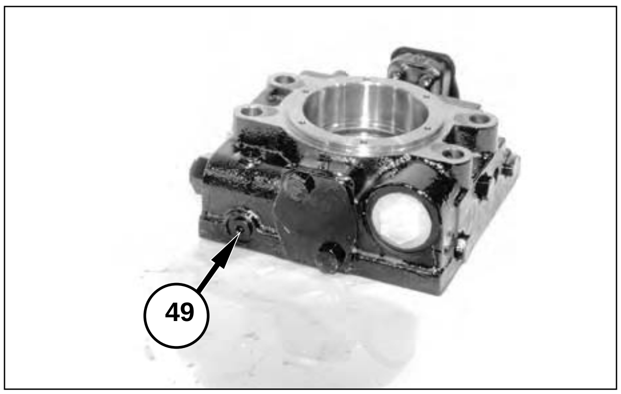
23. If necessary, remove plugs (38) and (40).

24. Remove plug (36) with the O-ring seal. Check the O-ring seal for wear or damage, and replace it if necessary.

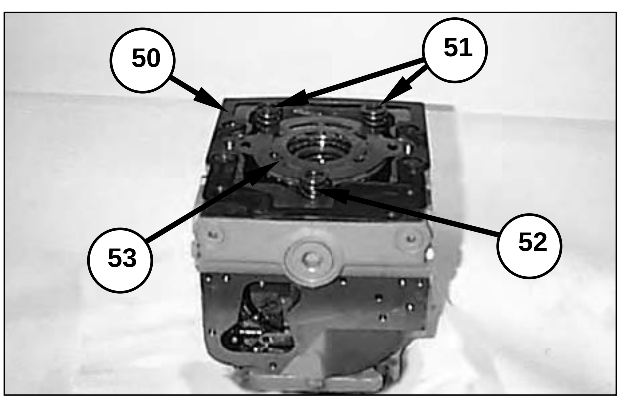
25. If necessary, remove journal bearing (35).



26. Remove plugs (42), (43), (44), (45), (46), (47), and (48) with the O-ring seals from end cap (33). Check the O-ring seals (one on each plug) for wear or damage, and replace them if necessary.

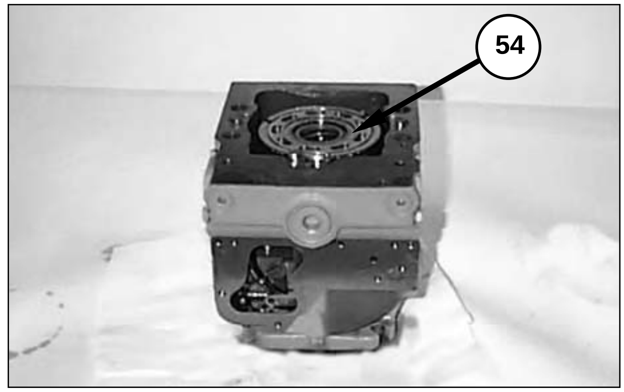


27. Remove plug (49) with the O-ring seal from end cap (33). Check the O-ring seal for wear or damage, and replace it if necessary.



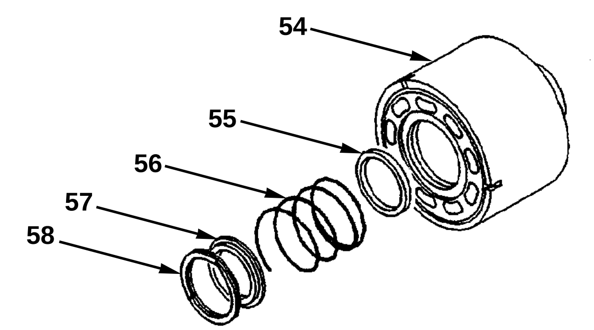
28. Remove gasket (50), springs (51), spring (52) and port plate (53). Inspect the gasket and the port plate for wear or damage, and replace them if necessary.

NOTE: The arrows in port plate (53) indicate the direction of pump rotation, as viewed from the input shaft.



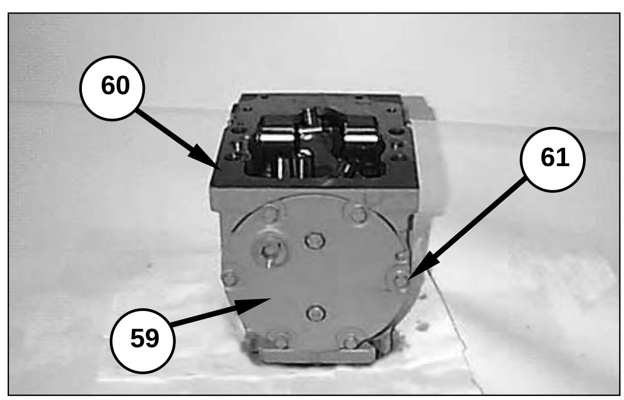
29. Remove cylinder block (54).

NOTE: Cylinder block (54) is not serviced separately. The cylinder block should be considered damaged if the sealing surface has scratches or pitting that can be felt with a fingernail.



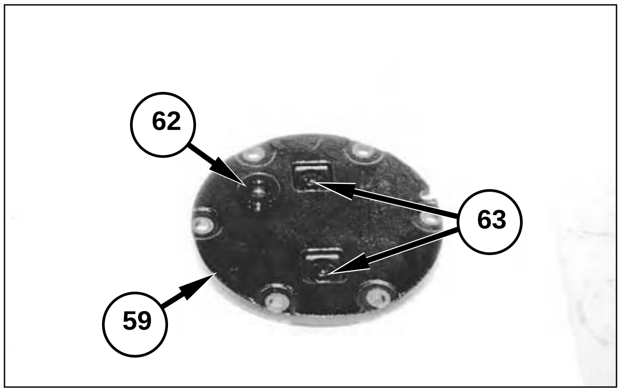
30. If necessary, use a press to compress spring (56), and remove retaining ring (58) and retaining spring (57) from cylinder block (54).

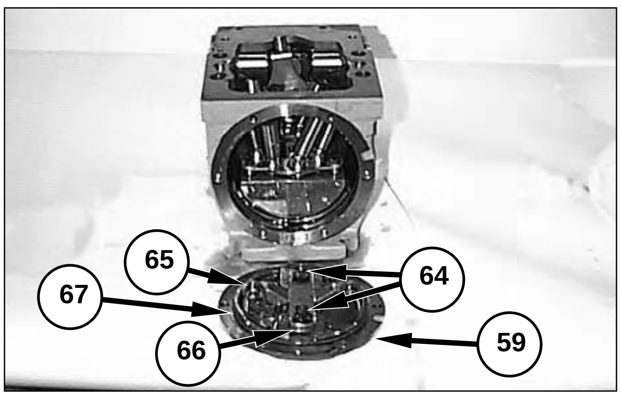
31. Remove spring (56) and seat (55) from cylinder block (54).



32. Accurately mark the position of cover (59) in relation to pump housing (60). Remove six bolts (61). Upon reassembly, tighten the bolts to a torque of **32 N•m (24 lb ft).**

NOTE: Since this mark identifies the zero-displacement position of the swashplate, the mark must be a thin, straight line which can be accurately aligned during the assembly process. If the mark is lost or poorly made, a **127-5654 Neutral Plate** can be used to reset the swashplate to the zero-displacement position.



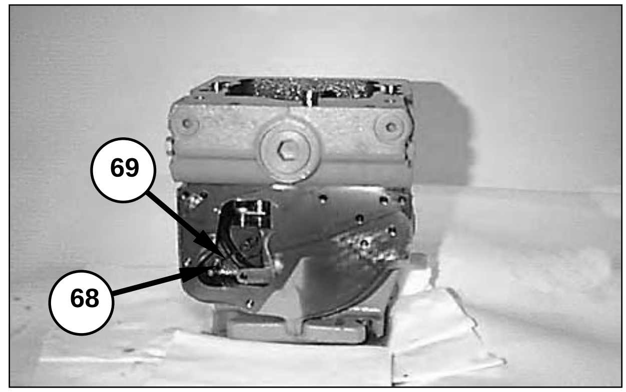


33. Remove plug (62), with the O-ring seal, from cover (59). Check the O-ring seal for wear or damage, and replace it if necessary.

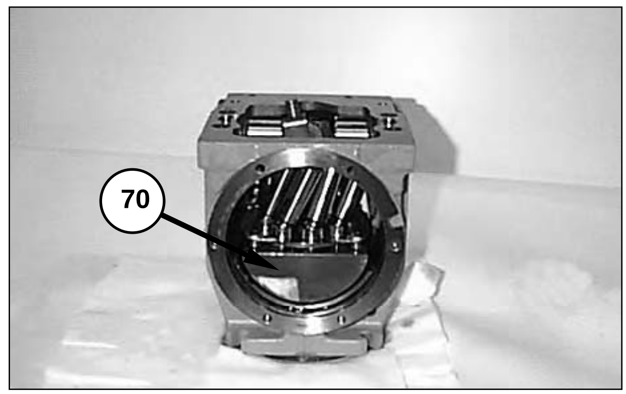
34. Remove O-ring seal (67) from cover (59). Inspect the O-ring seal for wear or damage, and replace if necessary.

35. Remove two nuts (63) and two guide posts (64).

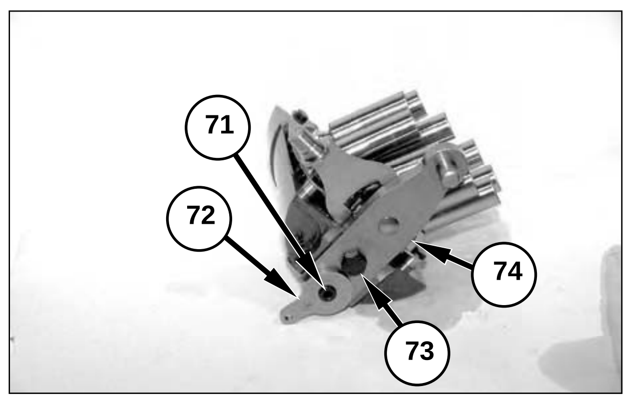
36. Remove leveler (65) and insert (66)



37. Remove pin (68) and cage lock link (69).

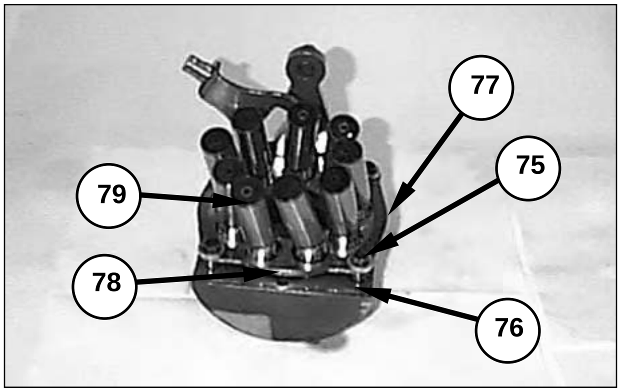


38. Remove swashplate assembly (70).



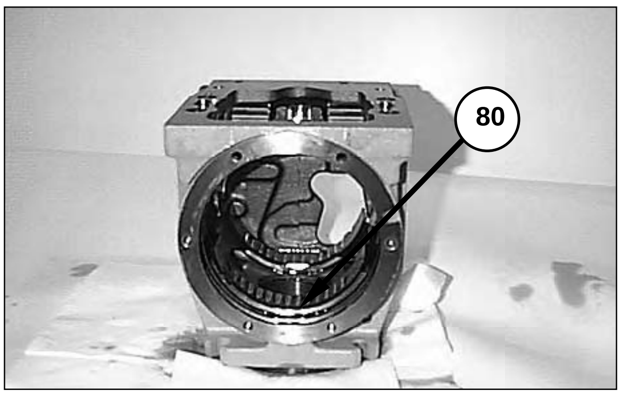
39. Remove bolt (71). Remove feedback link (72) with the plate, pin, and washer.

40. Remove bolt (73), and remove linkage (74).



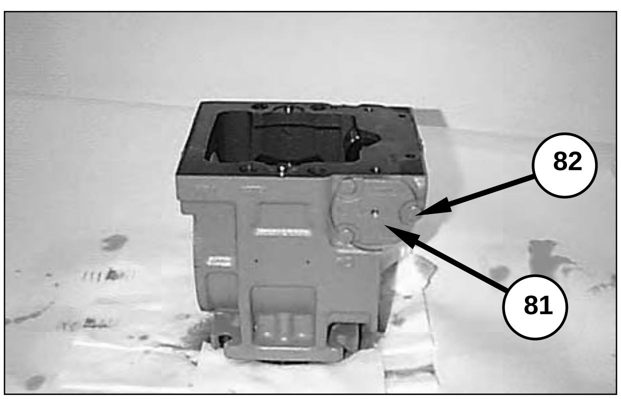
41. Remove four bolts (75), four spacers (76), and two guide bearings (77).

42. Remove slipper guide (78) and nine pistons (79).

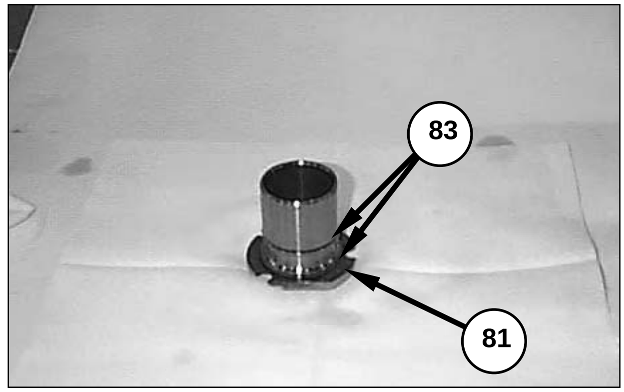


43. Remove bearing and race assembly (80).

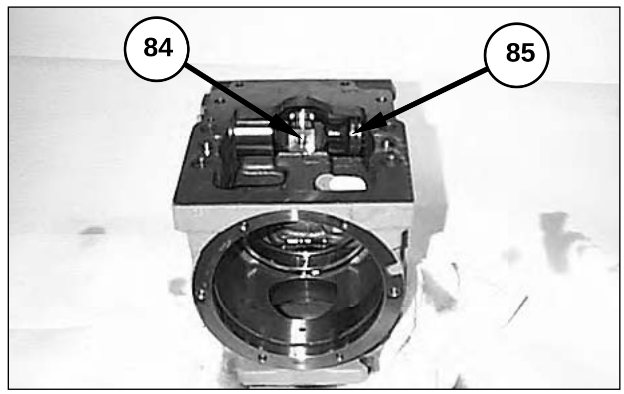
NOTE: The races are pinned to the housing with dowel pins.



44. Mark one of two servo cylinders (81) for the correct location during reassembly. Remove six bolts (82) and the two servo cylinders. Upon reassembly, tighten the bolts to a torque of **24 N•m (18 ft lb).**

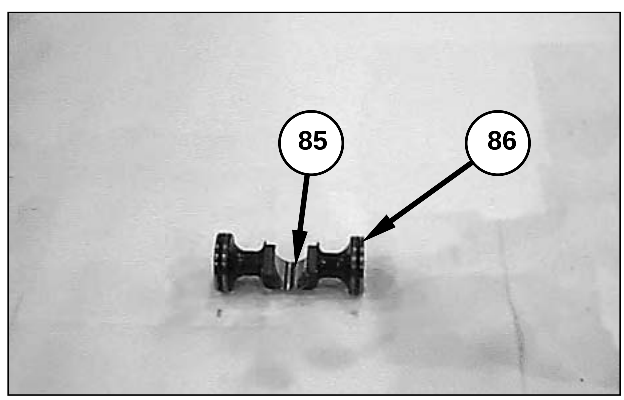


45. Remove two seals (83) from each servo cylinder (81). Inspect the seals for wear or damage, and replace them if necessary.



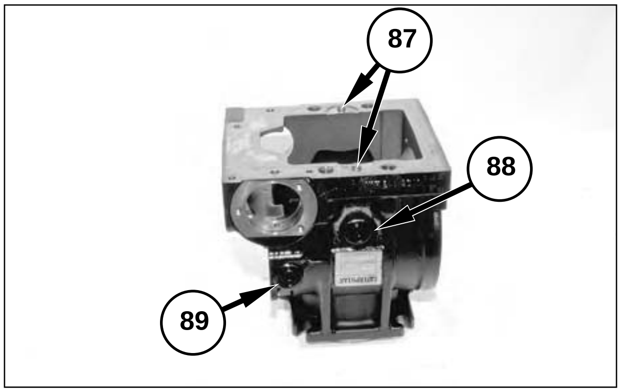
46. Remove slider block (84) from servo piston (85).

47. Remove servo piston (85).



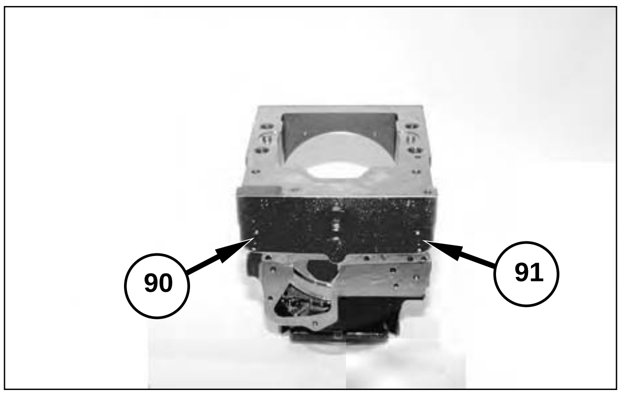
48. Inspect two piston ring kits (86) on servo piston (85) for wear or damage, and replace the kits if necessary.

NOTE: A piston ring kit (86) is made up of two seals: a flat outer seal and a round inner seal.

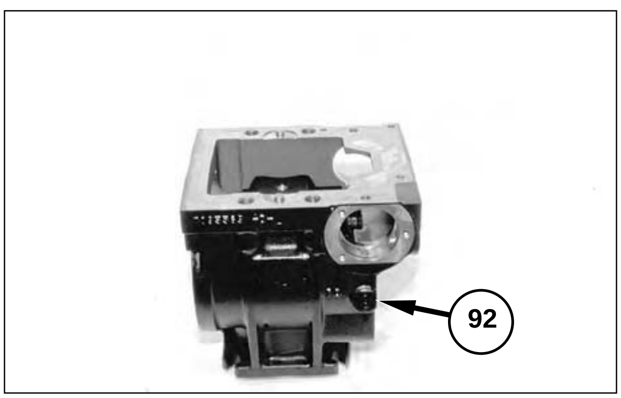


49. Remove pins (87).

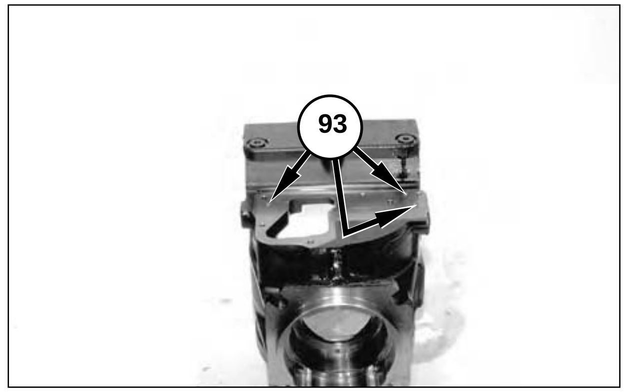
50. Remove plugs (88) and (89) with the O-ring seals. Inspect the O-ring seals for wear or damage, and replace them if necessary.



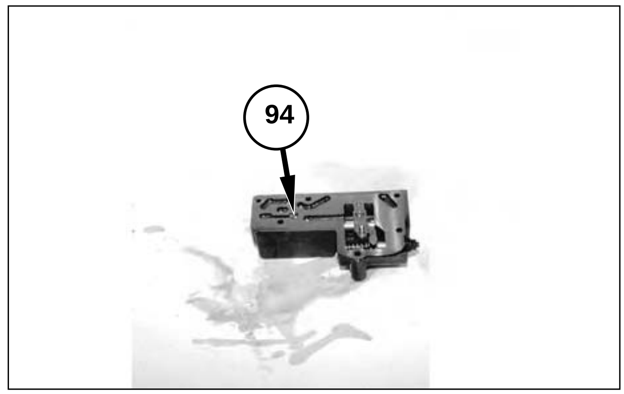
51. Remove plugs (90) and (91) with the O-ring seals. Inspect the O-ring seals for wear or damage, and replace them if necessary.



52. Remove plug (92) with the O-ring. Inspect the O-ring for wear or damage, and replace it if necessary.



53. Remove filter control screens (93).



54. Remove orifice kit (94) with the spring and spring retainer.

NOTE: To assemble the steering pump, reverse the disassembly steps.

End By:

a. Install the steering pump.

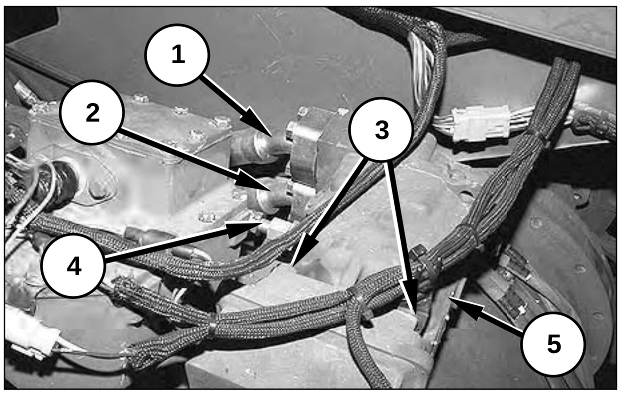
Steering Motor

Remove and Install

Start By:

a. Remove the winch bracket and winch assembly. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Hydraulic System,* "Winch Bracket With Winch Assembly."

NOTE: The group number related to this procedure is 126-6624.



Fuel Tank Removed for Photographic Purposes.

1. Disconnect, cap and plug case drain line (4).

2. Disconnect, cap and plug two steering lines (1) and (2).

3. Remove four bolts (3, only two shown) with washers, and steering motor (5) with the O-ring seal. Upon reassembly, apply **9S-3263 Thread Compound (Loctite™ 242)** sparingly to the threads of the bolts.

NOTICE

Use of any other thread compound on bolts (3) could result in transmission shifting problems.

NOTE: To install the steering motor, reverse the removal steps.

End By:

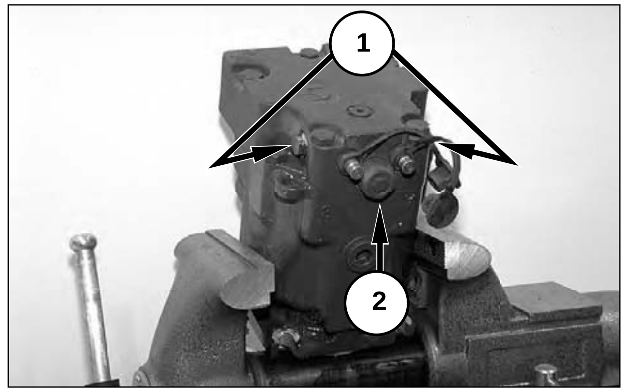
a. Install the winch bracket and winch assembly.

Disassemble

Start By:

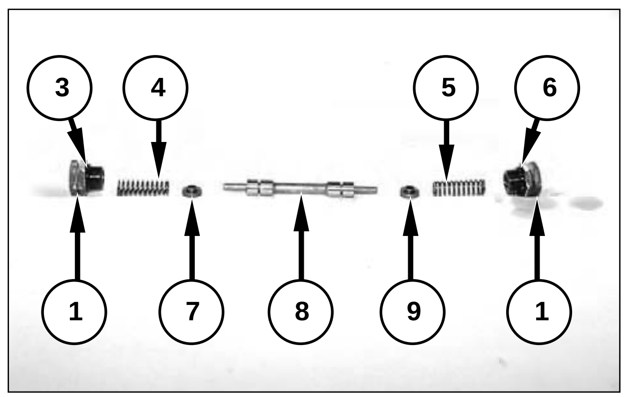
a. Remove the steering motor.

NOTE: The group number related to this procedure is 124-3605.

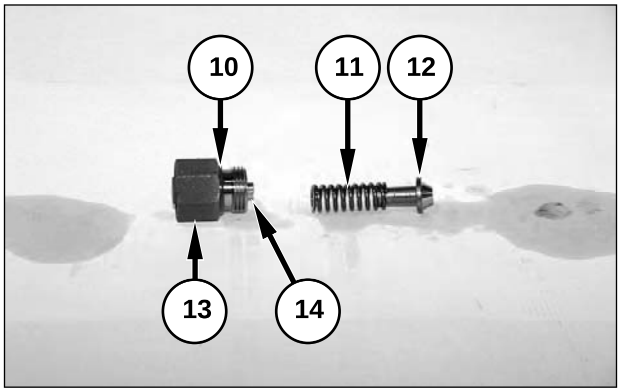


1. Remove special plugs (1) from both sides of the motor.

NOTE: Only one of two special plugs (1) is shown. The second special plug is located on the opposite side of the motor



2. Remove O-rings (3) and (6) from special plugs (1). Remove spring (4), spring guide (7), valve spool (8), spring guide (9), spring (5) from the motor housing.

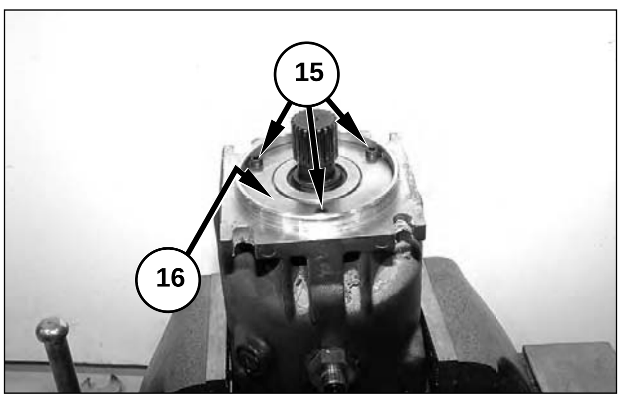


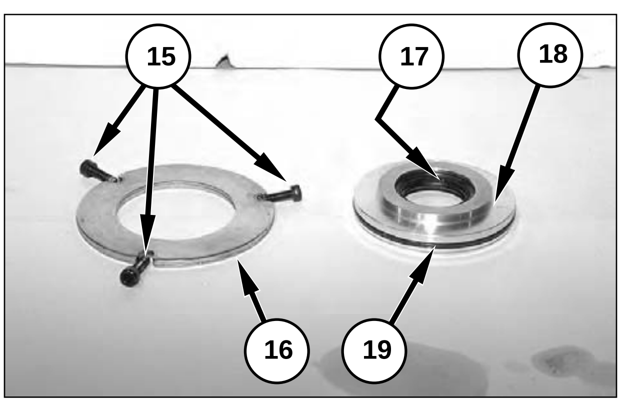
3. Remove cooling relief valve (2).

4. If necessary, remove special nut (13) and O-ring seal (10) from plug (14).

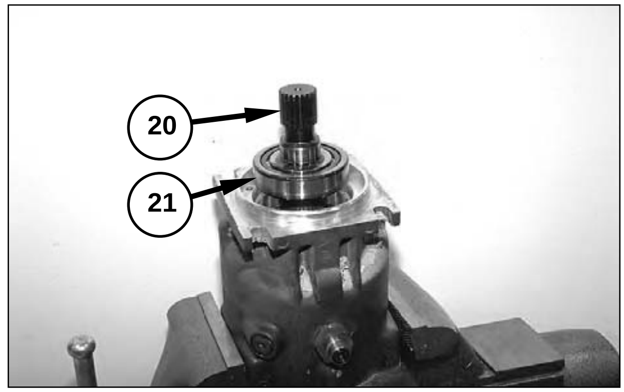
NOTE: If the relative position of special nut (13) and plug (14) is changed, cooling relief valve (2) must be adjusted after the motor is installed on the machine. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage, Steering, and Brakes,* "Testing and Adjusting, Steering System Procedures, Flushing Relief Valve Adjustment."

5. Remove spring (11) and poppet (12) from the motor housing.

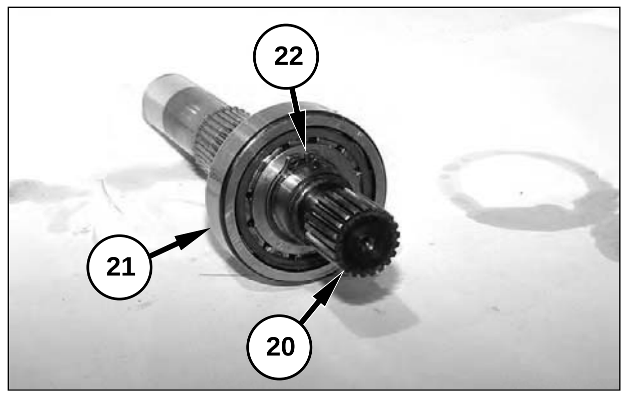




6. Remove three socket head bolts (15), retainer plate (16), and remove seal carrier (18) with lip seal (17) and O-ring seal (19).

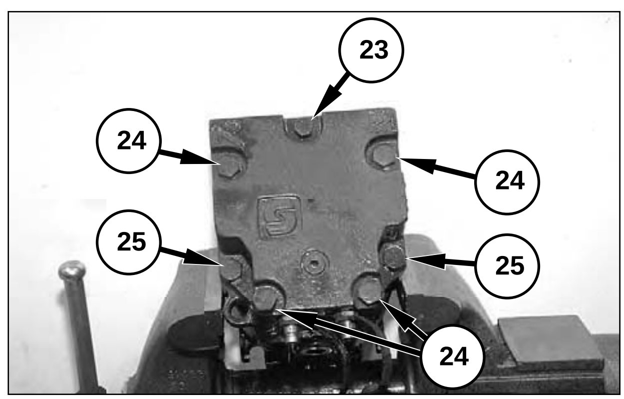


7. Remove shaft (20) with bearing (21) from the motor housing.

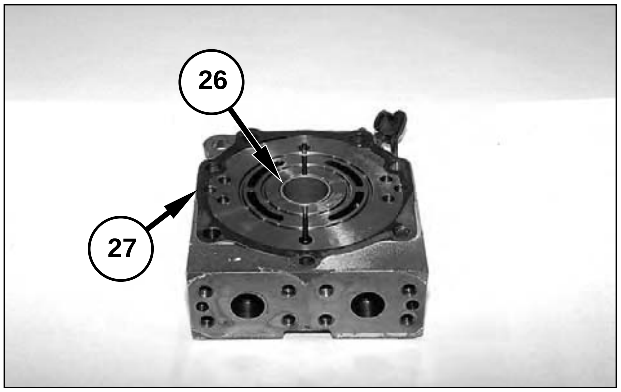


8. Remove retaining ring (22) from shaft (20).

9. If necessary, use a suitable puller to remove bearing (21) from shaft (20).

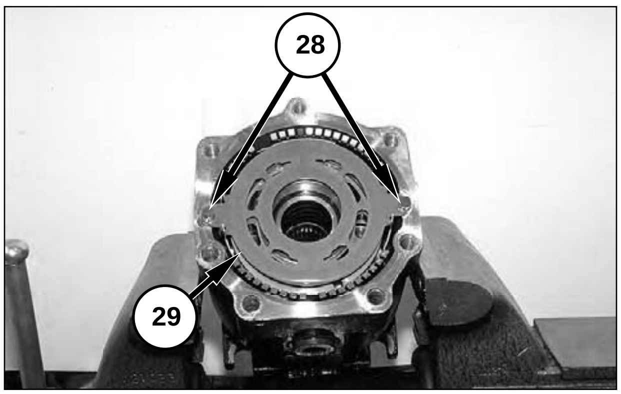


10. Remove four bolts (24), one bolt (23), and two bolts (25), and remove the end cap.



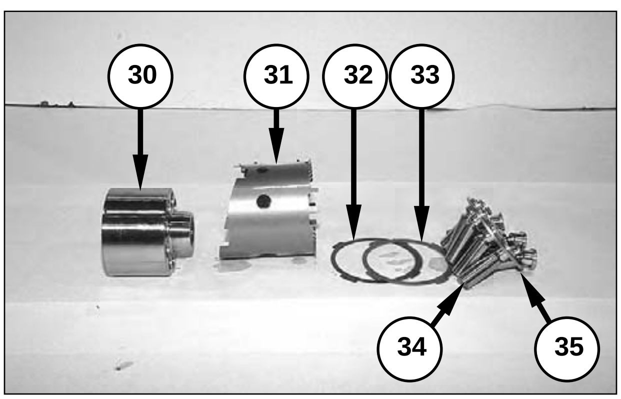
11. Use a suitable puller to remove bearing journal (26) from the end cap.

12. Remove end cap gasket (27). Upon reassembly, replace the end cap gasket.



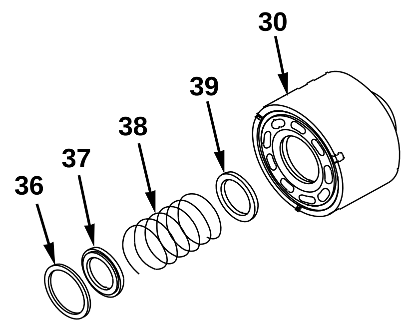
13. Remove two pins (28), and remove valve plate (29) from the pump housing.

NOTE: Pins (28) and valve plate (29) may remain with the end cap when the end cap is removed.

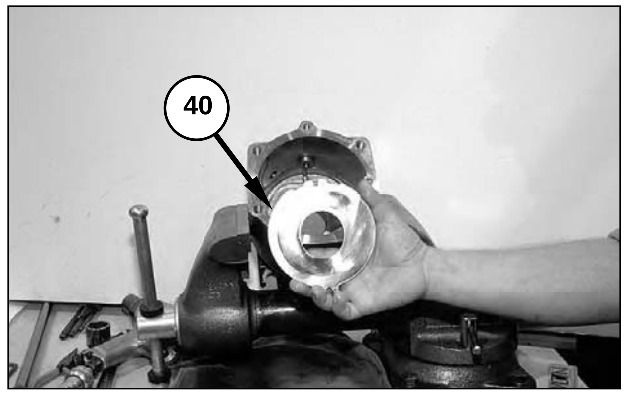


14. Place the pump housing on its side, and remove cylinder block (30), hold-down tube (31), shim (32), retainer (33), and nine pistons (34) with guide (35).

15. Remove individual pistons (34) from guide (35).



16. Remove retaining ring (36), retainer (37), spring (38) and seat (39) from cylinder block (30).

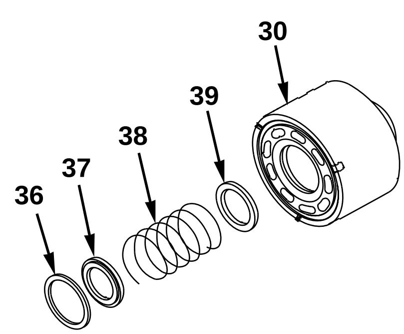


17. Remove thrust plate (40) from the pump housing.

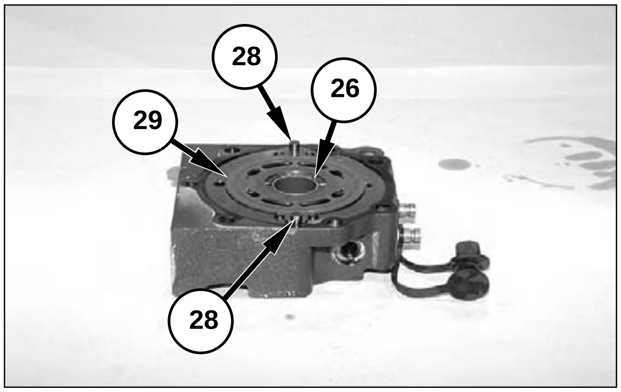
Assemble

NOTE: The group number related to this procedure is 124-3605.

NOTE: If bearing journal (26) was removed from the end cap, use a suitable press to install the bearing journal.

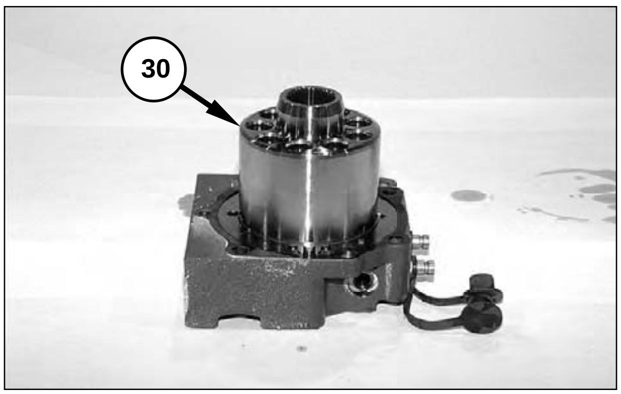


1. Install retaining ring (36), retainer (37), spring (38) and seat (39) in cylinder block (30).

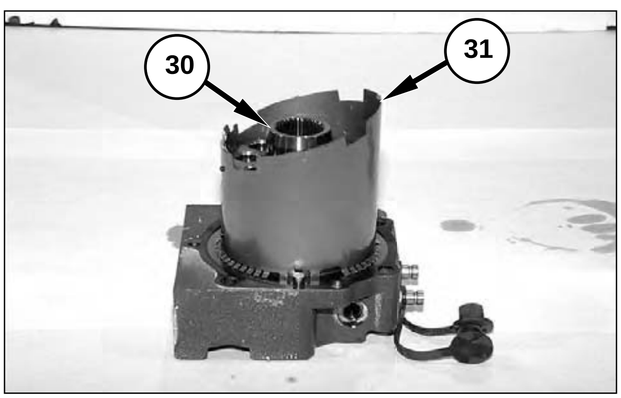


2. Install pins (28), and place valve plate (29) on the end cap with the tabs facing down.

3. Use clean hydraulic oil to lightly oil journal bearing (26) and valve plate (29).

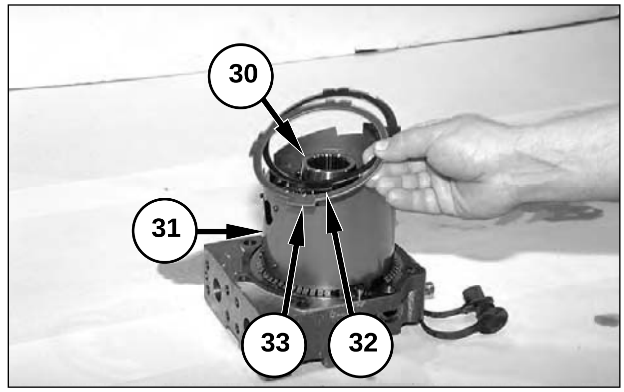


4. Place and center cylinder block (30) on valve plate (29).



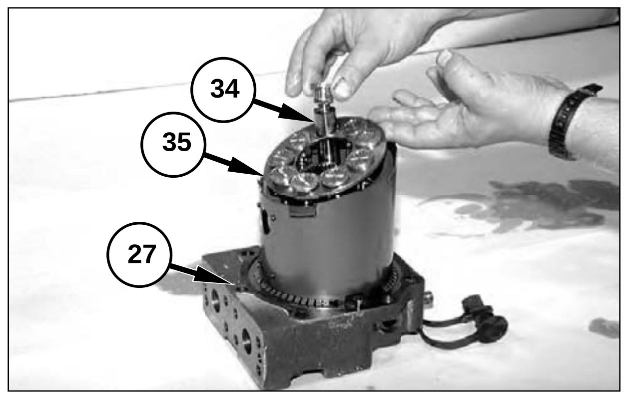
5. Place hold-down tube (31) over cylinder block (30) with the fluted end adjacent to the end cap.

NOTE: The tall side of hold-down tube (31) should be positioned towards the pressure taps on the end cap.



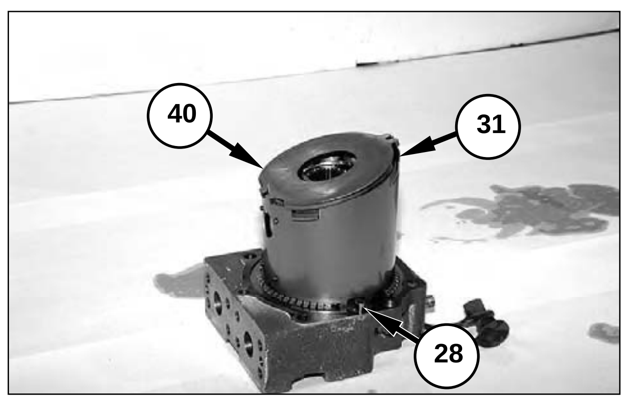
6. Place shim (32) and retainer (33) on cylinder block (30).

NOTE: One of the tabs on shim (32) and retainer (33) has a V-notch. The V-notch must be placed in the cutout which is located 45 degrees counterclockwise from the longest side of hold-down tube (31).



7. Install nine pistons (34) in guide (35), and then install the pistons in cylinder block (30).

8. Place end cap gasket (27) on the end cap with the beaded side away from the end cap.



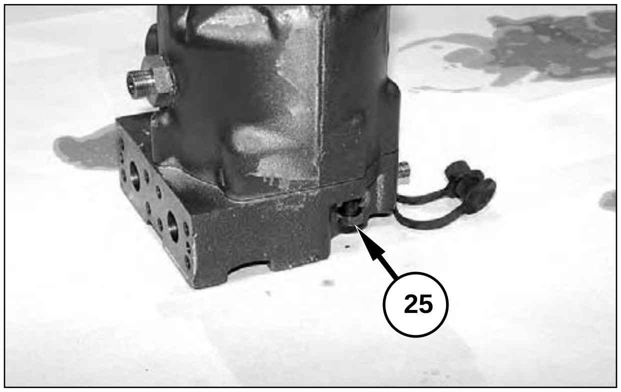
9. Lightly coat the components with clean hydraulic oil.

10. Place thrust plate (40) on piston slippers.

NOTE: Position the chamfered edge of thrust plate (40) away from the piston slippers.

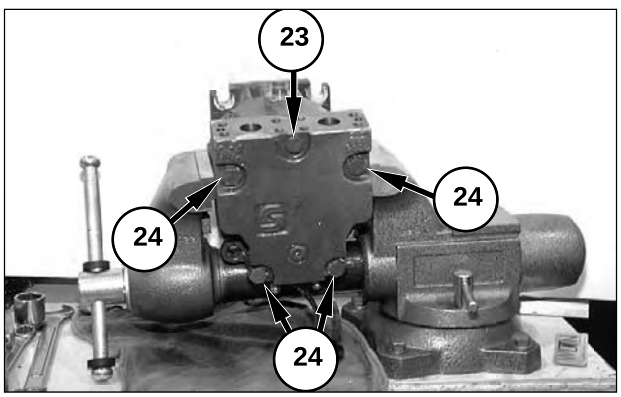
11. Place the pump housing onto the end plate, with the deep end of the pump housing aligned with the tall side of hold-down tube (31).

NOTE: Align two pins (28) in the end cap with the holes in the pump housing.

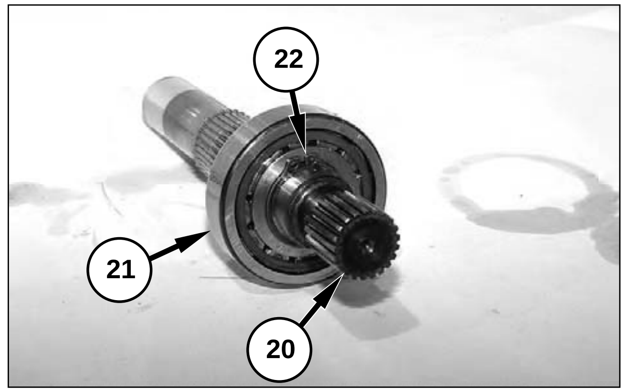


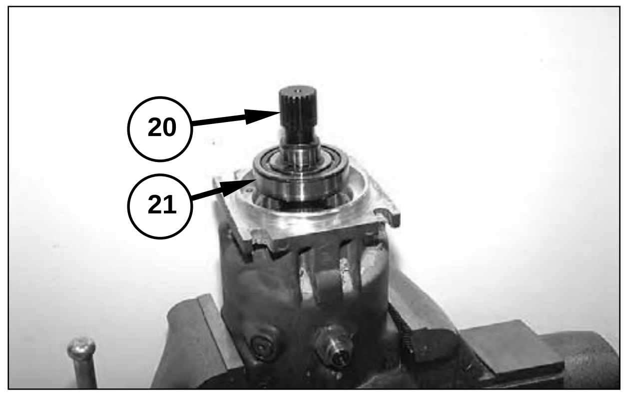
12. Install two bolts (25) in the end cap.

NOTE: Only one of two bolts (25) is shown. The other bolt should be installed in the opposite side of the end cap.



13. Place the motor in a vise, and install four bolts (24) and one bolt (23).

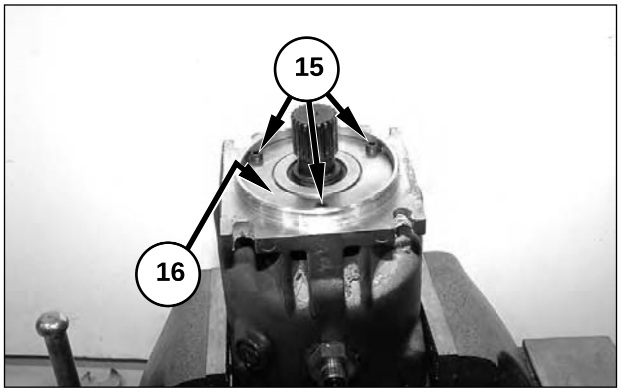


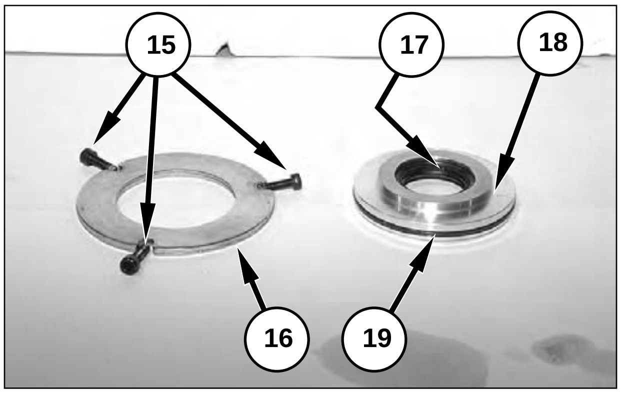


NOTE: If retaining ring (22) and bearing (21) were removed from shaft (20), replace the components on the shaft before the shaft is installed.

14. Stand the motor on the end cap end and install shaft (20).

15. Turn shaft (20) by hand after the shaft is installed. If the shaft does not freely turn, the motor is not properly assembled.

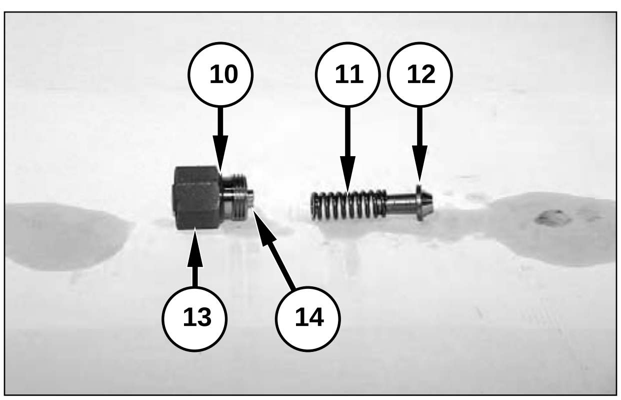




16. Install seal carrier (18) with lip seal (17) and O-ring seal (19) on shaft (20).

17. Install retainer plate (16), and install three socket head bolts (15).

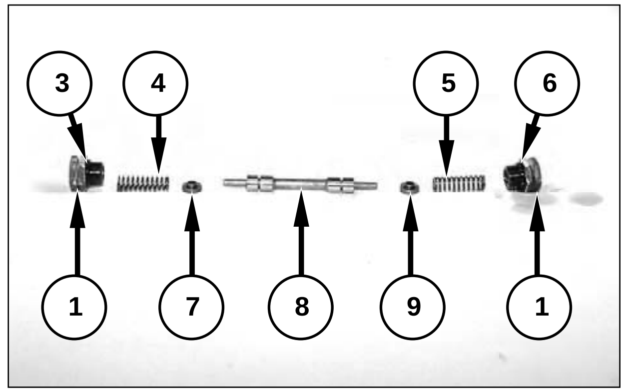
NOTE: Measure the torque required to rotate shaft (20). After the breakaway torque is overcome, the torque required to continue to rotate the shaft should be **8.7 ± 1.3 N•m (6.5 ± 1.0 lb ft)**. If the torque required to rotate the shaft is greater than this specification, the motor is assembled incorrectly.



18. Install spring (11) and poppet (12) in plug (14), and install O-ring seal (10).

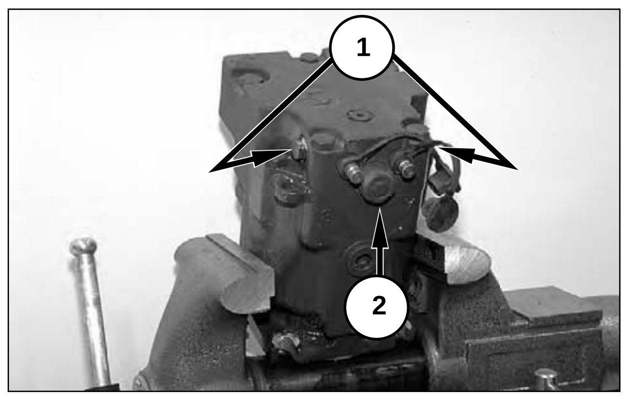
19. Install special nut (13) in the motor housing. Tighten the nut to a torque of **52 N•m (38 lb ft)**.

NOTE: If the relative position of special nut (13) and plug (14) was changed, cooling relief valve (2) must be adjusted after the motor is installed on the machine. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage, Steering, and Brakes,* "Testing and Adjusting, Steering System Procedures, Flushing Relief Valve Adjustment."



20. Install O-rings (3) and (6) on special plugs (1).

21. Assemble spring (5), spring guide (9), valve spool (8), spring guide (7), and spring (4), and install the assembly in the motor housing.



22. Install special plugs (1) in both sides of the motor housing. Tighten the special plugs to a torque of **40 N•m (30 lb ft)**.

End By:

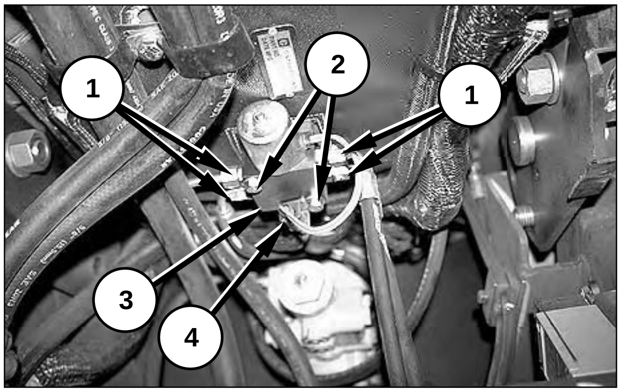
a. Install the steering motor.

NOTE: Adjust cooling relief valve (2) if necessary. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage, Steering, and Brakes,* "Testing and Adjusting, Steering System Procedures, Flushing Relief Valve Adjustment."

Steering Solenoid Valve

Remove and Install

NOTE: The group number related to this procedure is 131-2624.



1. Raise the cab. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Machine Features, Cab Tilt."

2. Disconnect four lines (1). Mark the lines for correct location during reinstallation.

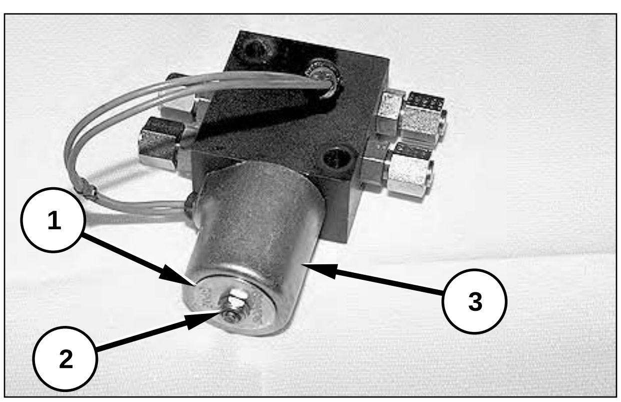
3. Disconnect electrical connector (4).

NOTE: Electrical connector (4) is a two-pin connector. The wires in the connector are F881-OR and 200-BK.

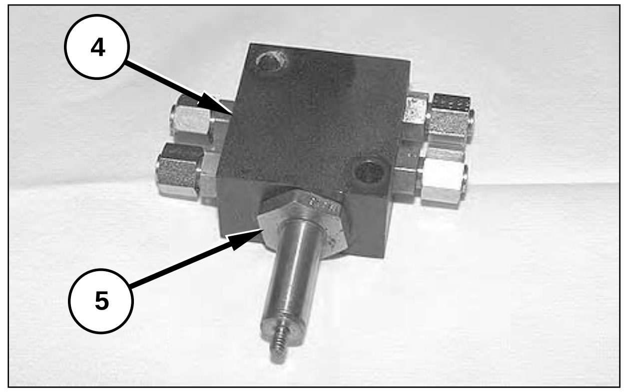
4. Remove two bolts (2) with washers, and solenoid valve (3).

NOTE: To install the steering solenoid valve, reverse the installation steps.

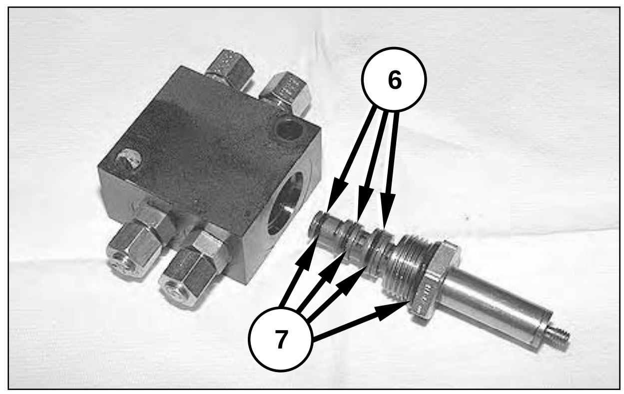
Disassemble and Assemble



1. Remove lock nut (2), hard washer (1) and coil assembly (3). Upon reassembly, tighten the lock nut to a torque of **9.0± 0.5 N•m (80 ± 4.5 lb in).**



2. Remove cartridge assembly (5) from manifold (4). Upon reassembly, tighten the cartridge assembly to a torque of **115 ± 7 N•m (84 ± 5 lb ft).**



3. If necessary, remove three backup rings (6) and four O-ring seals (7). Replace the backup rings and O-ring seals if they are damaged or worn.

NOTE: To assemble the steering solenoid valve, reverse the disassembly steps.

Support Group, Left and Right

Remove and Install

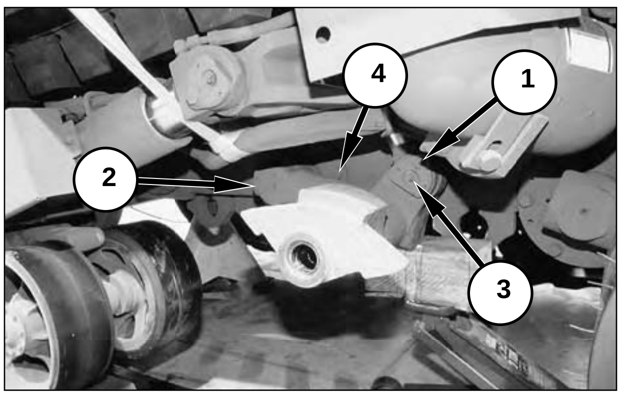
Tools Needed	A	B
M16-2 X 130 mm Alignment Dowel (Fabricate)	3	
7I1206 M16-2 X 130 mm Bolt		3

NOTE: Group numbers related to this procedure include 142-0067 and 142-0068.

NOTE: The following procedure is for the component on the left side of the machine. The procedure for the component on the right side of the machine is the same.

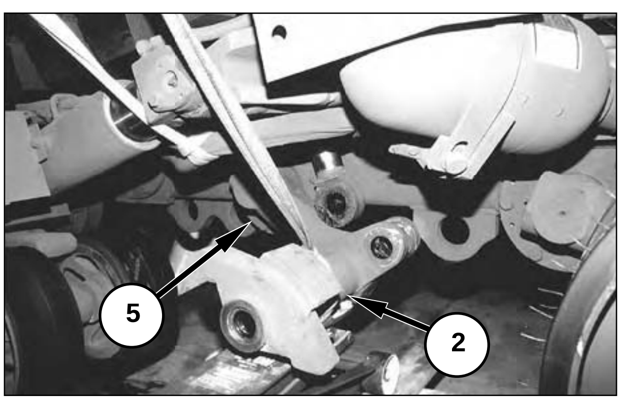
Start By:

a. Remove the center midroller bogie assembly.



1. With swing arm (2) still supported by the floor jack (after removal of the center midroller bogie assembly), remove bolt (1) with washer, and cylinder pin (3).

2. Remove six bolts (4) with washers.

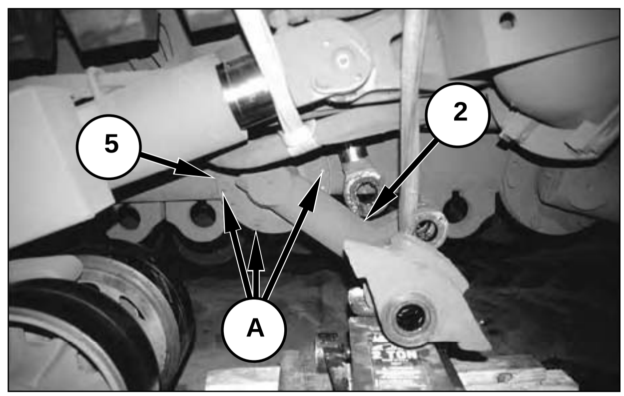


3. Use a floor jack or a forklift to support swing arm (2). Pull on the swing arm to remove the arm, with socket (5) and shims. Take care to handle the shims so that they can be reinstalled in the same location during reassembly. The weight of the swing arm assembly is **113 kg (250 lb).**

NOTE: If necessary, disconnect the hose between the recoil accumulator and the recoil cylinder, at the recoil cylinder, to provide sufficient space to remove swing arm (2).

NOTE: The following steps are for installing the support group.

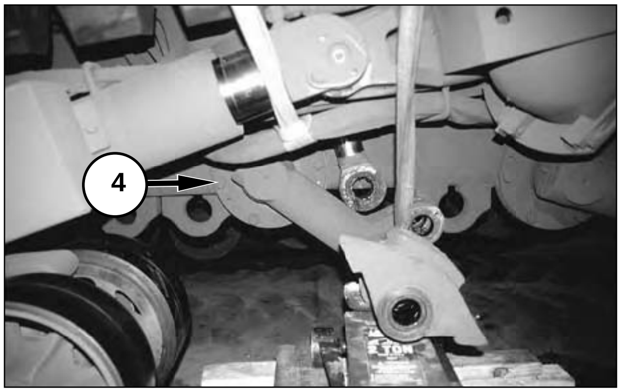
4. Apply **4C-5598 Thread Lubricant (Antiseize)** to all surfaces of socket (5), and to the inside of the socket mount in the frame.



5. Install Tooling (A) into the bolt holes, and install swing arm (2).

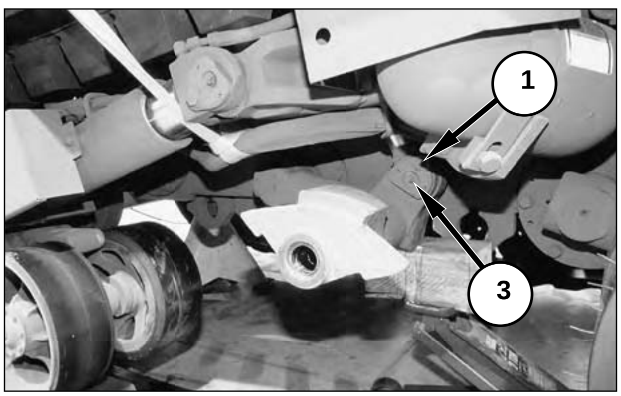
NOTE: A plastic hammer may be required to drive swing arm (2) into the machine frame.

6. After socket (5) is installed on the alignment dowels, remove the dowels and replace the dowels with Tooling (B). Use Tooling (B) to draw the socket into the frame. When the end of the threads are reached, remove the tooling.



7. When the original mounting bolts can be installed, install the shims and six bolts (4) with washers. Tighten six bolts (4) to a torque of **240 ± 40 N•m (177 ± 30 lb ft).**

NOTE: Add or subtract shims to align the centerline of the midroller assembly to within **1.5 mm (0.06 in)** of the centerline of the drive wheel. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage, Steering and Brakes,* "Suspension System Procedures, Undercarriage Alignment Procedure."



8. Install cylinder pin (3). Apply **9S-3263 Thread Compound (Loctite™ 242)** to the threads of bolt (1) and install the bolt with washer. Tighten the bolt to a torque of **120 ± 20 N•m (88 ± 15 lb ft).**

End By:

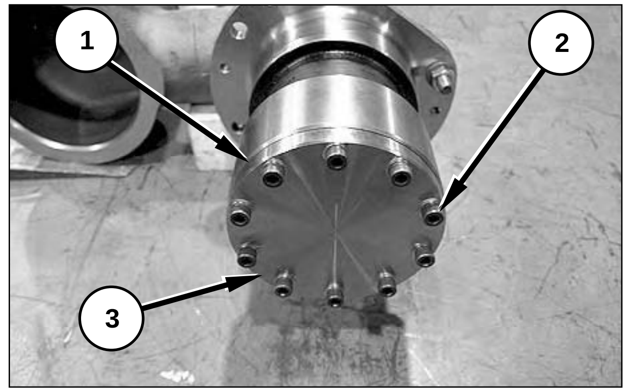
a. Install the center midroller bogie assembly.

Disassemble and Assemble

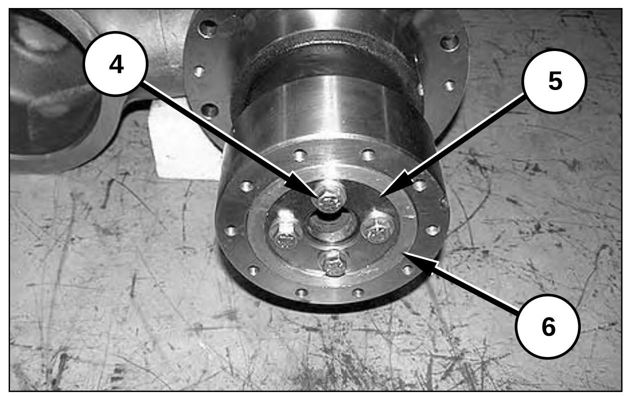
Start By:

a. Remove the support group.

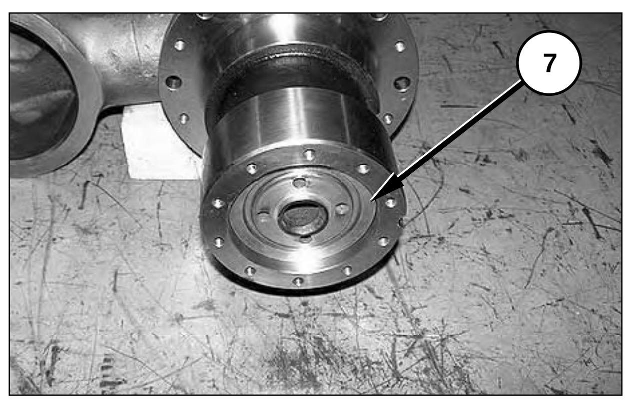
NOTE: Group numbers related to this procedure include 142-0067 and 142-0068.



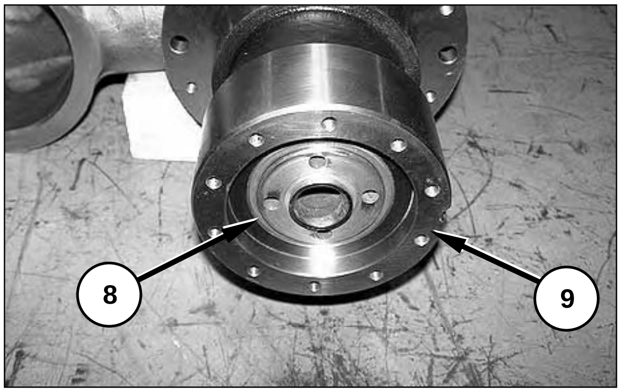
1. Remove 10 bolts (2) with washers, and cover (3) with shims (1).



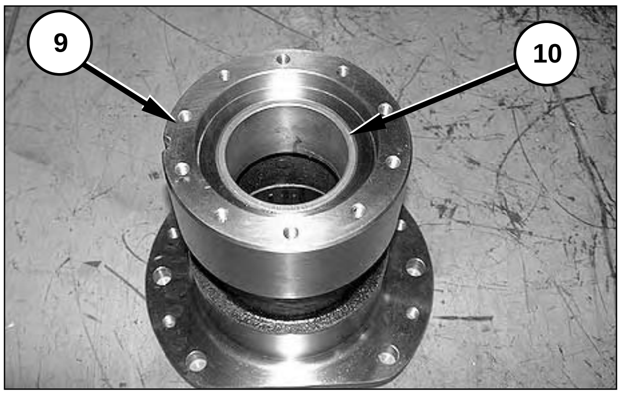
2. Remove four bolts (4) with washers, thrust plate (5), and thrust washer (6).



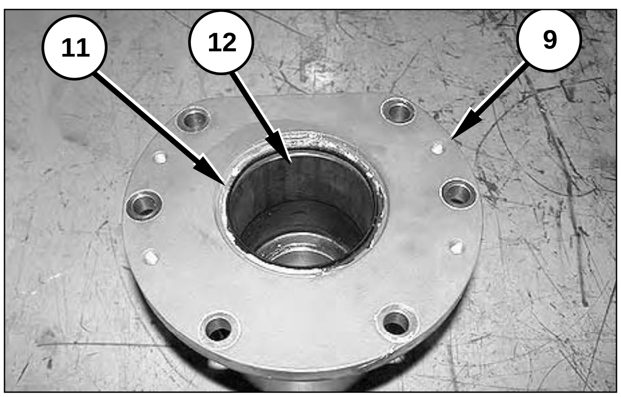
3. Remove thrust washer (7).



4. Remove socket (9) from swing arm (8).



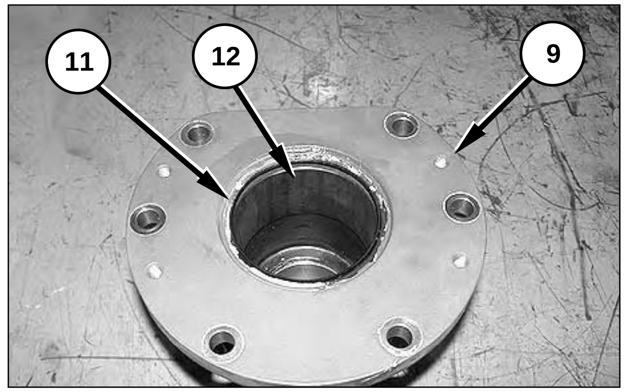
5. Remove bearing (10) from socket (9).



6. Remove seal (11). Replace the seal if there is damage or wear.

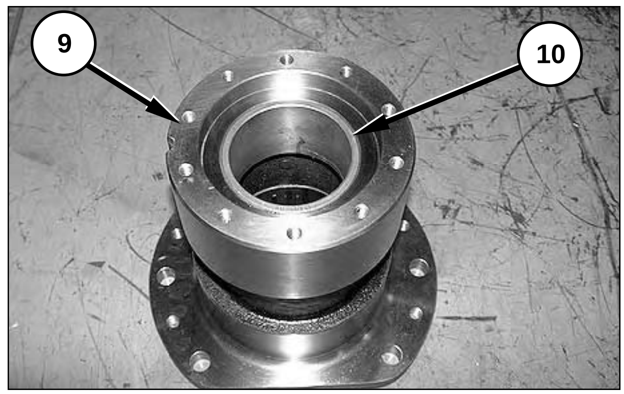
7. Remove bearing (12) from socket (9).

NOTE: The following steps are for assembly of the support groups.

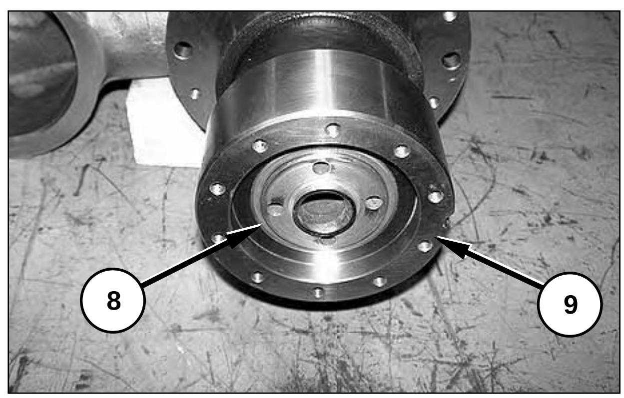


8. Chill bearing (12) to **–100°C (–150°F)**, and install the bearing in socket (9).

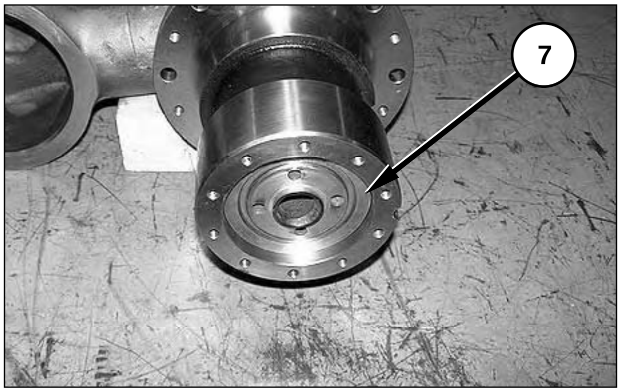
9. Install seal (11), and lubricate the seal lip with clean grease.



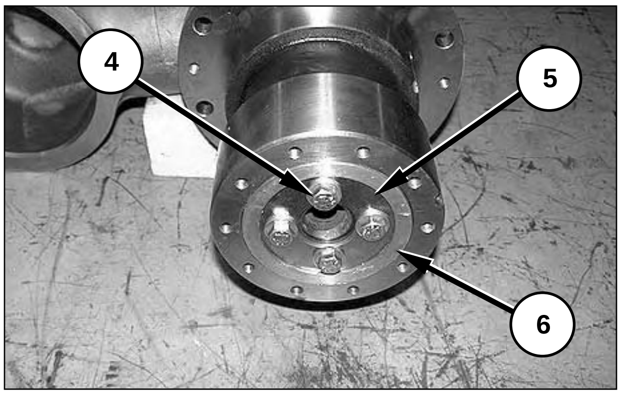
10. Chill bearing (10) to **–100°C (–150°F)**, and install the bearing in socket (9).



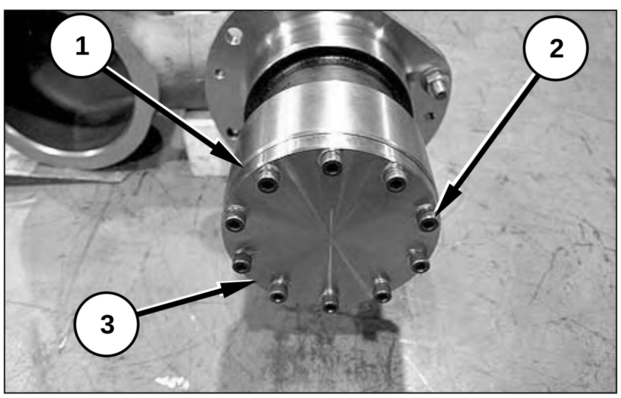
11. Install socket (9) on swing arm (8).



12. Install thrust washer (7).



13. Install thrust plate (5), thrust washer (6), and four bolts (4) with washers.



14. Install cover (3) with shims (1) and 10 bolts (2) with washers. Adjust the thickness of shims (1) to achieve a rolling resistance of **204 ± 68 N•m (150 ± 50 lb ft)**.

NOTE: A spring scale can be used to measure the rolling resistance.

End By:

a. Install the support group.

Suspension Lock Valve

Remove and Install

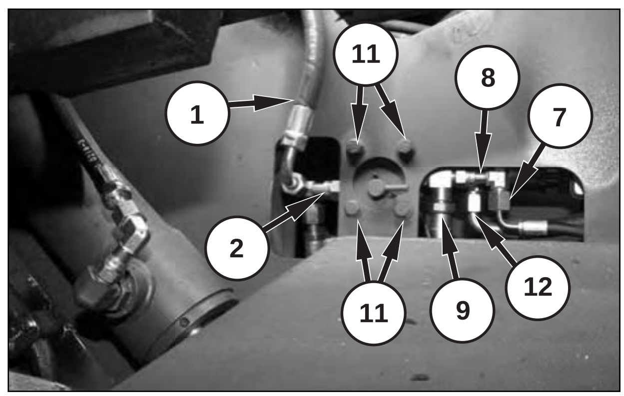
Start By:

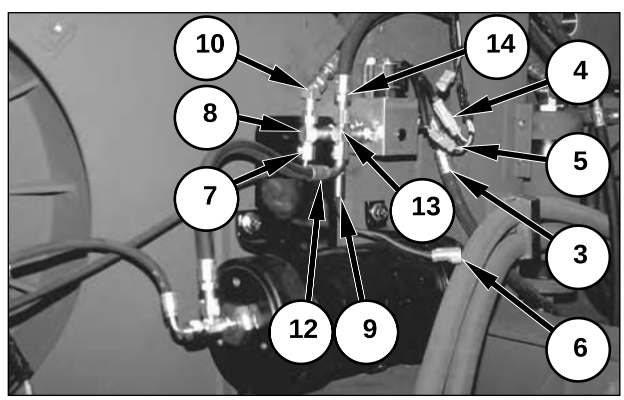
a. Remove the suspension cover group.

NOTE: Group numbers related to this procedure include 126-6575, 144-9746, and 169-7418.

NOTE: The machine is equipped with one suspension lock valve on the right side and one suspension lock valve on the left side. This procedure is valid for the removal and installation of either suspension lock valve.

1. Release the track tension. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage Steering and Brakes,* "Testing and Adjusting, Suspension System Procedures, Suspension Hydraulic Charging Procedure."





Transmission Removed for Photographic Purposes.

2. Loosen hose (1) on the front side of the suspension lock valve at elbow (2). Move the hose out of the way, and remove the elbow from the suspension lock valve.

3. Remove the inner elbow on the front side of the suspension lock valve, leaving hose (3) attached.

4. Cut wire ties as needed, and disconnect harness connectors C303 (4), C343 (5), and C313 (6). Mark the harness connectors for reassembly.

NOTE: Harness connector C313 (6) is shown disconnected.

5. Remove hose (7) from T-fitting (8).

6. Disconnect T-fitting (8) from track tension sensor (9), leaving top hose (10) attached to the T-fitting.

7. Remove four mounting bolts (11) with washers.

8. Remove hose (12) from T-fitting (13).

9. Remove hose (14) from T-fitting (13).

10. Remove the suspension lock valve through the large hole in the machine frame.

NOTE: To install the suspension lock valve, reverse the removal steps.

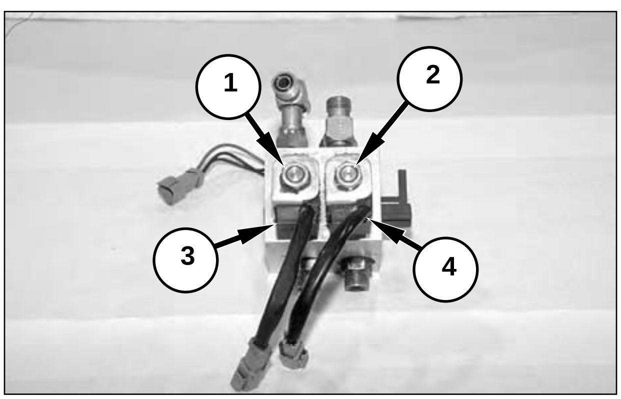
End By:

a. Replace the suspension cover group.

Disassemble and Assemble

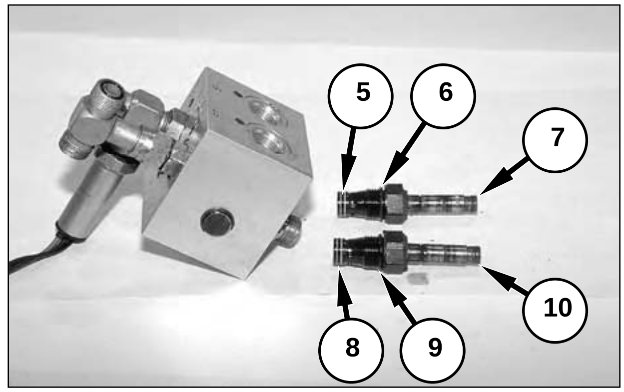
Start By:

a. Remove the suspension lock valve.



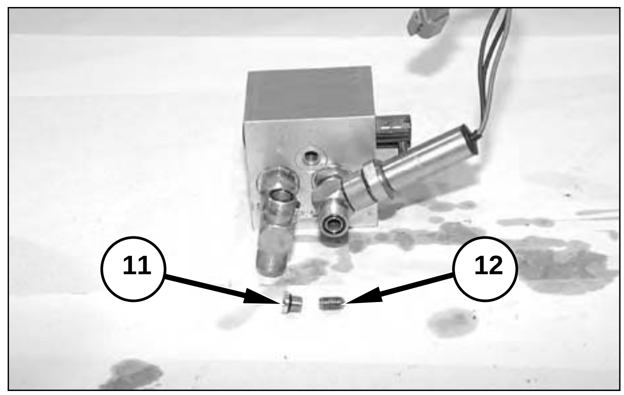
1. Remove solenoid retaining nuts (1) and (2). Upon reassembly, tighten the solenoid retaining nuts to a torque of **4.1 N•m (3 lb ft)**.

2. Remove solenoids (3) and (4).

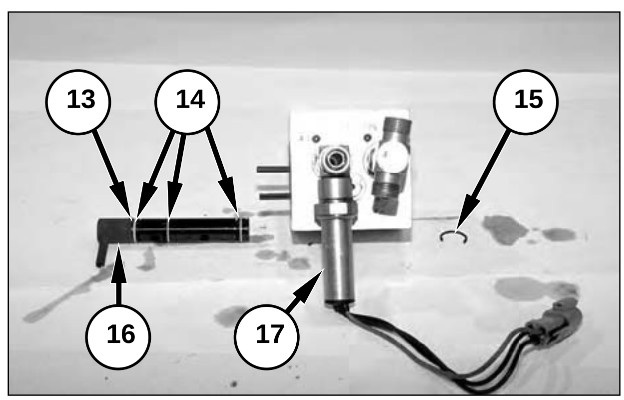


3. Remove cartridges (7) and (10) from the valve body. Upon reassembly, install the cartridges to a torque of **115 ± 7 N•m (85 ± 5 lb ft)**.

NOTE: Cartridges (7) and (10) are identical. Each cartridge has a large O-ring seal (6) and (9) near the nut. The end of each cartridge has two backup rings and one O-ring seal (5) and (8).



4. Remove plug (11) with O-ring seal, and remove ball plunger (12) from the valve body.



5. Remove retaining ring (15), and remove spool (16) with three O-rings and three backup rings (14), and retaining ring (13).

6. Remove track tension sensor (17).

NOTE: To assemble the suspension lock valve, reverse the disassembly steps.

End By:

a. Install the suspension lock valve.

Swing Arm, Front, Right and Left

Remove and Install

Tools Needed	A	B
M16-2 x 130 mm Alignment Dowel (Fabricate)	3	
7L-1206 M16-2 x 130 mm Bolt		3

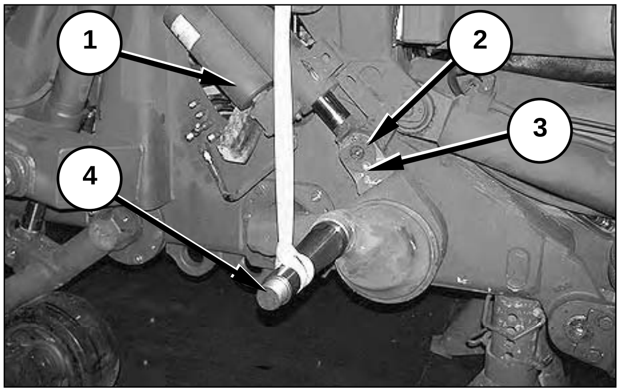
NOTE: Group numbers related to this procedure include 124-3842, 142-0071, and 142-0073.

NOTE: The following procedure is for the component on the right side of the machine. The procedure for the component on the left side of the machine is the same.

Start By:

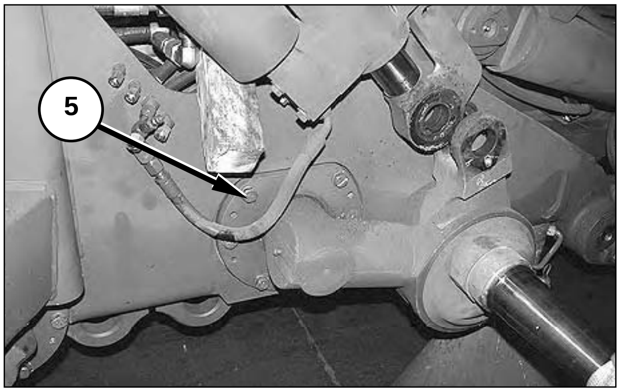
a. Remove the suspension cover group.

b, Remove the recoil cylinder with the major bogie.

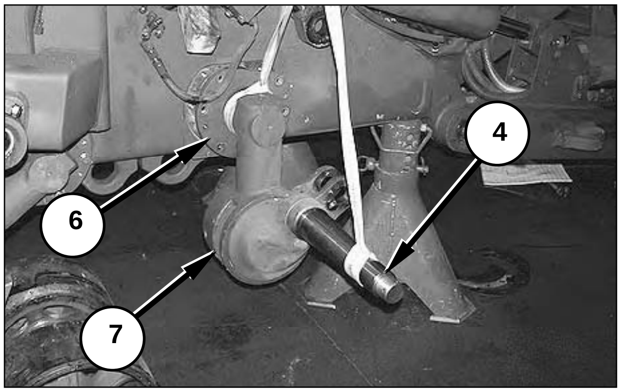


1. Support pivot arm (4) with a hoist. Insert a block between front cylinder (1) and the machine frame.

2. Remove bolt (3) with washer and spacer (if present), and remove pin (2). Allow front cylinder (1) to rest against the block.



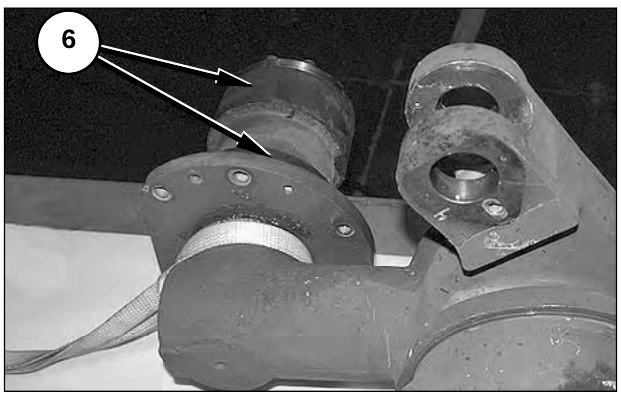
3. Remove six bolts (5) with washers.



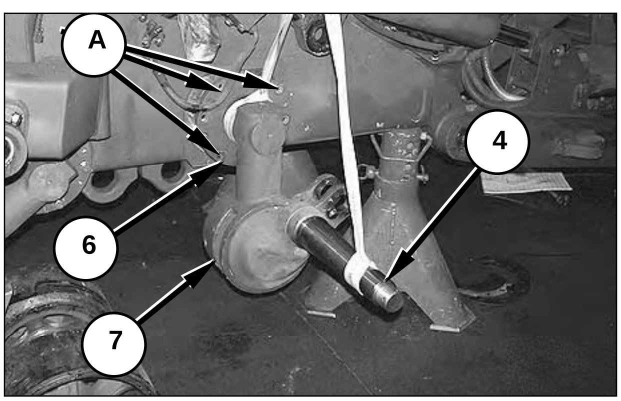
4. Reposition the hoist and use two **M12 bolts** to push socket (6) out of the machine frame.

5. Remove swing arm (7) with shims, together with pivot arm (4). Take care to note the position of the shims for correct location during reassembly. The weight of the swing arm with the pivot arm is **159 kg (350 lb).**

NOTE: The following steps are for the installation of the swing arm and pivot arm assembly.



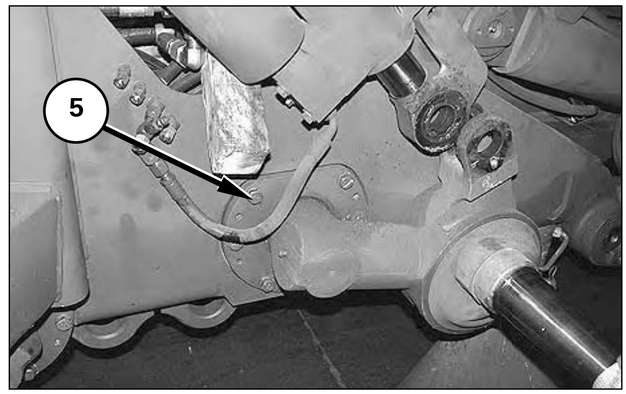
6. Apply **4C-5592 Thread Lubricant (Antiseize)** to all surfaces of socket (6), and to the inside of the socket mount in the frame.



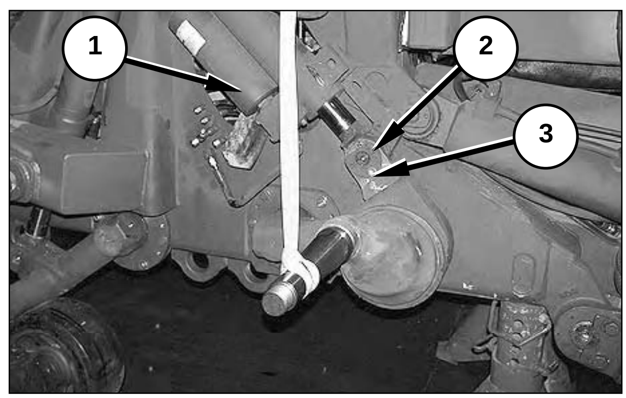
7. Install Tooling (A) to install swing arm (7) with shims, together with pivot arm (4). The weight of the swing arm, with the pivot arm, is **159 kg (350 lb).**

NOTE: If new shims are used, install the thickness of shims required to align the centerline of the track guides to within **1.5 mm (0.06 in)** of the centerline of the drive wheels. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage, Steering, and Brakes,* "Testing and Adjusting, Undercarriage Alignment Procedure."

8. After socket (6) is installed on the alignment dowels, remove the dowels and replace the dowels with Tooling (B). Use the bolts to draw the socket into the frame. When the end of the threads are reached on the **130 mm long bolts**, replace the **130 mm bolts** with shorter ones until it is possible to install bolts (5).



9. Install six bolts (5) with washers. Tighten the bolts to a torque of **240 ± 40 N•m (177 ± 30 lb ft)**.



10. Raise front cylinder (1) and install pin (2).

11. Apply **9S-3263 Thread Compound (Loctite™ 242)** to the threads of bolt (3). Install the bolt with the washer, and tighten the bolt to a torque of **120 ± 20 N•m (88 ± 15 lb ft)**.

12. Remove the block from between front cylinder (1) and the machine frame.

End By:

a. Install the suspension cover group.

b. Install the recoil cylinder with the major bogie.

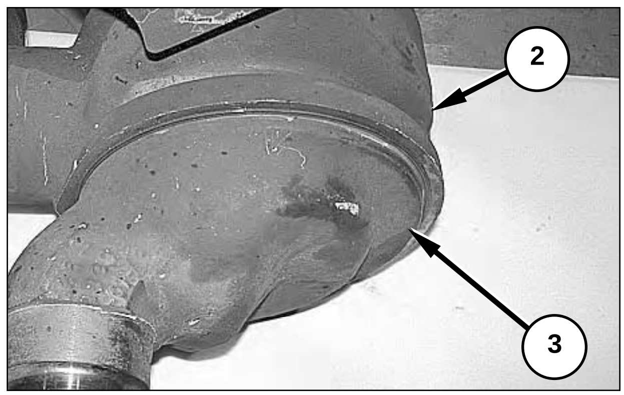
Disassemble and Assemble

Start By:

a. Remove the front swing arm.

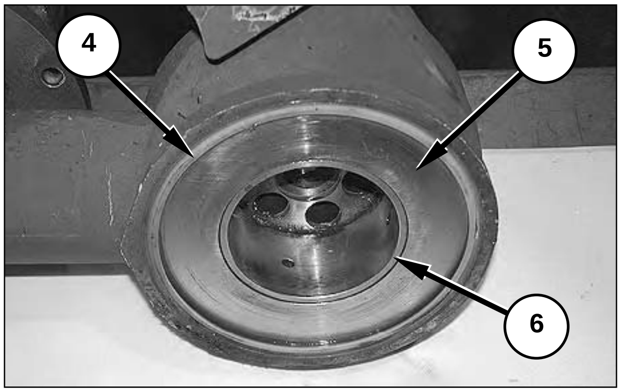
NOTE: To disassemble and assemble the swing arm socket, refer to “Support Group, Left and Right, Disassemble and Assemble.”

1. Remove six bolts (1) with washers.



2. Use two people to pry between pivot arm (3) and swing arm (2), and remove the pivot arm. The weight of the pivot arm is **41 kg (90 lb).**

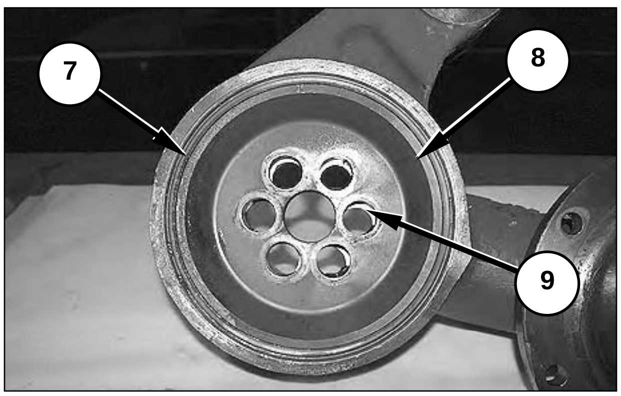
NOTE: To remove pivot arm (3), pry hard enough to break the suction force created by the grease in the assembly.



3. If necessary, remove seal (4). Replace the seal if there is damage or wear.

4. Remove thrust washer (5).

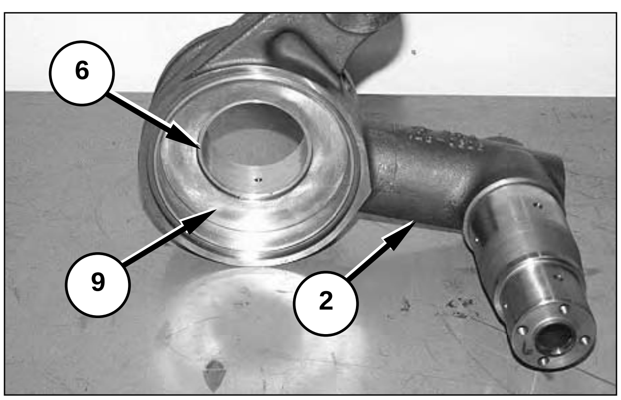
5. Remove bearing (6).



6. Remove retainer (8) with shims, and thrust washer (9).

7. If necessary, remove seal (7). Replace the seal if there is damage or wear.

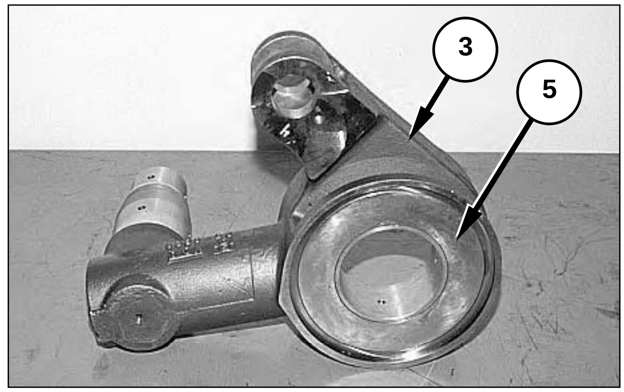
NOTE: The following steps are for assembly of the front swing arm.



8. Cool bearing (6) to a temperature of **-100°C (-150°F),** and install the bearing in swing arm (2).

9. Install thrust washer (9).

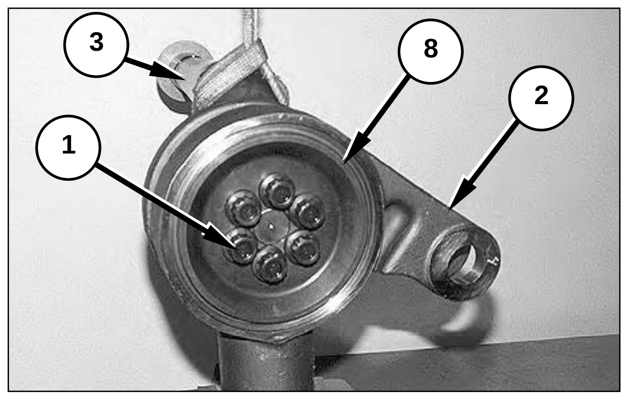
NOTE: Do not install seal (7) at this time. The bearing preload must be set without the seal installed.



10. Install thrust washer (5) in pivot arm (3).

NOTE: Do not install seal (4) at this time. The bearing preload must be set without the seal installed.

11. Lubricate the faces of thrust washers (5) and (9) with clean grease.

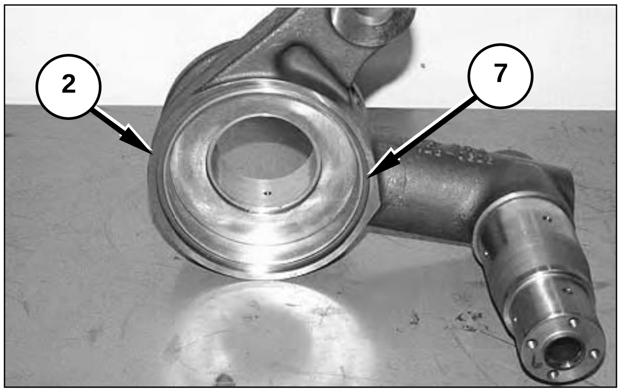


12. Install pivot arm (3) in swing arm (2).

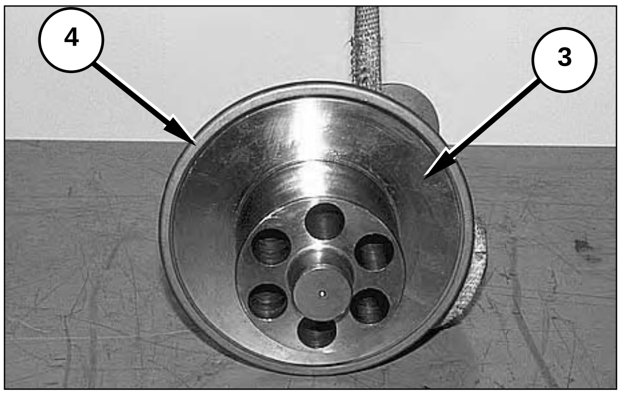
13. Install retainer (8) with shims and bolts (1). Tighten the bolts to a torque of **700 ± 90 N•m (516 ± 66 lb ft).**

14. Add or subtract shims behind retainer (8) to achieve a rolling torque of **204 ± 68 N•m (150 ± 15 lb ft).** Adding shims increases the rolling torque, and removing shims decreases the rolling torque.

15. Remove six bolts (1) and retainer (8) with shims and pivot arm (3), when the correct rolling torque has been achieved.

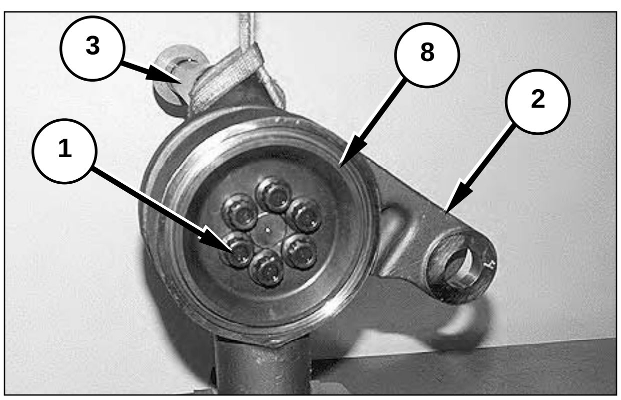


16. Install seal (7) in swing arm (2).



17. Heat seal (4) to a temperature of **150°C (250°F)** for 10 minutes, then install the seal on pivot arm (3). Install the seal so that the sealing lip faces away from swing arm (2) when the pivot arm is assembled to the swing arm.

NOTE: Do not use a torch to heat seal (4).



18. Install pivot arm (3) in swing arm (2).

19. Install retainer (8) with shims, and six bolts (1). Tighten the bolts to a torque of **700 ± 90 N•m (516 ± 66 lb ft).**

End By:

a. Install the front swing arm.

Swing Arm, Rear, Left and Right

Tools Needed	A	B
M16-2 X 130 mm Alignment Dowel (Fabricate)	3	
7I1206 M16-2 X 130 mm Bolt		3

NOTE: The following procedure is for the component on the right side of the machine. The procedure for the component on the left side of the machine is the same.

Remove and Install

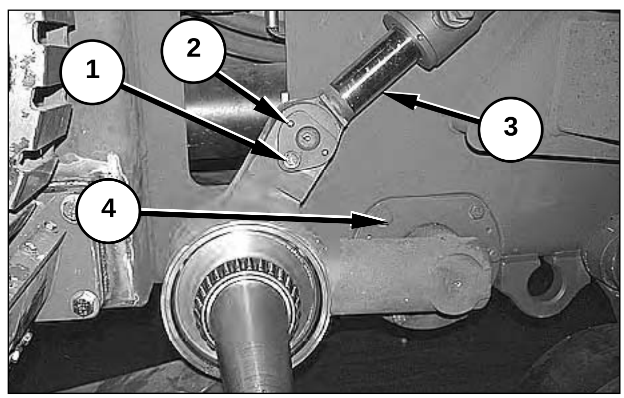
Start By:

a. Remove the suspension cover group.

b. Remove the rear idler hub.

NOTE: Group numbers related to this procedure include 124-3901, 142-0065, and 142-0066.

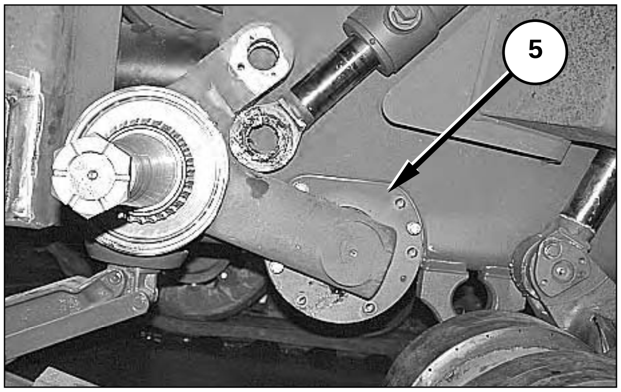
NOTE: The recoil accumulator may be removed before this procedure is performed, to provide more space. However, removal of the accumulator is not required. (The accumulator been removed from the photos below.)



1. Remove bolt (1) with the washer, and pin (2). Allow rear suspension cylinder (3) to rest against the machine frame.

NOTE: The rear swing arm may need to be lowered, or the cylinder rod retracted to allow the rear suspension cylinder to lay against the machine.

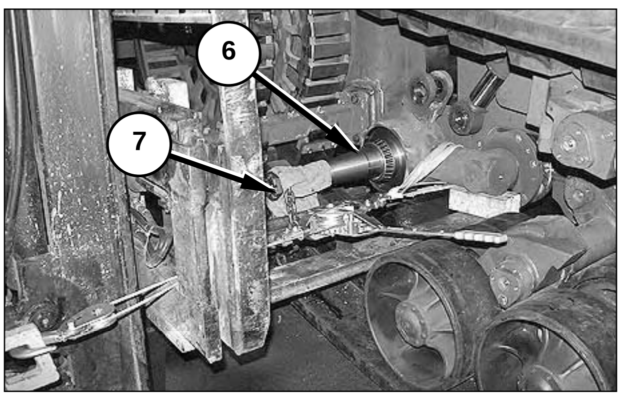
2. Remove six bolts (4) with washers.



3. Install two pusher bolts into the threaded holes on rear socket (5). Turn the pusher bolts clockwise to push the rear socket out of the machine frame.

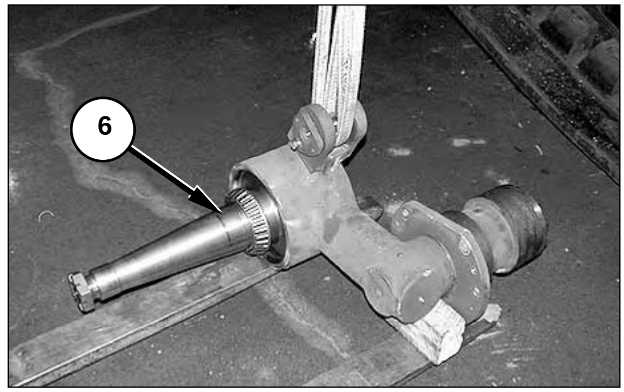
4. As rear socket (5) moves away from the machine frame, remove the pusher bolts and the shims that are located between the socket and the frame. Keep the shim stacks for correct location during reassembly.

NOTE: The rear swing arm may need to be raised to provide access to the pusher holes in the rear swing arm socket.



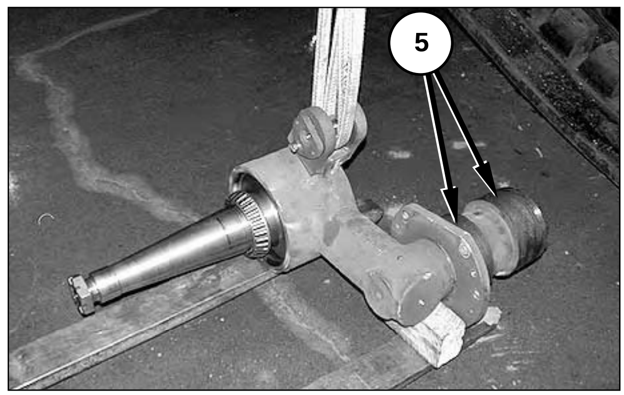
5. Support rear swing arm (6) with a forklift. The weight of the rear swing arm is **136 kg (300 lb).** Protect the threads on the end of the rear swing arm, and install a chain and nut (7). Use a hand-operated winch to pull the rear swing arm socket out of the machine frame and onto the forks.

NOTE: Nut (7) was removed with the rear idler hub.

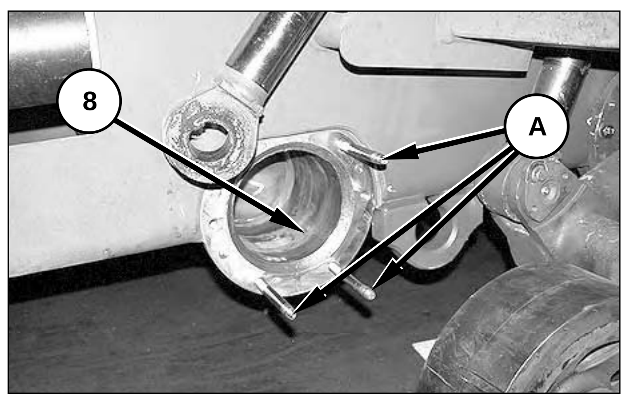


6. Use a hoist to remove rear swing arm (6) from the forklift forks. The weight of the rear swing arm is **136 kg (300 lb).**

NOTE: The following steps are for reinstalling the rear swing arm.

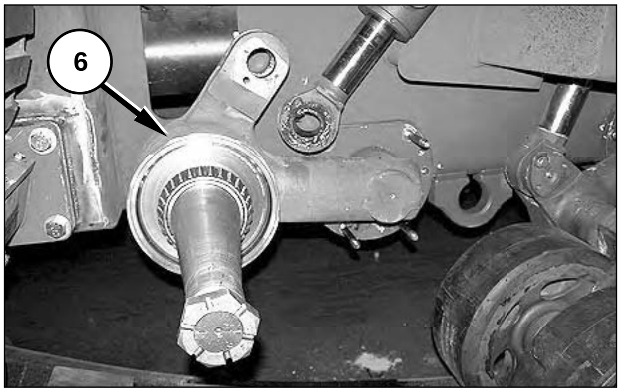


7. Apply **4C-5592 Thread Lubricant (Antiseize)** to the bearing surfaces of socket (5), and to the inside of the socket mount in the frame.



8. Install Tooling (A).

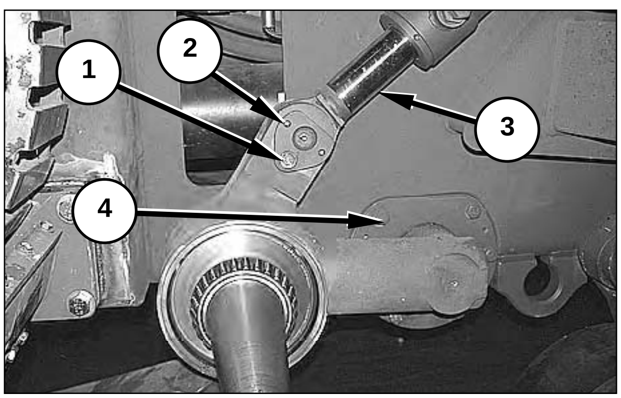
9. Apply **4C-5592 Thread Lubricant (Antiseize)** to area (8) inside the machine frame. Coat the entire inner surface with thread lubricant.



10. Install rear swing arm (6) into the machine frame using the forklift.

NOTE: A plastic hammer may be required to drive the swing arm into the machine frame.

11. After socket (5) is installed on the alignment dowels, remove the dowels and replace the dowels with Tooling (B). Use the bolts to draw the socket into the frame. When the end of the threads are reached on the **130 mm** long bolts, replace the **130 mm** bolts with shorter ones until it is possible to install bolts (4).



12. When the original mounting bolts can be installed, install the shims and six bolts (4) with washers. Tighten the six bolts to a torque of **240 ± 40 N•m (177 ± 30 lb ft).**

NOTE: If components have been replaced, add or subtract shims to align the centerline of the rear idler hub to within **1.5 mm (0.06 in)** of the centerline of the drive wheel. The centerline measurement must be checked after the rear hub has been installed. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage, Steering, and Brakes,* “Testing and Adjusting, Undercarriage Alignment Procedure.”

13. Align cylinder (3).

14. Install pin (2). Apply **9S-3263 Thread Compound (Loctite™ 242)** to the threads of bolt (1), and install the bolt with washer. Tighten the bolt to a torque of **120 ± 20 N•m (88 ± 15 lb ft).**

End By:

a. Install the rear idler hub.

b. Install the suspension cover group.

Torque Converter Group

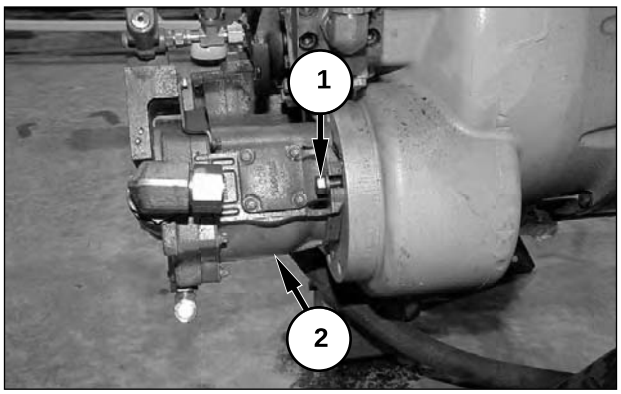
Remove and Install

Tools Needed	A
138-7574 Link Bracket	2

Start By:

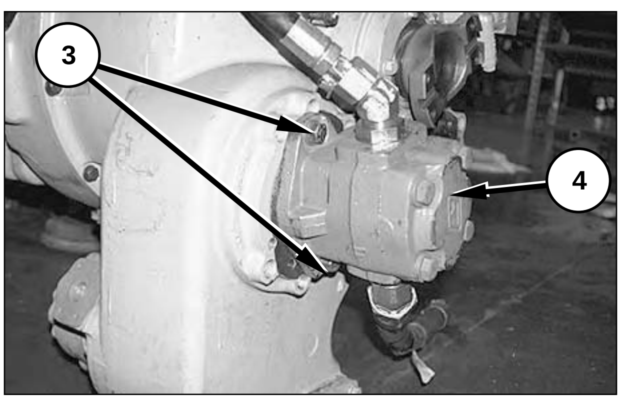
a. Remove the engine and torque converter.

NOTE: Group numbers related to this procedure include 175-2284, 126-6567, 122-8644 and 144-8599.

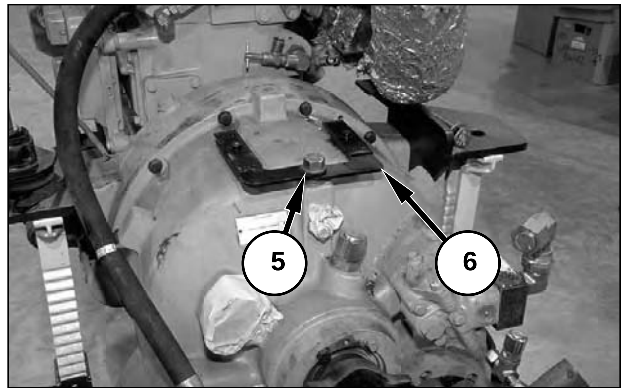


1. Remove two bolts (1) with washers, and remove implement pump (2).

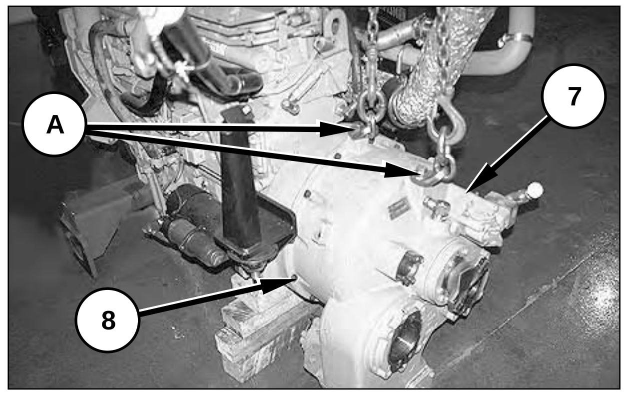
NOTE: Only one of two bolts (1) is shown. The other bolt is located on the opposite side of the pump.



2. Remove two bolts (3) with washers, and fan pump (4).



3. Remove bolt (5) and bracket (6).



4. Install Tooling (A) and support the torque converter with a hoist. The weight of the torque converter is approximately **477 kg (1050 lb)**.

5. Remove 12 bolts (8) with washers, and remove torque converter (7). The weight of the torque converter is approximately **477 kg (1050 lb)**.

NOTE: To install the torque converter, reverse the removal steps.

End By:

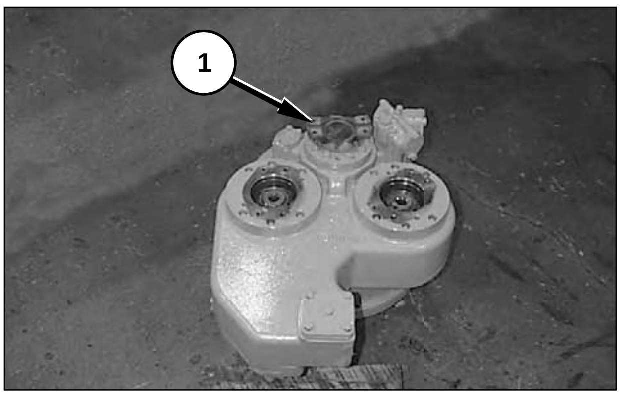
a. Install the engine and torque converter.

Disassemble

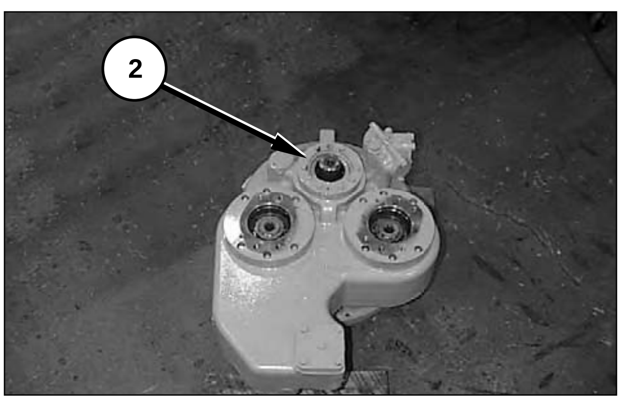
Tools Needed		A	B	C	D	E
3/8 in-16	Forcing Screws	4				
1P-0520	Driver Group		1			
6V-2156	Link Bracket			2		
1/2 in-14	Forcing Screws				2	
5F-7343	Puller Assembly					1
		F	G			
1P-0510	Driver Group	1				
1/4 in-20	Eyebolts		1			

Start By:

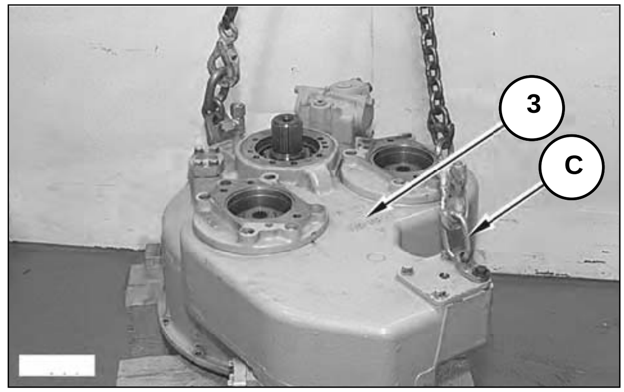
a. Remove the torque converter.



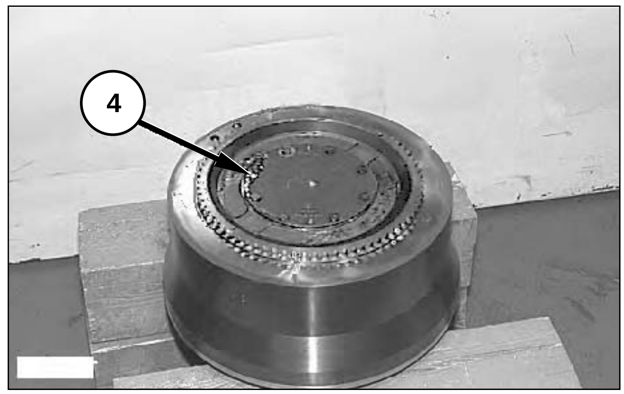
1. Lay the torque converter on suitable blocks and remove yoke assembly (1).



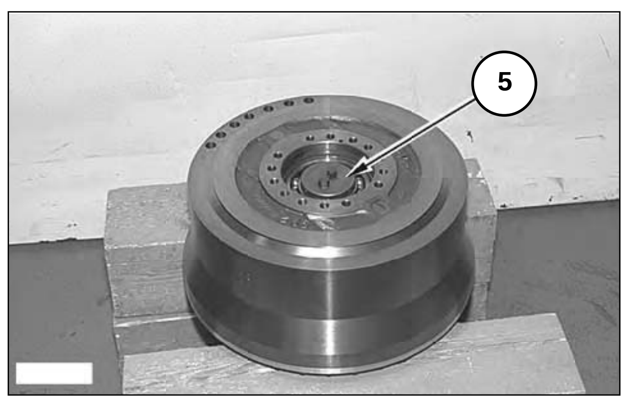
2. Use forcing screws Tooling (D) to remove seal carrier (2) and the gasket.



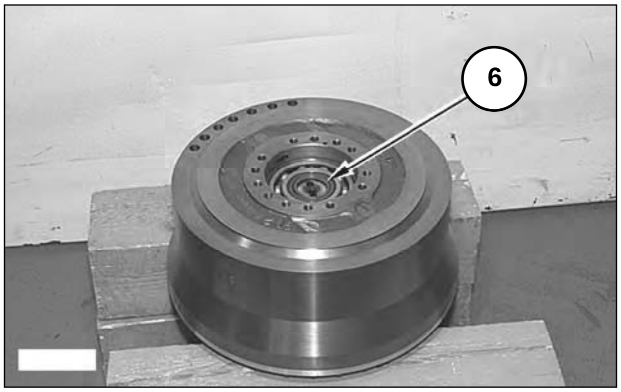
3. Use Tooling (C) and a suitable lifting device and remove case (3) from the torque converter. The weight of the case is **141 kg (310 lb).**



4. Use Tooling (C) and a suitable lifting device to turn over and block the torque converter. Remove eight bolts and flange assembly (4).

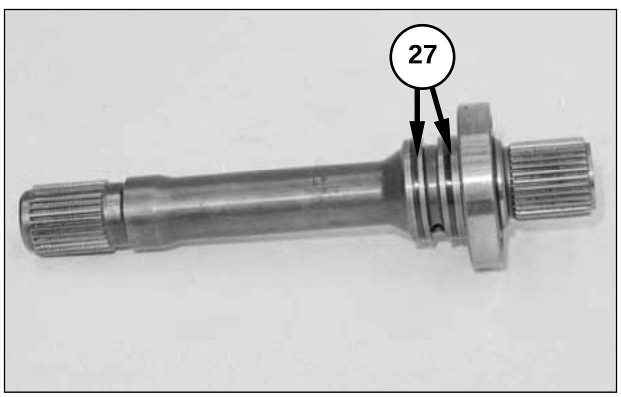


5. Remove two bolts, and remove retainer (5) and the shims.

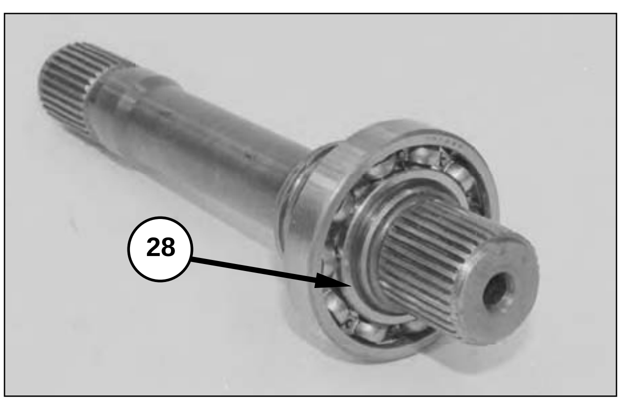


6. Remove O-ring seal (6) from the torque converter.

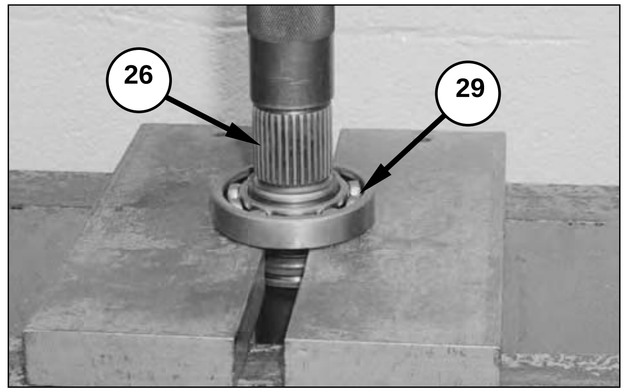
7. Remove shaft (7) from the torque converter.



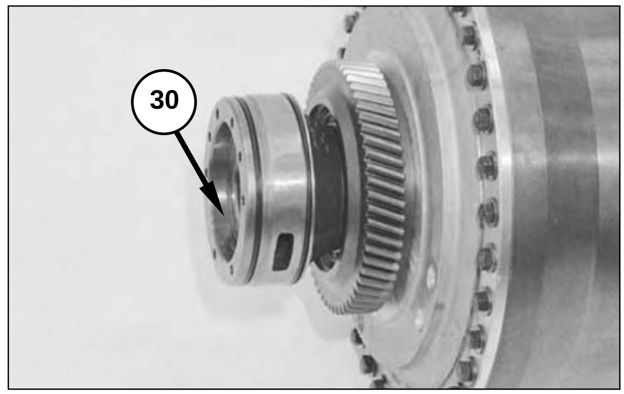
8. Remove rings (8) from shaft (7).



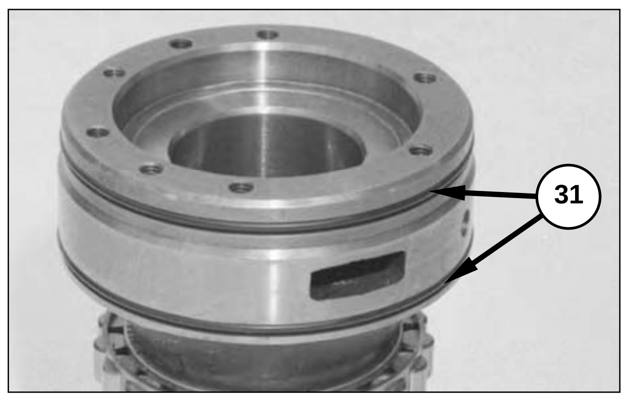
9. Remove ring (9) from shaft (7).



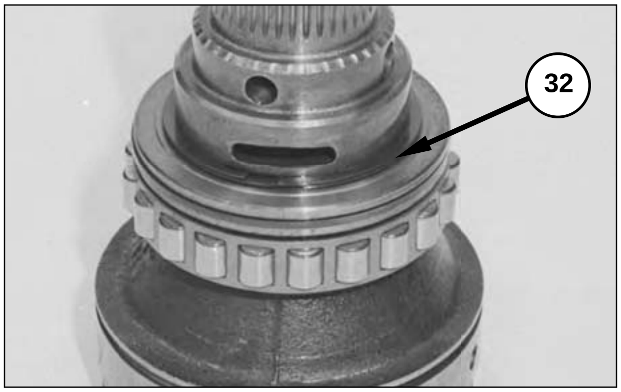
10. Use a press to remove bearing (10) from shaft (7).



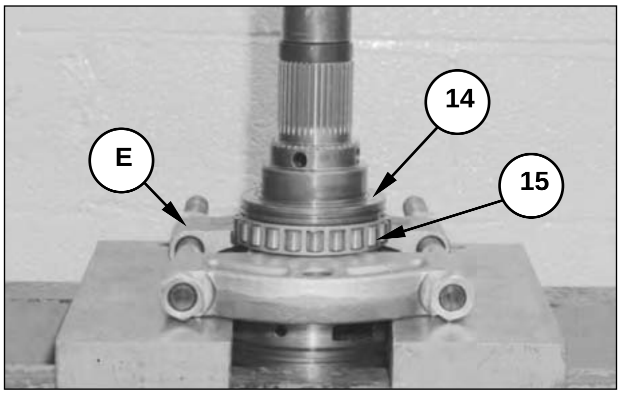
11. Remove carrier (11) from the torque converter.



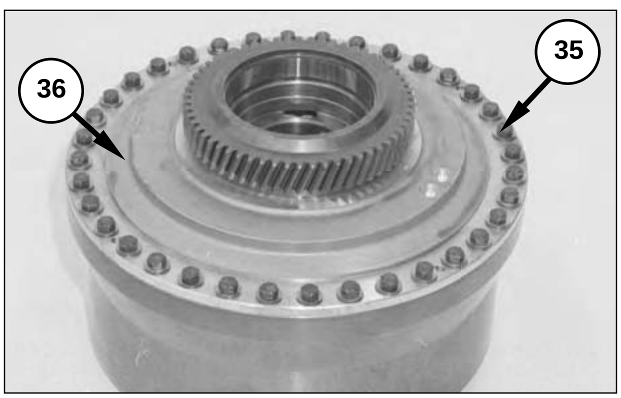
12. Remove seals (12) from carrier (11).



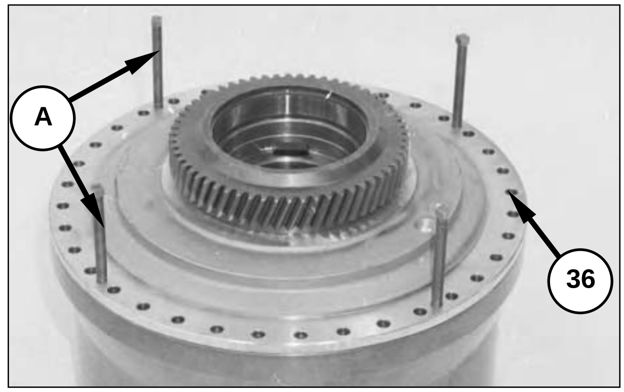
13. Remove ring (13) from carrier (11).



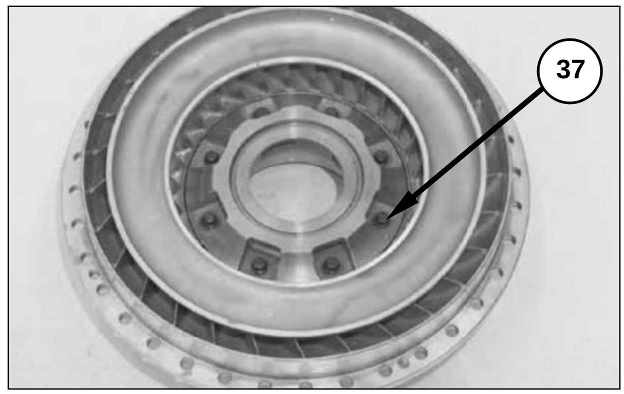
14. Use Tooling (E) and (F) and a press to remove carrier (14) and bearing (15) from carrier (11).



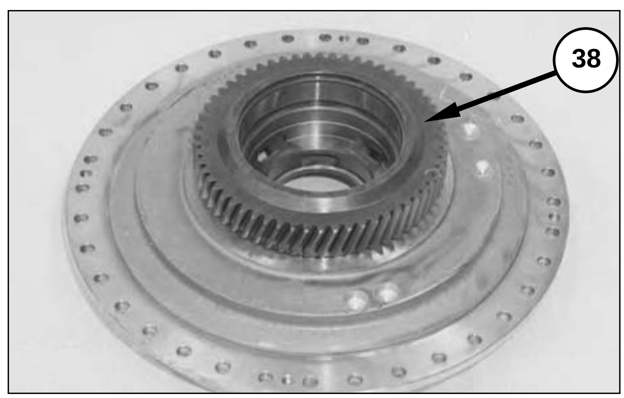
15. Remove 36 bolts (16) and washers, which hold impeller (17) to the housing.



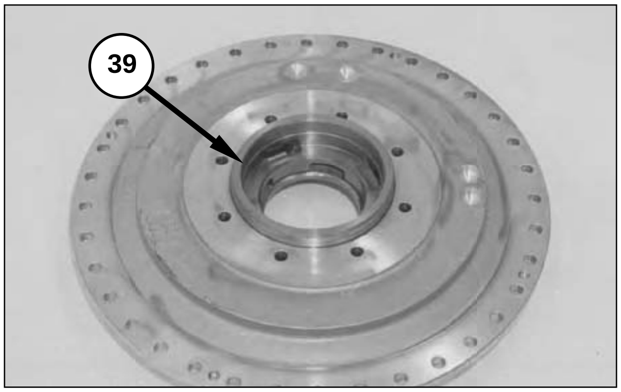
16. Install Tooling (A) as shown, and remove impeller (17) from the bearing.



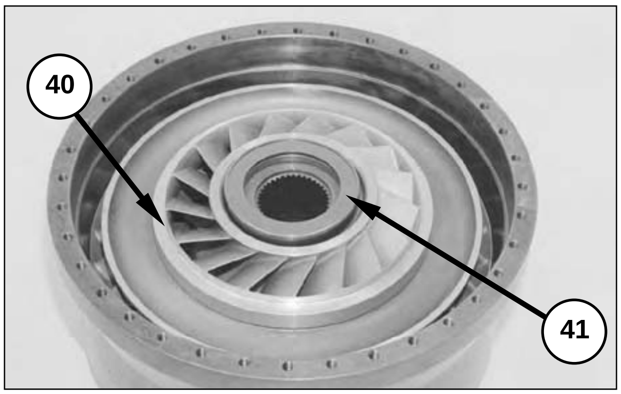
17. Remove bolts (18), which hold the gear to impeller (17).



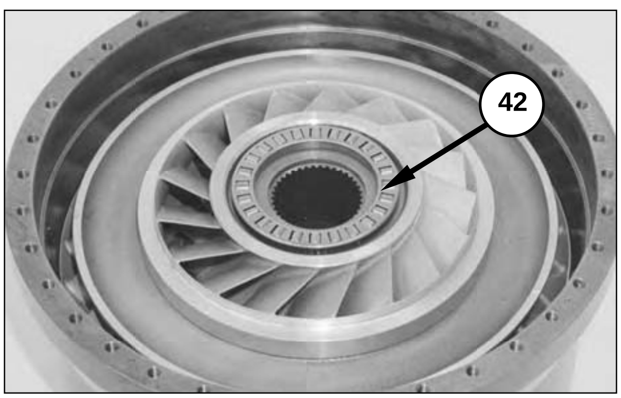
18. Remove gear (19) from impeller (17).



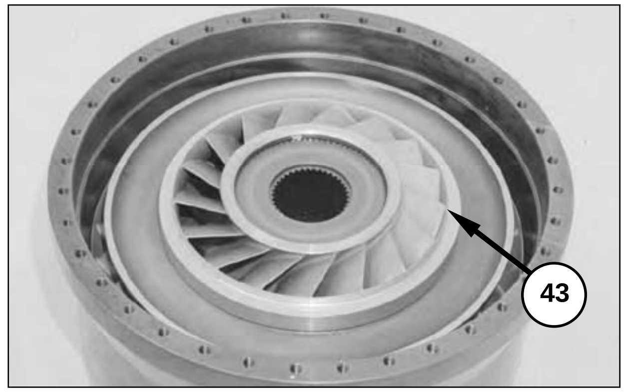
19. Remove hub (20) from impeller (17).



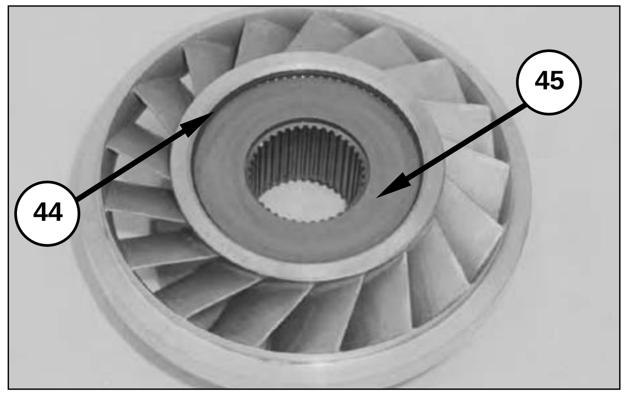
20. Remove retainer (21) and race (22) from the torque converter.



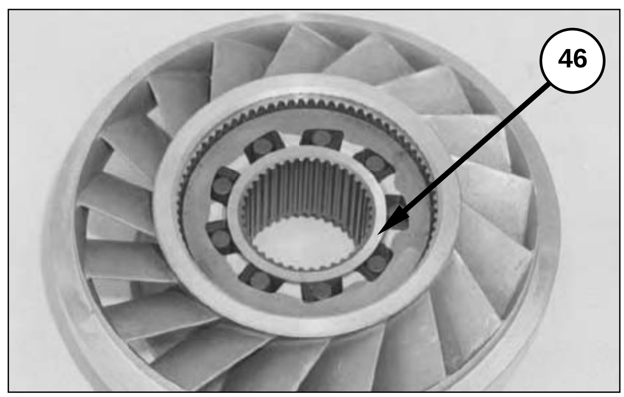
21. Remove bearing (23) from the torque converter.



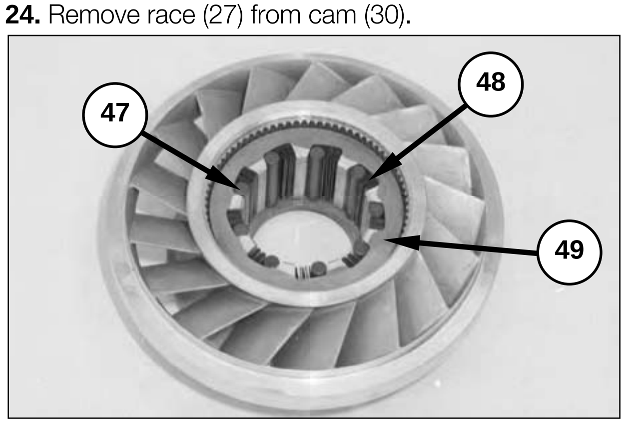
22. Remove stator (24) from the turbine.



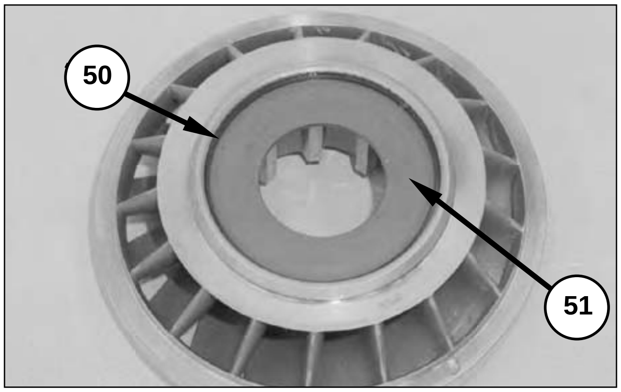
23. Remove ring (25) and race (26) from stator (24).



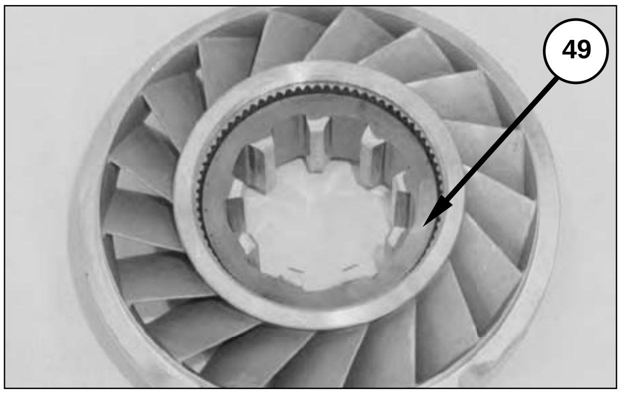
24. Remove race (27) from cam (30).



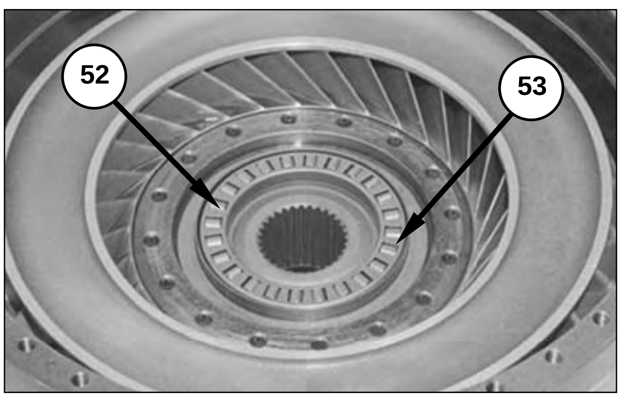
25. Remove rollers (28) and springs (29) from cam (30).



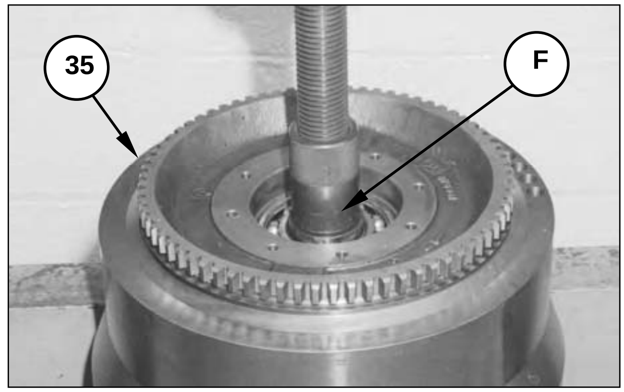
26. Remove ring (31) and race (32) from retarder stator (24).



27. Remove cam (30) from retarder stator (24).

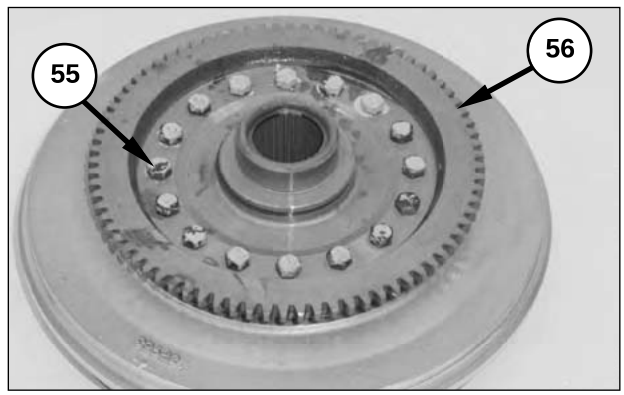


28. Remove retainer (33), bearing (34) and the race from the torque converter.

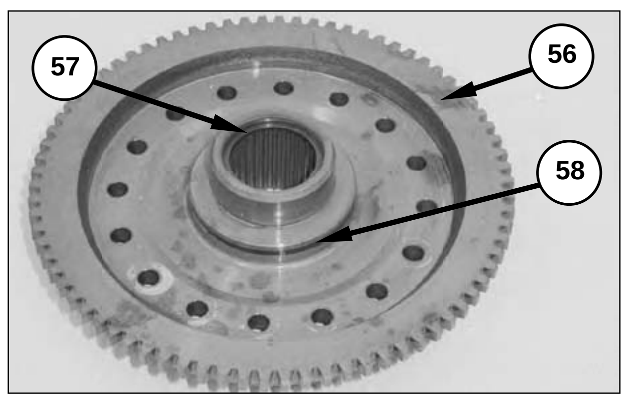


29. Put housing (35) and the turbine in position on a press. The weight of the housing and the turbine is **41 kg (90 lb).**

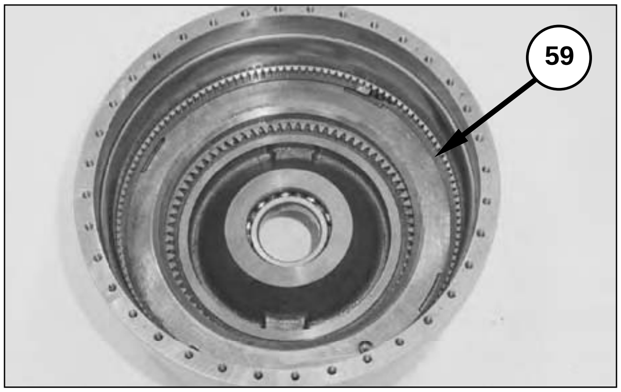
30. Use a press and Tooling (F) to remove the turbine from housing (35).



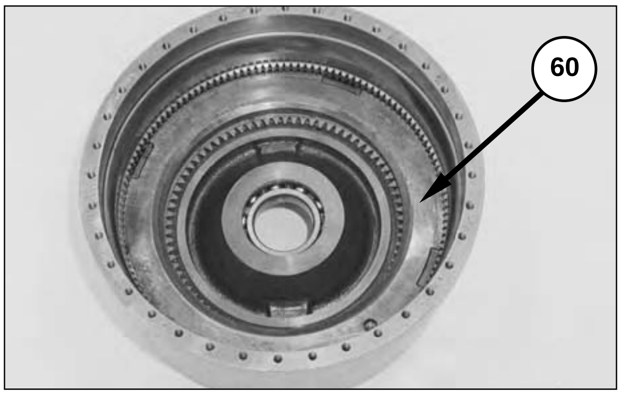
31. Remove 16 bolts (36) and hub (37) from the turbine.



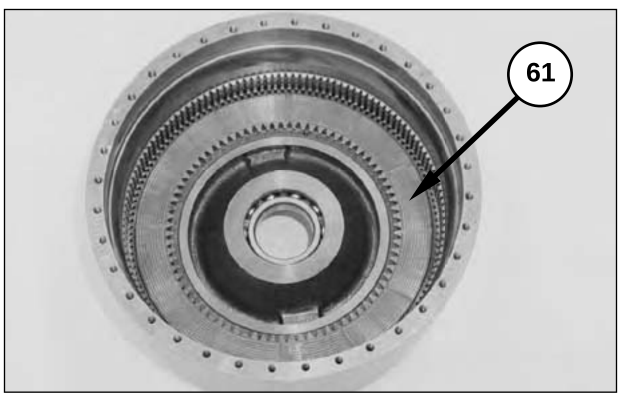
32. Remove rings (38) and (39) from hub (37).



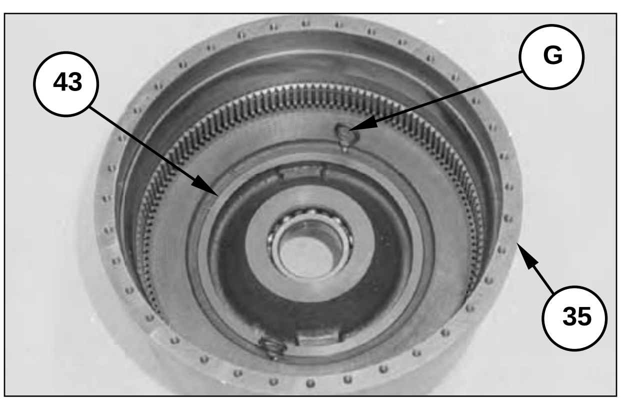
33. Remove ring (40) from housing (35).



34. Remove plate (41) from housing (35).



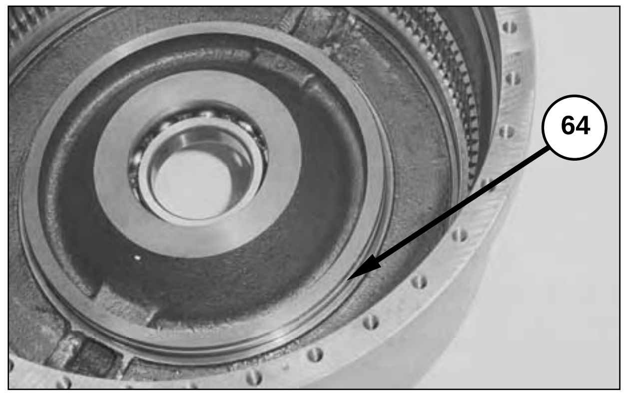
35. Remove disk (42) from housing (35).



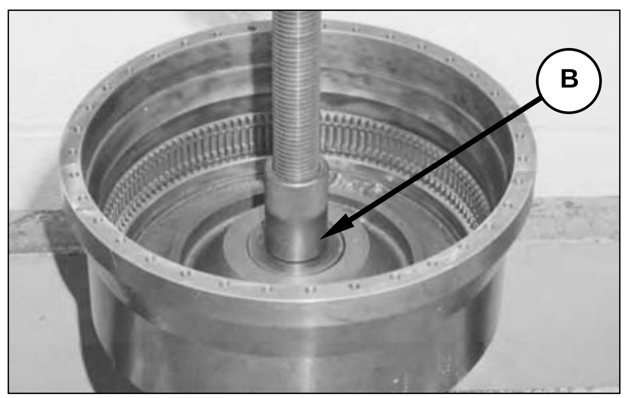
36. Install Tooling (G) in piston (43), as shown.

37. Remove piston (43) from housing (35).

38. Remove ring (44) from piston (43).



39. Remove ring (45) from housing (35).

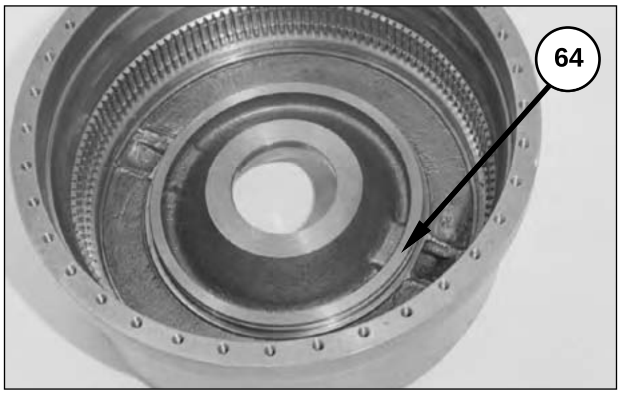


40. Use a press and Tooling (B) to remove the bearing from housing (35).

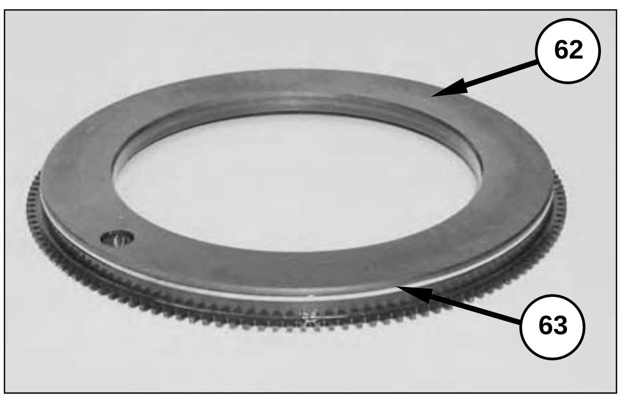
Assemble

NOTICE

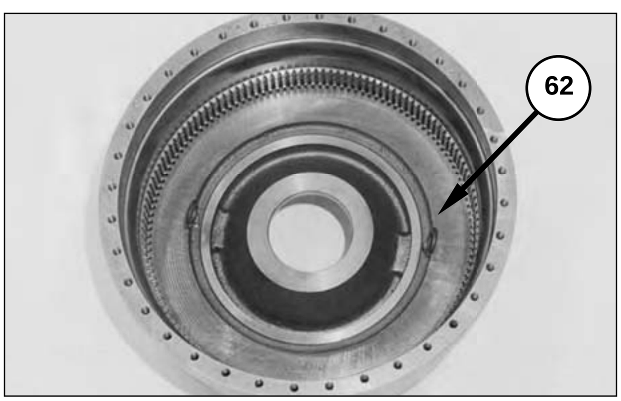
Before the torque converter is assembled, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Transmission and Torque Converter* "Specifications, Torque Converter Group" and "Torque Converter" for correct clearances. These clearances must be correct for the torque converter to operate with efficiency. Use acceptable inside and outside micrometers and other necessary equipment to measure the components.



1. Install ring (45) in housing (35).

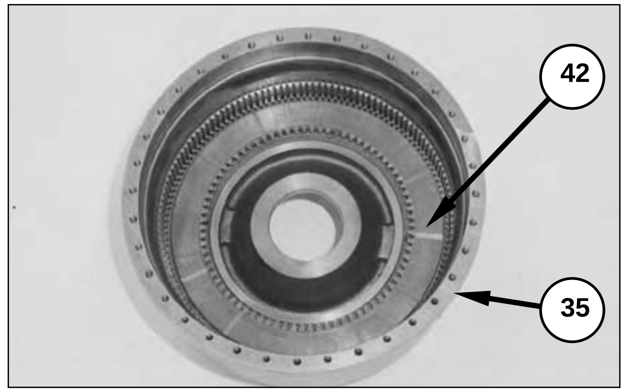


2. Install ring (44) on piston (43).

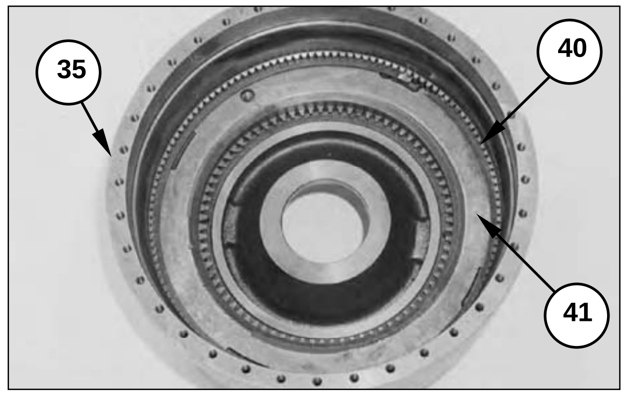


3. Install Tooling (G) on piston (43), as shown.

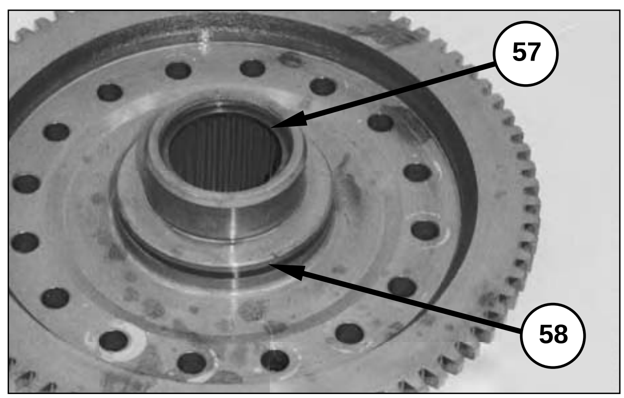
4. Install piston (43) in housing (35), as shown.



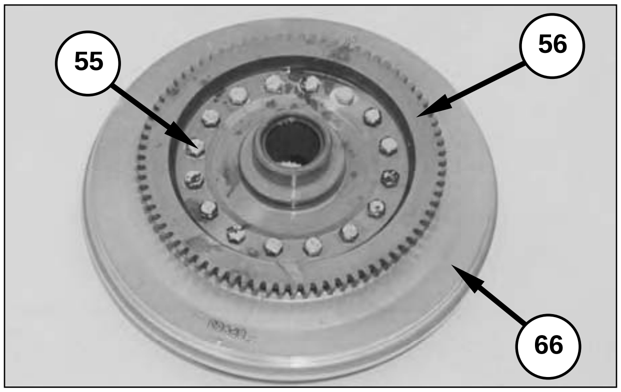
5. Install disk (42) in housing (35).



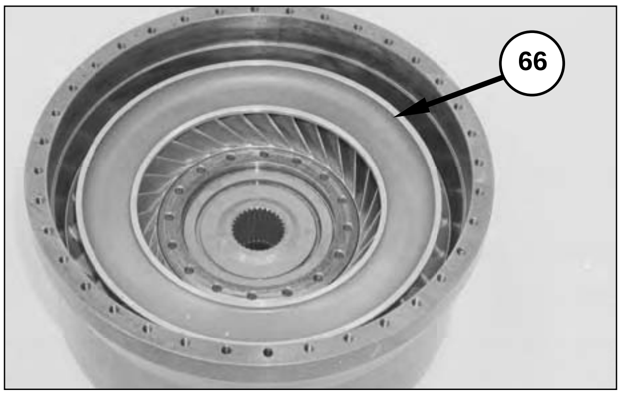
6. Install plate (41) and ring (40) in housing (35).



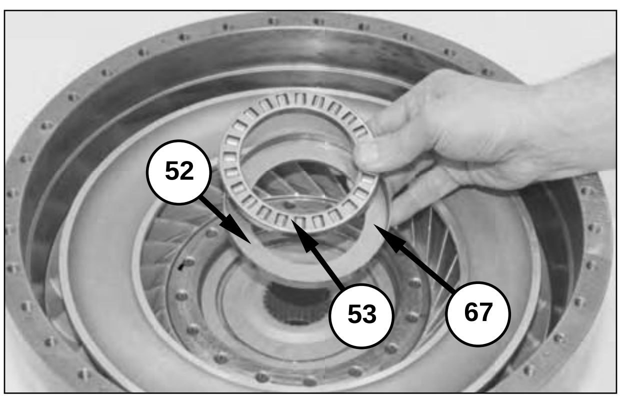
7. Install ring (38) and ring (39) in hub (37).



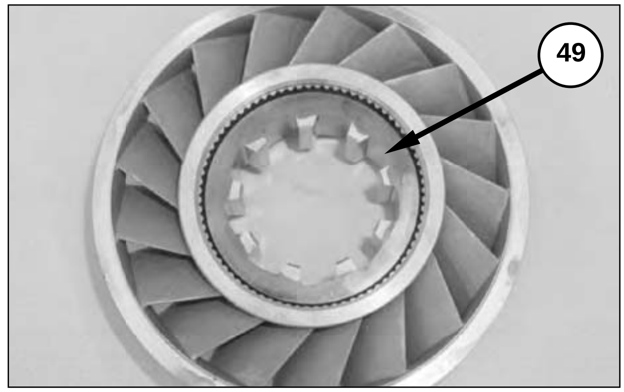
8. Install hub (37) on turbine (47) with 16 bolts (36). Tighten the bolts to a torque of **49 ± 3 N•m (36 ± 2 lb ft)**.



9. Install turbine (47) in housing (35). Make sure hub (37) and disk (42) are in alignment.



10. Install race (48), retainer (33) and bearing (34) in turbine (47).

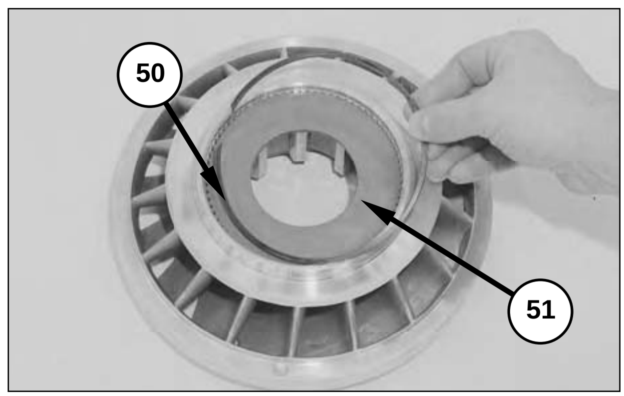


11. Heat the stator to a maximum temperature of **135° C (275° F)** for approximately four minutes, and lower the temperature of cam (30).

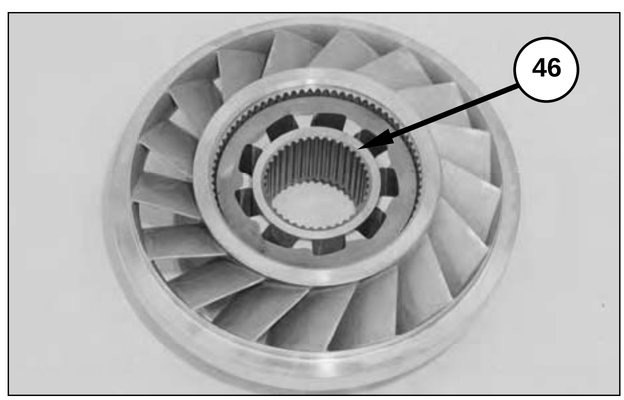
NOTE: Do not heat the stator with a torch.

NOTE: There is an identification on the cam that reads “impeller side.’’ Make sure that when the cam is installed in the retarder stator that the impeller side of cam will face the impeller in the housing.

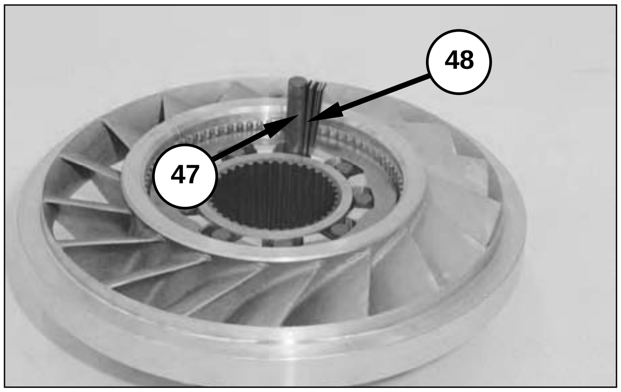
12. Install cam (30) in retarder stator (24).



13. Install race (32) and ring (31) on retarder stator (24).



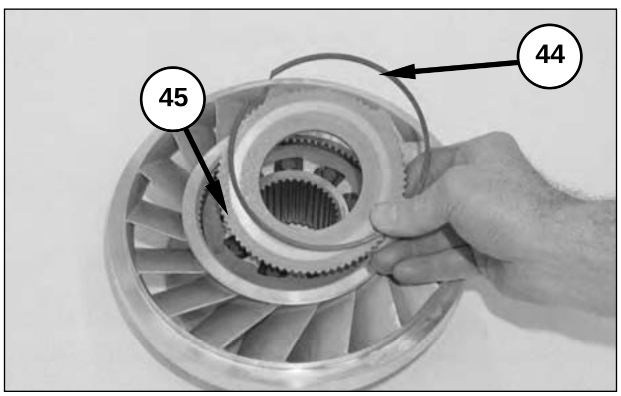
14. Install race (27) in retarder stator (24).



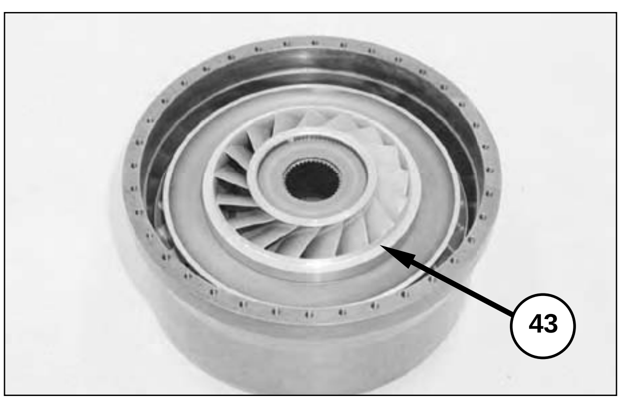
15. Install springs (29) and rollers (28) in cam (30), with the springs in the deeper part of each cam groove, as shown.

NOTE: The springs must be installed with the maximum number of loops toward the outside (cam side).

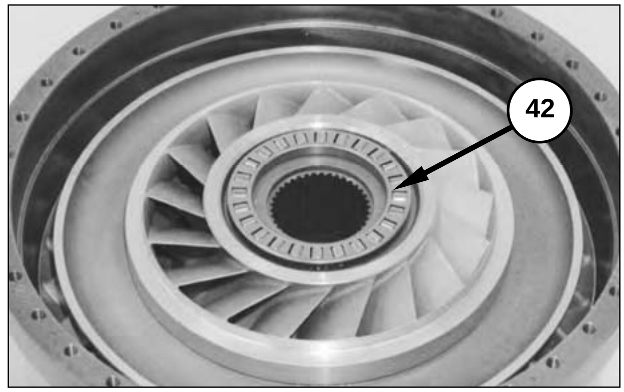
NOTE: After the springs and rollers are installed, the stator must turn freely in a counterclockwise direction, but not in a clockwise direction. If the stator does not turn counterclockwise, the springs and rollers have been installed incorrectly.



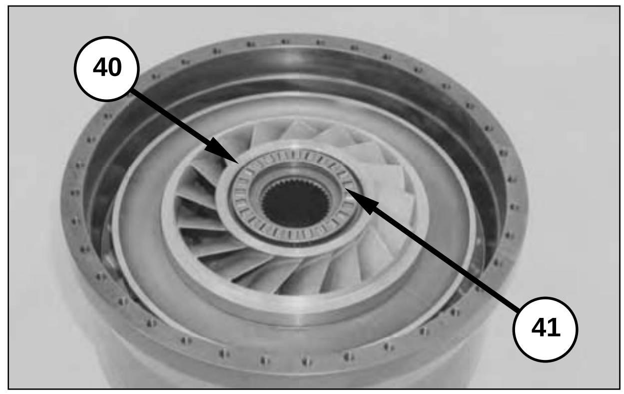
16. Install race (26) and ring (25) on retarder stator (24).



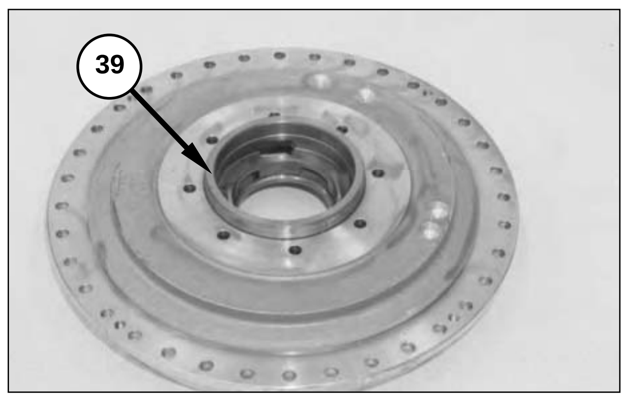
17. Install stator (24) on the turbine.



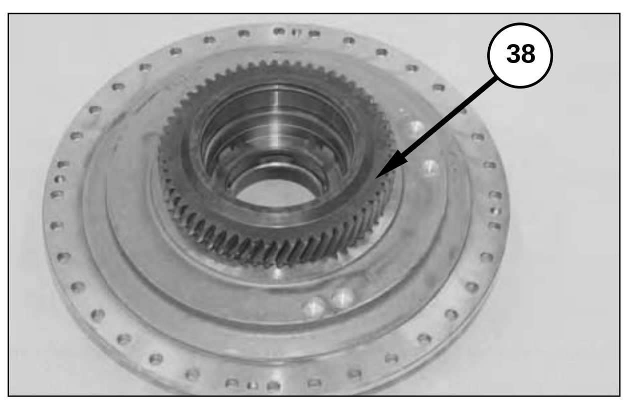
18. Install bearing (23) on retarder stator (24).



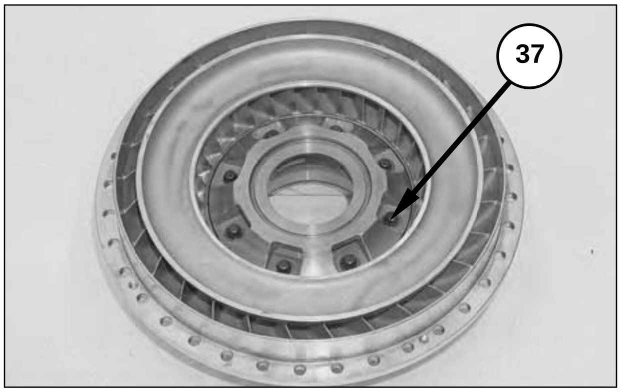
19. Install race (22) and retainer (21) on bearing (23).



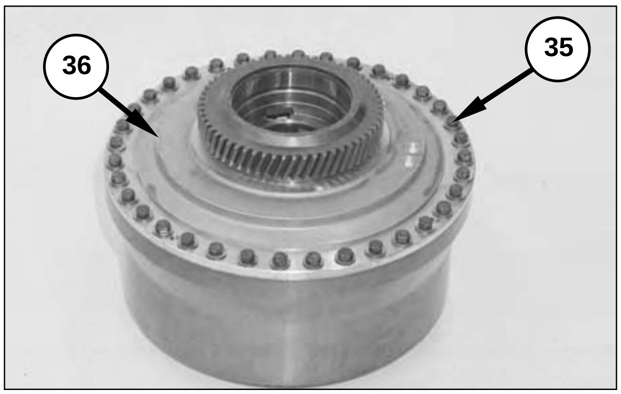
20. Install hub (20) on impeller (17).



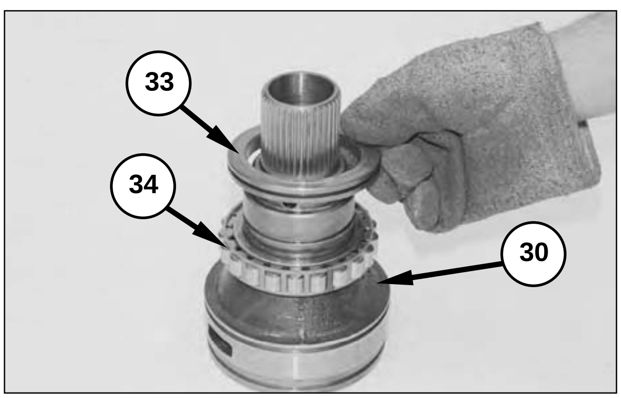
21. Install gear (19) on impeller (17).



22. Install bolts (18), which hold the hub and gear to the impeller. Tighten the bolts to a torque of **50 ± 7 N•m (37 ± 5 lb ft).**



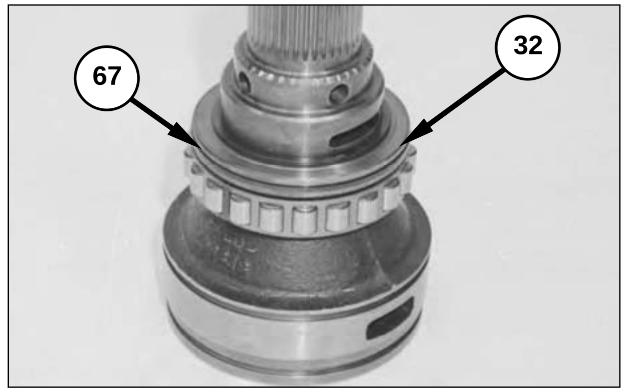
23. Install impeller (17) on housing (35), and install bolts (16). Tighten the bolts to a torque of **50 ± 7 N•m (37 ± 5 lb ft).**



24. Heat bearing (15) and carrier (14) to a maximum temperature of **149° C (300° F).**

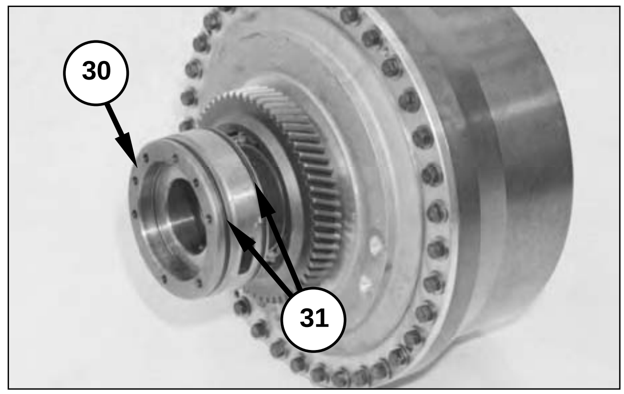
NOTE: Do not heat bearing (15) and carrier (14) with a torch.

25. Install bearing (15) and carrier (14) on carrier (11).



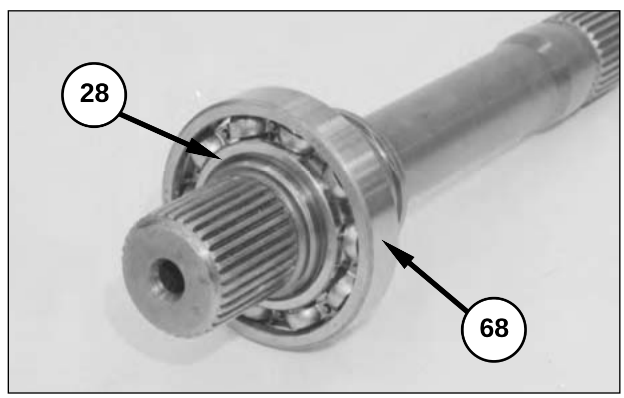
26. Install ring (13) on carrier (11).

27. Install ring (48) which holds bearing (15) and carrier (14) in place on carrier (11).

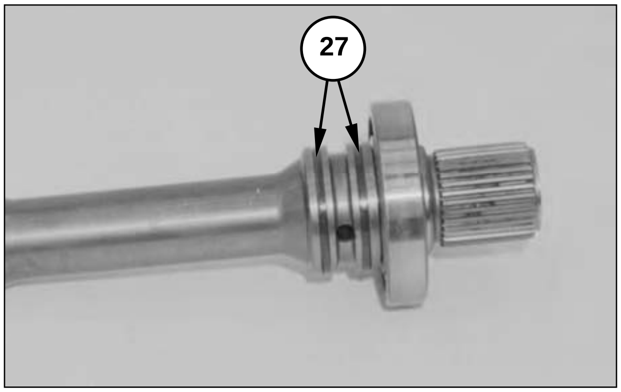


28. Install carrier (11) in the torque converter.

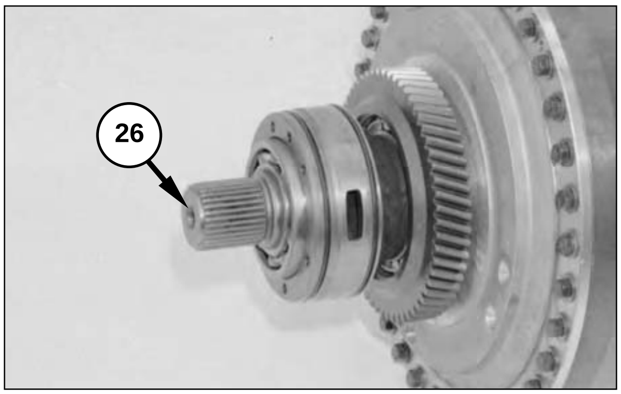
29. Install seals (12) on carrier (11).



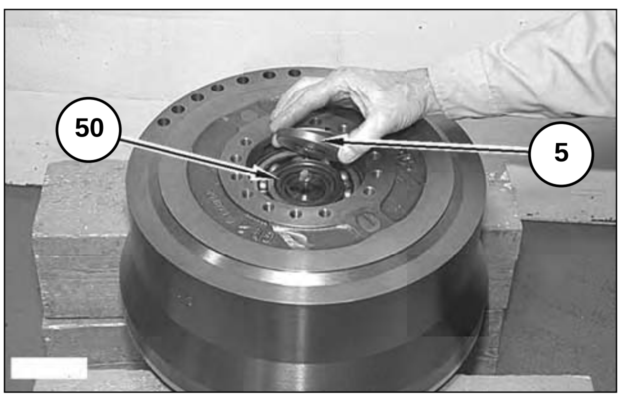
30. Install bearing (49) on shaft (7) and ring (9) that holds the bearing in place.



31. Install rings (8) on shaft (7).



32. Install shaft (7) in the torque converter.

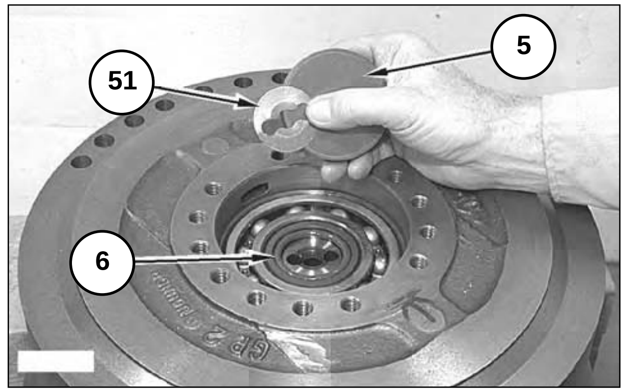


33. Put a small piece of lead (50) between the end of the shaft and retainer (5). Install the bolts and tighten them to a torque of **50 ± 7 N•m (37 ± 5 lb ft).**

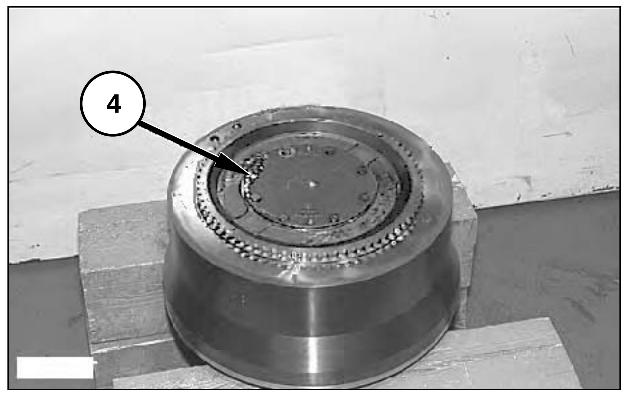
34. Remove the bolts and retainer (5).

35. Measure the thickness of lead (50) to find the distance between shaft (7) and retainer (5).

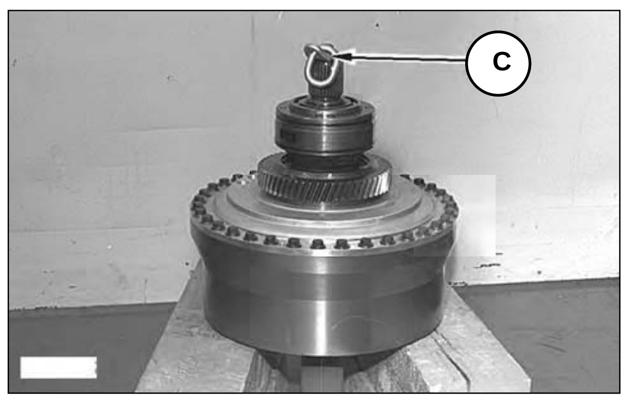
36. Use shims as necessary between shaft (7) and retainer (5) to give a shim thickness of **0.025 to 0.076 mm (0.0010 to 0.0030 in)** less than the measured gap.



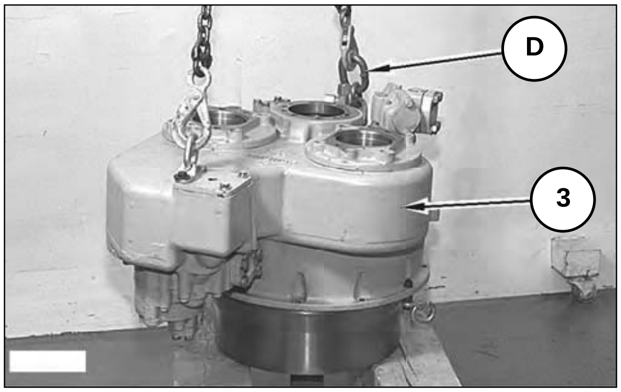
37. Install O-ring seal (6), shims (51) and retainer (5) on the end of shaft (7). Install the two bolts and tighten to a torque of **50 ± 7 N•m (37 ± 5 lb ft).**



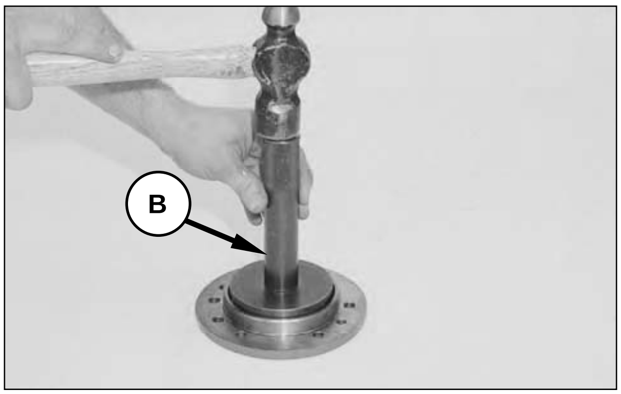
38. Install flange assembly (4), and tighten the bolts to a torque of **120 ± 15 N•m (90 ± 11 lb ft).**



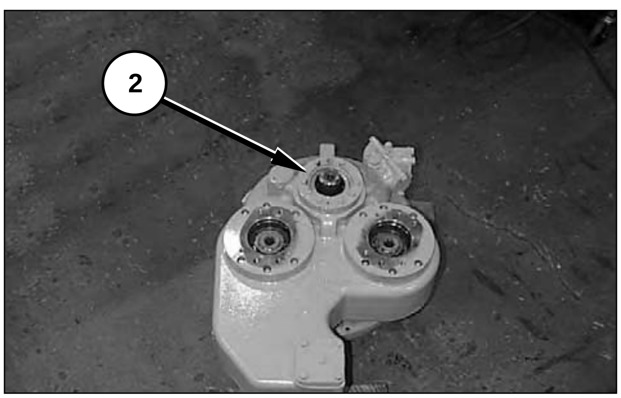
39. Install Tooling (C) and rotate **180 degrees**. Block the torque converter using a suitable lifting device. The weight of the torque converter is approximately **94 kg (207 lb).**



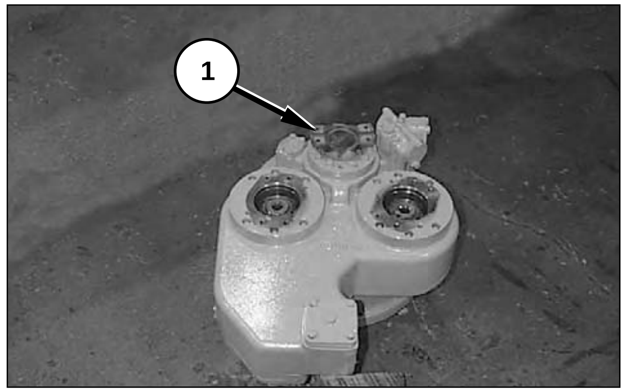
40. Using Tooling (C) and a suitable lifting device, install case (3) on the torque converter. The weight of the case is approximately **141 kg (310 lb).**



41. Use Tooling Group (B) to install the lip seal in the carrier.



42. Install seal carrier (2) and the gasket, and tighten the bolts to a torque of **50 ± 7 N•m (37 ± 5 lb ft).**



43. Install yoke assembly (1).

End By:

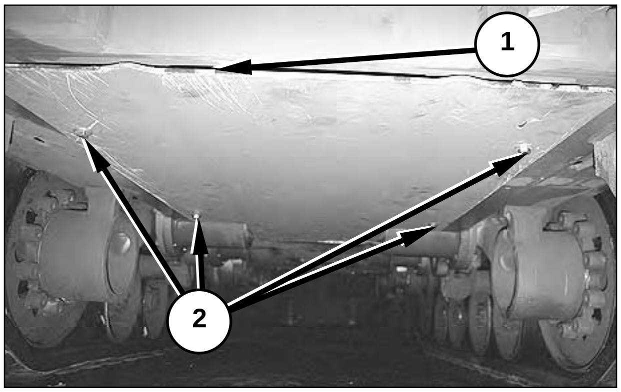
a. Install the torque converter.

Torque Converter Lockup Control Valve

Tools Needed		A
FT-0745	Modified Pliers	1

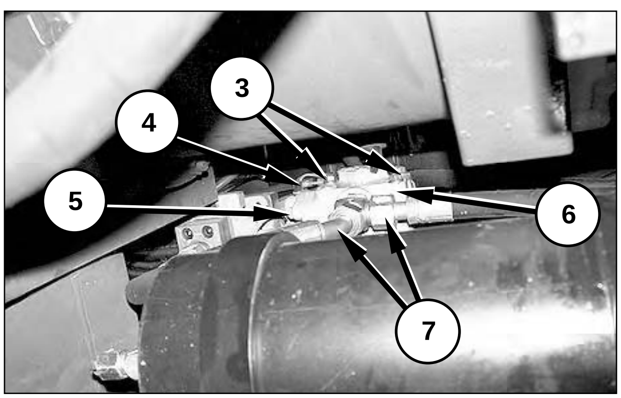
Remove and Install

NOTE: The group number related to this procedure is 126-6628.



1. Remove four bolts (2) with washers, and bottom cover (1). The weight of the cover is **50.5 kg (111 lb).**

NOTE: If dirt or other debris has accumulated on the top side, the bottom cover may weigh more than **50.5 kg (111 lb)**. Use a suitable floor jack, or other tool, to support the bottom cover if there is a large amount of debris.



2. Disconnect, cap and plug two lines (7).

3. Disconnect connecter (4) on solenoid (5).

4. Remove three bolts (3) with washers, and torque converter lockup clutch valve group (6).

NOTE: Only two of three bolts (3) are visible in the photograph.

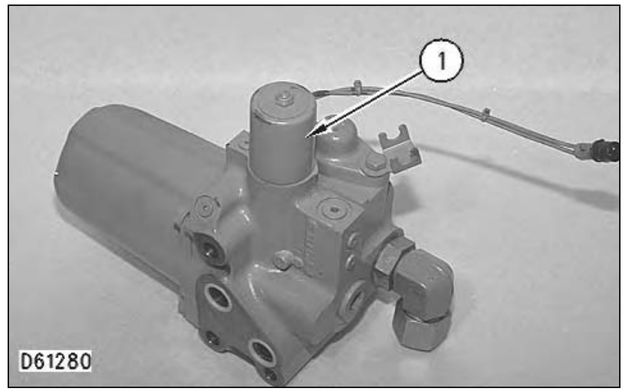
NOTE: To install the torque converter lockup control valve, reverse the removal steps.

Disassemble and Assemble

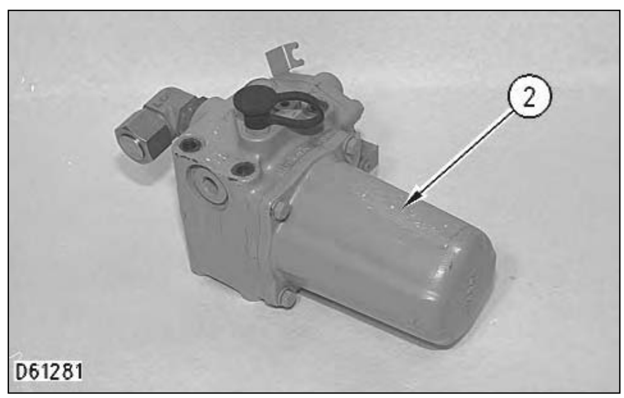
Start By:

a. Remove the torque converter lockup control valve.

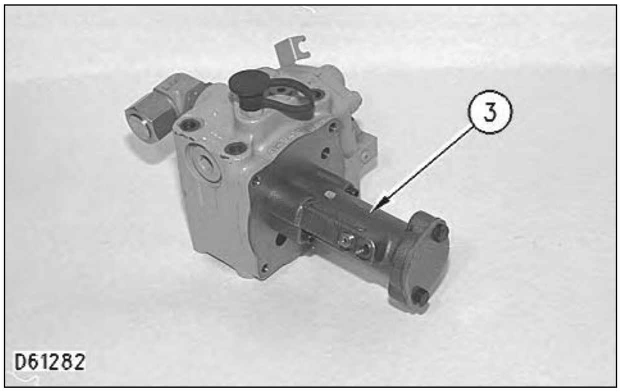
NOTE: Group numbers related to this procedure include 6I-9514, 126-6628, and 144-6292.



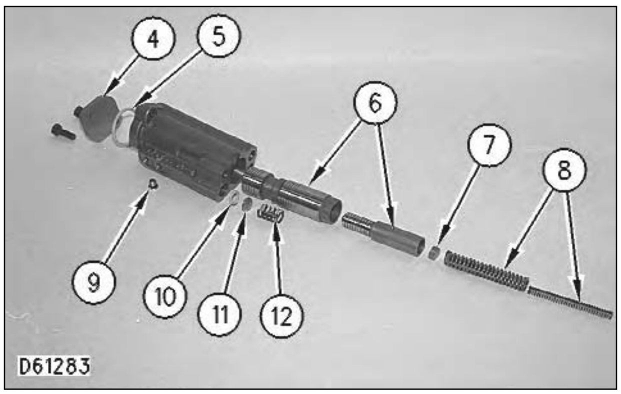
1. Remove coil (1) and the cartridge assembly (not shown) from the valve body. Check the O-rings for wear or damage, and replace if necessary. Upon reassembly, tighten the coil nut to a torque of **9 ± 0.5 N•m (6.7 ± 0.4 lb ft)**. Upon reassembly, install the cartridge assembly to a torque of **80 ± 5 N•m (59.2 ± 3.7 lb ft)**.



2. Remove the four bolts and washers, and remove cover (2) from the valve body. Remove the valve body. Remove the O-ring seal from the cover. Upon reassembly, tighten the four bolts to a torque of 30 ± 7 N•m (23 ± 5 lb ft).



3. Remove body (3) from the valve body.



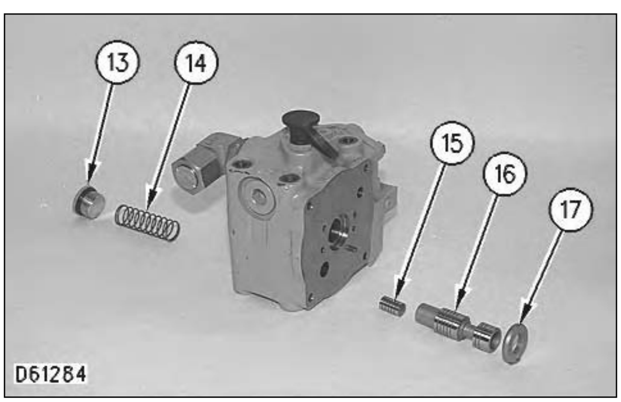
4. Disassemble body (3) as follows:

a. Remove spring (12), orifice (11) and O-ring seal (10) from the body.

b. Remove inner and outer springs (8), shims (7) and inner and outer pistons (6) from the body.

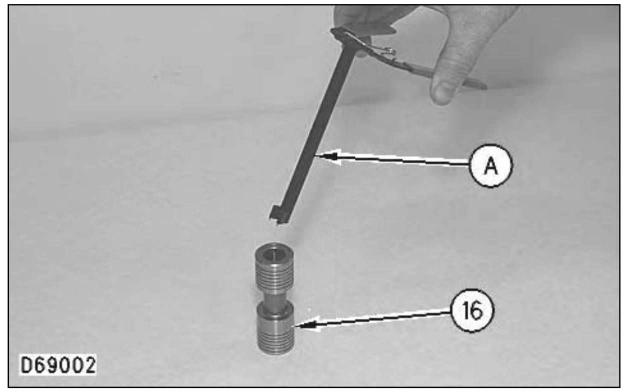
c. Remove plug (9) and the O-ring seal from the body.

d. Remove the bolts, and remove cover (4) and O-ring seal (5) from the body.

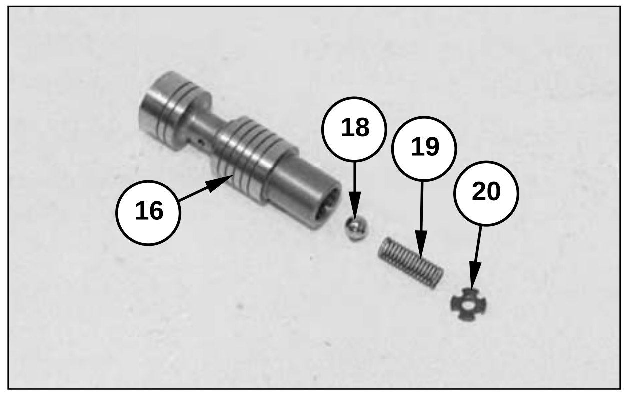


5. Remove spool (16) and stop (17) from the valve body. Remove slug (15) from the spool.

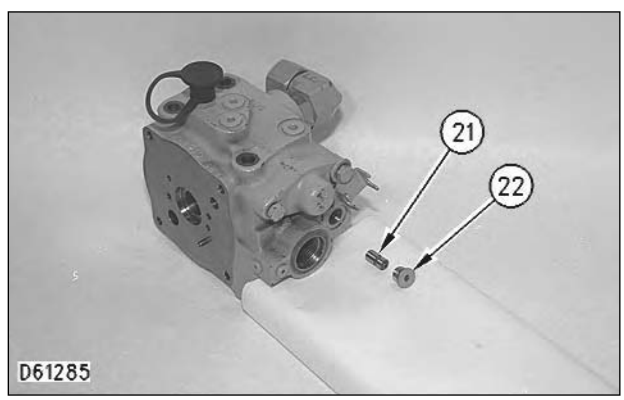
6. Remove plug (13) and spring (14) from the valve body.



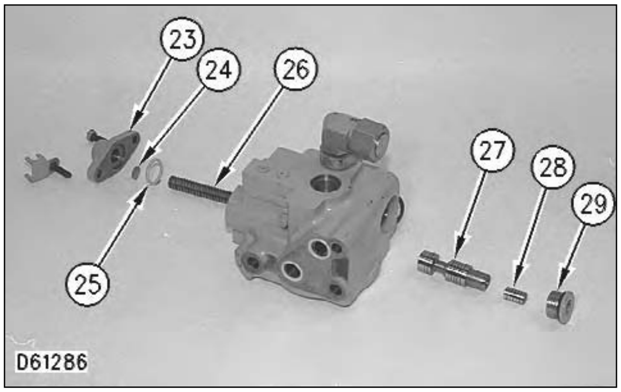
7. Use Tooling (A) to remove the snap ring from spool (16).



8. Remove retainer (20), spring (19) and ball (18) from spool (16).

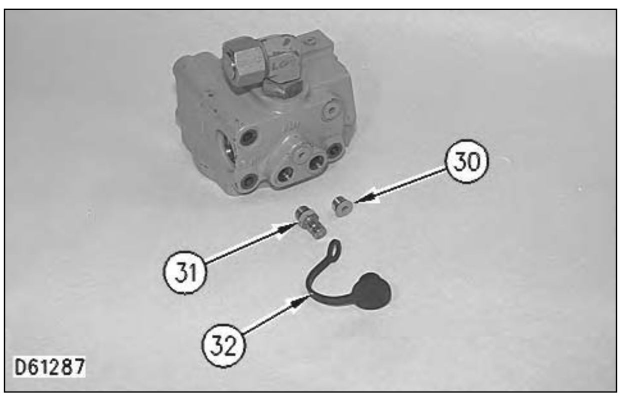


9. Remove plug (22) and valve (21) from the valve body.



10. Remove the bolts, and remove cover (23) and spring (26) from the valve body. Remove O-ring seal (25) and shims (24) from cover (23). Upon reassembly, tighten the bolts on the cover to a torque of **30 ± 7 N•m (22 ± 5 lb ft).**

11. Remove plug (29) and spool (27) from the valve body. Remove slug (28) from the spool. If necessary, repeat Steps 7 and 8 to disassemble the spool.



12. Remove nipple assembly (31) and dust cap (32) from the valve body. As necessary, remove other plugs (30) and replace the seals.

NOTE: Assemble the lockup clutch valve in the reverse order.

NOTE: Clean all parts thoroughly. Put a thin coat of clean oil on them before assembly.

End By:

a. Install the torque converter lockup control valve.

Transmission Hydraulic Control Valve

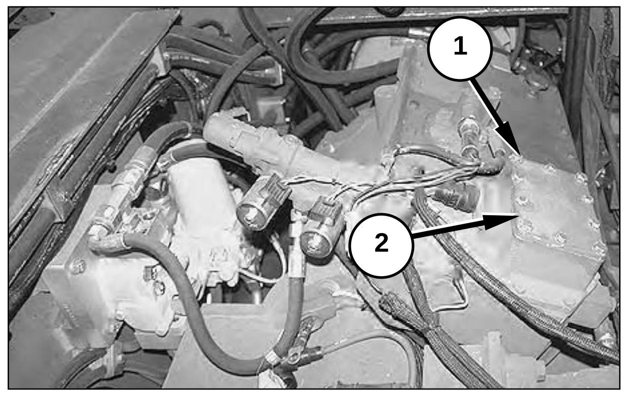
Remove and Install

Tools Needed	
138-7575 Link Bracket	2

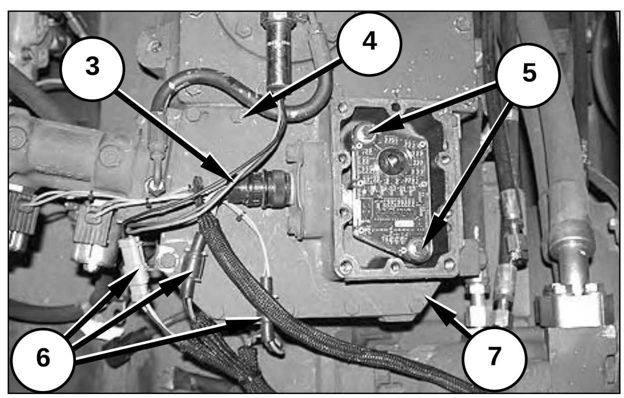
Start By:

a. Remove the fuel tank.

NOTE: Group numbers related to this procedure include 6I-9234, 9U-9491, and 137-4919.



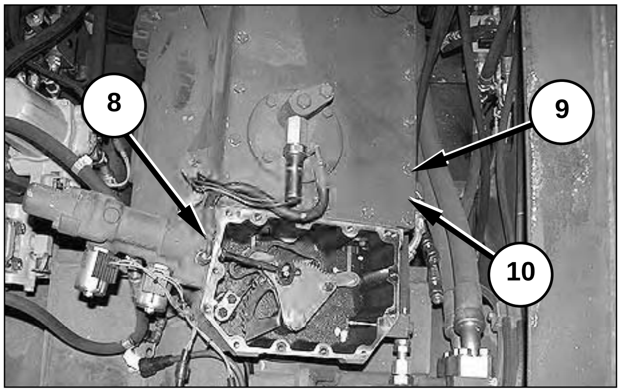
1. Remove 10 bolts (1) and cover (2) with the gasket. Replace the gasket if there is damage.



2. Disconnect connector C332 (3) and connectors C342, C312, and C322 (6). Mark the connectors for correct connection during reassembly.

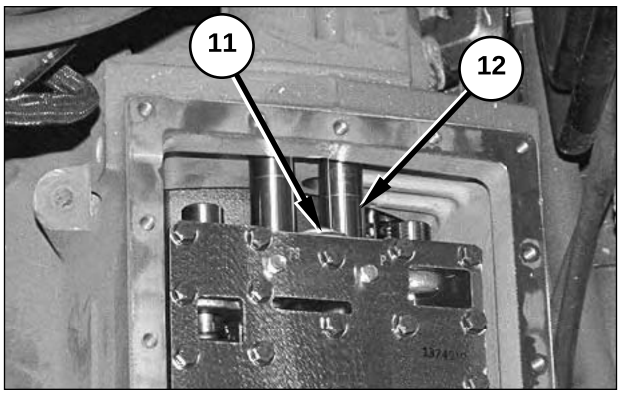
3. Remove two bolts (5) and the transmission gear switch.

4. Remove eight bolts (4) with washers, and cover (7) with gasket. Replace the gasket if there is wear or damage.

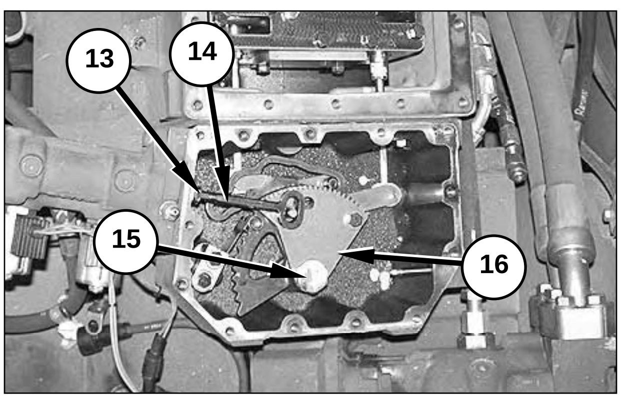


5. Disconnect, cap and plug pilot line (8).

6. Remove 18 bolts (9) and cover assembly (10) with the gasket. Replace the gasket if there is wear or damage.

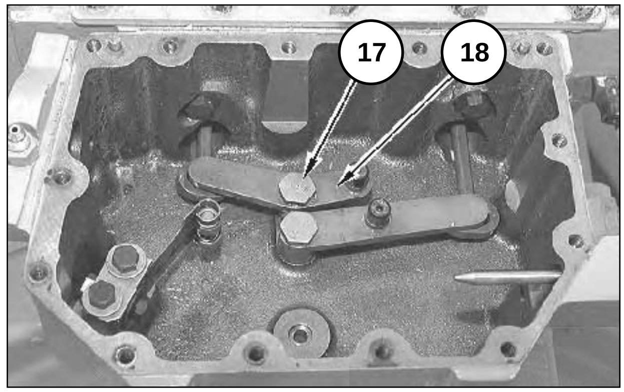


7. Remove bolt (11) with the retainer. Carefully slide two sleeves (12) away from the hydraulic control valve.

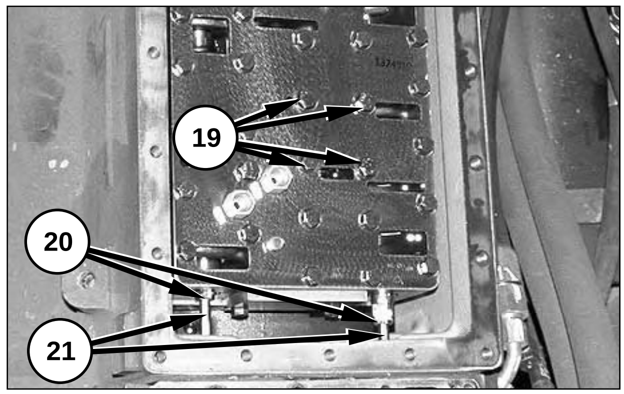


8. Loosen lock nut (13) and remove rod (14).

9. Remove the nut (not shown) on the other end of cam pin (15), and remove the cam pin. Remove sector and cam (16).

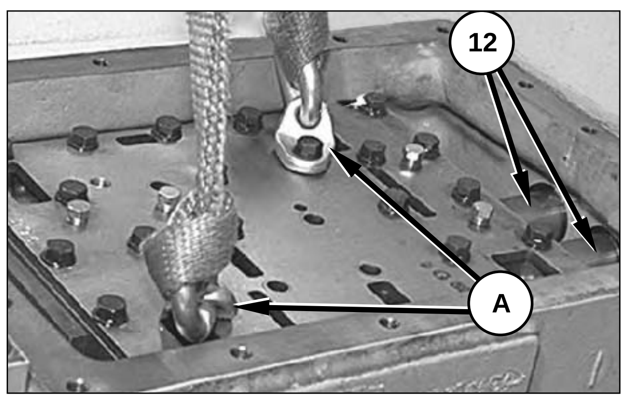


10. Remove the nuts from the bottom of two cam pins (17), and remove two levers (18).



11. Loosen two lock nuts (20), and remove two rods (21).

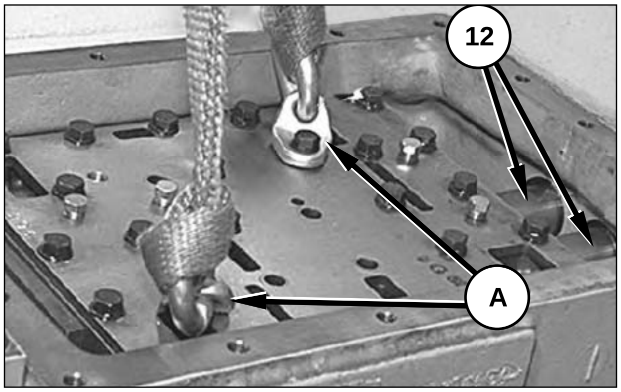
12. Remove four bolts (19), which retain the hydraulic control valve.



13. Install Tooling (A) to remove the hydraulic control valve. The weight of the hydraulic control valve is **39 kg (86 lb)**.

14. Remove two sleeves (12) with O-ring seals. Replace the O-ring seals if they are damaged or worn.

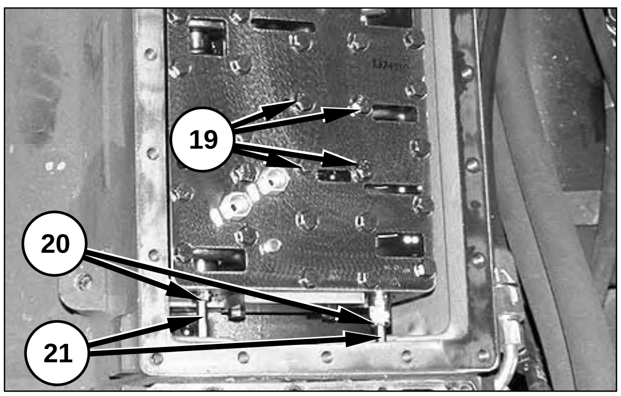
NOTE: The following steps are for installation of the transmission control valve.



15. Install two sleeves (12) with the O-ring seals in place in the transmission housing, and install bolt (11) with the retainer.

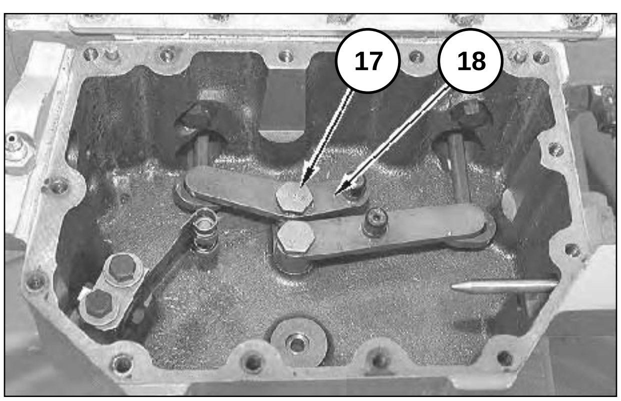
NOTE: Refer to Step 7 for the location of bolt (11).

16. Use Tooling (A) and a hoist to place the hydraulic control valve in the transmission housing.

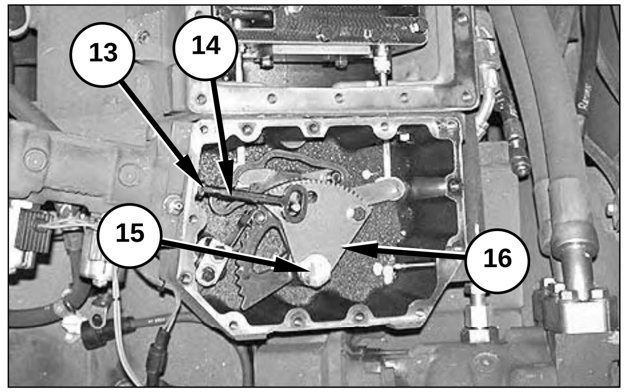


17. Install two rods (21). Do not tighten lock nuts (20) at this time.

18. Install four bolts (19). Do not fully tighten four bolts (19) at this time.

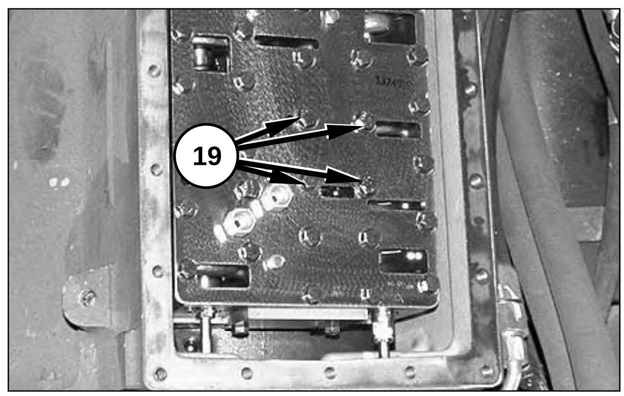


19. Install two levers (18) with two cam pins (17) and nuts.

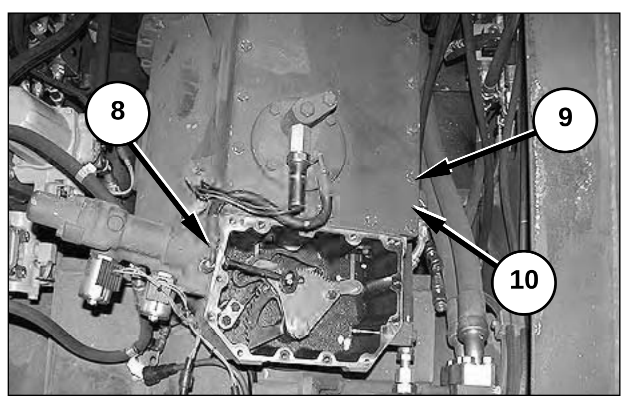


20. Install cam and sector (16) with cam pin (15) and nut, and install rod (14) and lock nut (13).

21. Perform Steps 1 through 11 of the shift linkage adjustment procedure. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Transmission and Torque Converter,* "Testing and Adjusting," "Transmission Shift Control Linkage Adjustment."

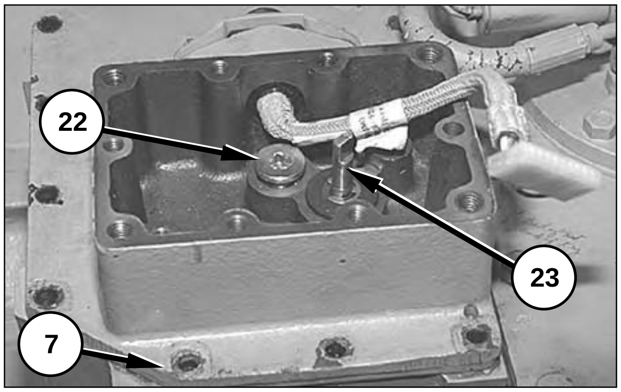


22. Tighten four bolts (19) to a torque of **48 ± 4 N•m (35 ± 3 lb ft)**.



23. Install cover assembly (10) with the gasket and 18 bolts (9).

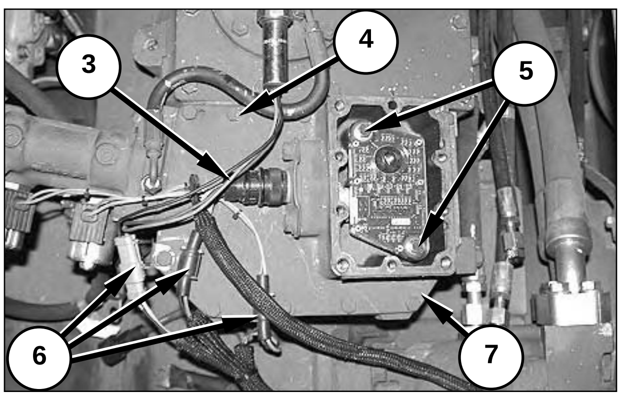
24. Connect pilot line (8).



25. Remove plug (22) from cover (7).

26. While installing cover (7) with the gasket, look through the hole for plug (22) and rotate shaft (23) to align the “V” stamped on sector and cam (16) (not shown) with the tooth space between the adjacent teeth marked with a “V” on the drive gear. Do not install bolts (4) for cover (7) at this time.

27. Install plug (22).

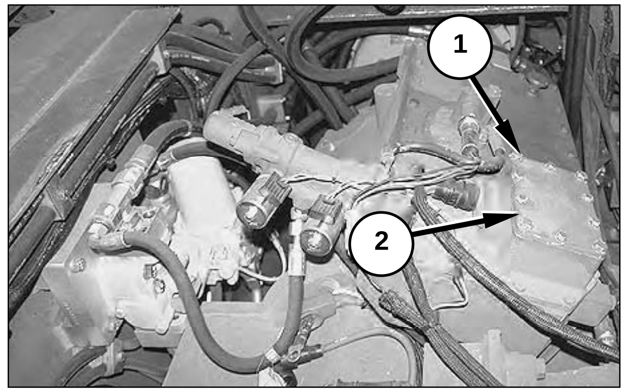


28. Install the present gear switch with two bolts (5). Tighten the bolts to a torque of **12 ± 4 N•m (8 ± 2 lb ft).**

29. Install eight bolts (4).

30. Connect connector C332 (3) and connectors C342, C312, and C322 (6).

NOTE: When connector C332 (3) is reconnected to the transmission gear switch, install lock wire. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Transmission and Torque Converter,* “Testing and Adjusting, Transmission Hydraulic System, Installation of Lock Wire on Transmission Gear Switch and Transmission Speed Sensor Connectors.”



31. Install cover (2) with the gasket and 10 bolts (1).

End By:

a. Install the fuel tank.

TM5-2430-200-24

Specifications
Systems Operation
Testing & Adjusting

Deployable Universal Combat Earthmover (DEUCE)

Implement & Fan Hydraulic System

PIN: 7RR00003-Up

Important Safety Information

Most accidents involving product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “WARNING” as shown below.

The meaning of this safety alert symbol is as follows:

⚠ WARNING

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning, explaining the hazard, can be either written or pictorially presented.

Operations that may cause product damage are identified by NOTICE labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are therefore not all inclusive. If a tool, procedure, work method or operating technique not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and others. You should also ensure that the product will not be damaged or made unsafe by the operation, lubrication, maintenance or repair procedures you choose.

The information, specifications, and illustrations in this publication are on the basis of information available at the time it was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service given to the product. Obtain the complete and most current information before starting any job. Caterpillar dealers have the most current information available. For a list of the most current publication form numbers available, see the Service Manual Contents Microfiche, REG1139F.

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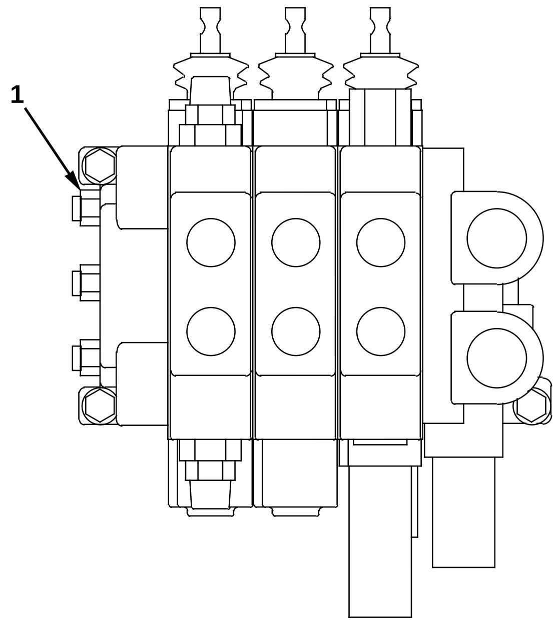
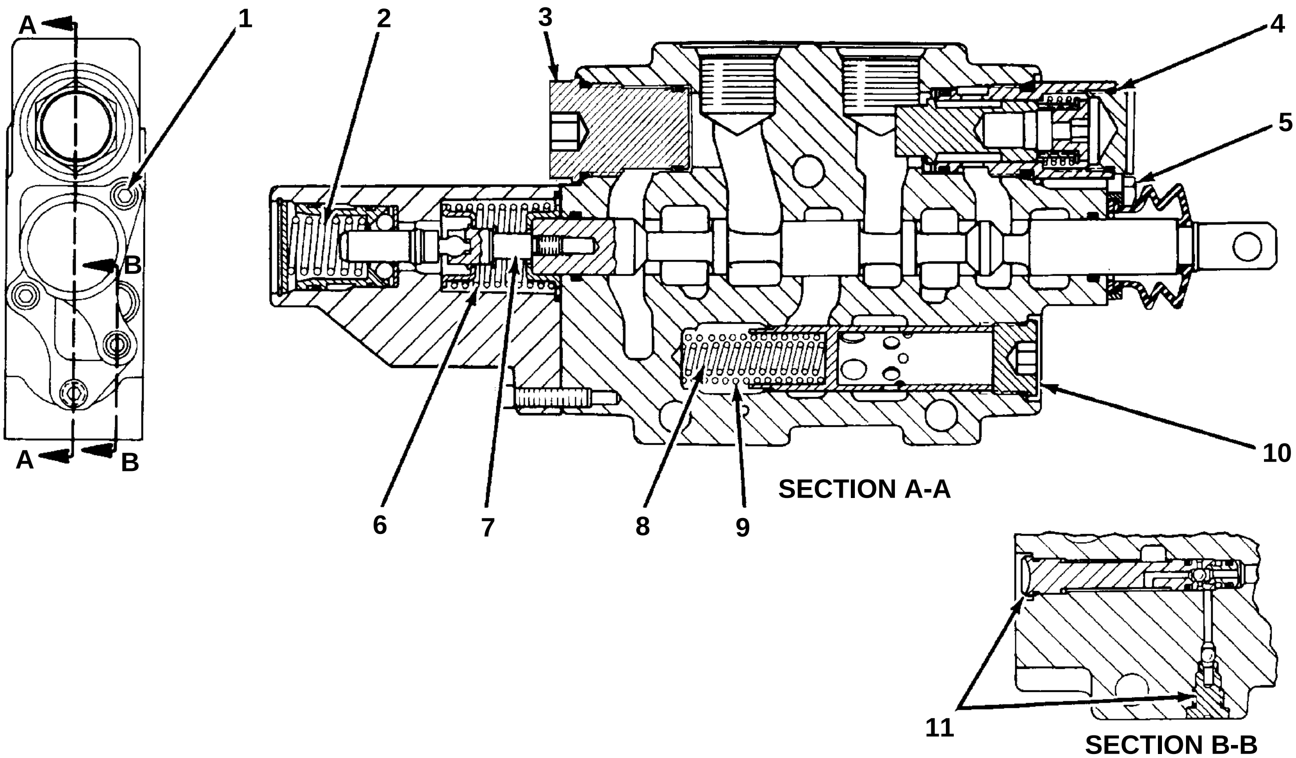
Blade Control Valve



(1) Tighten three nuts to a torque of .....25.5 ± 1.4 N•m
....(20 ± 4 lb ft)

Blade Lift Control Valve



(1) Tighten three socket head cap screws to a torque of ....11 ± 2.8 N•m (8 ± 2 lb ft)

(2) 9T-0822 Spring:
Free length after test .... 43.4 mm (1.71 in)
Outside diameter..........................19.3 mm (0.76 in)

(3) Tighten plug to a torque of................... 27 ± 3 N•m ....(20 ± 2 lb ft)

(4) Installation torque for makeup valve ......27 ± 3 N•m ....(20 ± 2 lb ft)

(5) Tighten two bolts to a torque of ....5.5 ± 1.5 N•m ....(49 ± 13 lb in)

(6) 4T-4513 Spring:
Free length after test ....63.5 mm (2.5 in)
Inside diameter.............................22.9 mm (0.90 in)

(7) Coupling to spool installation torque ....6.8 ± 1.4 N•m (5 ± 1 lb ft)

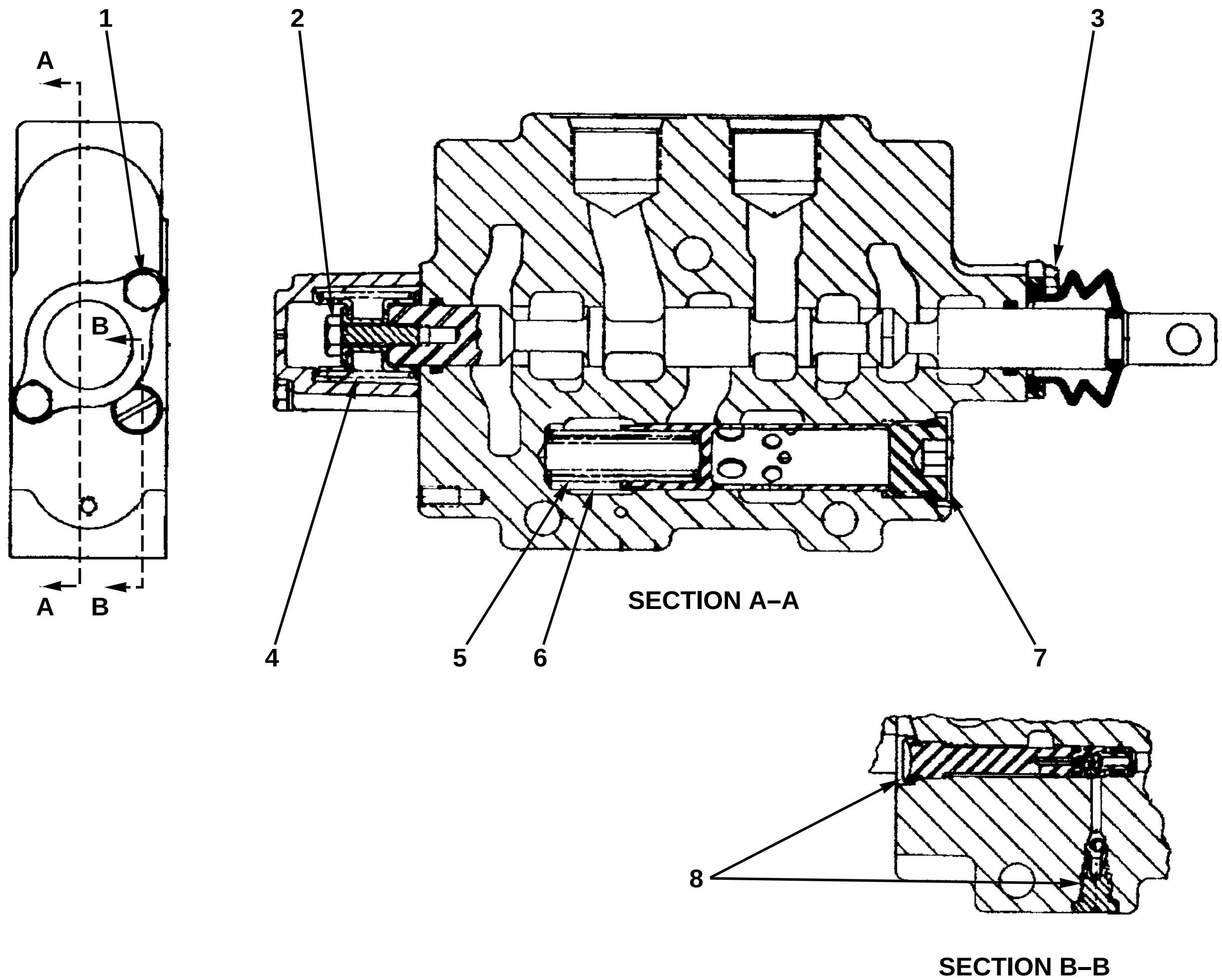
(8) 4T-7810 Spring:
Free length after test ....50.8 mm (2.00 in)
Outside diameter..........................11.7 mm (0.46 in)

(9) 4T-4534 Spring:
Free length after test ....60.96 mm (2.400 in)
Outside diameter......................16.02 mm (0.630 in)

(10) Tighten plug to a torque of....................27 ± 3 N•m ....(20 ± 2 lb ft)

(11) Installation torque for valve and seat ...12 ± 1 N•m ....(8.9 ± .7 lb ft)

Blade Tilt Control Valve



(1) Tighten two bolts to a torque of ....11 ± 2.8 N•m ....(8 ± 2 lb ft)

(2) Tighten bolt to a torque of..................11 ± 2.8 N•m ....(8 ± 2 lb ft)

(3) Tighten two bolts to a torque of ....5.5 ±1.5 N•m ....(49 ± 13 lb in)

(4) 9T-0874 Spring:
Free length after test ....64.30 mm (2.531 in)
Inside diameter...........................23.4 mm (0.921 in)

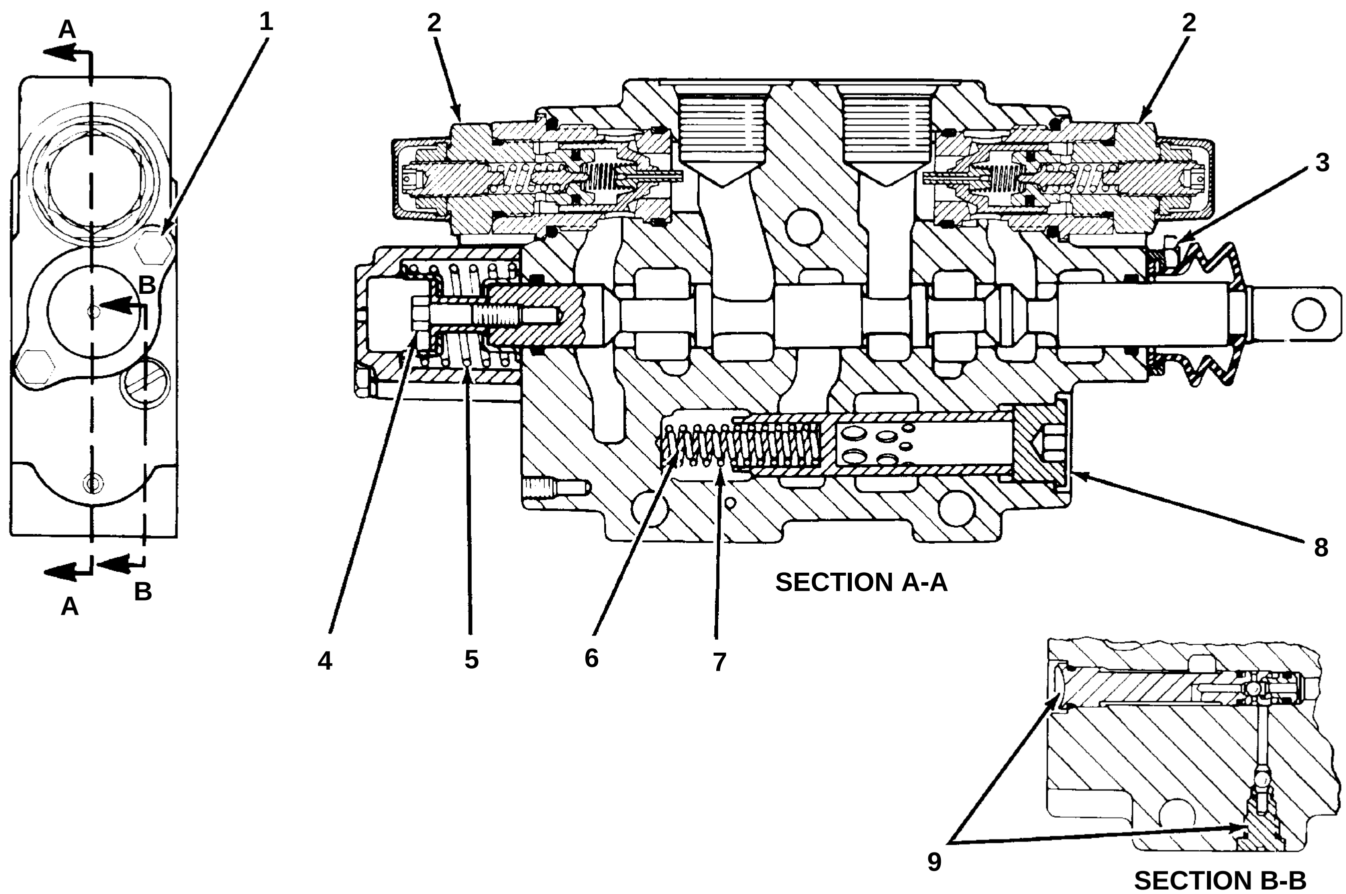
(5) 4T-7810 Spring:
Free length after test ....50 .8 mm (2.00 in)
Outside diameter..........................11.7 mm (0.46 in)

(6) 4T-4534 Spring:
Free length after test ....60.96 mm (2.400 in)
Outside diameter......................16.02 mm (0.630 in)

(7) Tighten plug to a torque of....................27 ± 3 N•m ....20 ± 2 lb ft)

(8) Installation torque for valve and seat .....12 ± 1 N•m ....(8.9 ± .7 lb ft)

Blade Angle Control Valve



(1) Tighten two bolts to a torque of ....11 ± 2.8 N•m ....(8 ± 2 lb ft)

(2) 6E-0772 Relief Valve:
Installation torque ....27 ± 3 N•m (20 ± 2 lb ft)

(3) Tighten two bolts to a torque of ....5.5 ± 1.5 N•m ....(49 ± 13 lb in)

(4) Tighten spacer bolt to a torque of ......11 ± 2.8 N•m ....(8 ± 2 lb ft)

(5) 9T-0874 Spring:
Free length after test ....64.3 mm (2.531 in)
Inside diameter...........................23.4 mm (0.921 in)

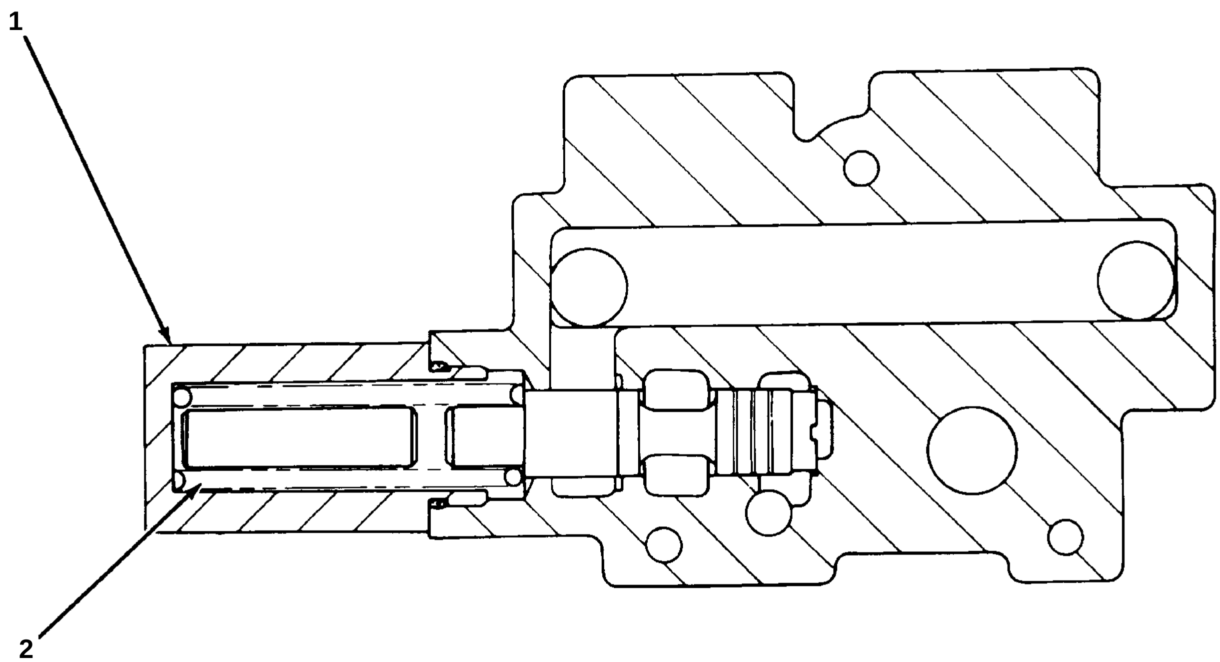
(6) 4T-7810 Spring:
Free length after test ....50.8 mm (2.00 in)
Outside diameter..........................11.7 mm (0.46 in)

(7) 4T-4534 Spring:
Free length after test ....60.96 mm (2.4 00 in)
Outside diameter......................16.02 mm (0.630 in)

(8) Tighten plug to a torque of....................27 ± 3 N•m ....(20 ± 2 lb ft)

(9) Installation torque for valve and seat .....12 ± 1 N•m ....(8.9 ± .7 lb ft)

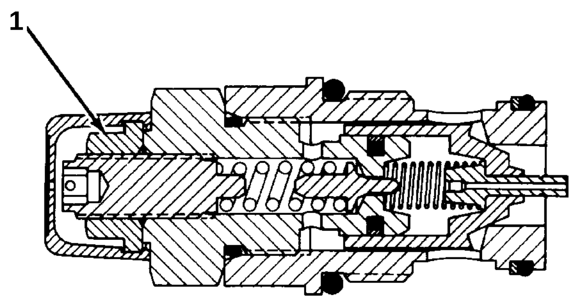
Inlet Manifold



(1) Installation torque for relief valve housing ....70 ± 7 N•m (52 ± 5 lb ft)

(2) 9T-6694 Spring:
Length under test force ....76.86 mm (3.026 in)
Test force...........................186 ± 15 N (42 ± 3.4 lb)
Free length after test ....88.90 mm (3.500 in)
Outside diameter......................19.89 mm (0.783 in)

Line Relief and Makeup Valve (Angle)



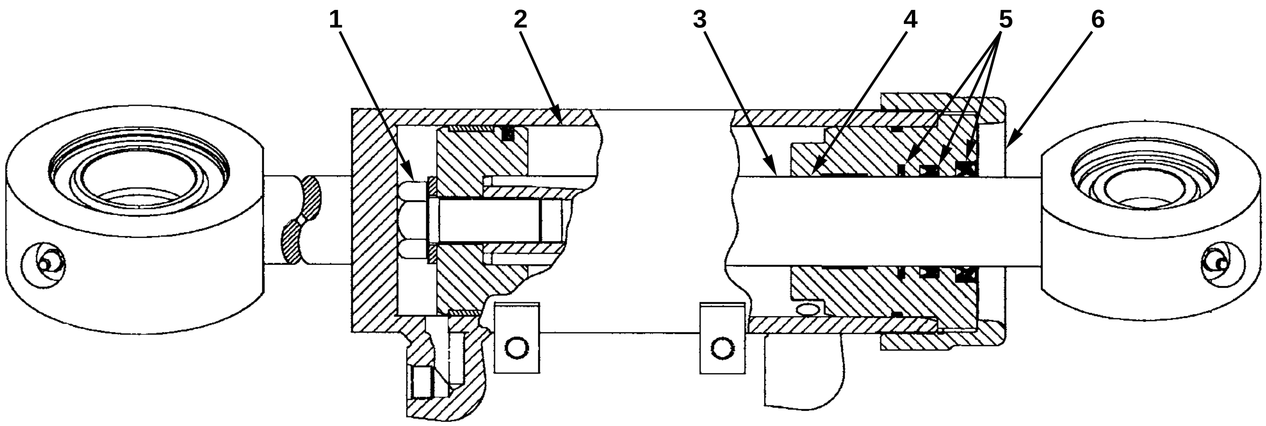
Pressure setting.........34 460 ± 350 kPa (5000 ± 51 psi)
At a flow of ..2 ± 0.5 liter/min (0.5 ±.0.13 U.S. gpm)

Installation torque.....................27 ± 3 N•m (20 ± 2 lb ft)

(1) Tighten lock nut to a torque of ....20 ± 3 N•m ....(15 ± 2 lb ft)

Blade Cylinders

Tilt Cylinder



(1) Lubricate threads and tighten to a torque of ....1125 ± 100 N•m (832 ± 74 lb ft)

(2) Bore of new cylinder ....107.95 +0.13/-0.05 mm ....(4.25 0.005/-.002 in)

(3) Diameter of new rod (after plating) ....50.750 ± 0.039 mm (1.9980 ± 0.0015 in)

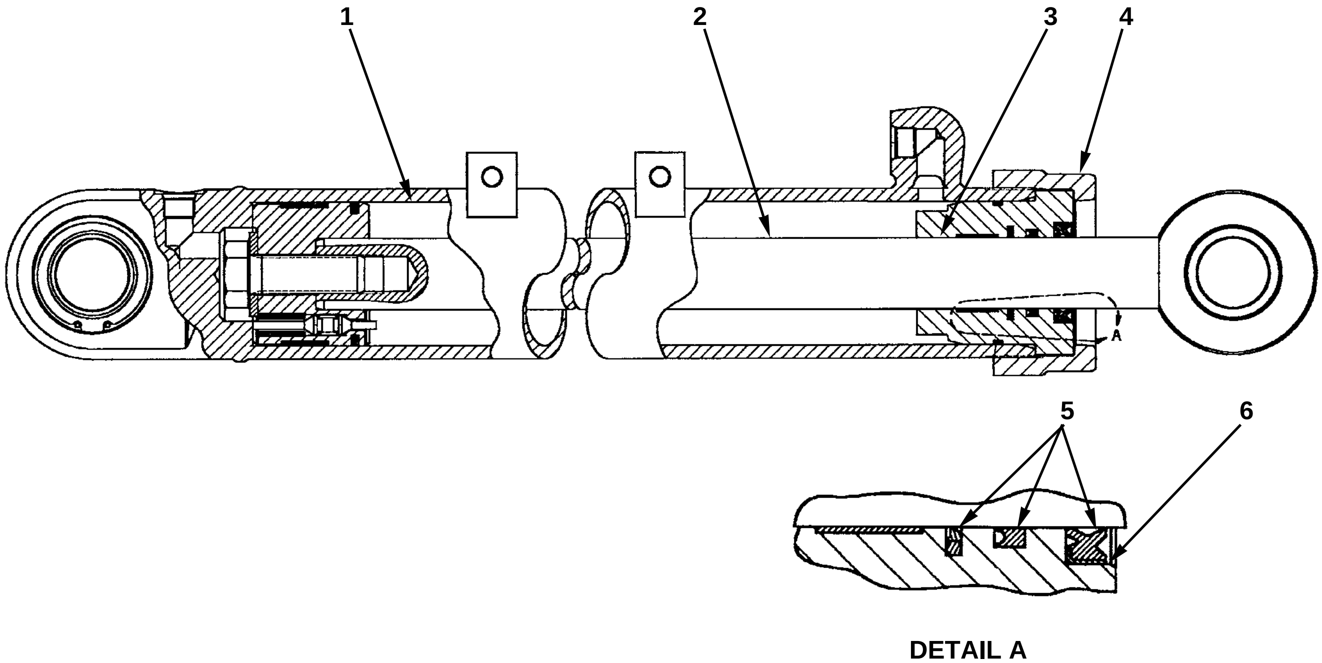
Thickness of chrome plating ....0.020 +0.100/-0.006 mm ....(0.0008 +0.004/-0.0002 in)

(4) Bore of new head.........................51.08 ± 0.03 mm ....(2.0110 ± 0.0012 in)

(5) Coat sealing lips with lubricant that is to be sealed.

(6) Lubricate threads with clean grease and tighten to a torque of ....600 ± 130 N•m (444 ± 96 lb ft)

Angle Cylinder



(1) Bore of new cylinder ....88.90 +0.13/-0.05 mm ....(3.5 +0.005/-.002 in)

(2) Diameter of new rod (after plating) ....44.400 ± 0.038 mm (1.748 ±0.0015 in)

Thickness of chrome plating ....0.020 +0.100/-0.006 mm ....(0.0008 +.004/-0.0002 in)

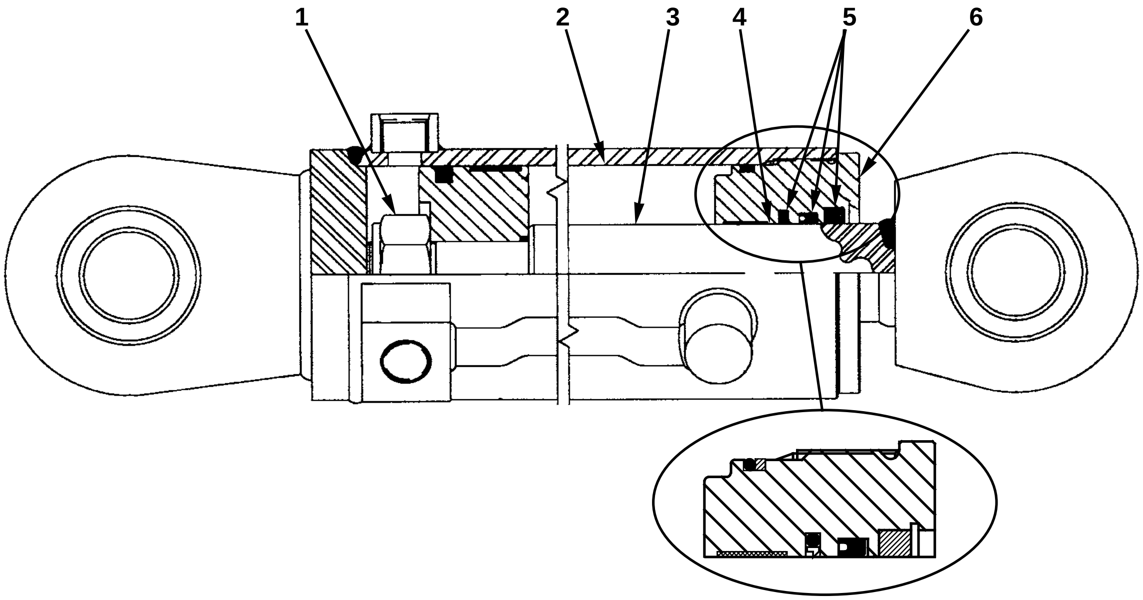
(3) Bore of new head.........................44.73 ± 0.03 mm ....(1.7610 ± 0.0012 in)

(4) Apply clean grease to threads and tighten to a torque of ....600 ± 130 N•m (450 ± 100 lb ft)

(5) Coat sealing lips with lubricant that is to be sealed.

(6) Apply 4C-4032 Sealant to wiper seal groove prior to installation of wiper seal.

Lift Cylinder



(1) Tighten nut to a torque of..................800 ± 27 N•m
....(590 ± 20 lb ft)

(2) Bore of new cylinder ....127.00 mm (5.000 in)

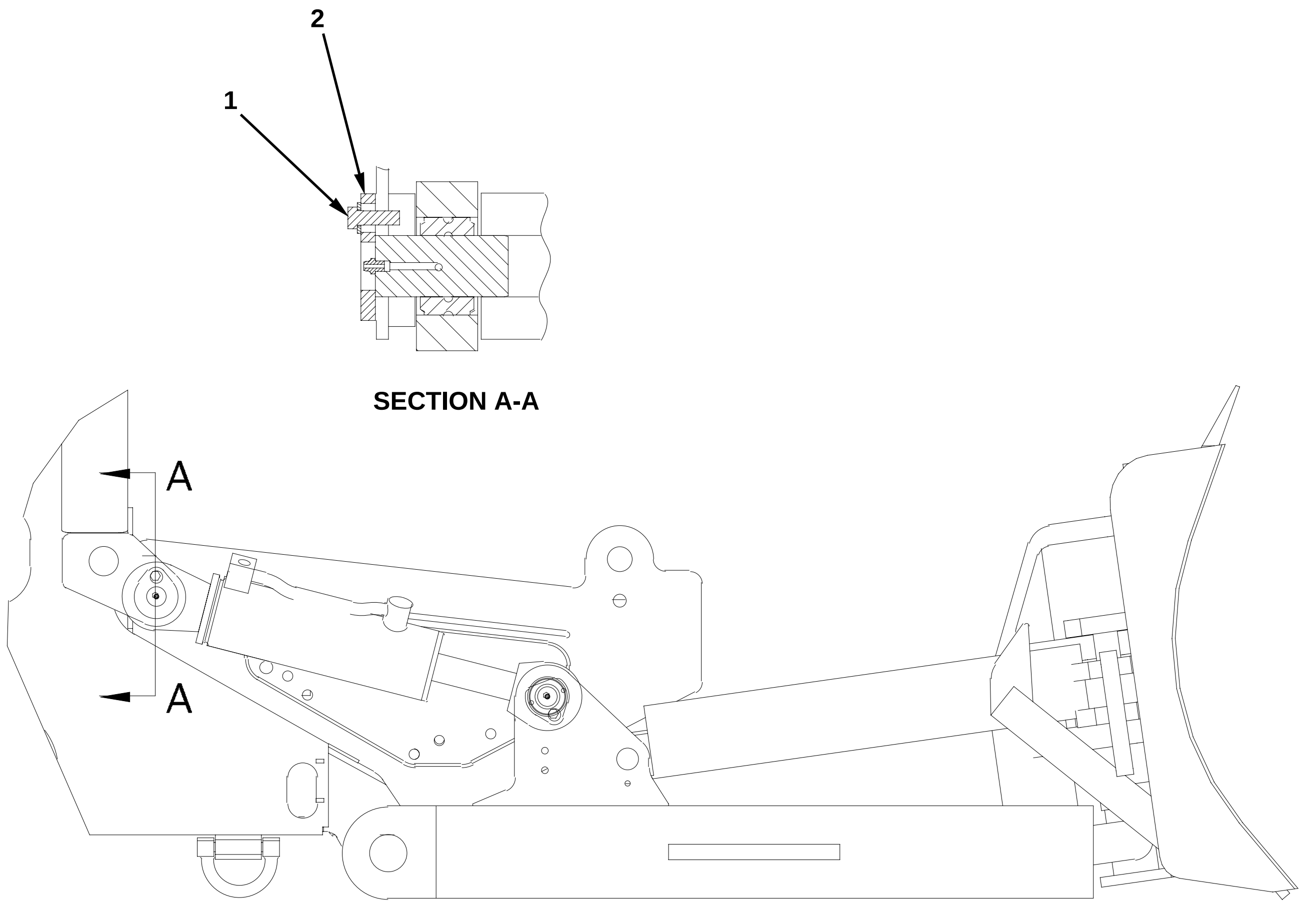
(3) Diameter of new rod.................57.15 mm (2.250 in)

(4) Bore of new head.....................57.48 mm (2.263 in)

(5) Coat sealing lips with lubricant that is to be sealed.

(6) Tighten to a torque of........................508 ± 20 N•m
....(375 ± 15 lb ft)

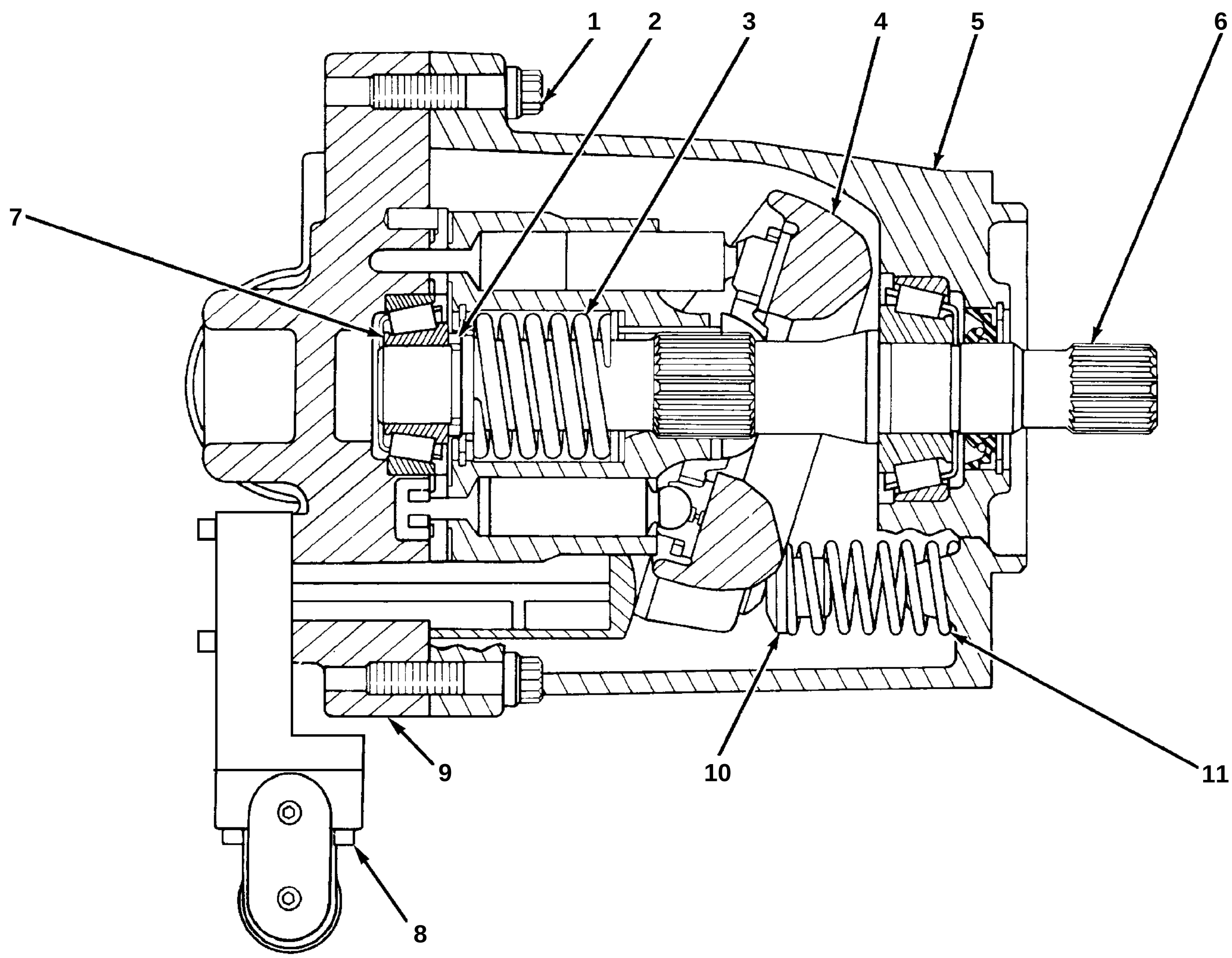
Lift Cylinder Mounting Group



(1) Apply 4C-4030 sealant to threads at assembly.

(2) Coat pin assembly with 5P-0960 Multipurpose Lubricant before assembly.

Implement Hydraulic Pump



Rotation is clockwise when seen from shaft end.

Type of pump: Variable piston.

For test, use SAE 10W oil at 65°C (150°F)

Test at Full Speed:

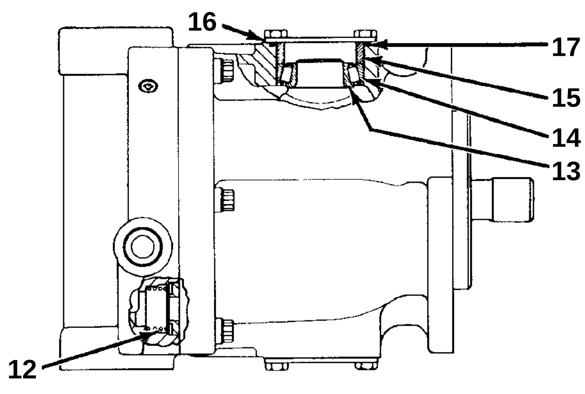
Output..............................99.2 liter/min (26.2 U.S. gpm)
At a pressure of............................690 kPa (100 psi)
With pump at ....2200 rpm
With engine at ....2200 rpm

Output..............................97.7 liter/min (25.8 U.S. gpm)
At a pressure of........................6900 kPa (1000 psi)
With pump at...2200 rpm
With engine at ....2200 rpm

Test at Half Speed

Output..............................49.6 liter/min (13.1 U.S. gpm)
At a pressure of............................690 kPa (100 psi)
With pump at ....1100 rpm
With engine at ....1100 rpm

Output..............................48.1 liter/min (12.7 U.S. gpm)
At a pressure of........................6900 kPa (1000 psi)
With pump at ....1100 rpm
With engine at ....1100 rpm



(1) Tighten six screws to a torque of ....33 ±2 N•m ....(24 ± 1 lb ft)

(3) 9T-3858 Spring:
Length under test force ....34.75 mm (1.368 in)
Test force ....578 ± 58 N (130 ± 13 lb)
Free length after test ....67.77 mm (2.668 in)
Outside diameter......................40.26 mm (1.585 in)

(8) Tighten four screws to a torque of ....7.3 ± 0.5 N•m ....(65 ± 5 lb in)

(11) 9T-2168 Spring:
Length under test force ....36.1 mm (1.42 in)
Test force ....325 ± 32 N (73 ± 7 lb)
Free length after test ....53.987 mm (2.1255 in)
Outside diameter......................26.80 mm (1.055 in)

(12) 9T-3867 Spring:
Length under test force ....11.2 mm (0.44 in)
Test force ....11.4 ± 1.2 N (2.56 ± .26 lb)
Free length after test ....40.13 mm (1.580 in)
Outside diameter..........................24.9 mm (0.98 in)

(16) Tighten eight screws to a torque of.......20 ± 1 N•m ....(15 ± 1 lb ft)

Shaft Bearing Setting Check

1. Do this procedure when shaft bearing, head, or housing is replaced.

NOTE: Do not install the barrel assembly or pistons for this procedure.

2. Install bearing cone (7) on the splined end of shaft (6), and install bearing cups in the body and head. Be sure that the cups and cone are against their location shoulders.

3. Install the shaft and bearing cone into the body.

4. Install thickest bearing spacer (2) over shaft (6) with the chamfer toward the shoulder.

5. Install bearing cone (7) on shaft (6) against the spacer.

6. Assemble head (9) to housing (5). Do not install the gasket between the head and housing at this time.

7. Turn the shaft to seat the bearings, and tighten six screws (1) to a torque of 0.6 N•m (5 lb in).

8. The opening between head (9) and housing (5) should be as even as possible after tightening.

9. Use a feeler gauge to measure the opening between head (9) and housing (5). Take four equally spaced measurements. Average the four readings by adding them together and dividing by four. Calculate the required thickness of the shaft bearing spacer as follows:

+3.81 mm (0.150 in)	**Measure thickness of bearing spacer (2)**
–0.69 mm (0.027 in)	**Opening between head and housing (averaged)**
+0.05 ± 0.025 mm (0.002 ± 0.001 in)	**Preload setting**
+0.51 mm (0.020 in)	**Compressed thickness of gasket**
3.68 ± 0.025 mm (0.145 ± 0.001 in)	**Required bearing spacer (2) thickness to provide a 0.05 ± 0.025 mm (0.002 ± 0.001 in) bearing preload.**

10. Remove six screws (1) and remove head (9) from the housing.

11. Remove bearing cone (7) and spacer (2). Replace the spacer with a spacer of the required thickness to provide proper preload.

Adjustment of Swashplate Bearings

1. Install the shaft assembly into the housing.
2. Place housing (5) on a flat surface with the mounting flange down.
3. Install spring (11) and seat (10) in the housing.
4. Install swashplate (4) into the housing.
5. Assemble bearing cones (13) on each end of the swashplate, and insert bearing cups (14).
6. Install bearing spacer (15) on one end.
7. Install O-ring seal (17) into the groove.
8. Install a 0.25 mm (0.010 in) shim under the cover and install four screws (16). Tighten the screws to a torque of 20 ± 1 N•m (15 ± 1 lb ft).
9. Place the housing on its side so that the bearing bore is up. Install the bearing spacer and rotate the swashplate back and forth to seat the bearings. With the spacer firmly against the bearing, use a depth micrometer and measure the difference in height between the bearing spacer and the housing. Measure in two place,180 degrees apart, and calculate the average. A 0.20 ± 0.25 mm (0.008 ± 0.001 in) preload is required on the bearings. Calculate the necessary shim thickness to provide this preload as follows:

+0.71 mm (0.002 in) Average depth micrometer reading
–0.29 ± 0.025 mm (0.008 ± 0.001 in) Preload setting

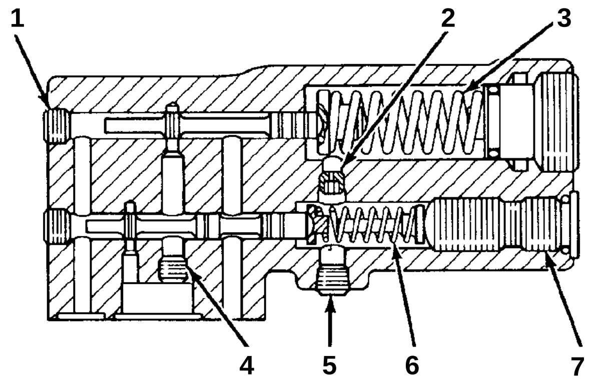
+0.51 ± 0.025 mm (0.020 ± 0.001 in) Required shim thickness

NOTE: If the calculated shim thickness is greater than 0.51 mm (0.020 in), another shim must be added to the opposite side of the swashplate to reduce the total shim thickness to less than 0.51 mm (0.020 in). Shim thicknesses at either cover must not exceed 0.51 mm (0.020 in). This is necessary to ensure proper O-ring compression and to prevent seal leakage.

10. Install the correct shims and cross tighten cover screws (16) to a torque of 20 ± 1 N•m (15 ± 1 lb ft).

NOTE: Swashplate (4) will be stiff but should be free enough to be moved by hand. The tightness indicates that the bearings are preloaded. If the swashplate can not be moved by hand, the preload is too great. Repeat the preload adjustment.

Pressure and Flow Compensator Valve



Margin Pressure Setting........................2070 ± 345 kPa
....(300 ± 50 psi)

Pressure setting...........................20 670 kPa (3000 psi)

(1) Installation torque for two plugs ....2.0 ± 0.5 N•m
....(18 ± 4 lb in)

(2) Installation torque for orifice ....2.0 ± 0.5 N•m
....(18 ± 4 lb in)

(3) 9T-3814 Spring:
Length under test force............29.92 mm (1.178 in)
Test force.......................609 ± 61 N (137 ± 13.7 lb)
Free length after test ....35.61 mm (1.402 in)
Outside diameter......................16.51 mm (0.650 in)

(4) Installation torque for plug.................3.0 ± 0.5 N•m
....(27 ± 4 lb in)

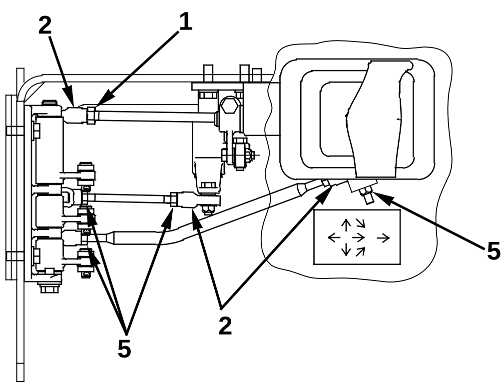
(5) Installation torque for plug.................2.0 ± 0.5 N•m
....(18 ± 4 lb in)

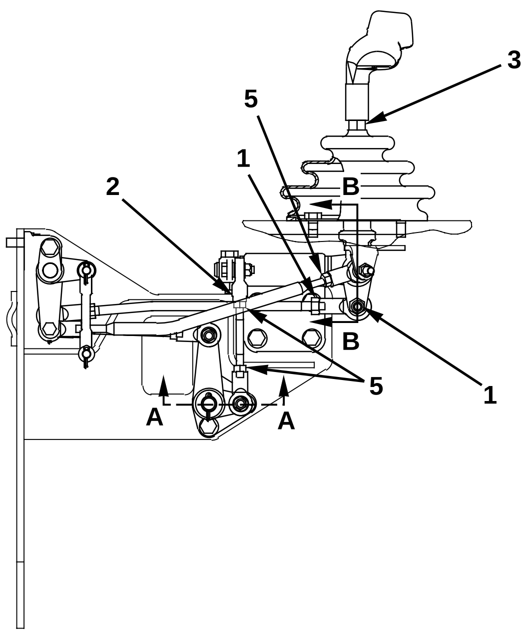
(6) 9T-3811 Spring:
Length under test force................23.6 mm (0.93 in)
Test force..............................43.6 ± 4 N (9.8 ± 1 lb)
Free length after test ....24.54 mm (0.966 in)
Outside diameter........................9.83 mm (0.387 in)

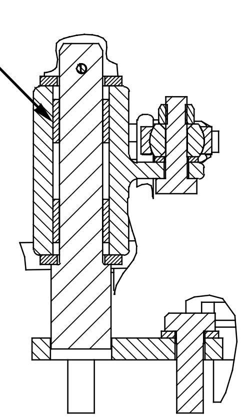
(7) Installation torque for plug.................7.5 ± 1.5 N•m
....(67 ± 13 lb in)

(8) Installation torque for plug used in alternate signal port (not shown) ....7 ± 2 N•m (62 ± 18 lb in)

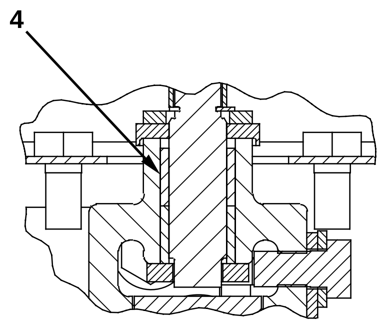
Blade Control Group







View A–A.



View B–B.

(1) Tighten eight nuts to a torque of ....14 ± 4 N•m ....(125 ± 36 lb in)

(2) Adjust position of rod ends on rods so that control handle is centered when control valve spools are in neutral position.

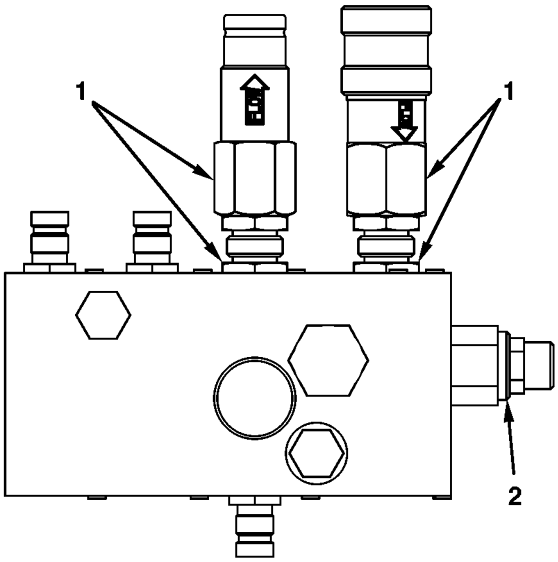
(3) Tighten nut to a torque of......................50 ± 2 N•m ....(37 ± 1.5 lb ft)

(4) 5P-9209 Bearings:

Pack 12 bearings and bearing cavities with 1P-0808 Lithium Grease.
Drive only on the stamped end of the bearings.

(5) Tighten nuts to a torque of......................7 ± 2 N•m ....(5.2 ± 1.5 lb ft)

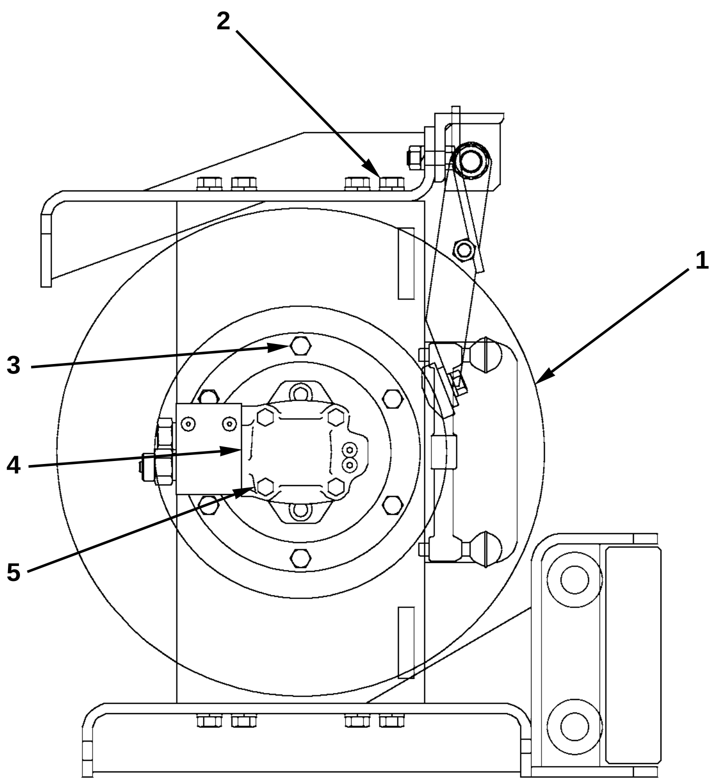
Remote Hydraulic Tool Manifold



(1) Tighten fittings to a torque of.................82 ± 5 N•m
....(60.5 ± 3.5 lb ft)

(2) Relief valve pressure setting ....14 490 ± 138 kPa
....(2100 ± 20 psi)

Winch Group



(1) Winch cable capacity with 5/8 inch diameter cable
Layer 1 ....9144 mm (30 ft)
Layer 2 ....19 202 mm (63 ft)
Layer 3 ....30 175 mm (99 ft)
Layer 4 ....43 367 mm (139 ft)
Layer 5 ....55 169 mm (181 ft)

NOTE: At least five turns of cable must be left on the winch drum to hold a load.

Winch line pull force with 5/8 inch cable
Layer 1 ....97 856 N (22,000 lb)
Layer 2 ....88 070 N (19,800 lb)
Layer 3 ....80 064 N (18,000 lb)
Layer 4 ....73 392 N (16,500 lb)
Layer 5 ....67 610 N (15,200 lb)

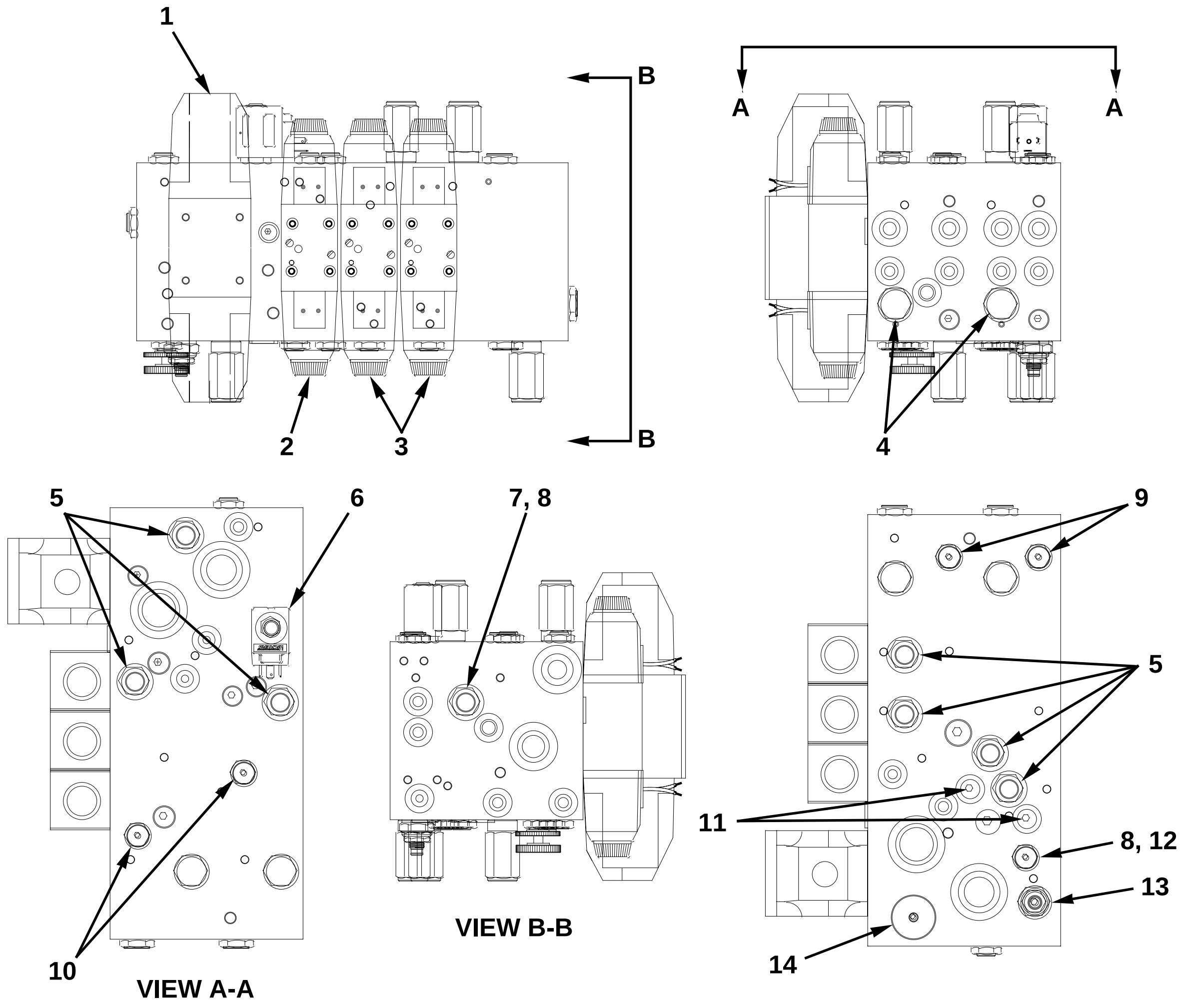
(2) Tighten 16 bolts to a torque of.........75 ± 13.6 N•m
....(55 ± 10 lb ft)

(3) Tighten six bolts to a torque of.........68 ± 13.6 N•m
....(50 ± 10 lb ft)

(4) Motor displacement per revolution.............158.1 cc
....(9.66 cu in)
Maximum continuous speed ....477 rpm

(5) Tighten four bolts in a diagonal cross pattern to a torque of..50 N•m (37 lb ft)

Multifunction Valve Block



(1) Install valve to torque of...............13 N•m (115 lb in)
Coil resistance ....13.5 ohms

(2) Install valve to torque of ......6 ± 1 N•m (53 ± 9 lb in)
Coil resistance ....19.7 ohms

(3) Install valve to torque of ......6 ± 1 N•m (53 ± 9 lb in)
Coil resistance ....19.7 ohms

(4) Install check valve to torque of ....50.5 ± 3.5 N•m
....(37.5 ± 2.5 lb ft)

(5) Install shuttle valve to torque of ....50.5 ± 3.5 N•m
....(37.5 ± 2.5 lb ft)

(6) Install cartridge to torque of ....50.5 ± 3.5 N•m
....(37.5 ± 2.5 lb ft)

Install coil nuts to torque of ....6.5 ± 1.5 N•m
....(5 ± 1 lb ft)

Coil resistance ....32 ohms

(7) Install check valve to torque of ....50.5 ± 3.5 N•m
....(37.5 ± 2.5 lb ft)

(8) Orifice size.................................1.57 mm (0.062 in)

(9) Install relief valve to torque of ....50.5 ± 3.5 N•m
....(37.5 ± 2.5 lb ft)

(10) Install relief valve to torque of ....50.5 ± 3.5 N•m
....(37.5 ± 2.5 lb ft)

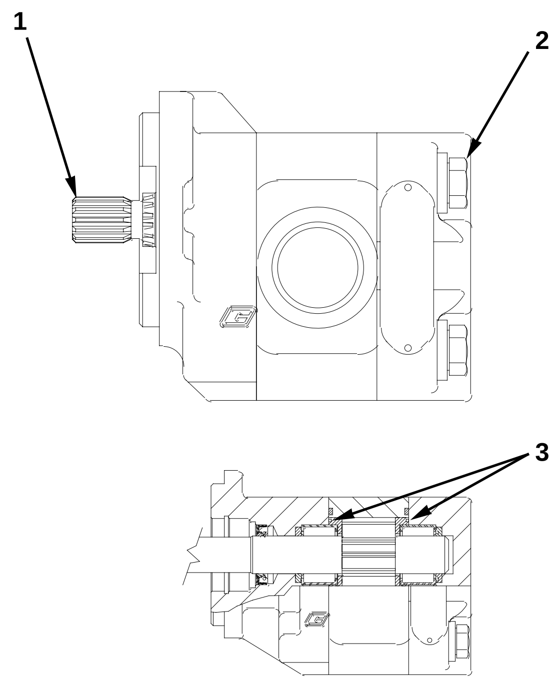
(11) Orifice size ....0.762 mm (0.030 in)

(12) Install relief valve to torque of ....50.5 ± 3.5 N•m
....(37.5 ± 2.5 lb ft)

(13) Install pilot valve to torque of...........50.5 ± 3.5 N•m
....(37.5 ± 2.5 lb ft)

(14) Install needle valve to torque of ....50.5 ± 3.5 N•m
....(37.5 ± 2.5 lb ft)

Pump Group–Fan

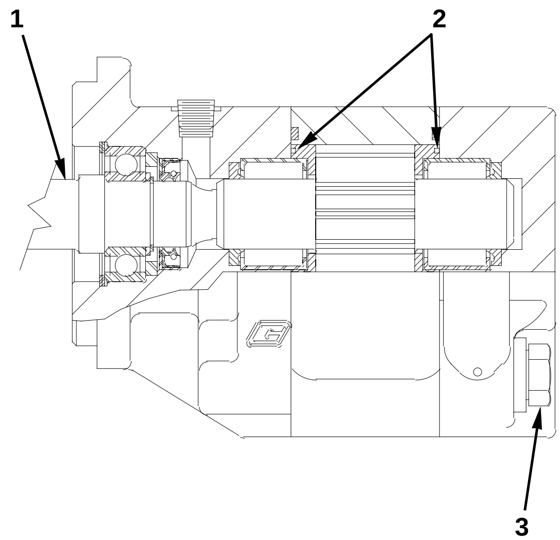


(1) Pump rotation.............................Counterclockwise
Pump displacement per revolution...............48.4 cc
....(2.95 cu in)
Maximum continuous speed ....2400 rpm

(2) Tighten four bolts in a cross pattern.

(3) Cut seal strip to required length.

Motor Group–Fan

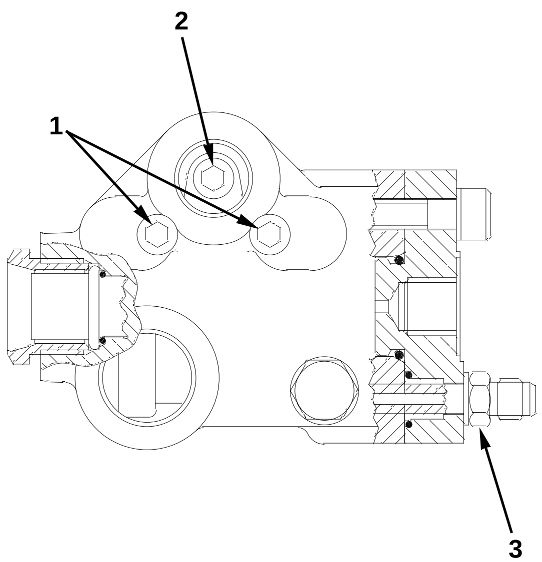


(1) Motor rotation on machine...........Counterclockwise
Motor displacement per revolution...............40.9 cc
....(2.50 cu in)
Maximum continuous speed ....2400 rpm

(2) Cut seal strip to required length.

(3) Tighten four bolts in a cross pattern.

Valve Group–Fan Control

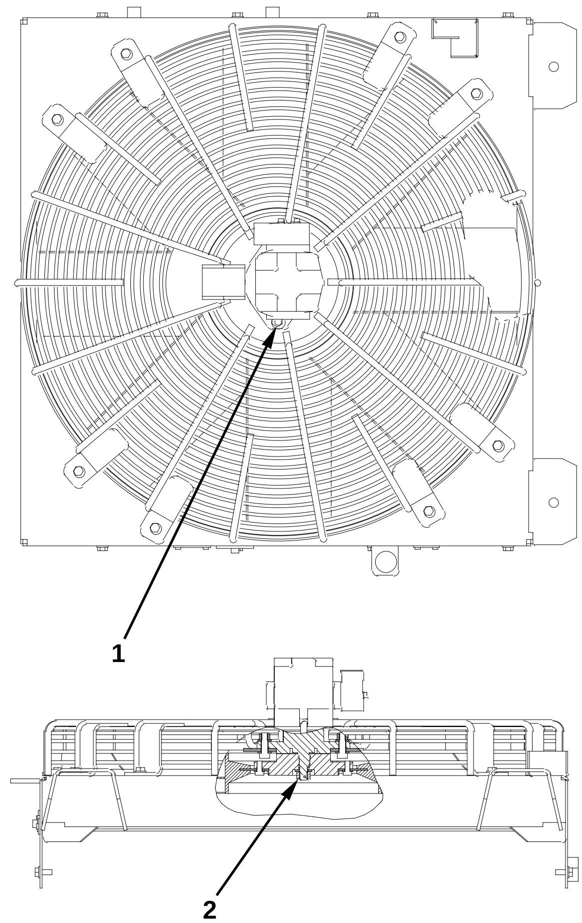


(1) Tighten two bolts to a torque of ....22.3 ± 2 N•m ....(16.5 ± 1.5 lb ft)

(2) Tighten bolt to a torque of..................22.3 ± 2 N•m ....(16.5 ± 1.5 lb ft)

(3) Tighten fitting to a torque of...........28 N•m (21 lb ft)

Mounting Group–Fan

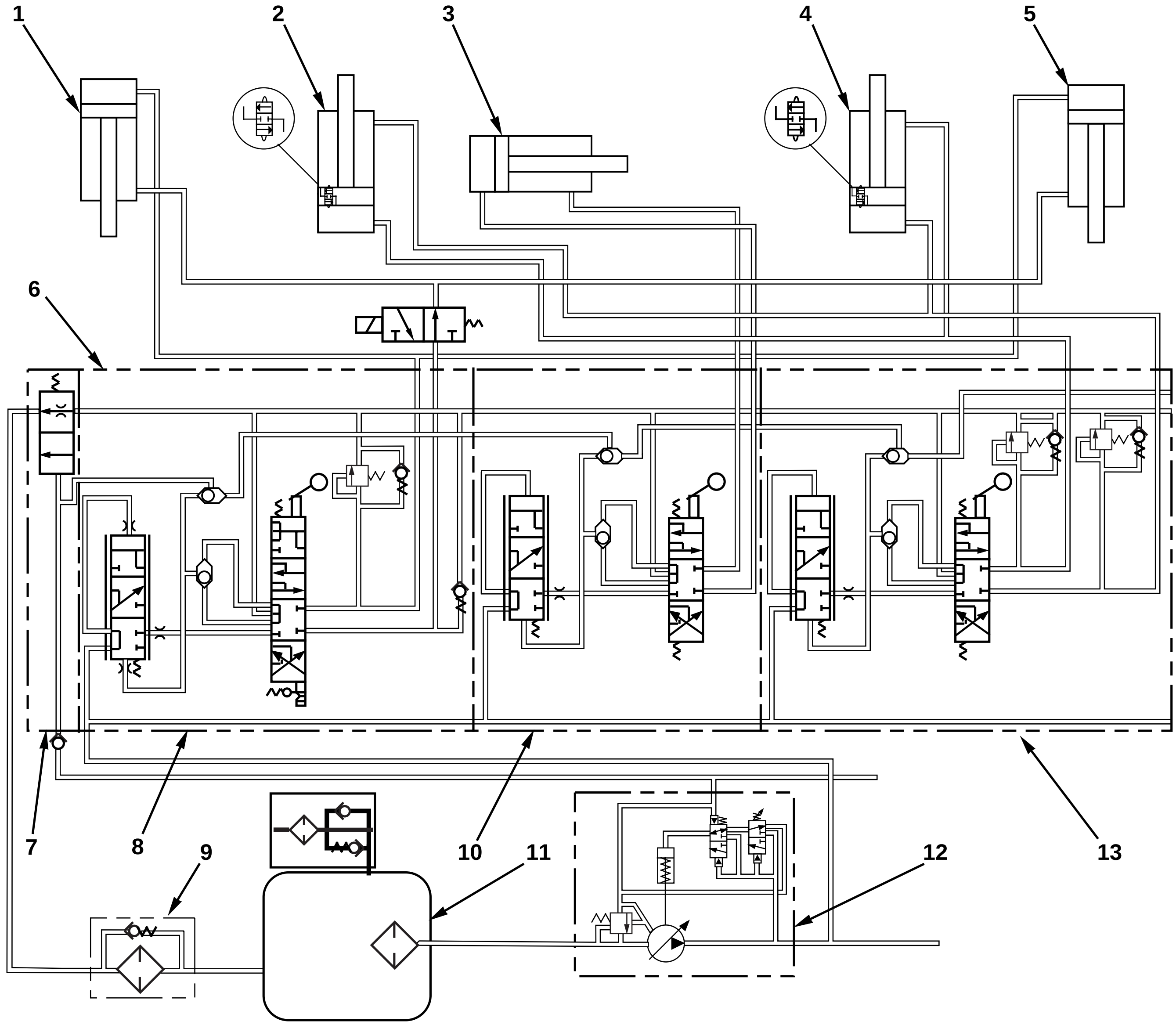


(1) Tighten two nuts to a torque of ....105 ± 20 N•m ....(77 ± 14. 8 lb ft)

(2) Tighten nut to a torque of..................115 ± 20 N•m ....(85 ± 15 lb ft)

Systems Operation

Blade Hydraulic System



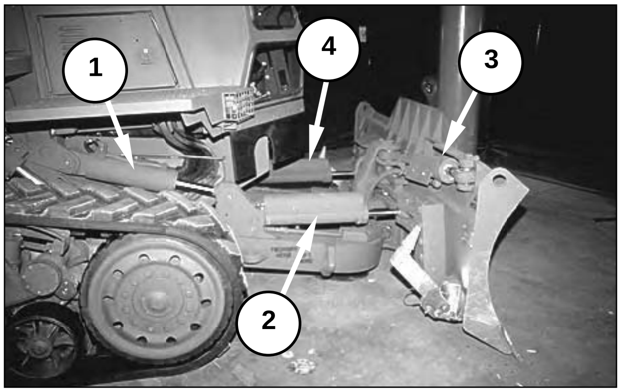
Blade System Hydraulic Schematic.
(1) Lift cylinder. (2) Angle cylinder. (3) Tilt cylinder. (4) Angle cylinder. (5) Lift cylinder. (6) Blade control valve group. (7) Inlet manifold. (8) Lift control section. (9) Return filter. (10) Tilt control section. (11) Hydraulic tank. (12) Hydraulic pump. (13) Angle control section.

The implement hydraulic system controls the operation of the blade, winch, and suspension systems. Each system shares the pump and the hydraulic tank. The blade hydraulic system controls the blade.

The blade hydraulic system consists of hydraulic tank (11), return filter (9), hydraulic pump (12), hydraulic cylinders (1), (2), (3), (4), and (5), and blade control valve group (6) (consisting of three pressure-compensated control sections [8], [10] and [13]).

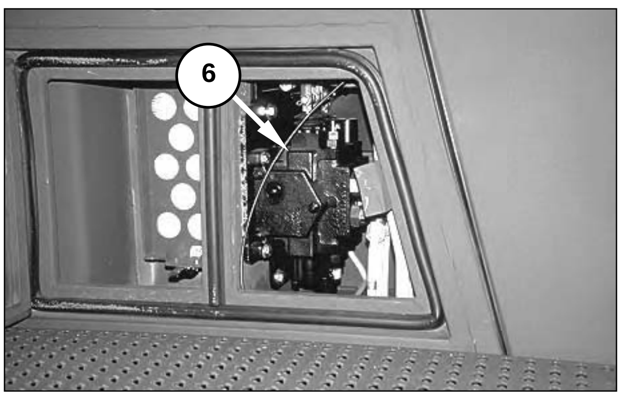
The hydraulic system is a load-sensing (both flow and pressure compensated), closed-centered system. This system keeps constant flow for a given directional control spool position by maintaining a constant pressure difference across the orifice made by the spool.

Component Location



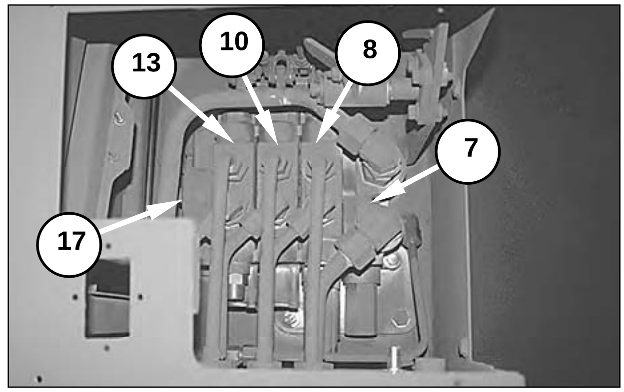
Front of Machine.
(1) Lift cylinder. (2) Angle cylinder. (3) Tilt cylinder. (4) Angle cylinder.

The blade hydraulic system controls the operation of the power angling and tilt (PAT) blade. The PAT blade is positioned using two lift cylinders (1, only one shown), two angle cylinders (2 and 4), and a single tilt cylinder (3).



Right Side of Machine, Under Cab Window.
(6) Blade control valve group.

Blade control valve group (6) is mounted vertically in a compartment below the control console, to the right of the operator. The control valve is accessible through a door on the right side of the cab.

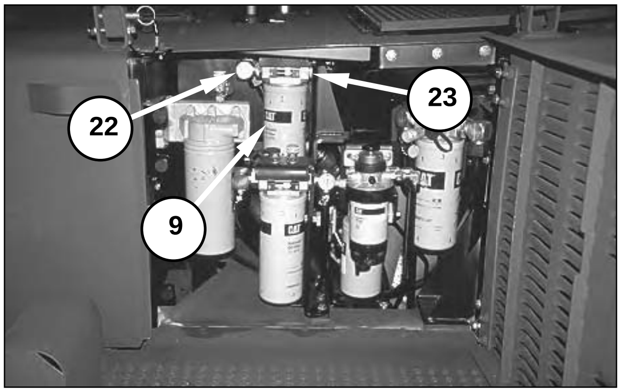


Front View of Blade Control Valve Group, Partially Assembled.
(7) Inlet manifold. (8) Lift control section. (10) Tilt control section. (13) Angle control section. (17) End cover.

Pressure-compensated control valves are fastened together with inlet manifold (7) and end cover (17), to form a control valve bank which controls the blade. Lift control section (8) contains a combination makeup and relief valve in the head end passage. Angle control section (13) has combination makeup and relief valves in both work ports. Tilt control section (10) does not contain a line relief or makeup valve. The inlet manifold is equipped with a return restrictor which ensures that the makeup valves open when conditions require.

Each control section is equipped with two resolver valves, and a signal passage which is connected to each port. Both primary and secondary resolvers use a ball and two seats with a signal hole between the seats. Each end of the primary resolver is connected to a signal passage in the control valve.

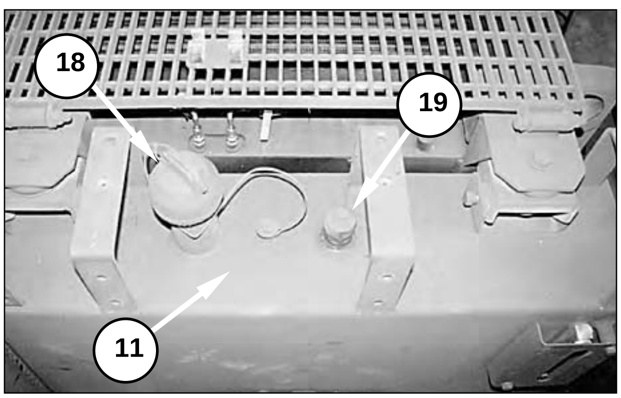
As the directional control spool is actuated, oil pressure is sent to the correct end of the primary resolver and then to the secondary resolver, where it is compared to the highest pressure of the adjacent downstream control valve. The secondary resolvers form a series circuit to send the highest pressure of the control valve group to the pump. When the control valves are shifted to HOLD, the signal pressure is vented to the tank, allowing pump pressure to decrease to a lower (standby) pressure.



Oil Filter Compartment, Right Side of Machine.
(9) Return filter. (22) Line to hydraulic tank. (23) Line from implement and steering hydraulic systems.

Return filter (9) is located in the oil filter compartment on the right side of the machine. Return oil from the implement and steering hydraulic systems flows into the filter through line (23). Oil flowing from the filter flows through line (22) directly to the hydraulic tank.

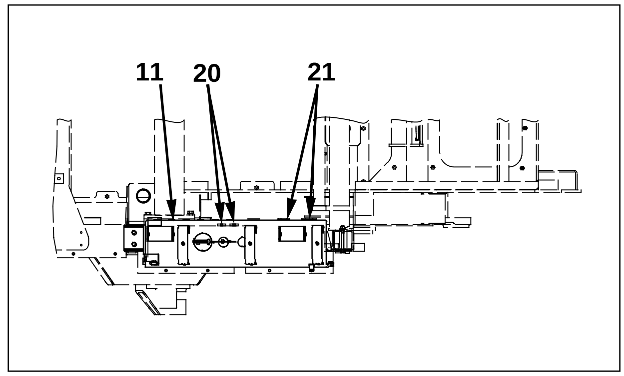
The filter base contains an integral bypass relief valve which opens at 172 ± 12 kPa (25 ± 2 psi) to allow oil to flow around the filter, if the filter becomes plugged. The filter base also contains a bypass indicator to visually indicate if the filter is plugged. The filter should be replaced if the indicator is in the red zone when the machine is operating.



Right Side of Machine.
(11) Hydraulic Tank. (18) Fill cap. (19) Breather.

Hydraulic tank (11) is mounted on the right side of the machine, behind the cab. The hydraulic tank serves as a reservoir for the hydraulic oil used in the implement and fan hydraulic systems. The hydraulic tank also serves as a structural mount for the cooling package.

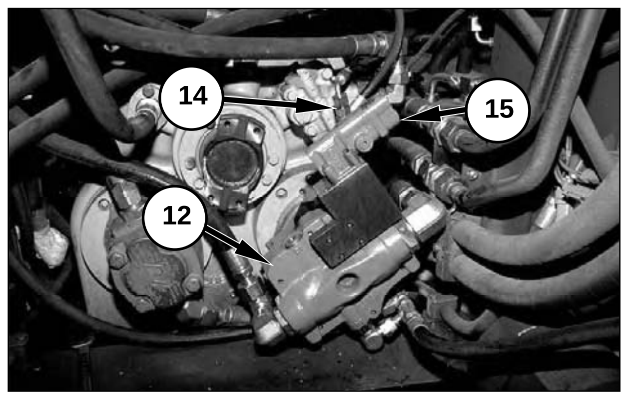
NOTE: Hydraulic tank (11) is also the reservoir for the steering hydraulic system. For additional information, refer to “Systems Operation” in *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage Steering and Brakes.*



Top View of Hydraulic Tank.
(11) Hydraulic tank. (20) Return ports. (21) Suction ports.

Hydraulic oil for the three hydraulic pumps (fan, steering, and implement) is supplied from hydraulic tank (11) through suction ports (21). The fittings in the suction ports each contain an internal screen which removes large debris from the oil before the debris reaches the pumps.

Hydraulic oil returned to the tank flows through return ports (20) on the side of the tank.



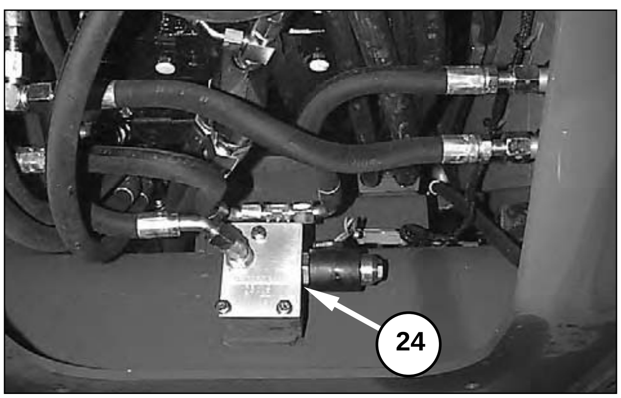
End View of Torque Converter, Transmission Removed From Machine.
(12) Hydraulic pump. (14) Signal port. (15) Compensator valve.

Compensator valve (15) in hydraulic pump (12) automatically keeps pump pressure and flow at a level needed to fulfill the system’s requirements. When none of the hydraulic circuits are being used, the pump is at low pressure standby, which is approximately 2415 kPa (350 psi). If one or more circuits are being used, a resolver network compares the control valve work port pressures. The single highest pressure goes through signal port (14) to the pump compensator valve. This valve keeps the pump flow at a level needed to fulfill system flow and pressure requirements. The actual system pressure is 2070 ± 345 kPa (300 ± 50 psi) above the highest work port pressure requirement unless the pump is at full stroke. The difference between work port pressure and the higher supply pressure is called “margin pressure.”

Compensator valve (15) also has a pressure-limiting ability that prevents pump and system overloads. When work port pressure increases above the pump pressure setting of 20 700 kPa (3000 psi), the pressure limiter part of the compensator overrides the load sensing part of the compensator and lowers the pump output. This action starts at approximately 690 kPa (100 psi) below the maximum pressure setting. This protects the hydraulic system from damage due to high pressure.

Right Console.
(16) Blade control lever.

Blade control lever (16) controls the lift, tilt and angle operations of the blade. The control lever is connected to the control valve group by linkages.



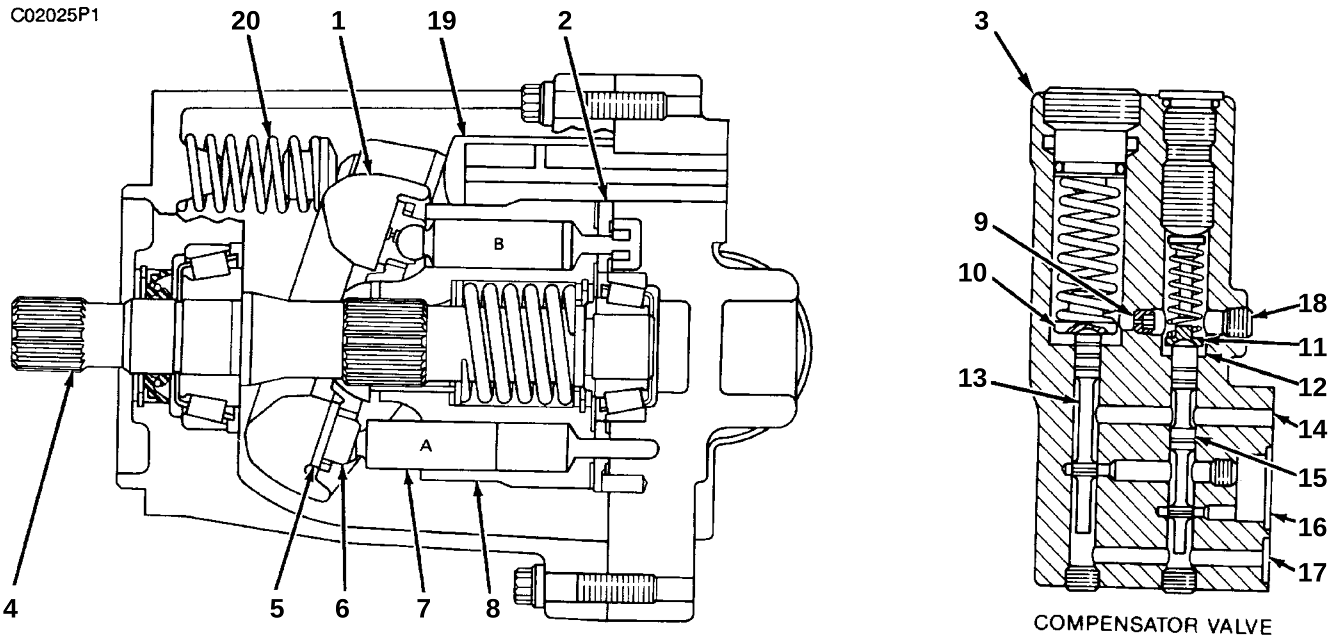
Front of Machine, Cover Removed.
(24) Blade lock valve.

Blade lock valve (24), located under the cab, is installed in the line between the lift control valve and the rod ends of the lift cylinders. The solenoid operated blade lock valve prevents the blade from lowering while the machine is in the SELF-DEPLOY mode.

NOTE: For additional information about blade lock valve (24), refer to “Systems Operation, Self-Deploy/Earthmoving Circuit” in *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System*.

System Operation

Hydraulic Pump Operation



Variable Displacement Piston Pump (Maximum Swashplate Angle Shown).
(1) Swashplate. (2) Port plate. (3) Compensator valve. (4) Drive shaft. (5) Shoe plate. (6) Piston shoes. (7) Pistons. (8) Cylinder barrel. (9) Plug orifice. (10) Seat. (11) Seat. (12) Chamber for load pressure. (13) Pressure compensator spool. (14) Drain passage to pump case. (15) Flow compensator spool. (16) Passage to swashplate control piston. (17) Passage to pump outlet. (18) Signal passage. (19) Actuator piston. (20) Swashplate control spring.

The pump for the implement hydraulic system is an automatically controlled, variable-displacement, axial piston pump. The pump has compensator valve (3) to limit system pressure. The compensator valve senses both pressure and flow needs.

When drive shaft (4) is rotated, cylinder barrel (8) also turns. Nine pistons (7) are held in, and turn with the cylinder barrel. The pistons have attached piston shoes (6). The piston shoes are held against swashplate (1) by shoe plate (5). At maximum swashplate angle (above), the pistons in position (A) are pulled out of the cylinder barrel. This pulls oil from the inlet port through port plate (2) and into the piston bore in the cylinder barrel. As the cylinder barrel rotates to position (B), the angled swashplate pushes the pistons back into the cylinder barrel. This pushes oil out of the piston bore, through the port plate, and into the output port.

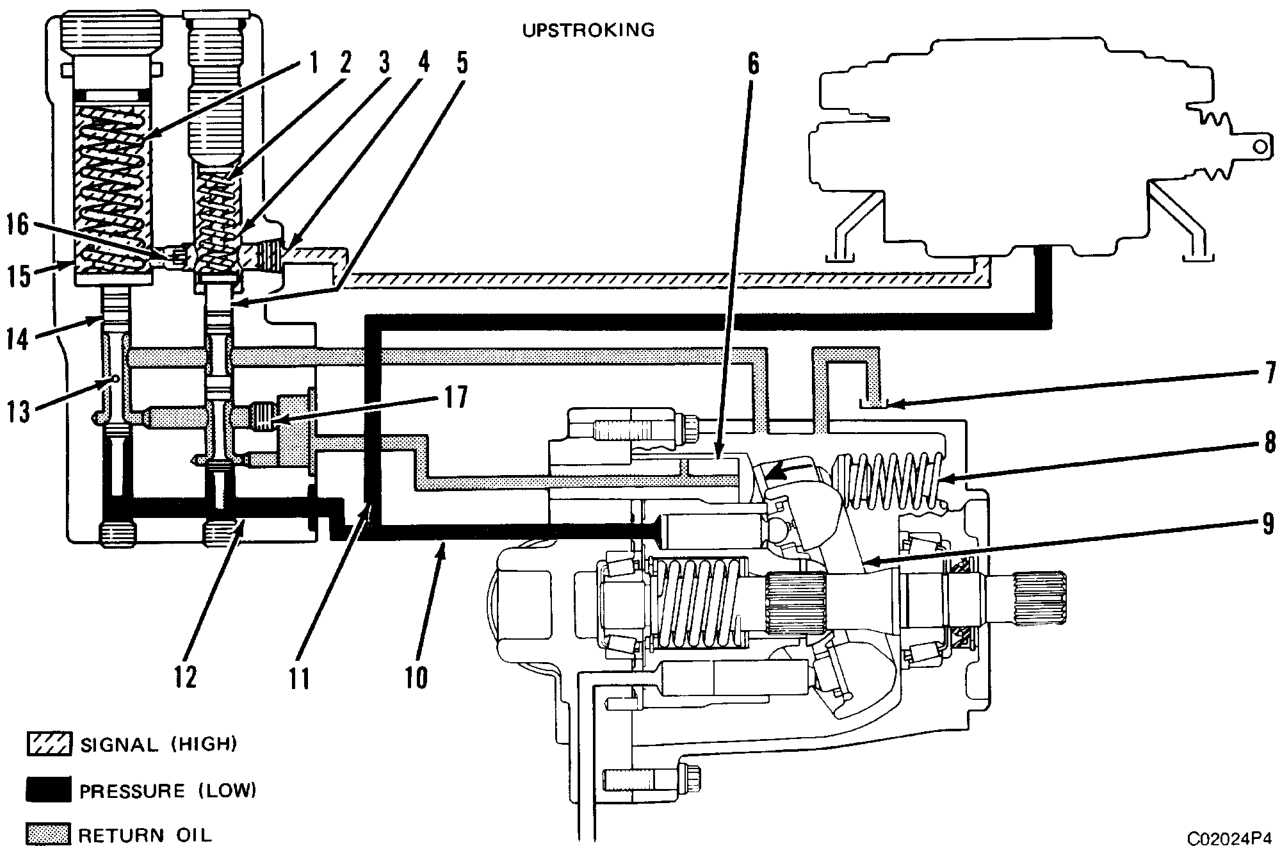
The angle of the swashplate determines how much oil is drawn into each piston bore. The angle therefore determines how much oil is pushed or pumped out of each piston bore per drive shaft revolution. There are infinite swashplate angle positions between neutral (zero degrees, or straight up and down) and the maximum angle. The greater the swashplate angle, the greater the amount of oil pulled into the pump, and the greater the amount of oil discharged through port plate (2) to the output port.

When swashplate (1) angle is at a minimum, pistons (7) do not move in and out of the rotating cylinder barrel. Therefore, no oil is drawn into the pump, and no oil is pushed or pumped out of the pump. There is zero displacement from the pump. The pump is not generating oil flow, and therefore, is not generating pressure. The pump is in this condition (zero degree swashplate angle) only when system pressure is being reduced.

Compensator valve (3) keeps pump pressure and flow at a level needed to fulfill the system load and flow needs. The compensator valve does this by either sending pump oil to or draining oil from actuator piston (19). This piston works with swashplate control spring (20) to continually adjust the swashplate angle. Pump outlet pressure is kept at approximately 2070 kPa (300 psi) above work port pressure needs. The compensator valve also has a pressure limiting ability that prevents pump and system overloads. When work port pressure goes over 20 670 kPa (3000 psi), pressure compensator spool (13) overrides flow compensator spool (15) and lowers pump output. This action starts at approximately 690 kPa (100 psi) below the maximum pressure setting.

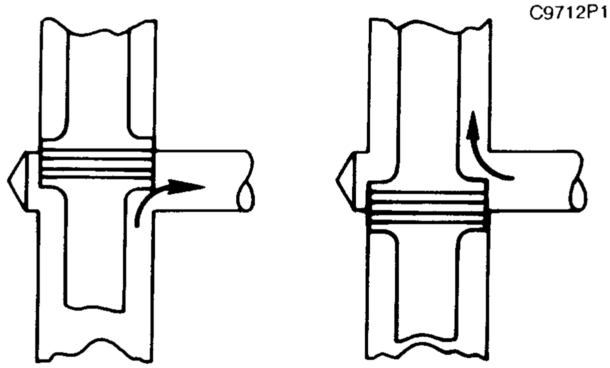
The following schematics show how the pump and the compensator valve respond to different conditions in the hydraulic system.

Upstroking



Variable Displacement Piston Pump (Maximum Swashplate Angle Shown).
(1) Pressure compensator spring. (2) Flow compensator spring. (3) Cavity. (4) Signal line. (5) Flow compensator spool. (6) Actuator piston. (7) Case drain. (8) Actuator spring. (9) Swashplate. (10) Passage. (11) Line. (12) Passage. (13) Orifice. (14) Pressure compensator spool. (15) Pressure compensator cavity. (16) Plug. (17) Check valve.

The pump upstrokes, increasing displacement (output), when the signal pressure increases due to a high load (implement or steering) at low pump output. The highest resolved signal pressure goes through signal line (4) and fills cavity (3). (Refer to "Signal Resolver Network," in this section.) The signal pressure and the force of spring (2), move flow compensator spool (5) down. This lets the oil behind actuator piston (6) go to case drain (7). The force of actuator spring (8) is now greater than the force behind the actuator piston. The angle of swashplate (9) increases, which increases pump output.

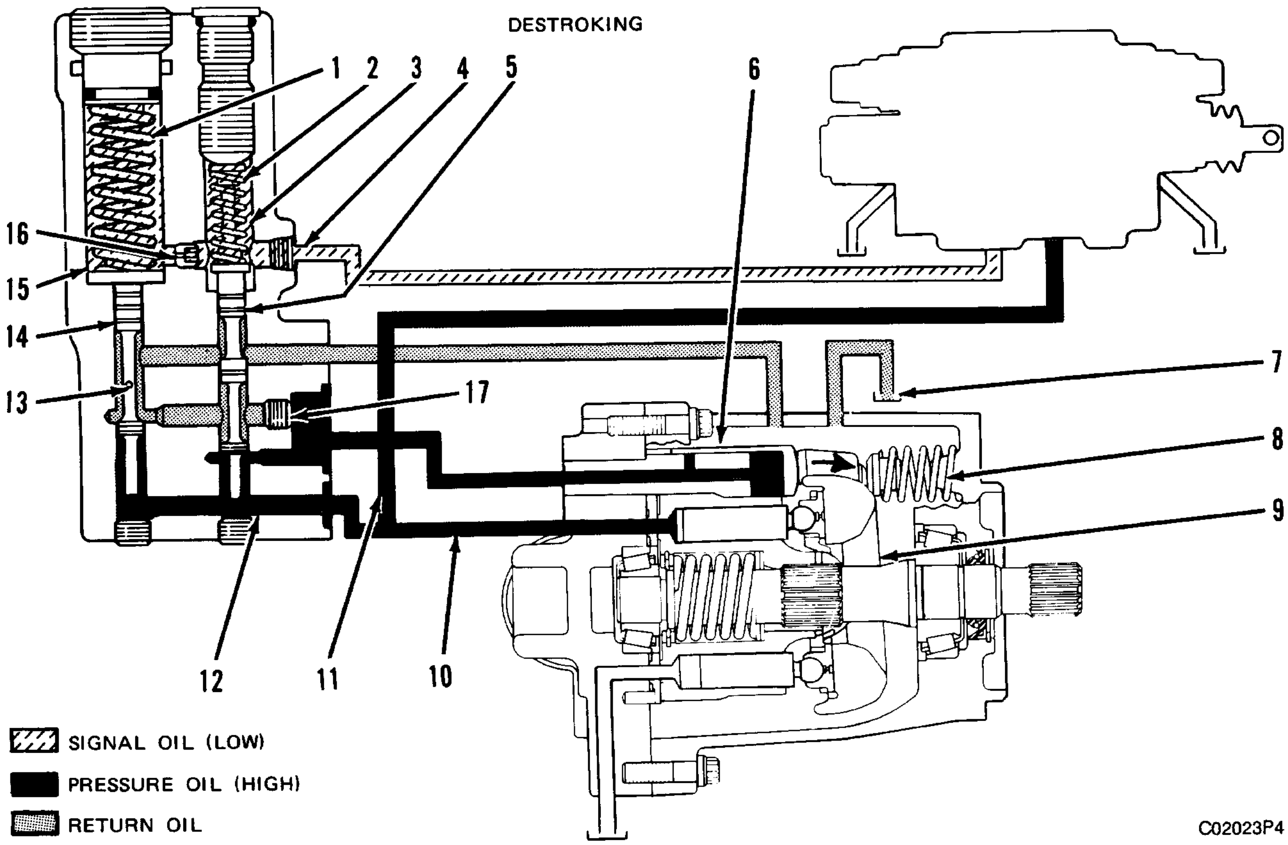


Metering Position.

The pump output pressure increases until the pressure in passage (12) moves flow compensator spool (5) up to the metering position. Initially, in the metering position (Figure 1), pump pressure is greater than the combined force of flow compensator spring (2) and the signal pressure in cavity (3). The flow compensator spool moves up. Pump pressure is now sent to actuator piston (6).This overcomes the force of actuator spring (8). The angle of swashplate (9) decreases, which reduces pump output.

When pump pressure reduces enough, the combined signal and spring force in cavity (3) moves flow compensator spool (5) down (Figure 2). The oil pressure behind actuator piston (6) vents into the case, as outlined above. Spring (8) forces the angle of swashplate (9) to increase. This slight up and down spool movement is called “metering.” Metering keeps the pressure on both ends of the flow actuator spool equal. The force created by flow compensator spring (2) is equivalent to 2070 ± 345 kPa (300 ± 50 psi). Therefore, pump pressure is 2070 ± 345 kPa (300 ± 50 psi) greater than signal pressure. This difference is called “margin pressure.”

Destroking



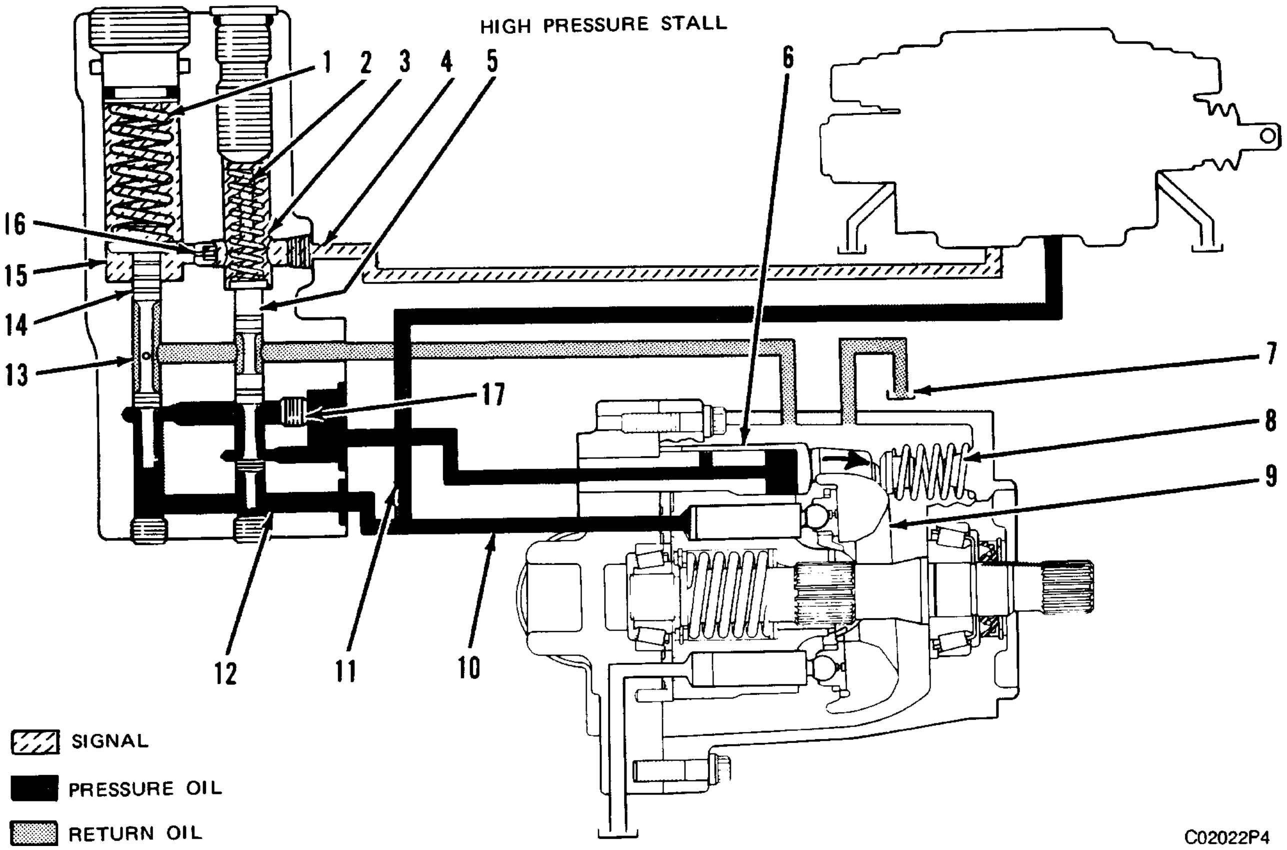
Variable Displacement Piston Pump.
(1) Pressure compensator spring. (2) Flow compensator spring. (3) Cavity. (4) Signal line. (5) Flow compensator spool. (6) Actuator piston. (7) Case drain. (8) Actuator spring. (9) Swashplate. (10) Passage. (11) Line. (12) Passage. (13) Orifice. (14) Pressure compensator spool. (15) Pressure compensator cavity. (16) Plug. (17) Check valve.

The pump destrokes, which decreases displacement (output), when the signal pressure decreases due to a low load (implement or steering) at high pump output. The lower signal pressure goes through signal line (4) and fills cavity (3). The signal pressure, plus the force of flow compensator spring (2) in cavity (3), is less than the pump pressure in passage (12). Flow compensator spool (5) is pushed up. Oil behind actuator piston (6) cannot go to case drain (7). Pump oil now flows through passage (12), past the flow compensator spool and into the actuator piston. Pump pressure behind the actuator piston is now greater than the force of the actuator spring, and the angle of swashplate (9) decreases. This decreases pump output.

Passage (12) pressure will become less than the combined force in cavity (3). Flow compensator spool (5) will now move down to the metering position. As long as the signal pressure stays the same, the spool will remain in the metering position, and the hydraulic system pressure and flow are now stabilized.

NOTE: Refer to “Upstroking” in this section (above) for an explanation of metering.

High Pressure Stall



Variable Displacement Piston Pump.
(1) Pressure compensator spring. (2) Flow compensator spring. (3) Cavity. (4) Signal line. (5) Flow compensator spool. (6) Actuator piston. (7) Case drain. (8) Actuator spring. (9) Swashplate. (10) Passage. (11) Line. (12) Passage. (13) Orifice. (14) Pressure compensator spool. (15) Pressure compensator cavity. (16) Plug. (17) Check valve.

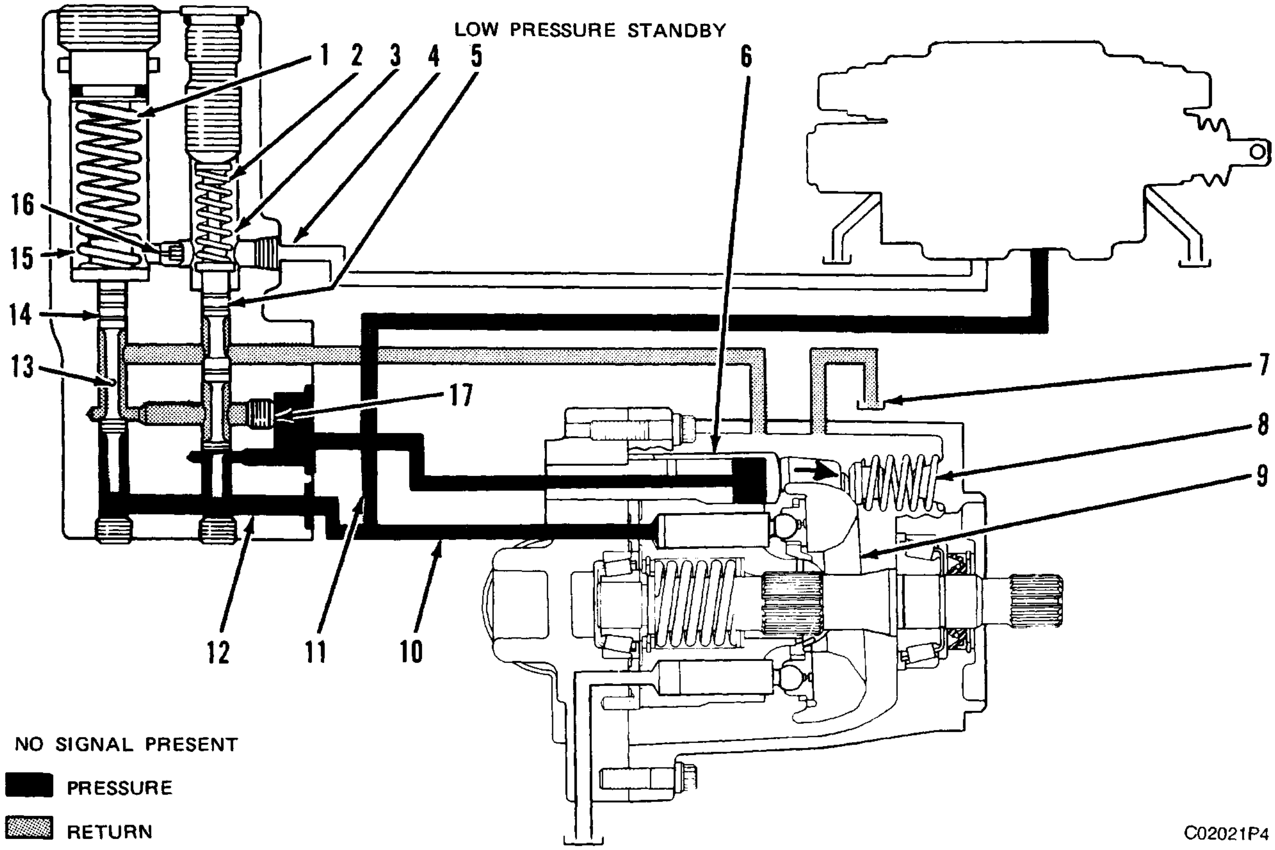
A high pressure stall occurs when the hydraulic system stalls under load, or when the cylinders reach the end of their stroke. A stall occurs when pump output reaches 20 670 kPa (3000 psi). At stall, the signal pressure in signal line (4) now equals pump output pressure. Flow compensator spring (2) moves flow compensator spool (5) down. This pressure also moves pressure compensator spool (14) up against the force of pressure compensator spring (1). Pump oil goes past spools (14) and (5) to the back of actuator piston (6). Swashplate (9) rotates right against the force of actuator spring (8). Pump output (flow) now decreases, while system pressure stays at 20 670 kPa (3000 psi).

If a control lever is moved to HOLD during a high pressure stall, the signal pressure in cavity (3) vents to the tank through signal line (4) and the implement control valve. System pressure begins to bleed down. At approximately 20 000 kPa (2900 psi), flow compensator spring (2) moves pressure compensator spool (14) down, and the system pressure in passage (12) acts against the force of the flow compensator spring to move flow compensator spool (5) up.

Supply oil flows past flow compensator spool (5) to actuator piston (6). The actuator piston destrokes the pump until system pressure decreases. As system pressure approaches low pressure standby, the flow compensator spool moves down to the metering position. Swashplate (9) maintains a slight angle that is sufficient to make up for system leakage and to fulfill the lower pressure requirement.

Check valve (17) prevents damage to the pump during stall conditions. The check valve allows system pressure oil to bypass the margin spool and go to actuator piston (6).

Low Pressure Standby



Variable Displacement Piston Pump.
(1) Pressure compensator spring. (2) Flow compensator spring. (3) Cavity. (4) Signal line. (5) Flow compensator spool. (6) Actuator piston. (7) Case drain. (8) Actuator spring. (9) Swashplate. (10) Passage. (11) Line. (12) Passage. (13) Orifice. (14) Pressure compensator spool. (15) Pressure compensator cavity. (16) Plug. (17) Check valve.

Low pressure standby occurs when the engine is running and the implements are in HOLD. There are no flow or pressure demands on the pump. Therefore, there is no signal pressure in signal line (4).

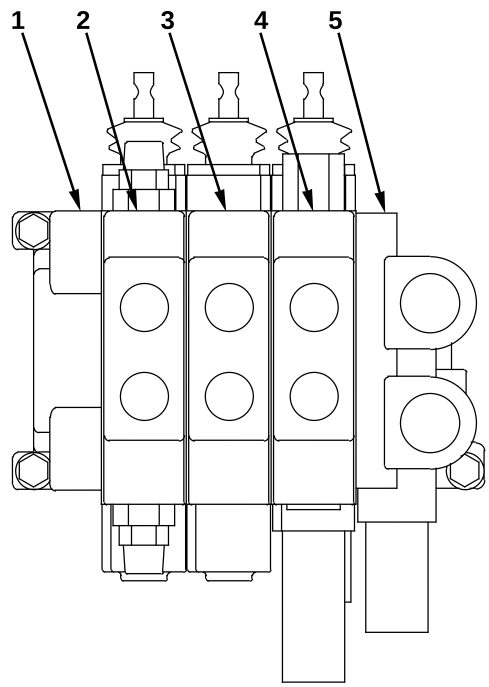
Before the engine is started, actuator spring (8) holds swashplate (9) at maximum angle. As the pump begins to turn (making oil flow), pressure builds in the system because of the closed-center implement valves. This pressure in passage (12) is felt at the bottom of both pressure compensator spool (14) and flow pressure compensator spool (5). The increasing pressure pushes the flow compensator spool against pressure compensator spring (1). When system pressure becomes greater than 2070 kPa (300 psi), the flow compensator spool moves up far enough to open a passage for pressure oil to the back of actuator piston (6). This causes the actuator piston to move to the right, which compresses the actuator spring and moves the swashplate toward minimum angle. The actuator piston moves to the right until the cross-drilled passage of the actuator piston rod is uncovered. This action allows oil to drain into the case.

At this point, the pump does not produce enough flow to make up for normal system leakage or the additional leakage through the cross-drilled hole. The force of actuator spring (8) overcomes the pressure acting against actuator piston (6), and the piston stops moving to the right. This limits the maximum travel of the piston to the right. The piston will now move slightly to the left until only a part of the cross-drilled hole is open to the case. At this point, the pump is producing enough flow to make up for system leakage and leakage to the pump case through the cross-drilled hole, while maintaining system pressure at approximately 2415 kPa (350 psi).

The pump is at low pressure standby. This pressure is different than margin pressure because of system leakage and the cross-drilled hole in the actuator piston rod. Flow compensator spool (5), instead of metering oil, must remain open and move up higher against flow compensator spring (2) to provide enough flow to the back side of the actuator piston to make up the leakage through the cross-drilled hole. This flow must be adequate to maintain the pressure that is required at the back of the piston to overcome actuator spring (8). System pressure must be approximately 345 kPa (50 psi) higher than margin pressure to shift the spool up this additional amount against the flow compensator spring. Oil pressure behind the actuator piston is less than system pressure because of the pressure drop caused by the flow compensator spool.

NOTE: Low pressure standby is not adjustable and does vary from machine to machine. Low pressure standby also varies in the same pump, as system or pump leakage increases. As leakage increases, the pump upstrokes slightly to compensate for the leakage, and the actuator piston covers up more of the cross-drilled hole. As this happens, low pressure standby drops toward margin pressure. When leakage hits the point at which the piston covers the cross-drilled hole completely, because of the increased swashplate angle required, low pressure standby equals margin pressure. At this point, the pump should be repaired or replaced.

Implement Control Valve Group



Implement Control Valve Group.
(1) Cover. (2) Angle control section. (3) Tilt control section. (4) Lift control section. (5) Inlet manifold.

The implement control valve group is located in the operator's compartment, to the right of the seat. This valve group includes cover (1), angle control section (2), tilt control section (3), lift control section (4), and inlet manifold (5).

Linkage rods connect the valve sections to the operator control levers. The blade control lever controls blade raise and lower, tilt right and left, and angle right and left.

The control valve group consists of individual control valves stacked together with three tie rods and nuts. O-rings are used between the control valves. Internal passages allow pump supply oil to flow to each control valve in parallel.

All sections are manually actuated and have closed-centered, directional stems. The blade tilt stem has three positions: EXTEND, HOLD and RETRACT. The blade angle stem has three positions: angle RIGHT, HOLD and angle LEFT. The blade lift stem has four positions: RAISE, HOLD, LOWER and FLOAT. The FLOAT position is the only one with a detent.

All sections have two load resolver valves: primary and secondary. The primary resolver valve resolves the higher of the two work ports and sends the higher pressure to the secondary resolver. The secondary resolver compares the load pressure of the section with those downstream. When the highest pressure of the valve bank is determined by the secondary resolver, the pressure signal is sent back to the pump compensator valve. (Refer to “Signal Resolver Network” in this section.)

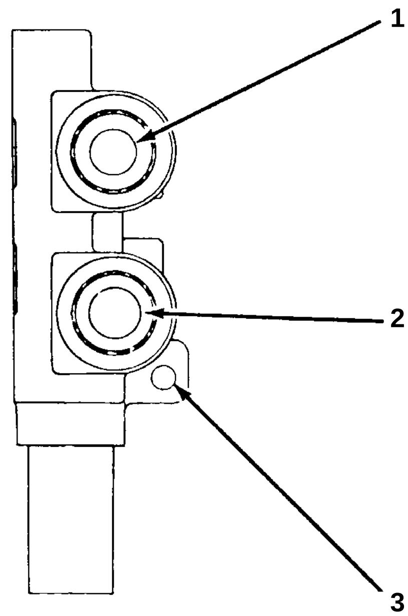
Each valve section has two signal passages which are open to the tank when the directional stem is in the HOLD position. When the stem is shifted either way, the load signal passage is closed to the tank and the load pressure is sent to the primary resolver.

The blade lift valve section has makeup valves which reduce pause time. Pause time occurs when the weight of the blade forces oil out of the rod end faster than the pump can fill the head end. The void in the head of the cylinder causes the pressure in the cylinder passage to be less than the pressure in the tank passage, causing flow to go from the tank to the head end of the cylinder. (Refer to “Makeup Valve” in this section.)

The blade angle section has two combination line relief and makeup valves to protect the lift cylinder circuit. (Refer to “Line Relief and Makeup Valve [Pilot Operated]” in this section .

All sections have load check valves to prevent back flow (pump pressure is less than the work port pressure) when the stem is shifted. This prevents unwanted blade movement (droop) as the stem is shifted.

Inlet Manifold and Return Oil Restrictor

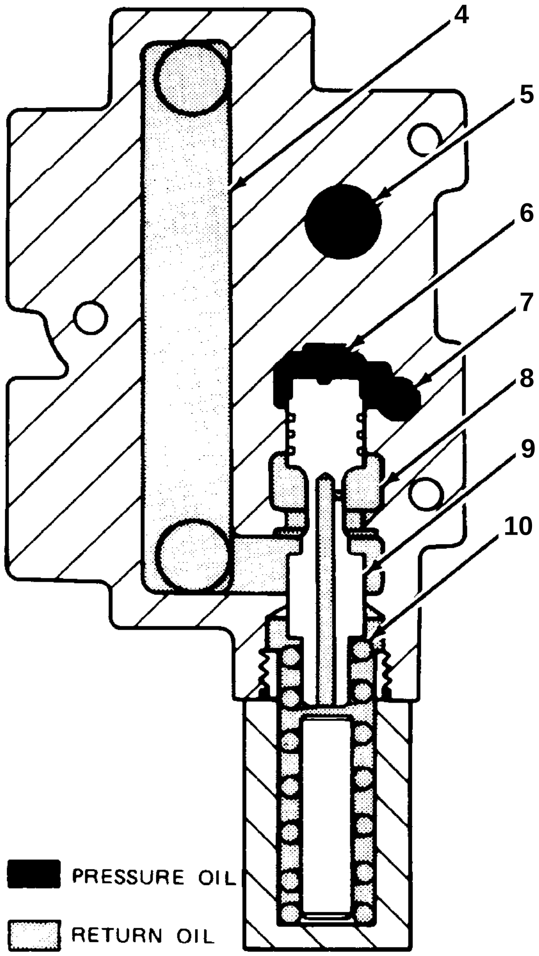


Inlet Manifold and Return Restrictor.
(1) Inlet port (from pump). (2) Outlet port (to tank). (3) Signal port (from resolver network).

The inlet manifold is bolted to the lift valve section. Three lines are connected to the manifold.

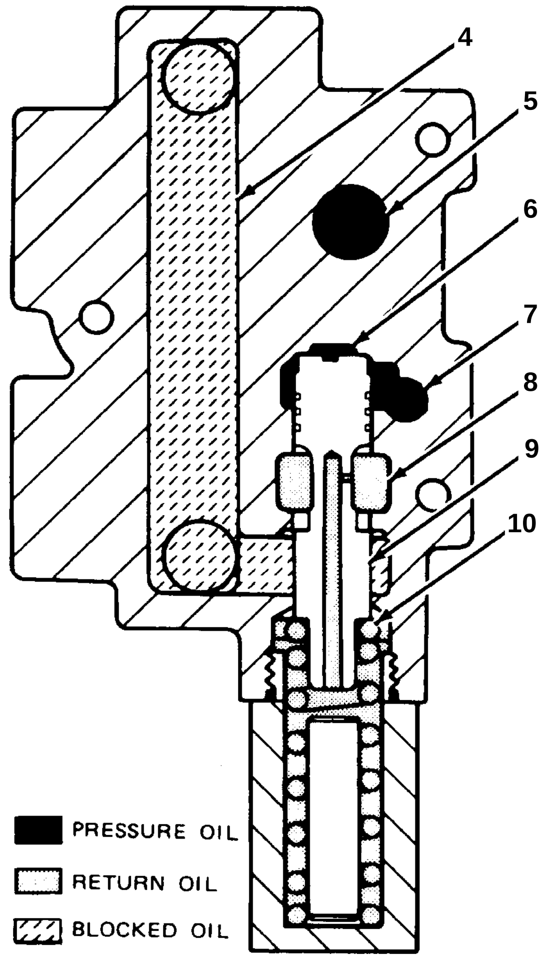
Inlet port (1) supplies oil from the pump. Outlet port (2) directs return oil to the tank. Signal port (3) directs the highest implement load signal to the pump compensator.

In addition to providing for line connections, this manifold houses a return restrictor valve.



Inlet Manifold and Return Restrictor, Open Position.
(4) Return chamber. (5) Supply passage. (6) Passage. (7) Signal inlet port. (8) Passage to return line. (9) Spool. (10) Spring.

When any implement circuit is operated at high pressure, the signal oil enters signal inlet port (7) and goes to passage (6). This pressure causes spool (9) to act against the force of spring (10). The spool shifts down, allowing oil returning from the implement circuits in chamber (4) to go around the spool and into passage to return line (8). This passage connects to outlet port to tank (2). Implement return oil now continues to the tank.



Inlet Manifold and Return Restrictor, Closed Position.
(4) Return chamber. (5) Supply passage. (6) Passage. (7) Signal inlet port. (8) Passage to return line. (9) Spool. (10) Spring.

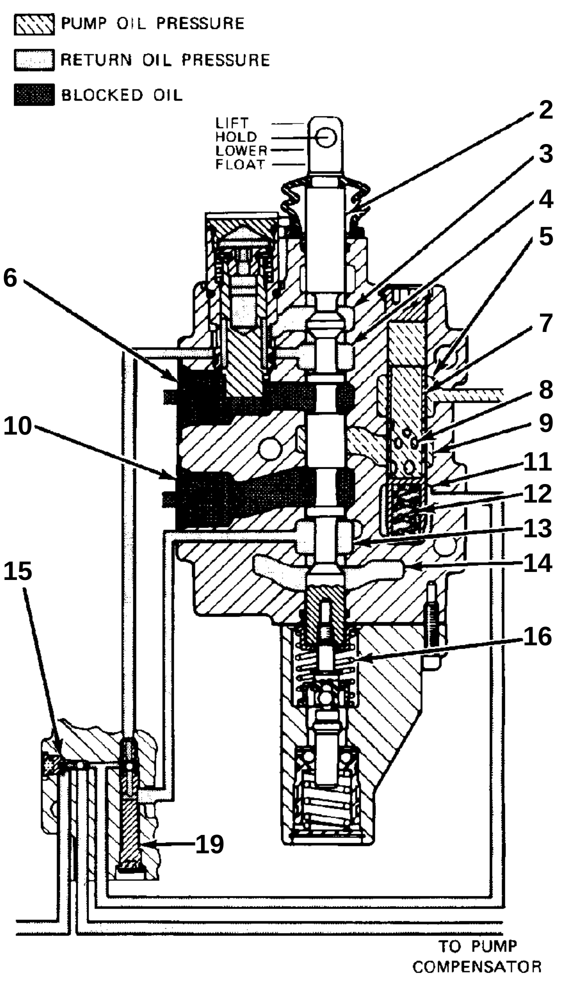
During overrunning load conditions (for example, dropping the blade quickly), the weight of the blade causes a high return flow rate. The resolved signal at the work port is low. Since the signal is low, spring (10) now pushes spool (9) up. This restricts the implement circuit return oil from going to passage to return line (8) and to the tank. Pressure now builds up inside return chamber (4) and in all of the implement valve sections. This back pressure forces oil through the makeup and relief valves and into the work ports. Cavitation is prevented. In overrunning load conditions in the implement circuit, the restrictor spool restricts flow to the tank and forces the makeup valve to redirect return oil to the work ports.

Blade Lift Valve

NOTE: The operation of the blade tilt control valve is the same as the blade lift control valve in the RAISE, LOWER and HOLD positions.

HOLD Position

In the following explanations, all control valves downstream of the lift control valve are assumed to be in the HOLD position.



Blade Lift Valve, HOLD Position.
(2) Control valve spool. (3) Drain passage. (4) Signal passage. (5) Pump passage. (6) Passage to head end of cylinder. (7) Flow control spool. (8) Holes. (9) Passage. (10) Passage to rod end of cylinder. (11) Flow control spring chamber. (12) Springs. (13) Signal passage. (14) Drain passage. (15) Secondary resolver. (16) Spring. (19) Primary resolver.

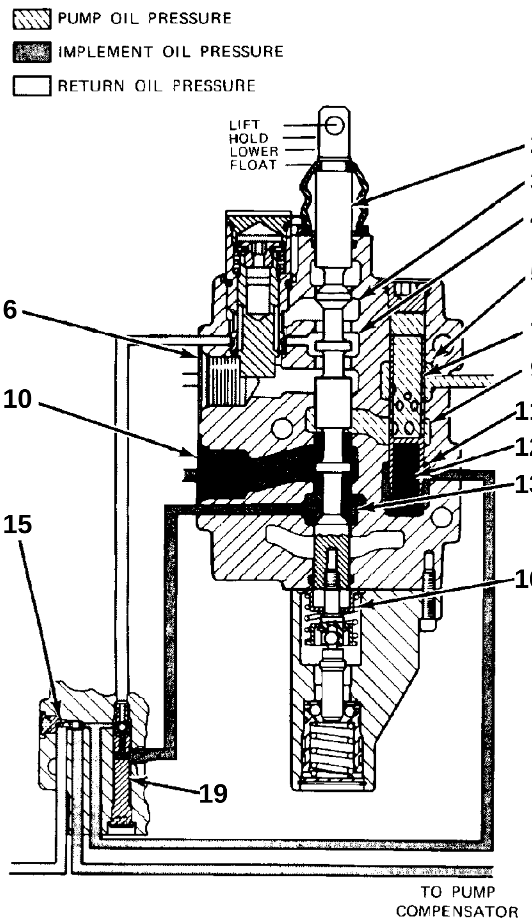
When the engine is running, oil from the pump passes through the inlet manifold to pump passage (5). This passage is common in all valve sections and has no outlet. The oil goes through holes (8) into flow control spool (7). This causes the flow control spool to move against the combined force of springs (12) and the pressure in flow control spring chamber (11). When holes (8) start to close off passage (5), a restriction is created which limits the pressure inside spool (7) and passage (9) to 415 kPa (60 psi) higher than the pressure in spring chamber (11).

In the HOLD position, control valve spool (2) stops the pressure oil in passage (9) from going into passage (6) or passage (10). The oil in passage (6) to the head end of the cylinders and passage (10) to the rod end of the cylinders is blocked. This holds the blade in position.

Signal passages (4) and (13), flow control spring chamber (11), and primary resolver (19) are all open to drain passages (3) and (14). Spring (16) holds control valve spool (2) in this position.

If no downstream valves are activated, secondary resolver (15) opens to drain, and the pump is in a low pressure standby condition.

RAISE Position



Blade Lift Valve, RAISE Position.
(2) Control valve spool. (3) Drain passage. (4) Signal passage. (5) Pump passage. (6) Passage to head end of cylinder. (7) Flow control spool. (9) Passage. (10) Passage to rod end of cylinder. (11) Flow control spring chamber. (12) Springs. (13) Signal passage. (15) Secondary resolver. (16) Spring. (19) Primary resolver.

When control valve spool (2) is shifted from HOLD to RAISE, signal passage (13) is opened to the pressure in passage to rod end of cylinder (10), before passage (10) is opened to passage (9). This pressure is immediately sent to primary resolver (19). The primary resolver sends this pressure to flow control spring chamber (11) and to secondary resolver (15).

If pump oil pressure inside flow control spool (7) is lower than the pressure in flow control spring chamber (11) (cylinder rod end pressure), then the flow control spool moves up and functions as a load check valve. The pressure of the oil in the flow control spring chamber and the force of springs (12) keep the flow control spool in its upper position, until pump pressure is approximately 420 kPa (60 psi) greater than the pressure in the flow control spring chamber (cylinder rod end pressure).

This prevents reverse flow from passage to rod end of cylinder (10) from reaching passage (9) and pump passage (5), and prevents the blade from dropping as control valve spool (2) is shifted.

From secondary resolver (15), the cylinder rod end pressure goes to the pump compensator valve and increases pump oil pressure. As pump oil pressure increases at pump passage (5), the increase is also felt inside flow control spool (7).

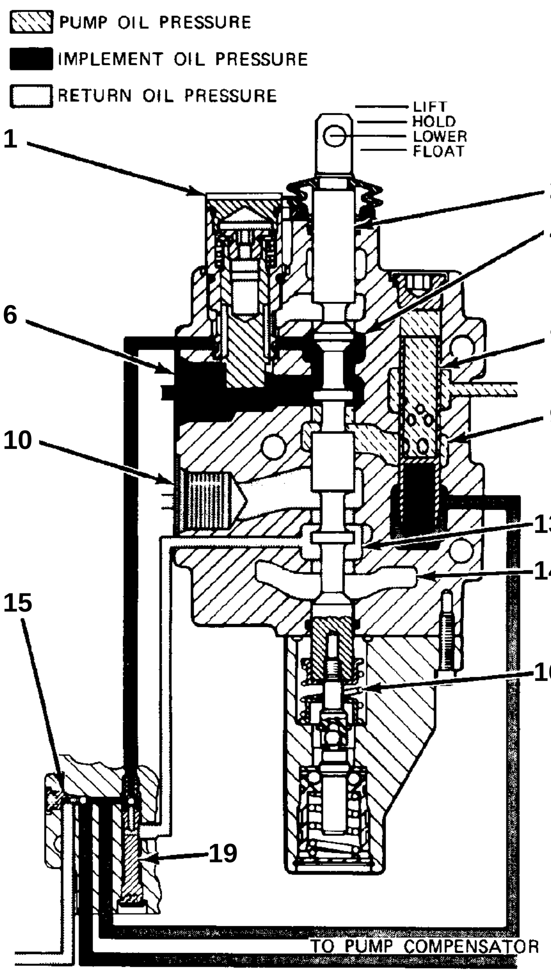
When the pump output pressure is approximately 420 kPa (60 psi) greater than the pressure in flow control spring chamber (11) (cylinder rod end pressure), flow control spool (7) moves downward, allowing flow from pump passage (5) to reach passages (9) and (10), and the rod end of the blade lift cylinders, which causes the blade to raise.

All of the above actions occur in a fraction of a second.

With control valve spool (2) in the lift position, passage to head end of cylinder (6) and signal passage (4) are open to drain passage (3).

Spring (16) is being compressed from the bottom in this position. When the control lever is released, spring (16) returns to the normal position. This pulls the control lever back into the HOLD position.

LOWER Position



Blade Lift Valve, LOWER Position.
(1) Makeup valve. (2) Control valve spool. (4) Signal passage. (6) Passage to head end of cylinder. (7) Flow control spool. (9) Passage. (10) Passage to rod end of cylinder. (13) Signal passage. (14) Drain passage. (15) Secondary resolver. (16) Spring. (19) Primary resolver.

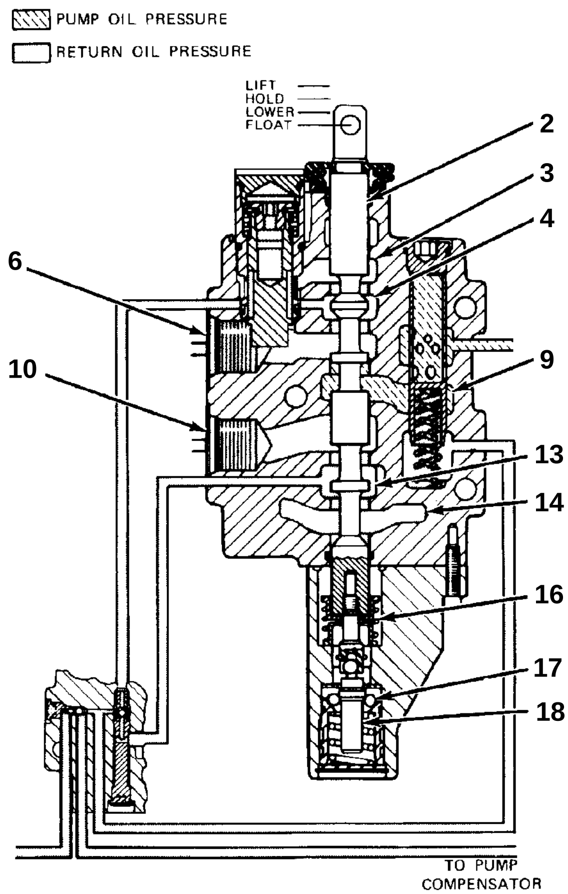
When the control valve is shifted from HOLD to LOWER, control valve spool (2) opens passage to rod end of cylinder (10) and signal passage (13) to drain passage (14). Shifting from HOLD to LOWER also opens passage to head end of cylinder (6) and signal passage (4) to pump pressure from passage (9).

As in the LIFT mode, passage to head end of cylinder (6) opens to signal passage (4) slightly before it opens to passage (9), and the cylinder head end pressure is sent to primary resolver (19). From this point, the operation of the primary resolver, secondary resolver (15), and flow control spool (7) is identical to their operation in the RAISE position.

Spring (16) is being compressed from the top in the LOWER position. When the control lever is released, spring (16) pushes flow control spool (7) and the control lever back into the HOLD position.

When the lift cylinder rods are extended faster than the pump can fill the head end of the cylinders, makeup valve (1) is employed. This condition occurs during rapid blade lowering. (Refer to “Makeup Valve” in this section.)

FLOAT Position

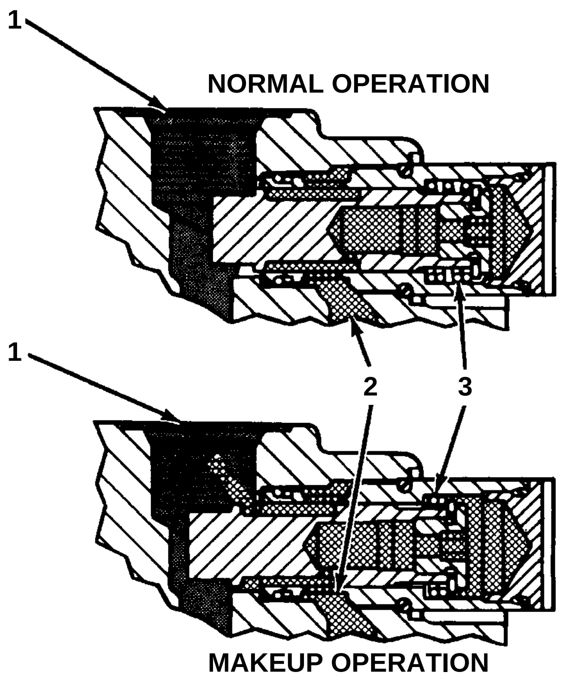


Blade Lift Valve, FLOAT Position.
(2) Control valve spool. (3) Drain passage. (4) Signal passage. (6) Passage to head end of cylinder. (9) Passage. (10) Passage to rod end of cylinder. (13) Signal passage. (14) Drain passage. (16) Spring. (17) Detent balls. (18) Pin.

When the control valve is shifted to the FLOAT position, control valve spool (2) is moved all the way down from the HOLD position. Spring (16) is fully compressed from the top. Detent balls (17) pass over the detent ridge on pin (18) and hold the control valve spool in the FLOAT position. Spring (16) does not have enough force to pull the detent balls back past the detent ridge. The control valve spool is held in FLOAT until the operator moves the control lever out of FLOAT.

With the control valve in the FLOAT position, control valve spool (2) blocks pressure oil in passage (9). Both passages to head end (6) and rod end (10) of cylinders, and signal passages (4) and (13) are open to drain passages (3) and (14). Since the cylinder rod and head ends are open to the drain, the blade follows the shape of the ground.

Makeup Valve

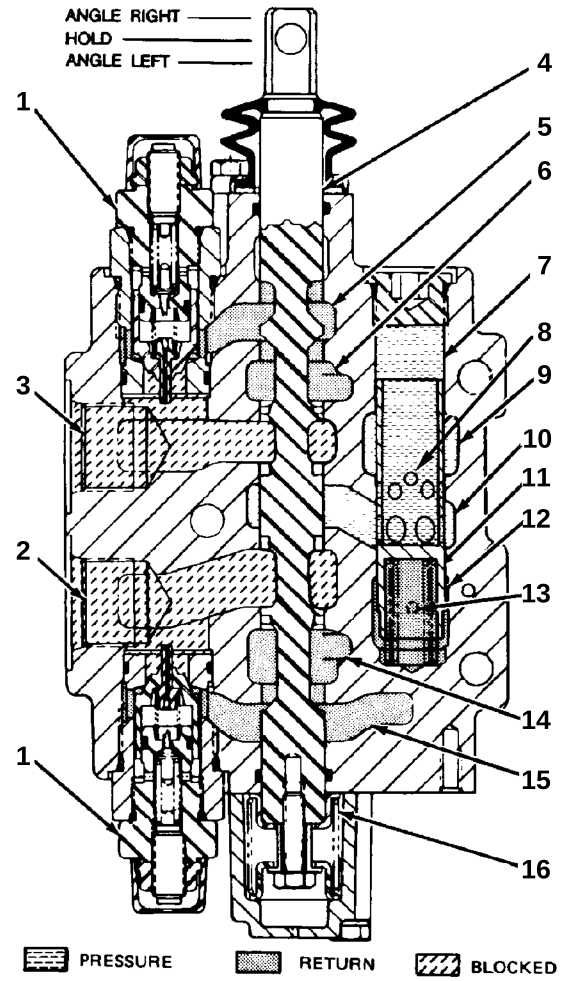


Makeup Valve.
(1) Passage to head end of blade lift cylinders (2) Drain passage. (3) Spring.

The makeup valve is in the passage to head end of blade lift cylinders (1). When there is pressure in the head end of the blade lift cylinders, the makeup valve is held closed. However, when the blade is lowered rapidly, the pressure in drain passage (2) is greater than the pressure in passage (1). Since drain passage pressure is felt in the makeup valve cavity, the pressure moves the valve to the left, compressing spring (3). Drain oil can now flow into the head end of the lift cylinders.

Blade Angle Control Valve

HOLD Position



Angle Valve, HOLD Position.
(1) Makeup and relief valves. (2) Port to rod end of right angle cylinder and head end of left angle cylinder. (3) Port to rod end of left angle cylinder and head end of right angle cylinder. (4) Control valve spool. (5) Passage to tank. (6) Signal passage to primary resolver. (7) Spool. (8) Holes. (9) Pump passage. (10) Passage. (11) Spring. (12) Signal cavity. (13) Signal port. (14) Signal passage to primary resolver. (15) Passage to tank. (16) Spring.

The blade angle control valve section is located between the end cover and the tilt control valve section.

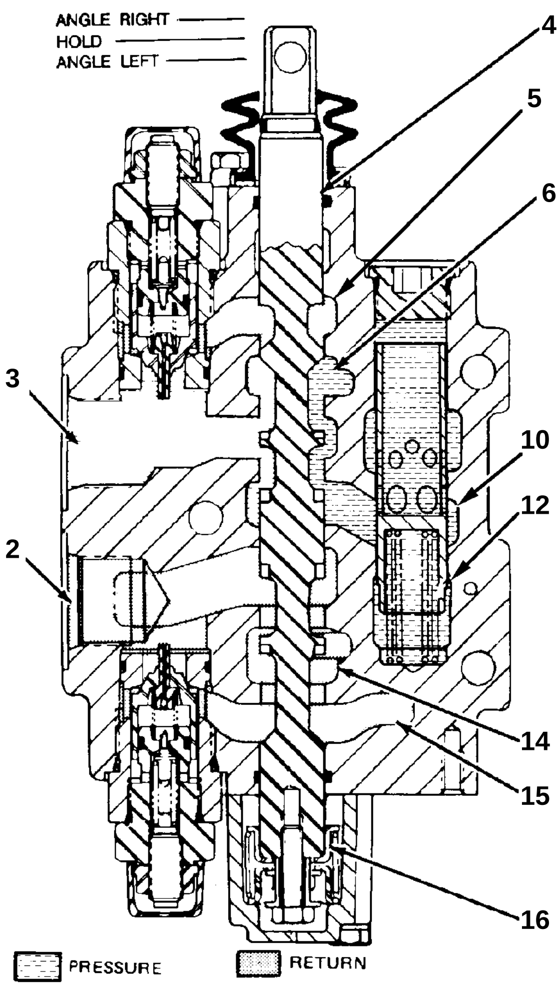
Spring (16) on the end of control valve spool (4) is compressed when the spool is moved to either the angle RIGHT or angle LEFT position. The spring moves the control valve spool and the control lever to the HOLD position when the spring is released.

Pump oil from the tilt control section enters the angle valve section through pump passage (9), which has no outlet. The pump passage is common to all of the valve sections. Pump oil goes through holes (8) into spool (7). This causes the spool to move down against the combined signal pressure from signal port (13) and the force of spring (11) in signal cavity (12). When holes (8) begin to close off the pump passage, a restriction is created which limits pressure inside spool (7) to 415 kPa (60 psi) greater than the pressure in the signal cavity. The pressure inside spool (7) is the same as the pressure in passage (10).

In the HOLD position, control valve spool (4) stops pressure oil in passage (10) from going into ports (2) and (3). The oil in port (3) to the rod end of the left angle cylinder and the head end of right angle cylinder is blocked. The oil in port (2) to the rod end of the right angle cylinder and the head end of the left angle cylinder is also blocked. The blade is now held in position. The oil in passage to tank (5), signal passage to primary resolver (6), signal cavity (12), signal passage to primary resolver (14), and passage to tank (15) goes to the drain.

Spring (16) now holds spool (4) in this position.

Angle LEFT Position

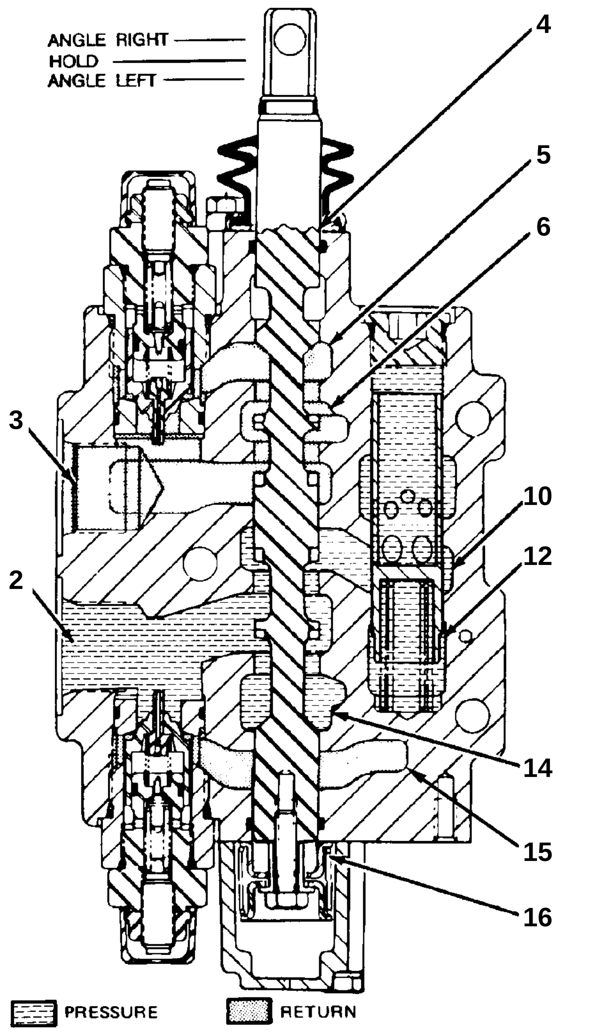


Angle Valve, Angle LEFT Position.
(2) Port to rod end of right angle cylinder and head end of left angle cylinder. (3) Port to rod end of left angle cylinder and head end of right angle cylinder. (4) Control valve spool. (5) Passage to tank. (6) Signal passage to primary resolver. (10) Passage. (12) Signal cavity. (14) Signal passage to primary resolver. (15) Passage to tank. (16) Spring.

In the angle LEFT position, control valve spool (4) is moved down. Oil from passage (10) now goes around the spool into port (3). Most of the oil goes to both the rod end of the left angle cylinder and the head end of the right angle cylinder. Some of the oil in port (3) goes through signal passage (6) to the resolver network where it adjusts the pump as required by the load. The oil from the head end of the left angle cylinder and the rod end of the right angle cylinder is forced through port (2), around spool (4), through signal passage (14), and to the tank through passage to tank (15). In angle LEFT position, pressure in signal cavity (12) is equal to the pressure in passage (6).

Spring (16) is compressed from the top in this spool position. When the control lever is released, the spring returns to the normal position. This pushes the control lever back into HOLD position. Refer to “Line Relief and Makeup Valve (Pilot Operated),” in this module, for the operation of item (1).

Angle RIGHT Position

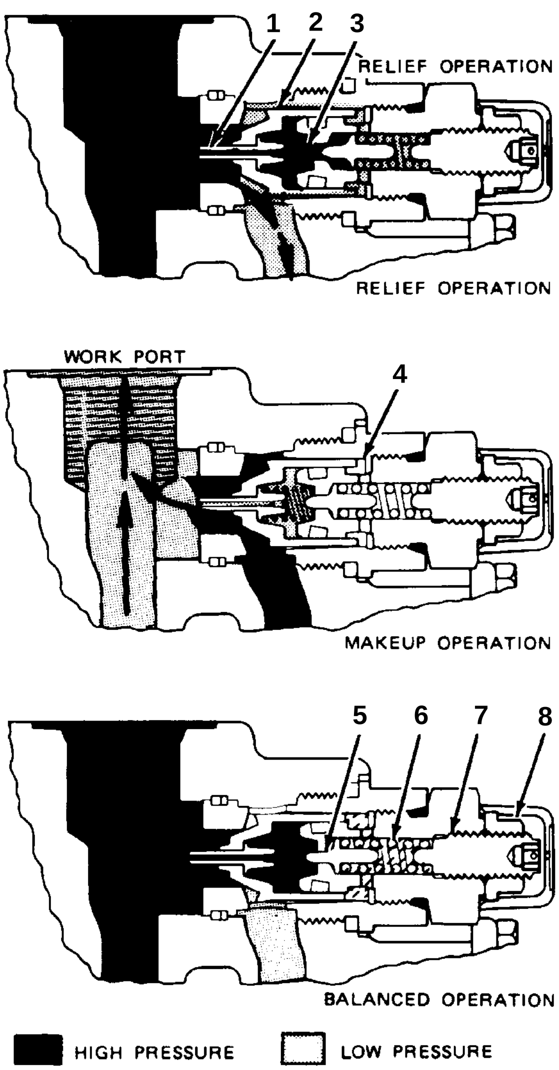


Angle Valve, Angle RIGHT Position.
(2) Port to rod end of right cylinder and head end of left cylinder. (3) Port to rod end of left cylinder and head end of right cylinder. (4) Control valve spool. (5) Passage to tank. (6) Signal passage to primary resolver. (10) Passage. (12) Signal cavity. (14) Signal passage to primary resolver. (15) Passage to tank. (16) Spring.

In the angle RIGHT position, control valve spool (4) is moved up. Oil from passage (10) now goes around the spool into port (2). Most of the oil goes to both the head end of left the angle cylinder and the rod end of the right angle cylinder. Some of the oil in port (2) goes through signal passage to primary resolver (14) and on to the resolver network to adjust the pump as required by the load. The oil from the rod end of the left angle cylinder and the head end of the right angle cylinder is forced through port (3), around the control valve spool, through signal passage (6) and to the tank through passage to tank (15). In angle RIGHT position, pressure in signal cavity (12) is equal to the pressure in the passage to the primary resolver.

Spring (16) is compressed from the top in this spool position. When the control lever is released, the spring returns to the normal position. This pushes the control lever back into HOLD position. Refer to “Line Relief and Makeup Valve (Pilot Operated),” in this module, for the operation of item (1).

Line Relief and Makeup Valve (Pilot Operated)



Valve Cross Section.
(1) Passage to spring chamber. (2) Valve. (3) Spring. (4) Passage to tank. (5) Pilot valve. (6) Spring. (7) Screw. (8) Lock nut.

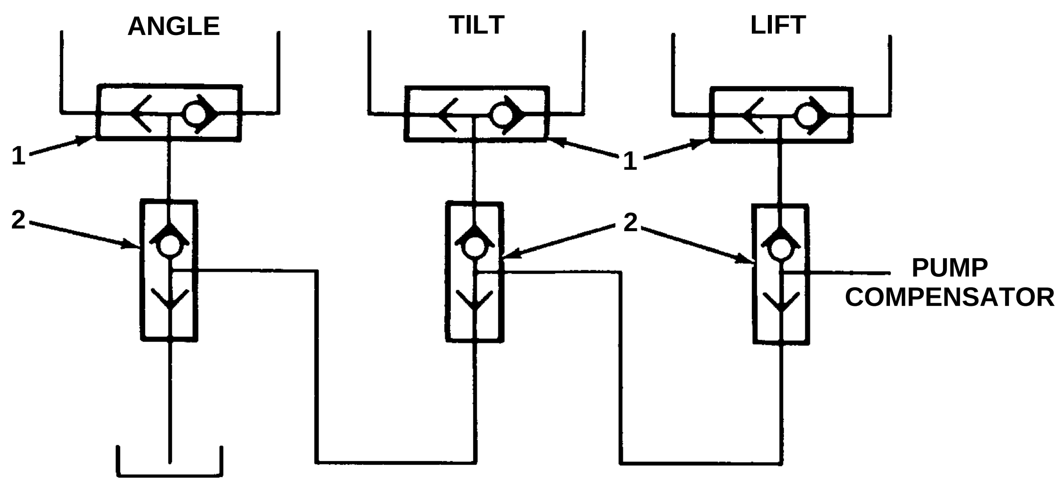
The relief valve is a pilot-type valve. Work port oil flows through passage (1) and into the spring chamber. This pressure and spring (3) hold valve (2) closed. The pressure of the oil also acts against pilot valve (5), which is held closed by spring (6).

When the oil in the chamber of spring (3) has more pressure than the force of spring (6), pilot valve (5) opens (moves right). The oil in the chamber of spring (3) now goes past the open pilot valve. This oil goes through passage to tank (4), faster than oil which comes through passage to spring chamber (1). With only the force of spring (3) on valve (2), the pressure of the work port oil against valve (2) opens the valve, and the work port oil goes to the tank. The open relief keeps the pressure of the work port oil from going higher than the setting of the relief valve.

The relief valve is also a makeup valve. Often the pressure of the pump oil which goes to the cylinder(s) is less than the pressure of the return oil from the cylinder(s). Therefore, the oil pressure in the chamber of spring (3) is also less than the return oil pressure. When the pressure of the return oil has more force on valve (2) than spring (3) has on the valve, the valve opens (moves right). The return oil now goes past valve (2) into the pump oil. The pressure of the pump oil and return oil becomes the same.

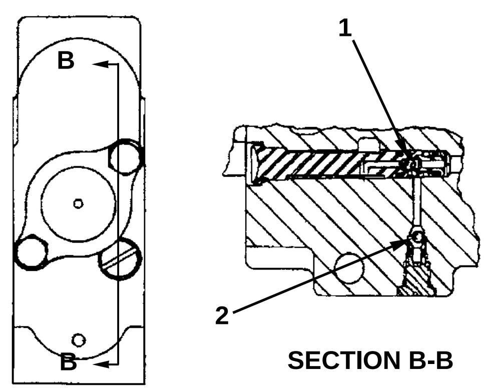
If the relief valve setting needs adjustment, screw (7) is turned in the direction needed to get either a pressure decrease or pressure increase. Lock nut (8) is used to keep the screw from turning after the adjustment is made.

Signal Resolver Network



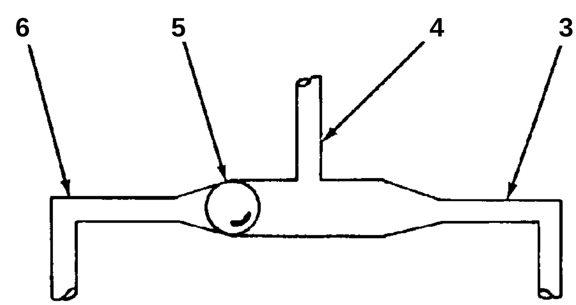
Resolver Network Line Schematic.
(1) Primary resolvers. (2) Secondary resolvers.

Each control valve section in the implement hydraulic system has two resolver check valves. Each resolver check valve compares two pressure signals. The higher of the two signals goes to the next resolver. One of the check valves is called the "primary resolver." The other check valve is called the "secondary resolver."

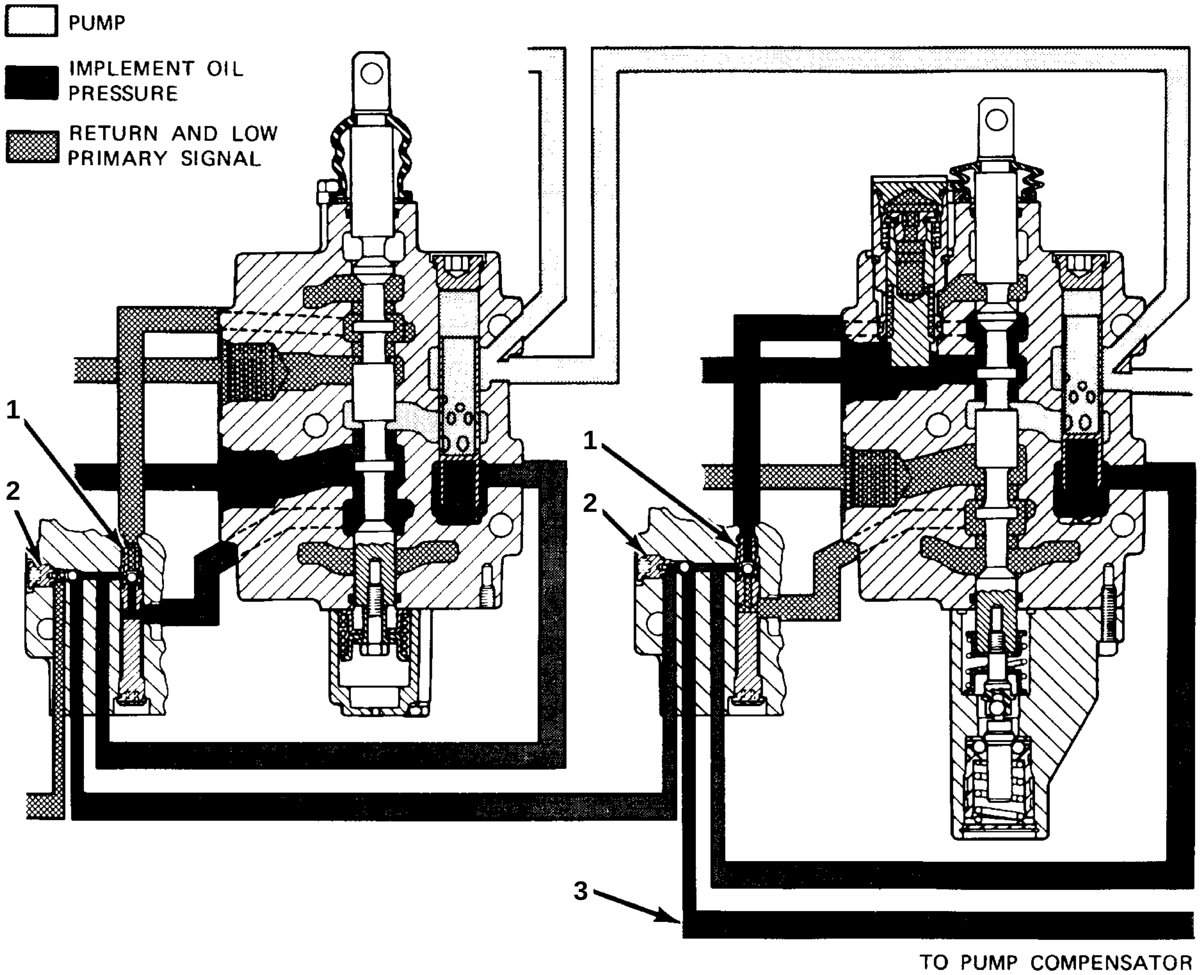


Typical Control Valve.
(1) Primary resolver. (2) Secondary resolver.

Primary resolver (1) is installed parallel to the control spool. The ball check is built into the resolver. Secondary resolver (2) is installed perpendicular to the primary resolver. The ball check is not contained in a housing. A plug holds the ball check in the valve body.



Check Valve.
(3) Signal line from cylinder head end. (4) Outlet line. (5) Ball check. (6) Signal line from rod end.



Partial Resolver Network Section Schematic.
(1) Primary resolver. (2) Secondary resolver. (3) Signal line.

Primary resolver (1) compares the head end pressure of the cylinder to the rod end pressure of the same cylinder.

In the previous illustration, the head end pressure in signal line from cylinder head end (3) is greater than the rod end pressure in signal line from rod end (6). The head end pressure forces ball check (5) right. This blocks line (6). The pressure in line (3) is now the highest resolved pressure in this resolver. This pressure can now go through outlet line (4) to the next resolver.

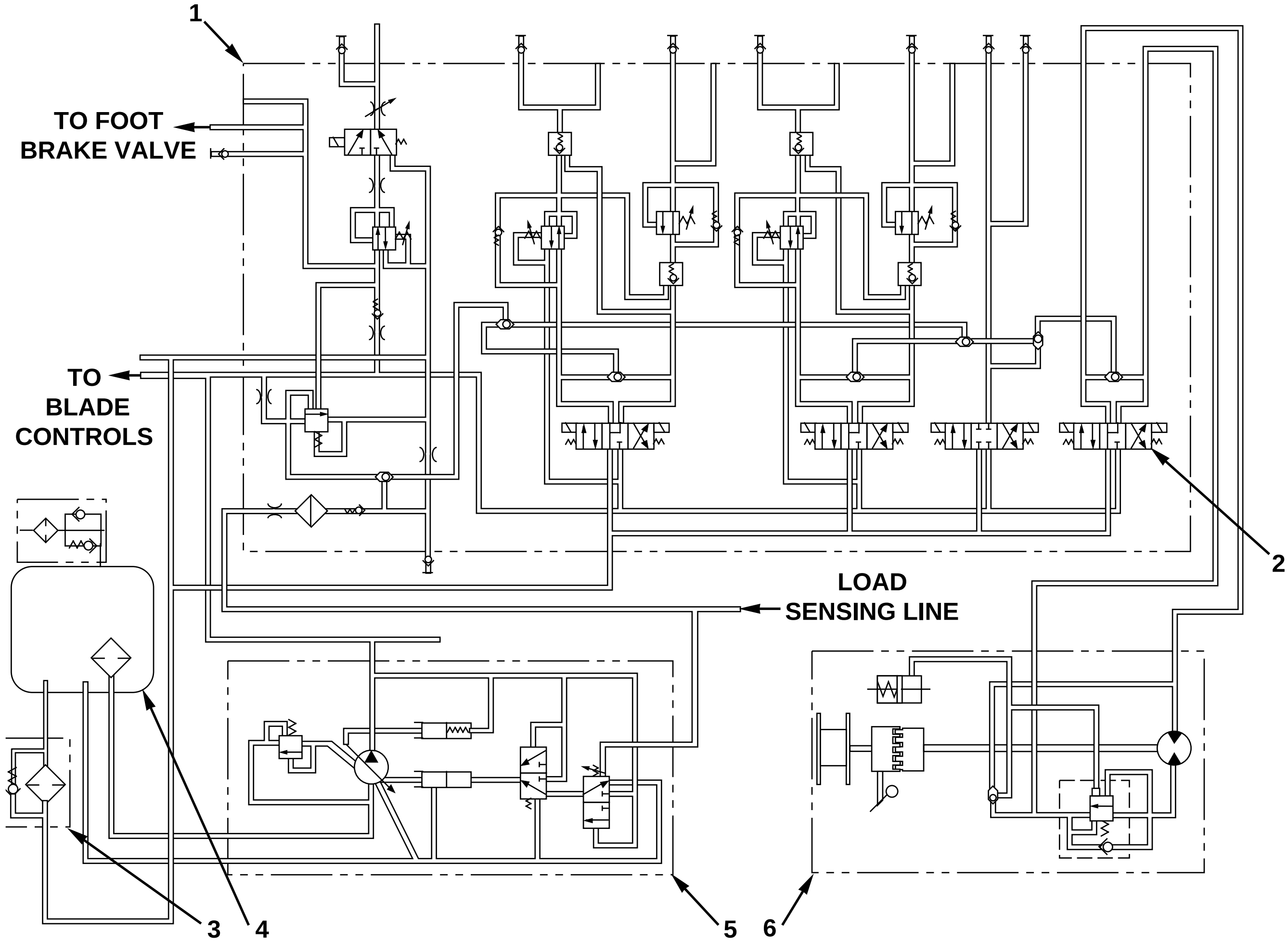
Secondary resolver (2) in each valve section compares the highest primary pressure signal in its control valve to the highest resolved signal from the previous control valve.

The highest resolved signal from the implement control valve group goes to the compensator valve on the pump. This signal then instructs the pump to vary output to meet the highest resolved load requirements. The pump compensator valve adds margin pressure to the load requirements. Note that the resolver network does not join the various loads. Instead, the single highest resolved load plus margin pressure governs pump output. Therefore, the entire system is supplied with 2070 ± 345 kPa (300 ± 50 psi) more pressure than necessary to handle the single largest load. The pump does not change output until the resolver network identifies a different highest resolved signal.

In the illustration above, the implement oil (work port) pressure for both valves is shown to be the same. If these pressures are different, the pressure in signal line (3) to the pump compensator is equal to the higher of the two work port pressures.

When two or more control valves are shifted at the same time and the system demand increases to a point greater than pump oil flow capacity, the control valve with the lower signal pressure gets flow first, with any excess going to the other sections.

Winch Hydraulic System



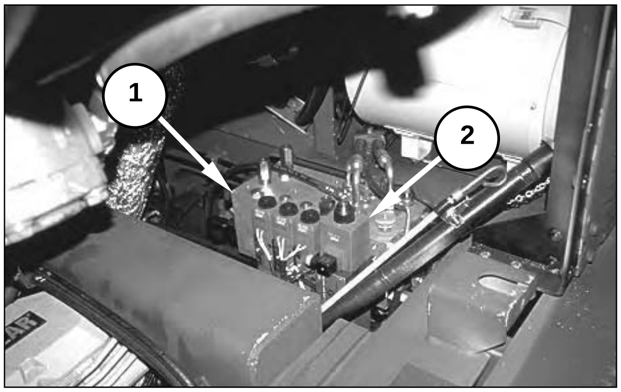
Winch System Hydraulic Schematic.
(1) Multifunction control valve. (2) Winch control valve. (3) Return filter. (4) Hydraulic tank. (5) Hydraulic pump. (6) Winch assembly.

The implement hydraulic system controls the operation of the blade, winch, brake, and undercarriage suspension. Each system shares the pump and hydraulic tank. The winch hydraulic system controls the winch.

The winch hydraulic system consists of winch control valve (2), return filter (3), hydraulic tank (4), hydraulic pump (5), and winch assembly (6). The winch control valve is part of multifunction control valve (1).

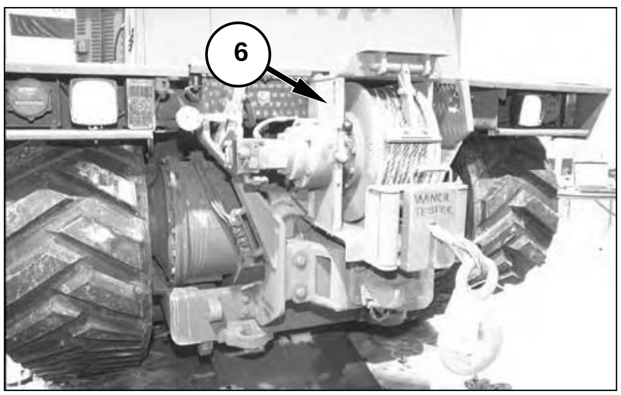
NOTE: For a description of the function and location of return filter (3), hydraulic tank (4), and hydraulic pump (5), refer to “Blade Hydraulic System” in this module.

Component Location



Left Side of Machine.
(1) Multifunction control valve. (2) Winch control valve.

Winch control valve (2) is part of multifunction control valve (1). The winch control valve is a solenoid-operated hydraulic valve.



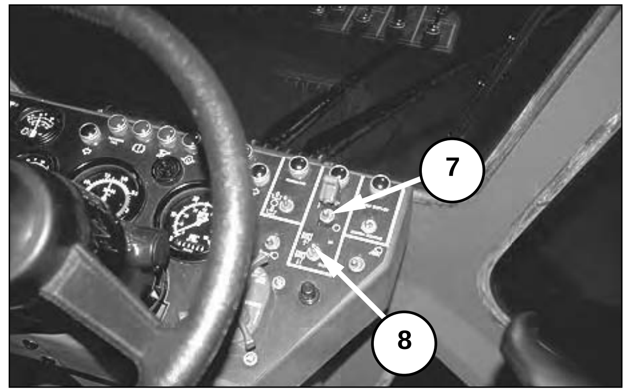
Rear of Machine.
(6) Winch assembly.

Winch assembly (6) is mounted on the rear of the machine, above the pintle hook. When loaded with one layer of five-eights inch cable, the winch has a pulling capacity of 97 856 N (22,000 lb).

NOTE: The greater the quantity of cable loaded on the winch, the lower the rated pulling capacity. When loaded with five layers of five-eights inch cable, the winch has a pulling capacity of 67 610 N (15,200 lb).

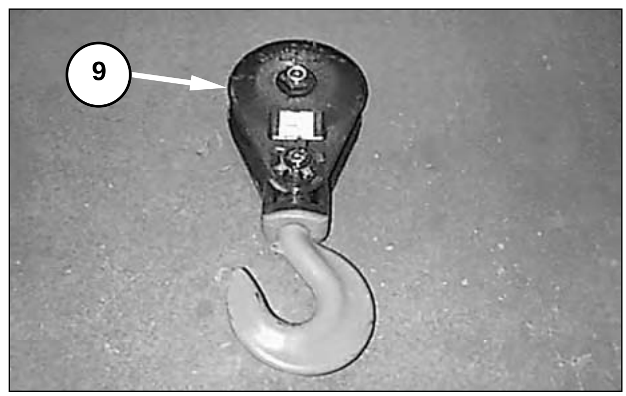
The winch is driven by a hydraulic motor and contains an integral brake and gear reducer. The winch brake is spring applied and hydraulically released. System pressure which is used to drive the winch releases the brake.

The winch also contains a counterbalance valve in the haul-in circuit which hydraulically locks the winch in place if there is a loss of pressure in the circuit.



Instrument Panel.
(7) Winch enable switch. (8) Winch control switch.

The winch is operated by a set of switches mounted on the instrument panel in the operator's compartment. Winch enable switch (7) enables the winch to be controlled by winch control switch (8). The cover on the winch enable switch protects against accidental winch operation.



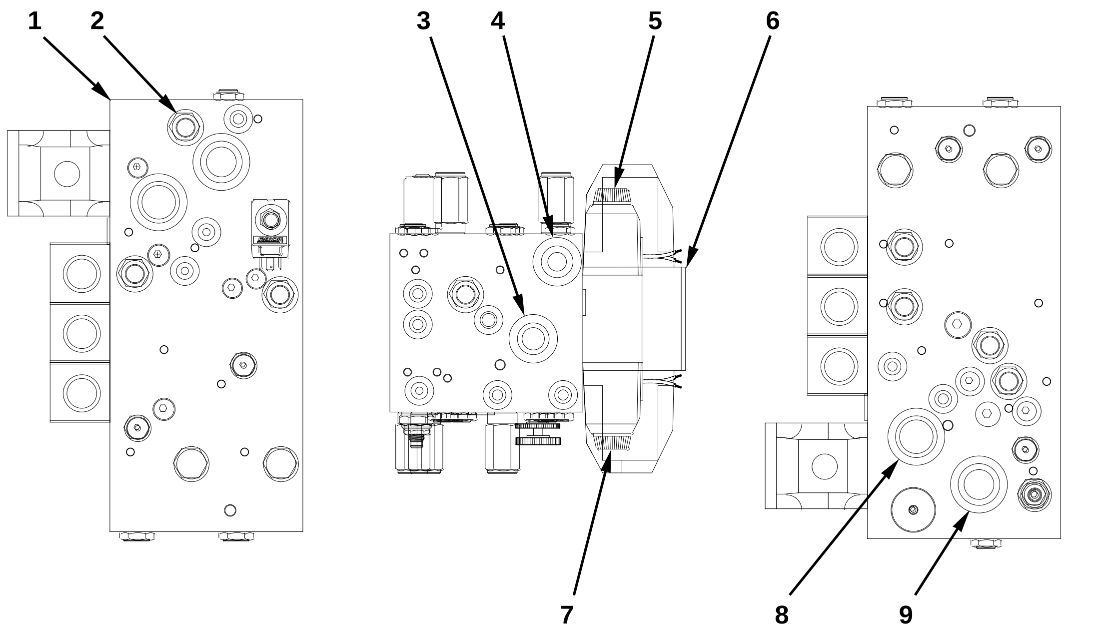
View of Doubling Block.
(9) Doubling block.

The machine is also equipped with doubling block (9) which doubles the pulling capacity of the winch. The pulling capacity can be doubled by running the winch cable around the doubling block pulley and attaching the end of the winch cable to the machine.

NOTE: Doubling block (9) is normally stored in the basic issue items (BII) box at the rear of the machine. Refer to "Operation Section, Machine Operation, Winch Operation" *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE)* for the doubling block installation instructions.

System Operation

Winch Control Valve



Multifunction Control Valve Group.
(1) Multifunction control valve. (2) Winch valve resolver. (3) Haul-in port. (4) Payout port. (5) Haul-in solenoid. (6) Winch control valve. (7) Payout solenoid. (8) Return port. (9) Pump pressure port.

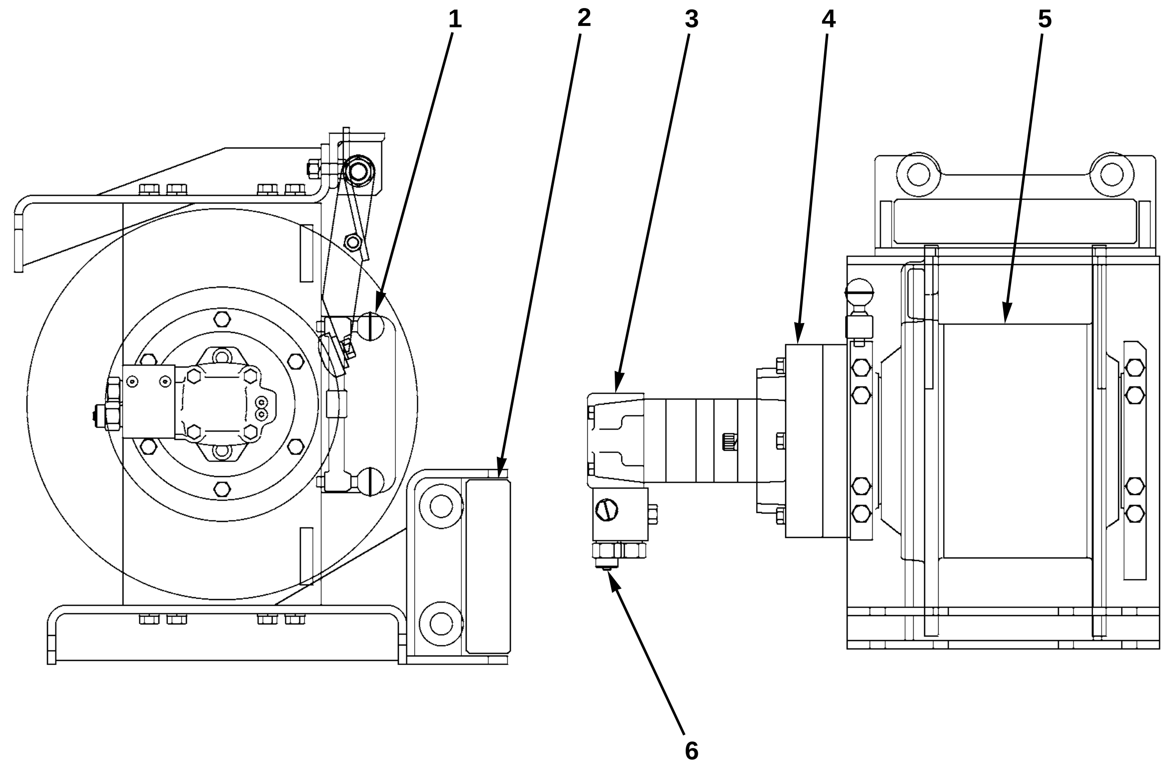
When the winch control switch is moved into the IN position and the winch enable switch is ON, haul-in solenoid (5) is activated. When the haul-in solenoid activates, winch control valve (6) shifts. This shift allows pressure oil that is flowing into multifunction control valve (1) through pump pressure port (9) to flow to the winch motor from haul-in port (3). Pressure oil turns the winch motor, which reels in the winch cable.

The winch supply pressure in haul-in port (3), which increases due to the torque on the winch motor, moves winch valve resolver (2). The winch supply pressure oil flows through the load sensing port on multifunction control valve (1) to the load sensing port on the implement hydraulic pump and upstrokes the pump.

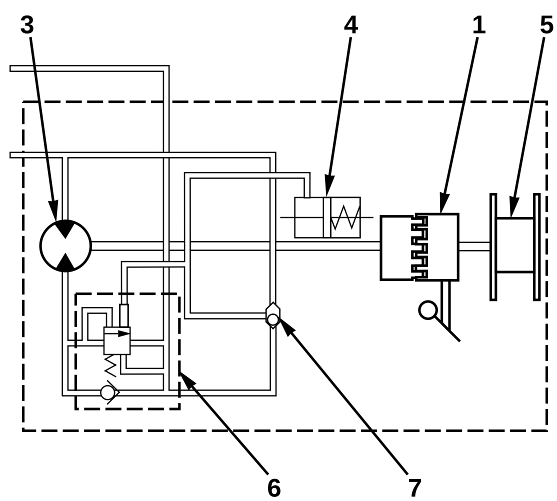
As the winch begins to turn, oil in the return side of the winch hydraulic circuit enters multifunction control valve (1) through payout port (4) and returns to the tank through return port (8).

When the winch control switch is moved into the OUT position, payout solenoid (7) is activated. The components in the winch control valve function in a similar manner for haul-in operation, except the pump pressure and return pressure ports are switched.

Winch Assembly



Winch Assembly.
(1) Clutch. (2) Fairlead. (3) Hydraulic motor. (4) Brake. (5) Spool. (6) Counterbalance valve.



Winch Assembly Schematic.
(1) Clutch. (3) Hydraulic motor. (4) Brake. (5) Spool.
(6) Counterbalance valve. (7) Resolver.

Pump pressure oil from the winch control valve turns hydraulic motor (3). Oil from the high pressure side of the motor flows through resolver (7) to release the spring applied brake (4).

When hydraulic motor (3) is operating in the payout direction, counterbalance valve (6) receives pressure from the high pressure side of the loop, through resolver (7). The pressure from the high pressure side of the loop opens the counterbalance valve to allow oil from the return side of the motor to flow back to the tank.

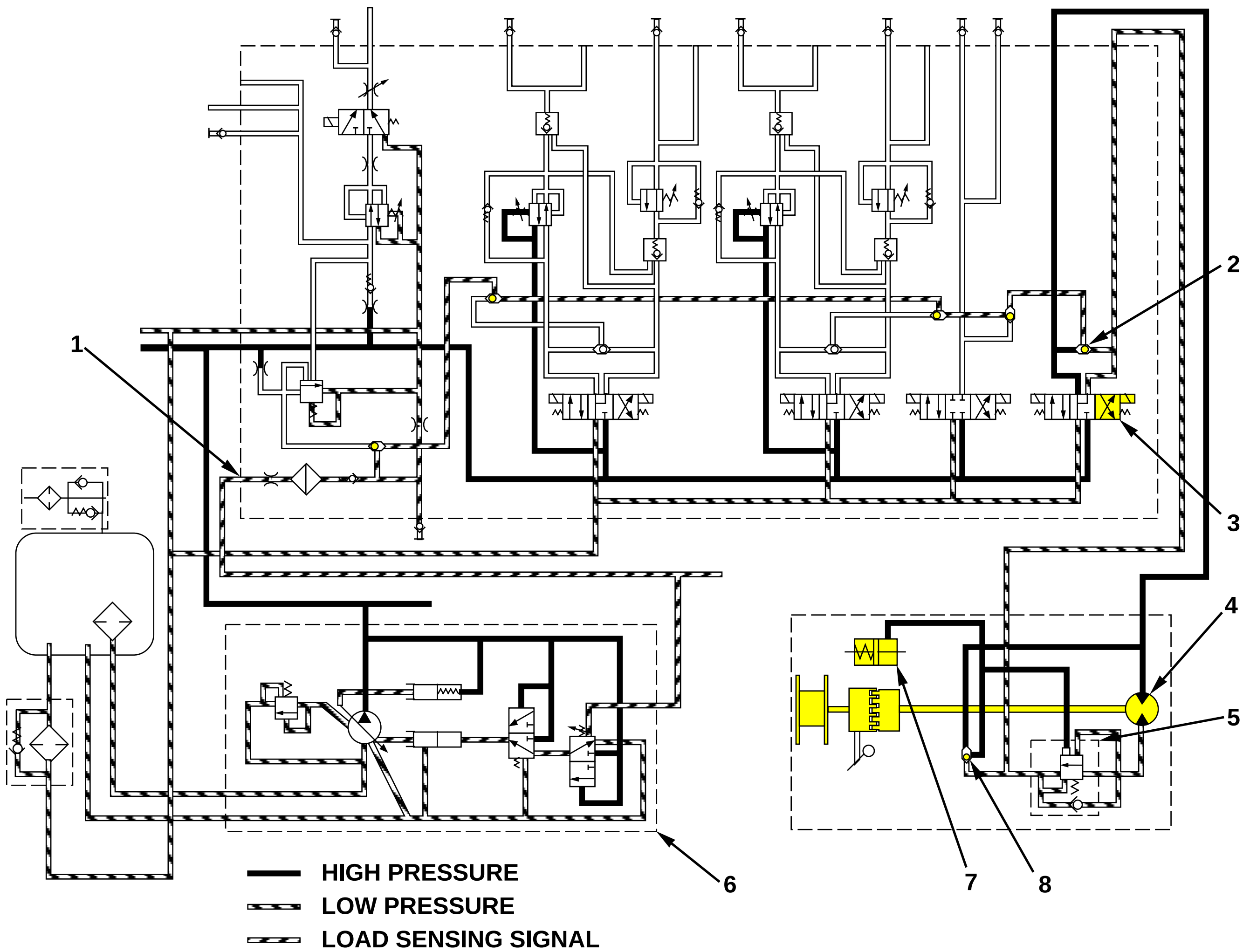
Counterbalance valve (6) protects against a possible loss-of-load retention should a sudden loss of pressure (hose rupture) in the haul-in pressure line occur. The counterbalance valve will remain closed and prevent oil from flowing out of the motor unless pressure is applied to the payout side of the motor.

The winch assembly contains mechanical clutch (1) which allows the winch to free spool. When the clutch lever is in the DISENGAGED position, the winch drive line is disconnected and spool (5) can rotate freely to payout cable. When the clutch lever is in the ENGAGED position, the spool is splined to the motor drive line and is held in position by brake (4) and the hydraulic lock on the motor.

Spool (5) contains a two-stage set of planetary reduction gears to increase the torque provided by hydraulic motor (3).

Winch Circuit Operation

HAUL IN



Winch System Hydraulic Schematic, HAUL IN.
(1) Load sensing signal port. (2) Winch valve resolver. (3) Winch control valve. (4) Winch motor. (5) Counterbalance valve. (6) Hydraulic pump. (7) Brake. (8) Winch motor resolver.

When the winch enable switch is ON and the winch control switch is held in the IN position, current flows to the solenoid on winch control valve (3) and shifts the valve to the left. Shifting the winch control valve to the left directs supply oil from hydraulic pump (6) to winch motor (4).

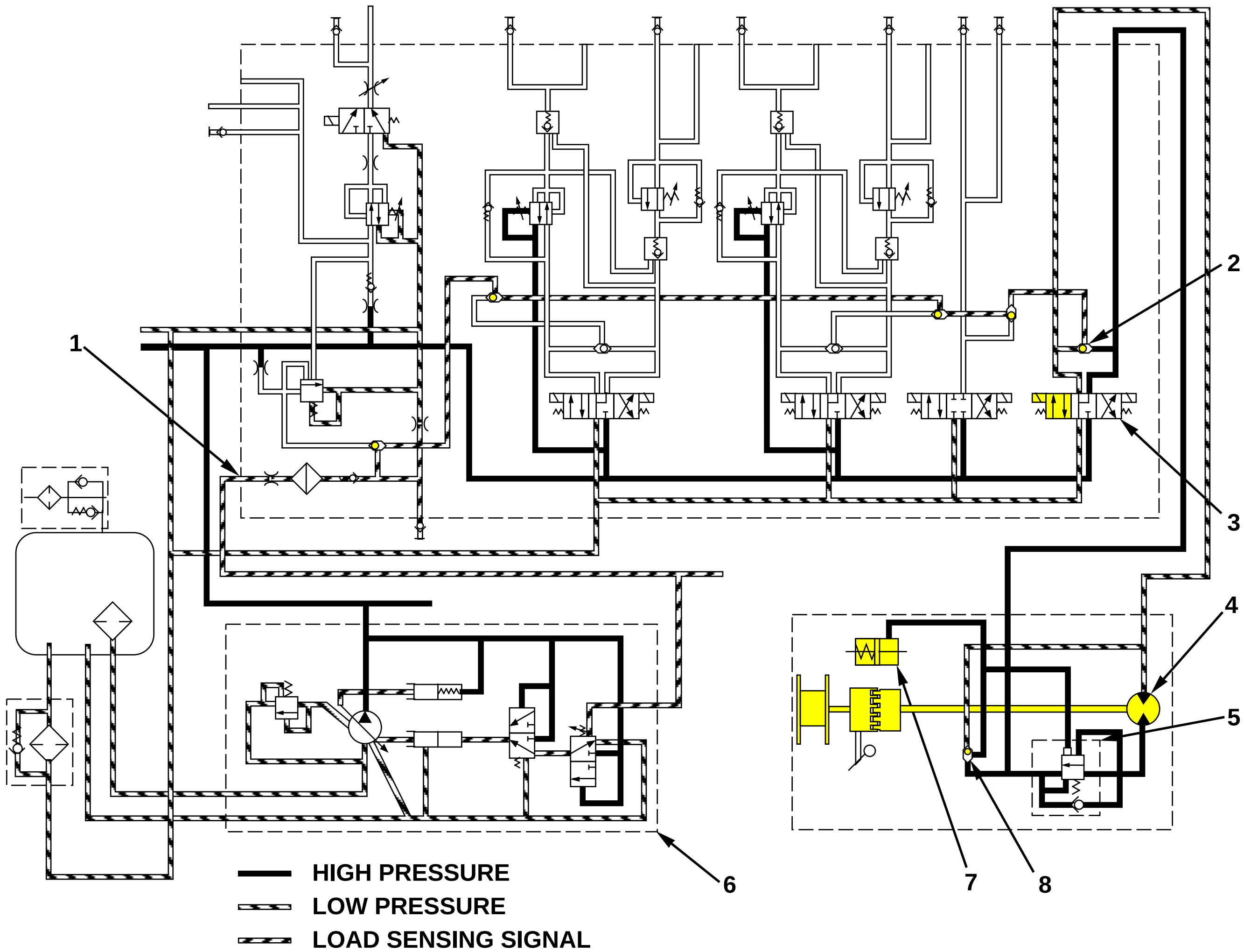
Pump pressure oil also flows through resolver (2) and flows out load sensing signal port (1). The load sensing signal goes back to the pump to establish the correct amount of flow for the load on the winch.

NOTE: For a description of the operation of hydraulic pump (6), refer to “Blade Hydraulic System, System Operation” in this module.

Pump pressure oil flowing through winch motor resolver (8) releases brake (7).

As winch motor (4) turns, oil flows out of the motor, through counterbalance valve (5) and winch control valve (3), before flowing through the return hydraulic filter and back to the hydraulic tank.

PAY OUT



Winch System Hydraulic Schematic, PAY OUT.
(1) Load sensing signal port. (2) Winch valve resolver. (3) Winch control valve. (4) Winch motor. (5) Counterbalance valve. (6) Hydraulic pump. (7) Brake. (8) Winch motor resolver.

When the winch enable switch is ON and the winch control switch is held in the OUT position, current flows to the solenoid of winch control valve (3) and shifts the valve to the right. When the winch control valve shifts left, pump pressure oil is directed from hydraulic pump (6) to winch motor (4).

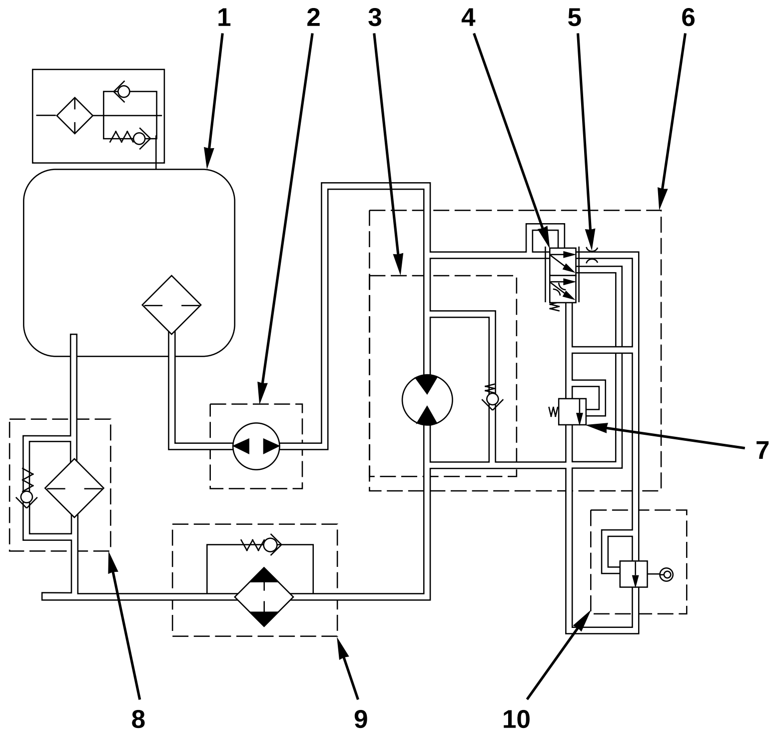
Pump pressure oil also flows through winch valve resolver (2) and flows out load sensing signal port (1). The load sensing signal goes back to the pump to establish the correct amount of flow for the load on the winch.

NOTE: For a description of the operation of hydraulic pump (6), refer to "Hydraulic Pump Operation" in "Blade System Operation" in this module.

Pump pressure oil flowing through winch motor resolver (8) releases brake (7).

As winch motor (4) turns, oil flows out of the motor, through counterbalance valve (5), which is held open by pump system pressure. Return oil from the motor flows through winch control valve (3) and the return oil hydraulic filter before flowing back to the hydraulic tank.

Cooling Fan System



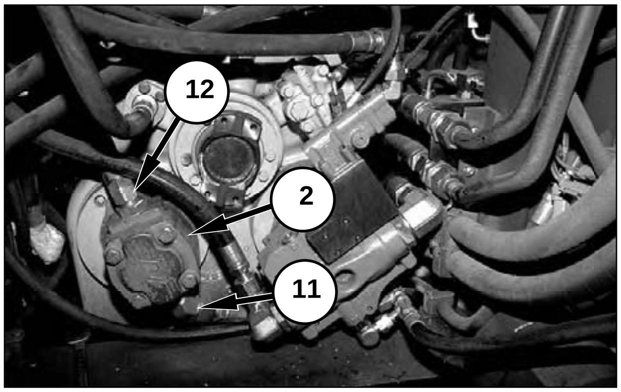
Cooling Fan System.
(1) Hydraulic tank. (2) Fan hydraulic pump. (3) Fan motor. (4) Bypass spool. (5) Orifice. (6) Bypass control valve. (7) Bypass relief valve. (8) Hydraulic return filter. (9) Hydraulic oil cooler. (10) Temperature valve.

The implement hydraulic system controls the operation of the blade, winch and cooling fan. Each system shares a common hydraulic tank. The cooling fan system controls the cooling fan.

The major components in the cooling fan system are hydraulic tank (1), fan hydraulic pump (2), fan motor (3), bypass spool (4), orifice (5), bypass control valve (6), bypass relief valve (7), hydraulic return filter (8), hydraulic oil cooler (9), and temperature valve (10).

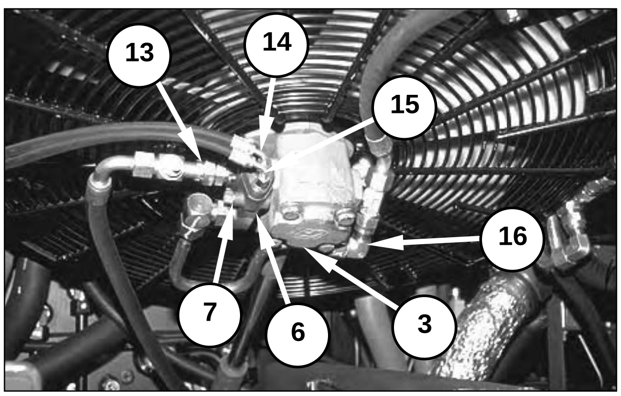
NOTE: For the function and location of hydraulic tank (1) and hydraulic return filter (8), refer to “Blade Hydraulic System” in this module.

Component Location



Rear, Left Side of Torque Converter.
(2) Fan hydraulic pump. (11) Suction line. (12) Outlet line.

Fan hydraulic pump (2) is driven off the rear, left side of the torque converter. The gear-type pump draws oil from the hydraulic tank through suction line (11), and sends supply oil to the fan motor and bypass control valve through outlet line (12).

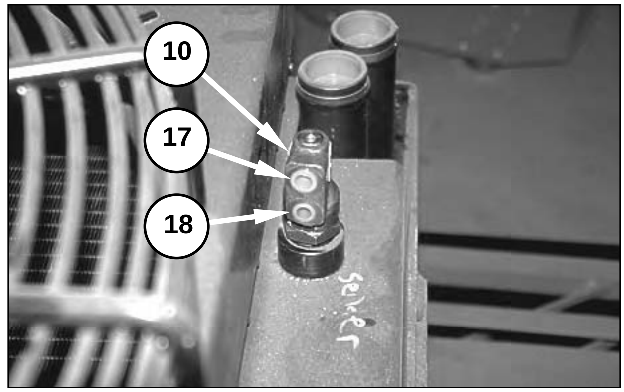


Left Side of Machine, Radiator Raised.
(3) Fan motor. (6) Bypass control valve. (7) Bypass relief valve. (13) Inlet port. (14) Outlet port. (15) Inlet port. (16) Return port.

Fan motor (3) is mounted on the bottom of the radiator group. The fan motor is a gear-type hydraulic motor that rotates a suction fan.

Bypass control valve (6) is mounted to fan motor (3). Pump supply oil enters the bypass control valve through inlet port (13). The position of the bypass spool determines the fan motor speed by controlling the volume of pump supply oil which flows through the fan motor. Bypass relief valve (7) limits the maximum speed of the fan.

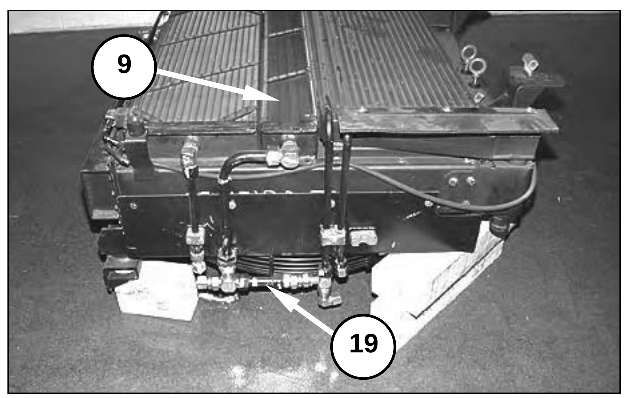
Outlet port (14) directs oil to the temperature valve. Oil returns from temperature valve (10) through inlet port (15). Return oil from bypass control valve (6) flows out of return port (16) and through the hydraulic oil cooler and return filter before returning to the hydraulic tank.



Right Rear Corner of Radiator, Radiator Removed.
(10) Temperature valve. (17) Inlet port. (18) Outlet port.

Temperature valve (10) is a wax-filled temperature transducer mounted in the radiator. When the engine coolant temperature is below 90°C (194°F), the temperature valve is open. As the temperature of the coolant reaches 90°C (194°F), the wax in the transducer begins to melt, causing the temperature valve to close.

Temperature valve (10) determines the position of bypass spool (4) and the bypass relief valve (7). The temperature valve receives flow from the bypass control valve through inlet port (17) and directs flow back to the bypass control valve through outlet port (18).

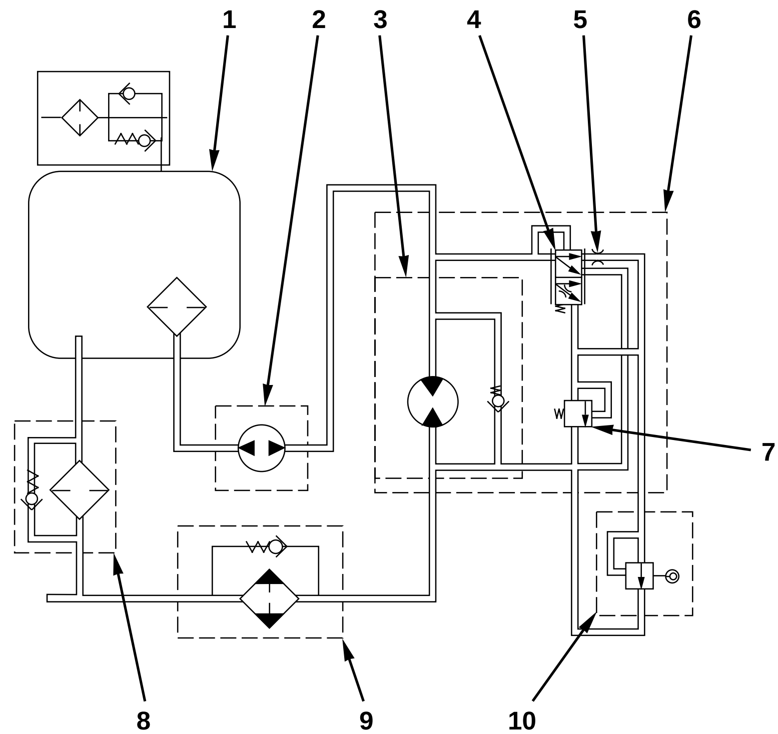


Radiator Group, Air Conditioning Condenser Removed.
(9) Hydraulic oil cooler. (19) Cooler bypass valve.

Hydraulic oil cooler (9) is part of the radiator group mounted behind the cab. The hydraulic oil flowing out to the fan motor then flows through the hydraulic oil cooler. Air pulled through the cooling fins on the hydraulic oil cooler transfers heat away from the hydraulic oil which is flowing through the cooler.

Cooler bypass valve (19) allows oil to flow around the cooler if the pressure at the cooler inlet is above 276 kPa (40 psi).

System Operation



Cooling Fan System.
(1) Hydraulic tank. (2) Fan hydraulic pump. (3) Fan motor. (4) Bypass spool. (5) Orifice. (6) Bypass control valve. (7) Bypass relief valve. (8) Hydraulic return filter. (9) Hydraulic oil cooler. (10) Temperature valve.

Fan hydraulic pump (2) generates flow when the engine is running. Supply oil from the fan hydraulic pump enters bypass control valve (6) and branches in two directions: to the inlet port of fan motor (3) and to bypass spool (4).

When the engine coolant temperature is below the fan cut in temperature (90°C [194°F]), temperature valve (10) is open, and the top envelope of bypass spool (4) is active. The top envelope of the bypass spool allows a large amount of pump supply oil to flow around fan motor (3), causing the motor to turn at the minimum speed.

When the engine coolant temperature rises above 90°C (194°F), the wax in temperature valve (10) begins to melt. The wax expands as it melts, causing the temperature valve to close. As the temperature valve closes, the pressure acting on the bottom of bypass spool (4) increases, and the spool begins to shift up. Shifting the bypass spool up allows more of the pump supply oil to flow through fan motor (3), causing the motor to rotate the fan at a higher rate.

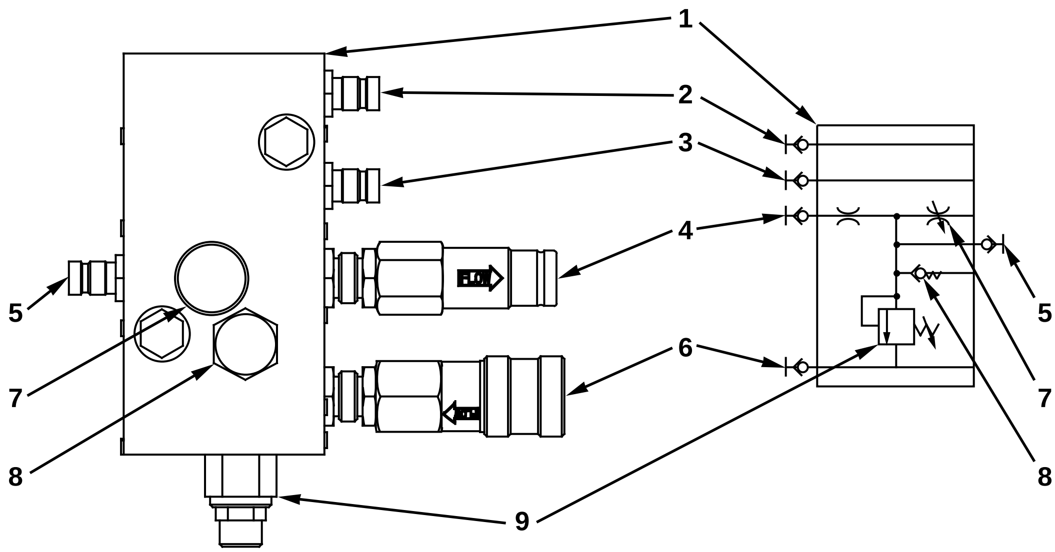
When the pressure acting against the bottom of bypass spool (4) reaches 13 027 kPa (1888 psi), bypass relief valve (7) opens, and the bypass spool does not shift any higher. Opening the bypass relief valve limits the maximum fan speed to 1900 ± 150 rpm.

The fan speed increases from minimum to maximum speed over a temperature range of approximately 6.7 to 8.3°C (12 to 15°F). This fan speed modulation range decreases wear in the system and allows intermediate levels of cooling, based on the engine coolant temperature.

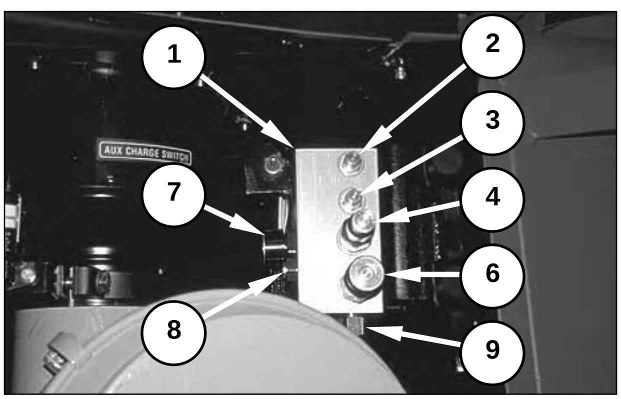
As the engine coolant temperature decreases, the wax in temperature valve (10) begins to solidify, causing the valve to open. The pressure acting against the bottom of bypass valve spool (4) decreases, and the bypass spool shifts down. This allows more of the pump supply oil to flow around fan motor (3), decreasing the speed of the fan motor. The fan motor returns to the minimum speed when the engine coolant temperature reaches 87.5 ± 0.3°C (189.5 ± 0.5°F).

NOTE: The delay between the melting and solidification of the wax in temperature valve (10) causes a 2.2 to 2.8°C (4 to 5°F) hysteresis between the fan cut-in and cut-out temperatures.

Remote Hydraulic Power Manifold



Remote Hydraulic Power Manifold.
(1) Remote hydraulic power manifold. (2) Port. (3) Port. (4) Port. (5) Port. (6) Port. (7) Needle valve. (8) Check valve. (9) Relief valve.



Left Side of Machine, Air Filter Compartment.
(1) Remote hydraulic power manifold. (2) Port. (3) Port. (4) Port. (6) Port. (7) Needle valve. (8) Check valve. (9) Relief valve.

Remote hydraulic power manifold (1) is located inside the air filter compartment, on the left side of the machine. Using the remote hydraulic power manifold, the machine hydraulic system can provide power to remote hydraulic tools, the park brake can be manually released, and the blade can be manually lifted.

Remote hydraulic power manifold (1) has five ports (2, 3, 4, 5, and 6), a needle valve (7), a check valve (8), and a relief valve (9). Port (2) allows oil from the suspension system to return to the tank when the procedure to release the hydraulic pressure in the accumulators is performed. Port (3) allows oil to be pumped into the park brake piston cavity when the park brake is manually released. Port (4) delivers pump supply oil to operate the remote hydraulic tools. Port (5) is a pressure tap for measuring pressure in the remote tool circuit. Port (6) returns the oil which is used to power the remote hydraulic tools to the tank.

Needle valve (7) controls the pump supply oil which flows into remote hydraulic power manifold (1). During normal operation, the needle valve should be closed.

When the remote hydraulic power manifold (1) is used to power remote hydraulic tools, check valve (8) opens, directing a load sensing signal to the implement pump. Relief valve (9) limits the pressure which reaches the remote hydraulic tools to 14 490 kPa (2100 psi).

Testing and Adjusting

⚠ WARNING

Some of the tests that follow must be done with the machine in operation. A trained machine operator will be needed. Whenever the engine is in operation, the machine operator must be in the cab with the parking and service brakes APPLIED, unless told differently.

With the engine running, this machine will spot turn when the steering wheel is turned, even if the transmission is in NEUTRAL.

To avoid personal injury due to unexpected movement, engage the parking brake and make sure the area is free of personnel before starting the engine.

At operating temperature, the hydraulic oil and components are hot. Any contact with the skin can cause severe burns.

Sudden movement of the machine or release of oil under pressure can cause injury to persons on or near the machine. To prevent possible injury, do the procedure that follows before testing and adjusting the hydraulic system.

1. Move the machine to a smooth horizontal location. Move away from working machines and personnel, and lower implements to the ground.

2. Permit only one operator on the machine. Keep all other personnel either away from the machine or in view of the operator.

3. Engage the parking brake.

4. Stop the engine.

5. Move the hydraulic control levers into and out of all positions to release the pressure in the hydraulic system.

6. Depress the brake pedal 120 times or more to relieve the pressure in the brake system accumulator.

7. Carefully loosen the filler cap on the hydraulic tank to release the pressure in the tank.

8. Make sure all hydraulic pressure is released before any fitting, hose or component is loosened, tightened, removed, or adjusted.

9. Tighten the filler cap on the hydraulic tank.

10. The pressure in the system has now been released and lines or components can be removed.

Procedure

When defining a hydraulic system problem, the following procedure should be followed. First, follow the procedures in “Visual Checks.” If the problem is not identified through a visual check, follow the procedures in “Operation Checks.” If the problem is still not identified, follow the procedures in “Instrument Tests.” As soon as the problem is identified, go to “Troubleshooting.” This section lists the probable causes of a known problem. Since there may be more than one cause for a problem, the “Troubleshooting” section may suggest specific inspections or instrument tests to be done. These inspections and tests help to identify which of the causes is most probable.

During a diagnosis of the hydraulic system, remember that correct oil flow and pressure are necessary for correct operation. The output of the pump (oil flow) increases with an increase in engine speed (rpm) and decreases when engine speed (rpm) is decreased. Oil pressure is caused by resistance to the flow of oil.

Use the 8T-5320 Hydraulic Test Group or the 4C-4892 Fitting Groups, a stop watch, a magnet, a thermometer and a millimeter (in) ruler for basic tests.

1. Measure drift rates in the implement circuits. Circuit drift is caused when oil leaks past the cylinder pistons, control valve spools, load check valves, or makeup valves. Excessive drift can result from problems with one or more components.

2. Measure cycle times in the implement circuits. Cycle times that are longer than shown in the charts are the result of leakage, pump wear and/or pump speed (rpm). If the basic operation checks indicate excessive circuit leakage, pressure tests are needed to determine which components have a problem.

Visual Checks

A visual inspection of the hydraulic system and its components is the first step to identify a problem. Stop the engine and lower the blade to the ground. To remove the tank filler cap, slowly turn the filler cap until the cap is loose. If oil comes out, let the tank pressure lower before removing the filler cap. Make the following inspections.

⚠ WARNING

Do not check for leaks with your hands. Pin hole (very small) leaks can result in a high velocity oil stream that is invisible close to the hose. This oil can penetrate the skin and cause personal injury. Use a piece of cardboard or paper to locate pin hole leaks.

1. Check all implement oil line connections for damage and leaks.
2. Follow all implement oil lines from the implement connections to the valve connections. Check the lines and connections for damage and leaks.
3. Check the control valves for leaks.
4. Check the pump and connections for damage and leaks.
5. Follow the pump lines to the tank and valves. Check the lines and tank for damage and leaks.
6. Check the tank oil level.
7. Use a clear bottle or container to get an oil sample from the tank immediately after the machine is stopped. Check for air bubbles in the oil sample.
8. Remove the filter element and check for particles which have been removed from the oil by the filter elements. A magnet can be used to separate ferrous particles from nonferrous particles (piston rings, O-rings, seals, etc.).
9. Inspect the blade control linkages for bent, broken or damaged components.

Troubleshooting

Troubleshooting Problem List

Hydraulic Pump and System

Blade System

Winch System Problem List

Cooling Fan System

2. Fan Runs at Maximum Speed With Engine Coolant Temperature Less Than 87.5 ± 0.3°C (189.5 ± 0.5°F) 6-66

Troubleshooting Problems

Troubleshooting Hydraulic Pump and System Problems

Problem 1: Oil Temperature Too High

Probable Cause(s):

- System load too high
- Wrong oil viscosity
- Low oil level
- Air in oil
- Hydraulic oil cooler externally plugged
- Restriction in oil passage(s)
- Hydraulic oil cooler internally restricted
- Flow compensator valve set wrong (margin pressure too high)
- Cooling fan system failure
- High pump wear

1. System load too high:

a. Evaluate the work the machine is performing.

b. If the load is determined to be too heavy, the oil temperature can be lowered by modifying the operating technique.

2. Wrong oil viscosity:

a. Measure the ambient temperature.

b. Determine the weight of the oil in the hydraulic system.

c. Refer to “Maintenance Section, Lubricant Viscosities and Refill Capacities” in *Operator’s Manual, Deployable Universal Combat Earthmover (DEUCE)* to determine if the oil matches the current operating environment.

d. If necessary, change the oil in the hydraulic system to an oil of the proper weight.

3. Low oil level:

a. Lower the blade to the ground.

b. Check the oil level in the hydraulic tank using the site gauge.

c. If the oil level is low, add oil to the tank until the site gauge indicates that the tank is full.

NOTE: The new oil should match the weight of the oil already in the hydraulic tank.

4. Air in oil:

NOTICE
Air in the hydraulic oil can cause pump damage.

---

a. Observe the oil in the site gauge.

b. If bubbles are present, visually inspect the hydraulic suction lines.

c. Repair any leak.

d. If time is not an issue, remove the cap on the hydraulic tank, cover the fill tube opening with something which will prevent dirt from entering the tank, and allow the machine to sit until the air in the oil has escaped. If time is an issue, skip this step and go to Step e.

Replace the cap on the hydraulic tank and lightly exercise the hydraulic system. Inspect the oil in the tank for air bubbles. Repeat this step until air bubbles are no longer present in the oil.

e. If time is an issue, drain the oil from the hydraulic system, and refill the system. Lightly exercise the hydraulic system. Inspect the oil in the tank for air bubbles. Repeat this step until air bubbles are no longer present in the oil.

5. Hydraulic oil cooler externally plugged:

Raise the radiator grill and clean any accumulated debris from the cooler cores.

NOTE: The air conditioner condenser may need to be removed to clean the hydraulic oil cooler core.

6. Restriction in oil passage(s):

a. Check the pressure differential on either side of the suspected restriction.

b. Disassemble and clean all parts to remove restrictions. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Hydraulic System.*

7. Hydraulic oil cooler internally restricted:

a. Measure the pressure in the inlet line to the oil cooler.

b. If the pressure is greater than 21 kPa (3 psi), the cooler core may be internally blocked.

8. Flow compensator valve set wrong (margin pressure too high):

a. Perform tests shown in “Testing and Adjusting, Instrument Tests, Blade Hydraulic System, Margin Pressure Test” in this module.

b. If the margin pressure is out of specification, perform “Testing and Adjusting, Instrument Tests, Blade Hydraulic System, Compensator Valve Adjustment ” in this module.

9. Cooling fan system failure:

a. Perform the procedure shown in “Testing and Adjusting, Instrument Tests, Cooling Fan System, Fan Speed Test” in this module.

b. If necessary, repair the cooling fan system. Refer to fan related topics in “Specifications” in this module and in *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Hydraulic System.*

10. High pump wear:

a. Perform the procedure shown in “Testing and Adjusting, Pump Efficiency Check” in this module.

b. If necessary, repair or replace the pump. Refer to “Specifications, Implement Hydraulic Pump” in this module and *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Hydraulic System*, “Implement Pump.”

Problem 2: Unusual Pump Noise, Cylinder Rods Not Moving Smoothly, and Oil Contains Air Bubbles

Probable Cause(s):

- Low oil level
- Wrong oil viscosity
- Pump aeration
- High pump wear

1. Low oil level:

a. Lower the blade to the ground.

b. Check the oil level in the hydraulic tank using the site gauge.

c. If the oil level is low, add oil to the tank until the site gauge indicates that the tank is full.

NOTE: The new oil should match the weight of the oil already in the hydraulic tank.

2. Wrong oil viscosity:

a. Measure the ambient temperature.

b. Determine the weight of the oil in the hydraulic system.

c. Refer to “Maintenance Section, Lubricant Viscosities and Refill Capacities” in *Operator’s Manual, Deployable Universal Combat Earthmover (DEUCE)* to determine if the oil matches the current operating environment.

d. If necessary, change the oil in the hydraulic system to an oil of the proper weight.

3. Pump aeration:

NOTICE

Air in the hydraulic oil can cause pump damage.

---

a. Observe the oil in the site gauge.

b. If bubbles are present, visually inspect the hydraulic suction lines for leaks.

c. Repair any leak.

d. If time is not an issue, remove the cap on the hydraulic tank, cover the fill tube opening with something which will prevent dirt from entering the tank, and allow the machine to sit until the air in the oil has escaped. Replace the cap on the hydraulic tank and lightly exercise the hydraulic system. Inspect the oil in the tank for air bubbles. Repeat this step until air bubbles are no longer present in the oil.

e. If time is an issue, drain the oil from the hydraulic system, and refill the system. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* “Maintenance Section, Maintenance Intervals, Every 1000 Service Hours or One Year.” Lightly exercise the hydraulic system. Inspect the oil in the tank for air bubbles. Repeat this step until air bubbles are no longer present in the oil.

4. High pump wear:

a. Perform the procedure shown in “Testing and Adjusting, Pump Efficiency Check” in this module.

b. If necessary, repair or replace the pump. Refer to “Specifications, Implement Hydraulic Pump” in this module and *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Hydraulic System*, “Implement Pump.”

Problem 3: Low Pressure Standby Too Low

Probable Cause(s):

- Flow compensator valve set wrong
- Flow compensator valve spring broken
- Pump swashplate blocked or actuator spring broken

1. Flow compensator valve set wrong:

a. Perform the tests shown in “Testing and Adjusting, Instrument Tests, Blade Hydraulic System, Pump Discharge Pressure Tests” in this module.

b. If margin pressure is out of specification, perform “Instrument Tests, Blade Hydraulic System, Compensator Valve Adjustment” in this module.

2. Flow compensator valve spring broken:

a. Disassemble the compensator valve, and inspect the flow compensator spring. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Hydraulic System*, “Implement Pump.”

b. Replace the spring, if it is broken.

c. Reassemble the compensator valve, and perform the procedure shown in “Testing and Adjusting, Instrument Tests, Blade Hydraulic System, Compensator Valve Adjustment” in this module.

3. Pump swashplate blocked or actuator spring broken:

a. Perform the procedure shown in “Testing and Adjusting, Pump Efficiency Check” in this module.

b. If necessary, repair or replace the pump. Refer to “Specifications, Implement Hydraulic Pump” in this module and *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Hydraulic System*, “Implement Pump.”

Problem 4: Low Pressure Standby Too High

Probable Cause(s):

- Flow compensator valve set wrong

1. Flow compensator valve set wrong:

a. Perform the tests shown in “Testing and Adjusting, Instrument Tests, Blade Hydraulic System, Pump Discharge Pressure Test” in this module.

b. If low pressure standby is out of specification, perform “Testing and Adjusting, Instrument Tests, Blade Hydraulic System, Compensator Valve Adjustment” in this module.

Problem 5: Margin Pressure Too Low

Probable Cause(s):

- Flow compensator valve set wrong
- Leak in the signal network

1. Flow compensator valve set wrong:

a. Perform the tests shown in “Testing and Adjusting, Testing and Adjusting, Instrument Tests, Blade Hydraulic System, Margin Pressure Test” in this module.

b. If margin pressure is out of specification, perform “Testing and Adjusting, Instrument Tests, Blade Hydraulic System, Compensator Valve Adjustment” in this module.

2. Leak in the signal network:

a. Perform the tests shown in “Testing and Adjusting, Operational Checks, Blade Hydraulic System, Resolver Network Check” in this module.

b. If necessary, replace damaged resolvers, and flush the system.

Problem 6: Margin Pressure Too High

Probable Cause(s):

- Flow compensator valve set wrong

1. Flow compensator valve set wrong:

a. Perform the tests shown in “Testing and Adjusting, Instrument Tests, Blade Hydraulic System, Margin Pressure Test” in this module.

b. If margin pressure is out of specification, perform "Testing and Adjusting, Instrument Tests, Blade Hydraulic System, Compensator Valve Adjustment" in this module.

Problem 7: Pump Discharge Pressure Too High (High Pressure Stall)

Probable Cause(s):

- Pressure compensator valve set wrong
- Pressure compensator valve not moving (stuck)
- Pump swashplate blocked or actuator piston stuck

1. Pressure compensator valve set wrong:

Perform the test shown in "Testing and Adjusting, Instrument Tests, Blade Hydraulic System, Compensator Valve Adjustment" in this module.

2. Pressure compensator valve not moving (stuck):

a. Disassemble the compensator valve, and inspect the pressure compensator section for damage.

b. If necessary, repair or replace the compensator valve.

3. Pump swashplate blocked or actuator piston stuck:

a. Inspect the pump for damage.

b. If necessary, repair or replace the pump.

Problem 8: Pump Discharge Pressure Too Low (High Pressure Stall)

Probable Cause(s):

- Pressure compensator valve set wrong
- Broken or fatigued pressure compensating valve spring
- Line reliefs set too low
- Leaks in signal network
- Engine speed too low

1. Pressure compensator valve set wrong:

Perform the test shown in "Testing and Adjusting, Instrument Tests, Blade Hydraulic System, Compensator Valve Adjustment" in this module.

2. Broken or fatigued pressure compensating valve spring:

a. Disassemble the compensator valve, and inspect the pressure compensator spring.

b. Replace the spring, if it is broken.

c. Reassemble the compensator valve, and perform the procedure shown in "Testing and Adjusting, Blade Hydraulic System, Compensator Valve Adjustment" in this module.

3. Line reliefs set too low:

a. Perform the test shown in "Testing and Adjusting, Instrument Tests, Blade Hydraulic System, Relief Valves" in this module.

b. Make the necessary adjustments.

4. Leaks in signal network:

a. Perform the tests shown in "Testing and Adjusting, Operational Checks, Blade Hydraulic System, Resolver Network Check" in this module.

b. If necessary, replace damaged resolvers, and flush the system.

5. Engine speed too low:

a. Check high idle speed.

b. Operate the engine at high idle when using the hydraulics.

Problem 9: System Pauses Before Reaching Pressure in All Circuits

Probable Cause(s):

- Air in signal network
- Dirt or debris in signal network

1. Air in signal network:

NOTICE

Air in the hydraulic oil can cause pump damage.

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a. Observe the oil in the site gauge.

b. If bubbles are present, visually inspect the hydraulic suction lines.

c. Repair any leak.

d. If time is not an issue, remove the cap on the hydraulic tank, cover the fill tube opening with something which will prevent dirt from entering the tank, and allow the machine to sit until the air in the oil has escaped. Replace the cap on the hydraulic tank and lightly exercise the hydraulic system. Inspect the oil in the tank for air bubbles. Repeat this step until air bubbles are no longer present in the oil.

e. If time is an issue, drain the oil from the hydraulic system, and refill the system. Lightly exercise the hydraulic system. Inspect the oil in the tank for air bubbles. Repeat this step until air bubbles are no longer present in the oil.

2. Dirt or debris in signal network:

a. Perform the tests shown in "Testing and Adjusting, Operational Checks, Blade Hydraulic System, Resolver Network Check" in this module.

b. If necessary, replace damaged resolvers, and flush the system.

Troubleshooting Blade System Problems

Problem 1: Blade Moves With Control Lever in HOLD Position

Probable Cause(s):

- Leak in connection between valve and cylinder
- Damaged or worn piston seal in cylinder
- Control valve spool not centered
- Worn control valve

1. Leak in connection between valve and cylinder:

a. Inspect the lines between the valve and cylinder for evidence of leaks.

b. Repair leaks.

2. Damaged or worn piston seal in cylinder:

a. Perform the cylinder drift checks described in "Testing and Adjusting, Operational Checks, Blade Hydraulic System" in this module.

b. Repair or replace damaged or worn cylinders.

3. Control valve spool not centered:

a. Disassemble the control valve and check for a broken spring or sticky valve spool. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Hydraulic System,* "Blade Control Valve."

b. Clean the control valve and repair or replace damaged components.

4. Worn control valve:

a. Disassemble and inspect the control valve for wear. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Hydraulic System,* "Blade Control Valve."

b. Repair or replace damaged components.

Problem 2: Valve Control Stem Does Not Shift Into Body

Probable Cause(s):

- Mechanical linkage damaged
- Dirt or water in end housing

1. Mechanical linkage damaged:

a. Inspect the linkage between the implement control lever in the cab and the control valve.

b. Repair the mechanical linkage if necessary.

2. Dirt or water in end housing:

a. Disassemble the valve and inspect for dirt or water.

b. Clean the control valve, and repair or replace damaged components.

Problem 3: Excessive Blade Drift

Probable Cause(s):

- Oil leaking past makeup valve
- Control valve spool not centered
- Worn control valve or spool
- Oil leaking past seals in hydraulic cylinders

1. Oil leaking past makeup valve:

a. Disassemble the combination line relief and makeup valve in the control valve, and inspect the makeup valve section for debris or damage.

b. Clean and/or repair the makeup valve, and reassemble the control valve.

c. Adjust the relief valve following the procedure shown in “Testing and Adjusting, Instrument Tests, Blade Hydraulic System, Relief Valves” in this module.

2. Control valve spool not centered:

a. Disassemble the control valve and check for a broken spring or sticky valve spool.

b. Clean the control valve and repair or replace damaged components.

3. Worn control valve or spool:

a. Disassemble the control valve, and inspect the valve spool for wear.

b. Clean the control valve and replace worn components.

4. Oil leaking past seals in hydraulic cylinders:

Repair or replace damaged cylinders.

Problem 4: Blade Droops When Moving From Partially Raised to Fully Raised Position

Probable Cause(s):

- Air in signal network
- Dirt or debris in resolver network
- Control valve spool not centered
- Broken or fatigued compensator valve spring
- Flow compensator valve set wrong

1. Air in signal network:

NOTICE

Air in the hydraulic oil can cause pump damage.

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a. Observe the oil in the site gauge.

b. If bubbles are present, visually inspect the hydraulic suction lines.

c. Repair any leak.

d. If time is not an issue, remove the cap on the hydraulic tank, cover the fill tube opening with something which will prevent dirt from entering the tank, and allow the machine to sit until the air in the oil has escaped. Replace the cap on the hydraulic tank and lightly exercise the hydraulic system. Inspect the oil in the tank for air bubbles. Repeat this step until air bubbles are no longer present in the oil.

e. If time is an issue, drain the oil from the hydraulic system, and refill the system. Lightly exercise the hydraulic system. Inspect the oil in the tank for air bubbles. Repeat this step until air bubbles are no longer present in the oil.

2. Dirt or debris in resolver network:

a. Perform the tests shown in “Testing and Adjusting, Operational Checks, Blade Hydraulic System, Resolver Network Check” in this module.

b. If necessary, replace damaged resolvers, and flush the system.

3. Control valve spool not centered:

a. Disassemble the control valve and check for a broken spring or sticky valve spool.

b. Clean the control valve and repair or replace damaged components.

4. Broken or fatigued compensator valve spring:

a. Disassemble the compensator valve, and inspect the pressure compensator spring.

b. Replace the spring, if it is broken.

c. Reassemble the compensator valve, and perform the procedure shown in “Testing and Adjusting, Blade Hydraulic System,Compensator Valve Adjustment” in this module.

5. Flow compensator valve set wrong:

a. Perform the tests shown in “Testing and Adjusting, Instrument Tests, Blade Hydraulic System, Margin Pressure Test” in this module.

b. If margin pressure is out of specification, perform “Testing and Adjusting, Instrument Tests, Blade Hydraulic System, Compensator Valve Adjustment” in this module.

Problem 5: Blade Cycle Times Too Slow

Probable Cause(s):

- Blockage or leakage in signal network
- Margin pressure setting incorrect
- Pump actuator piston stuck or swashplate blocked
- Low engine power

1. Blockage or leakage in signal network:

a. Inspect signal lines for leaks.

b. Repair any leak.

c. Perform the tests shown in "Testing and Adjusting, Operational Checks, Blade Hydraulic System, Resolver Network Check" in this module.

d. If necessary, replace damaged resolvers, and flush the system.

2. Margin pressure setting incorrect:

a. Perform the tests shown in "Testing and Adjusting, Instrument Tests, Blade Hydraulic System, Margin Pressure Test" in this module.

b. If margin pressure is out of specification, perform "Testing and Adjusting, Instrument Tests, Blade Hydraulic System, Compensator Valve Adjustment" in this module.

3. Pump actuator piston stuck, or swashplate blocked:

a. Perform the procedure shown in "Testing and Adjusting, Pump Efficiency Check" in this module.

b. If necessary, repair or replace the pump.

4. Low engine power:

For engine troubleshooting procedures, refer to "Troubleshooting, Engine Diagnostic Flash Codes" in *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System*.

Problem 6: Blade Floats Up With Control in HOLD When Dozing

Probable Cause(s):

- Mechanical linkage damaged
- Makeup valve not functioning properly
- Lift valve worn or damaged

1. Mechanical linkage damaged:

a. Inspect the linkage between the implement control lever in the cab and the control valve.

b. Repair the mechanical linkage if necessary.

2. Makeup valve not functioning properly:

a. Disassemble the combination line relief and makeup valve in the control valve, and inspect the makeup valve section for debris or damage.

b. Clean and/or repair the makeup valve, and reassemble the control valve.

c. Adjust the relief valve following the procedure shown in "Testing and Adjusting, Instrument Tests, Blade Hydraulic System, Relief Valves" in this module.

4. Lift valve worn or damaged:

a. Disassemble and inspect the lift valve for wear.

b. Repair or replace damaged components.

Problem 7: Blade Cycle Times Too Fast

Probable Cause(s):

- Margin pressure set too high

1. Margin pressure set too high:

a. Perform the tests shown in "Testing and Adjusting, Instrument Tests, Blade Hydraulic System, Margin Pressure Test" in this module.

b. If margin pressure is out of specification, perform "Testing and Adjusting, Instrument Tests, Blade Hydraulic System, Compensator Valve Adjustment" in this module.

Problem 8: Blade Pauses at Ground Level Before Raising

Probable Cause(s):

- Restrictor spool in blade inlet manifold not functioning properly

1. Restrictor spool in blade inlet manifold not functioning properly:

a. Disassemble the restrictor valve.

b. Inspect the restrictor valve for a damaged spring and/or evidence that the spool is sticking.

c. Repair or replace damaged components.

Problem 9: Line Relief Valves Too Noisy

Probable Cause(s):

- Relief valve set too low
- Broken or fatigued springs in relief valve

1. Relief valve set too low:

a. Check the pressure setting of the relief valve following the procedure shown in “Testing and Adjusting, Instrument Tests, Blade Hydraulic System, Relief Valves” in this module.

b. If necessary, adjust the relief valve following the procedure shown in “Testing and Adjusting, Instrument Tests, Blade Hydraulic System, Relief Valves” in this module.

2. Broken or fatigued springs in relief valve:

a. Disassemble the combination line relief and makeup valve in the control valve and inspect the relief valve section for broken or fatigued springs.

b. Replace the defective parts in the relief valve, and reassemble the control valve.

c. Adjust the relief valve following the procedure shown in “Testing and Adjusting, Instrument Tests, Blade Hydraulic System, Relief Valves” in this module.

Problem 10: Blade Will Not Lower in EARTHMOVING Mode

- Electrical problem
- Dirt or debris in signal network
- Spool in blade lock valve stuck

1. Electrical problem:

Refer to the troubleshooting procedure given in “Testing and Adjusting, Troubleshooting, Troubleshooting Problems, Problem 16: Blade Will Not Lower,” in *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System.*

2. Dirt or debris in signal network:

a. Perform the tests shown in “Testing and Adjusting, Testing and Adjusting, Operational Checks, Blade Hydraulic System, Resolver Network Check” in this module.

b. If necessary, replace damaged resolvers, and flush the system.

3. Spool in blade lock valve stuck:

a. Disassemble the blade lock valve.

b. Inspect the valve for evidence that the spool is sticking.

c. Repair or replace damaged components.

Troubleshooting Winch System Problems

Problem 1: Winch Does Not Rotate in Either Direction With Winch Control Switch Activated

Probable Cause(s):

- Electrical problem
- Winch control spool in multifunction control valve stuck
- Load sensing signal from winch control valve not reaching pump

1. Electrical problem:

Refer to the troubleshooting procedure given in “Testing and Adjusting, Troubleshooting, Troubleshooting Problems, Problem 21: Winch Does Not Function” in *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System*.

2. Winch control spool in multifunction control valve stuck:

a. Remove the winch solenoids from the multifunction control valve, and check the valve spool for evidence of sticking.

b. Repair or replace the faulty parts.

3. Load sensing signal from winch control valve not reaching pump

a. Measure the load sensing signal while operating the winch.

b. If a load sensing signal is not present, inspect the resolvers in the multifunction control valve for debris.

c. Inspect the check valve in the remote tool power manifold for debris.

d. Replace any damaged resolvers and flush the system.

Problem 2: Winch Only Rotates in One Direction

Probable Cause(s):

- Electrical problem
- Failed counterbalance valve

1. Electrical problem:

Refer to the troubleshooting procedure given in "Testing and Adjusting, Troubleshooting, Troubleshooting Problems, Problem 21: Winch Does Not Function," in *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System*.

2. Failed counterbalance valve:

NOTE: This problem will cause only the payout direction to stop.

a. Inspect the counterbalance valve for damage.

b. Repair or replace the counterbalance valve.

Problem 3: Winch Motor Rotates but Does Not Pull Cable

Probable Cause(s):

- Winch clutch in DISENGAGED position, or has failed

1. Winch clutch in DISENGAGED position, or has failed:

a. Ensure that the clutch lever is in the engaged position.

b. Inspect the winch clutch for damage. If necessary, repair or replace the clutch.

Problem 4: Winch Pulling Force Low

Probable Cause(s):

- Pump pressure compensator out of specification
- Pressure setting of counterbalance valve out of specification
- Failed winch spool brake

1. Pump pressure compensator out of specification:

Perform the test shown in "Testing and Adjusting, Instrument Tests, Blade Hydraulic System, Compensator Valve Adjustment" in this module.

2. Pressure setting of counterbalance valve out of specification:

a. Replace the counterbalance valve. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Hydraulic System,* "Winch Motor."

b. If the problem is no longer present, leave the new counterbalance valve installed. If the problem remains, remove the new counterbalance valve and reinstall the old valve. The counterbalance valve is not the problem.

3. Failed winch spool brake:

a. Inspect the winch brake for wear or damage.

b. If necessary, repair or replace the winch brake. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Hydraulic System,* "Winch Brake Assembly."

Problem 5: Winch Brake Will Not Release

Probable Cause(s):

- Insufficient system pressure to release brake
- Failed brake

1. Insufficient system pressure to release brake:

a. Test system pressure at the winch inlet while attempting to operate the winch.

b. If system pressure is present at the winch inlet, inspect the winch motor resolver for damage or debris. Refer to "Systems Operation, Winch Hydraulic System, System Operation, Winch Control Valve" in this module.

c. If necessary, replace the damaged resolver, and flush the system.

2. Failed brake :

a. Inspect the winch brake for a damaged piston or damaged seals.

b. Inspect the sealing surfaces in the brake housing for damage.

c. Inspect the end bearing for damage.

d. Inspect the discs and plates for warp damage or damage due to overheating.

e. Repair or replace damaged components. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Hydraulic System,* "Winch Brake Assembly."

Problem 6: Winch Brake Will Not Engage or Engages but Does Not Produce Sufficient Torque

Probable Cause(s):

- Failed brake

1. Failed brake:

a. Inspect the brake for broken or damaged springs.

b. Inspect the discs and plates for wear.

Troubleshooting Cooling Fan System Problems

Problem 1: Fan Speed Does Not Increase When Engine Coolant Temperature Reaches 90°C (194°F)

Probable Cause(s):

- Defective temperature valve
- Contamination prevents bypass relief valve from closing
- Defective bypass control valve

NOTE: Troubleshoot the fan cooling system following the procedure given in "Testing and Adjusting, Instrument Tests, Cooling Fan System" in this module.

Problem 2: Fan Runs at Maximum Speed With Engine Coolant Temperature Below 87.5 ± 0.3°C (189.5 ± 0.5°F)

Possible Cause(s):

- Defective temperature valve
- Defective bypass control valve

NOTE: Troubleshoot the fan cooling system following the procedure given in "Testing and Adjusting, Instrument Tests, Cooling Fan System" in this module.

Operational Checks

Blade Hydraulic System

⚠ WARNING

Refer to the WARNING on the first page of "Testing and Adjusting."

The operational checks can be used to find leaks in the system. They can also be used to find a bad valve or pump. To check the condition of the cylinders and the pump, monitor the speed of rod movement when the cylinders move.

The oil in the hydraulic system must be at an operating temperature of 38 to 54°C (100 to 130°F) while these checks are being performed.

The control valves have a parallel circuit arrangement. The hydraulic pump and the pressure relief valve are common to all circuits. Each valve section has a check valve to help prevent cylinder drift when the valve spool is first moved.

Relief valves help protect system components from too much pressure. The main relief valve is also a makeup valve. Makeup valves let extra oil go to the cylinders when needed.

Extend and retract each implement cylinder several times and perform the following steps:

1. Watch the cylinder as it extends and retracts. The movement must be smooth and regular.

2. Listen for noise from the pump.

3. Listen for the sound of a relief valve. A relief valve must not open except when the cylinders are fully extended or retracted.

An incorrect pressure setting on a relief valve can lower machine performance. A high pressure setting reduces the life of hoses and other parts of the system.

4. Allow the implement cylinder to travel full stroke in each direction.

5. Put each control valve in HOLD while the implement is off the ground. Watch for excessive cylinder rod drift.

Implement cylinder drift is caused when oil leaks past cylinder piston seals, control valve seals, check or makeup valves, and/or when there is too much spool to valve body clearance.

Lift Cylinder Rod Drift Test

The drift rates change under different conditions. Before the drift on the cylinder rod is measured, the cylinders must be extended at least five times. Measure rod drift using the following procedure:

1. Check the hydraulic oil temperature.

2. Raise the blade until the cutting edge is approximately 254 mm (10 in) off the ground. With the lift control lever in the HOLD position, stop the engine. Keep clear of the blade when the blade is off the ground.

3. Measure the length of the lift cylinder rods (from the lift cylinders) and make a record of the measurements.

4. Measure the distance (and check the time) that the cylinders extend, and check the chart below.

NOTE: The drift distances in the charts are for new machines.

Lift Cylinder Rod Drift			
Oil Temperature	**38 to 49°C (100 to 120°F)**	**49 to 66°C (120 to 150°F)**	**Over 66°C (Over 150°F)**
Maximum Permissible Drift	32 mm (1.26 in)	32 mm (1.26 in)	32 mm (1.26 in)
Time Interval (Minutes)	5	2.7	1.7

Too much lift cylinder rod drift is caused by:

1. Loose oil line connections and poor condition of the oil hoses between the control valve and the rod ends of the lift cylinders.

2. Leakage around the piston seals in the lift cylinders.

3. Leakage in the control valve (worn valve section and spool valve and/or makeup valve not on its seat).

When there is too much drift and the hydraulic oil temperature is below 54°C (130°F), and there is no leak in the lines to the lift cylinders, perform another test.

1. Start the engine. Move the lift control lever to the LOWER position. When the rods from the lift cylinders are extended and the front of the machine is off the ground, stop the engine.

2. Disconnect the oil lines from the rod end of each lift cylinder.

3. If only a very small amount of oil comes from the open oil line connection on the lift cylinder, the seals on the piston are not the cause of the excessive cylinder rod drift.

NOTE: When the piston seals in the lift cylinders are not the cause of excessive drift, the control valve is the cause (check valve not on its seat and/or worn valve spool and valve section).

Tilt Cylinder Rod Drift Test

Measure the tilt cylinder rod drift using the following procedure:

1. Check the hydraulic oil temperature.

2. Fully retract the tilt cylinder.

3. Lower the blade to raise the front idlers off the ground. With the lift and tilt control valves in the HOLD position, stop the engine.

4. Measure the distance (and check the time) that the tilt cylinder extends, and check the chart below.

NOTE: The drift distances in the chart are for new machines.

Tilt Cylinder Rod Drift			
Oil Temperature	**38 to 49°C (100 to 120°F)**	**49 to 66°C (120 to 150°F)**	**Over 66°C (Over 150°F)**
Maximum Permissible Drift	13 mm (0.5 in)	13 mm (0.5 in)	13 mm (0.5 in)
Time Interval (Minutes)	5	2.7	1.7

Too much tilt cylinder rod drift is caused by:

1. Loose oil line connections and poor condition of the oil hoses between the control valve and the rod end of the tilt cylinders.

2. Leakage around the piston seals in the tilt cylinders.

3. Leakage in the control valve (worn valve section and spool valve).

Cylinder Speed Tests

The oil in the system must be SAE 10 and at a temperature of 65 ± 3°C (150 ± 5°F) to get correct results. All speed tests should be performed with the engine at HIGH IDLE.

System speeds that are the same as those on the chart indicate normal circuit operation.

If only one of the cylinder speeds is slow, check that circuit for cylinder drift.

Use a stop watch or timer to measure the time each lift arm takes to raise, the time each blade takes to tilt in each direction, and the time each blade takes to angle in either direction.

Blade Lift Cylinder Speeds	
From ground to fully raised:	3 sec
From fully raised to ground:	4 sec

Blade Tilt Cylinder Speeds	
Fully retracted to fully extended	2 sec
Fully extended to fully retracted	2 sec

Blade Angle Cylinder Speeds	
From fully left to fully right	3 sec

If the cylinder speed is not correct:

1. Check the pump's efficiency.

2. Check the cylinders for leakage.

3. The makeup valve could have leaks (lift only).

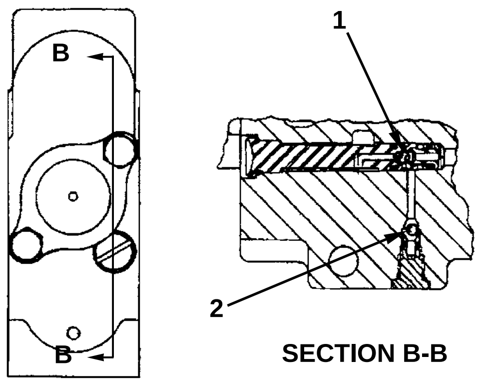
4. The valve spool for the affected circuit could be worn.

5. Margin pressure could be high (resulting in faster cycles) or low (resulting in slower cycles).

6. The signal network may have blockage or leakage.

Resolver Network Check

A resolver is a check valve which compares two pressures. The lower of the two pressures is blocked. The higher pressure goes to the next component in the resolver network.



Typical Control Valve.
(1) Primary resolver. (2) Secondary resolver.

There are two resolvers per implement control valve. Primary resolver (1) compares the pressure in the rod end to the pressure in the head end of the cylinders. Secondary resolver (2) compares the highest primary signal in its control valve to the highest primary signal in the next control valve. The secondary resolvers are arranged in series, leading to the pump compensator valve.

The primary and secondary resolvers can be affected by debris, cut or missing seals, bad resolver seats, or missing balls.

Troubleshooting the Resolver Network

The signal network can be easily checked. Start the engine and warm up the hydraulic oil. Run the engine at LOW IDLE for this check. Connect a 30 000 kPa (4000 psi) gauge to the signal line pressure tap. Operate each control lever in the following order:

1. Angle.

2. Tilt.

3. Lift.

Work each implement against a load. Watch the gauge. Maximum system pressure should be seen for all circuits. Small leakage problems, such as cut or missing seals, can be detected with the gauge.

Secondary Resolvers (Two or More Valve Sections)

If two or more control valves next to each other fail to work normally, the problem may be in the secondary resolver of the first implement control valve, which is closest to the malfunctioning pump. This control valve's secondary resolver is allowing signal pressure from any control valve further from the pump supply to leak through to either the rod or head end signal passage of that control valve to the tank. This leakage may be caused by a ball that is not seating against the drain side of the resolver, which causes the valve to malfunction.

The previous description holds true unless the ball is missing, there is debris preventing the ball from seating properly, or the seal is missing or leaking when multiple valves malfunction. Operate the malfunctioning valve farthest from the pump, and at the same time, start going through the previously mentioned valve order. The first valve that makes both of the implements work is the one with the bad secondary resolver. In this case, the farthest valve is sending a signal, and the valve with a bad seal or missing ball is also sending a signal. When both signals meet at the valve with the bad secondary resolver, the leak has no impact on the signal which goes to the pump, and therefore, has no effect on the flow control valve.

Primary Versus Secondary Resolver

If only one valve section fails to work in either one or both directions, or works slowly in one or both directions, the primary or secondary resolver in that control valve may be bad. To determine which secondary resolver is bad, perform the following check. Stall an implement further away from the pump than the valve in question. This causes the ball in the secondary resolver to seat away from the drain side of the resolver, and will eliminate the possibility of a leak on the drain side of the secondary resolver. Next, operate the suspected valve while holding the other implement in stall. If the valve is still operating slowly in one or both directions, the primary resolver may be bad.

Normally, if an implement is slow in both directions, the problem is in the secondary resolver. If an implement is slow in one direction, the problem is typically caused by a bad primary resolver (caused by debris or bad seals).

If the primary resolver is bad, then the pressure bleed-off caused by the bad resolver is effecting the operation of the flow control spool in the valve body. The effective force (signal pressure plus spring) which is trying to open the valve to allow flow to the cylinder is insufficient to meet the cylinder load requirement, and causes a slower response.

Other causes of malfunctioning valve sections might be a maladjusted linkage, a broken pressure reducing valve spring, an incorrectly installed flow control spool, or bad line relief and/or makeup valves.

NOTE: If there is debris in the system, the system should be flushed. To flush the system, remove all the balls in the secondary resolvers, and operate the implements. Enough flow is supplied to flush the debris to the tank.

Pump Efficiency Check

This test is designed to determine whether a pump is operating within design parameters. Presently, only a bench test is available. This test should be run only if all cylinder cycle times are too slow and the resolver network is functioning properly.

For any pump test, the pump flow measured in liters per minute (U.S. gpm) at 690 kPa (100 psi) is greater than the pump flow at 6900 kPa (1000 psi) at the same speed.

The difference between the pump flow of two operating pressures is the flow loss.

The following example is one method of finding flow loss:

Flow at 690 kPa (100 psi) ....217.6 liter/min (57.5 gpm)
Flow at 6900 kPa (1000 psi)....– 196. 8 liter/min (52.0 gpm)
Flow loss.....................................20.8 liter/min (5.5 gpm)

Flow loss, when expressed as a percent of pump flow, is used as a measure of pump performance.

The following example is a method for finding the percent of flow loss:

$$\frac{\text{liter/min (gpm) flow loss}}{\text{Pump flow @ 690 kPa (100 psi)}} \times 100 = \text{Percent of flow loss}$$

$$\frac{20.8\text{* liter/min (5.5* gpm)}}{217.6\text{* liter/min (57.5* gpm)}} \times 100 = 9.6\%$$

If the percent of flow loss is more than 10 percent, pump performance is not sufficient.

NOTE: The numbers in these examples are for illustration and are not values for any specific pump or pump condition. See the “Specifications” section of this module for the pump flow rates of new pumps.

Test On Bench

If the test bench can be run at 6900 kPa (1000 psi) and at full pump speed, find the percent of flow loss using the previous formula.

If the test bench can not be run at 6900 kPa (1000 psi) at full pump speed, run the pump shaft at 1000 rpm. Measure the pump flow at 690 kPa (100 psi) and at 6900 kPa (1000 psi). Use these values in the top part of the following formula. For the bottom part of the formula, run the pump shaft at 2000 rpm. Measure the pump flow at 690 kPa (100 psi).

$$\frac{\text{lpm @ 690 kPa} - \text{lpm @ 6900 KPa}}{\text{lpm @ 690 kPa @ 2000 rpm}} \times 100 = \text{Percent of flow loss}$$

$$\frac{\text{gpm @ 100 psi} - \text{gpm @ 1000 psi}}{\text{gpm @ 100 psi @ 2000 rpm}} \times 100 = \text{Percent of flow loss}$$

Instrument Tests

⚠ WARNING

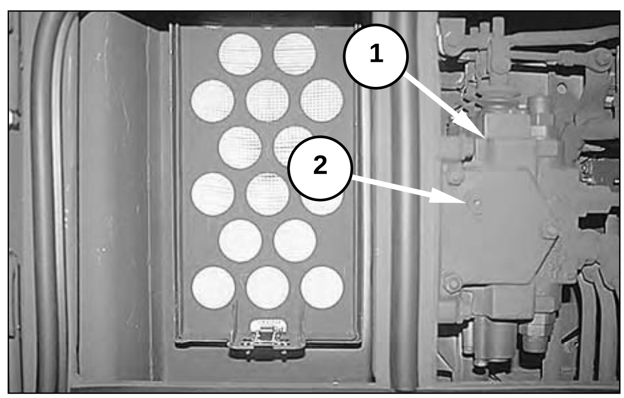
Refer to the WARNING on the first page of "Testing and Adjusting."

Instrument testing on the hydraulic system and its components is the final step when diagnosing a problem. Test results should verify the status of a component. Adjusting procedures are provided where needed.

Blade Hydraulic System

Pump Discharge Pressure Tests

Tools Needed		
177-7861	Hose Assembly	1
3J-1907	O-Ring Seal	1
6V-3965	Nipple	1
6V-3966	Nipple	1
6V-4143	Quick Coupler	2
8T-0855	Pressure Gauge, 4000 kPa (580 psi)	1
8T-0861	Pressure Gauge, 60 000 kPa (8700 psi)	1
8T-4188	Adapter (1/8 INT NPT X 1/4 IN NPT)	1



View Inside Compartment On Right Side Of Cab.
(1) Blade control valve. (2) Port.

Pump discharge pressures are known values and can be tested under two specific conditions. These two conditions are low pressure standby and high pressure stall.

Low Pressure Standby Test

1. Lower the blade to the ground.

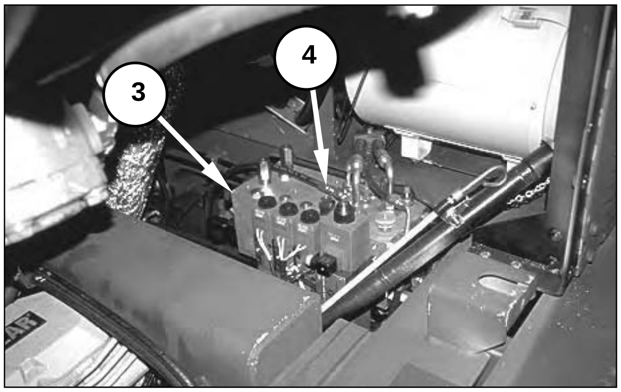
2. Shut off the engine, and move the blade control lever through all positions to release the system pressure.

3. Depress the brake pedal 120 times to release the pressure in the brake system accumulator.

4. Slowly open the hydraulic tank cap to release the pressure in the tank, and then close the cap.

5. Leave the blade control lever in the HOLD position and the winch enable switch in the OFF position.

6. Remove the plug from port (2) and install a 0 to 4000 kPa (0 to 580 psi) pressure gauge.



Left Side of Machine, Radiator Raised.
(3) Multifunction control valve. (4) "LS" port.

7. Remove the hose from "LS" port (4) on the top face of multifunction control valve (3). Plug the port and hose.

8. Start the engine and run it at high idle.

9. The pressure reading on the gauge must be approximately 2415 kPa (350 psi). Low pressure standby is approximately an additional 345 kPa (50 psi) higher than margin pressure. Margin pressure is 2070 ± 345 kPa (300 ± 50 psi).

NOTE: Adjustments to the pump output should not be made solely on the basis of this test. Instead, if the results are not acceptable, run the margin pressure test, in this section.

High Pressure Stall Test

1. Lower the blade to the ground.

2. Shut off the engine and move the blade control lever through all positions to release system pressure.

3. Depress the brake pedal 120 times to release the pressure in the brake system accumulator.

4. Slowly open the hydraulic tank cap to release the pressure in the tank, and then close the cap.

5. Install a 0 to 60 000 kPa (0 to 8700 psi) pressure gauge in port (2).

6. Start the engine and operate at high idle. Move the blade control lever into the LIFT position until the blade is all the way up. Continue holding the blade control lever in the LIFT position to initiate a stall condition. Do not keep the system in a stall condition for more than 10 seconds. If more time is needed, wait 30 seconds before returning to stall.

7. The pressure on the gauge should be 20 670 kPa (3000 psi).

NOTE: If the pressure readings are too low or too high, the pressure compensator valve needs to be adjusted. Refer to "Compensator Valve Adjustment" in this section .

Margin Pressure Test

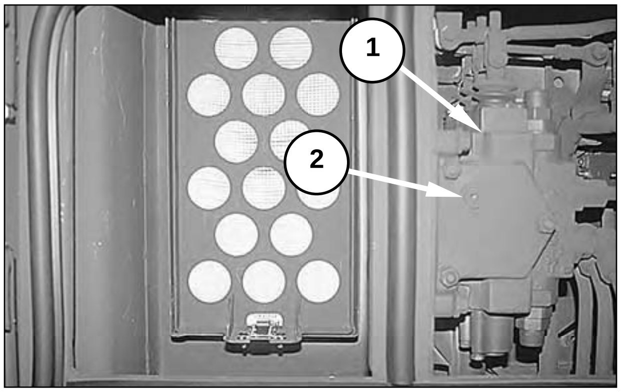
Tools Needed		
1U-5216	Manifold	1
3B7722	Bushing	2
3S-6224	Electric Hydraulic Pump	1
177-7861	Hose Assembly	2
6V-3966	Nipple	4
8T-0820	Gauge	1

1. Lower the blade to the ground.

2. Shut off the engine and move the blade control lever through all positions to release system pressure.

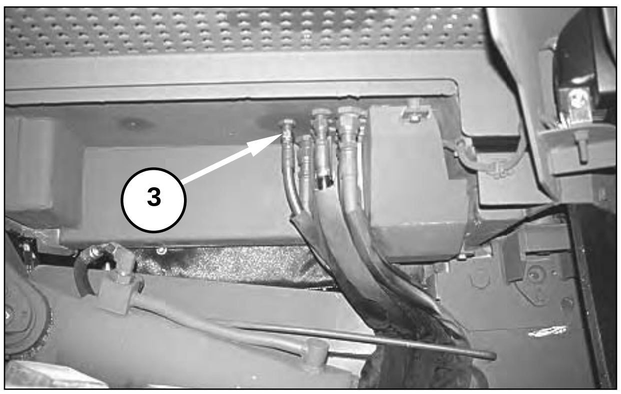
3. Depress the brake pedal 120 times to release the pressure in the brake system accumulator.

4. Slowly open the hydraulic tank cap to release the pressure in the tank, and then close the cap.



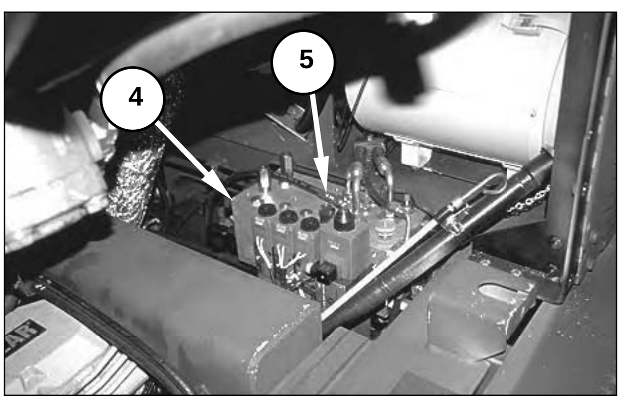
View Inside Compartment on Right Side of Cab.
(1) Blade control valve. (2) Port.

5. Remove the plug in port (2) and install a 6V-3965 Nipple with a 3J-1907 O-ring. Install the pump pressure side of the differential gauge to the nipple in port (2).



Location of Blade Signal Pressure Line.
(3) Blade signal pressure line.

6. Install a swivel tee with a nipple into blade signal pressure line (3). Install the signal pressure side of the differential pressure gauge to the nipple.



Left Side of Machine, Radiator Raised.
(4) Multifunction control valve. (5) "LS" port.

7. Remove the hose from "LS" port (5) on the top face of multifunction control valve (4). Plug the port and hose.

8. Start the engine and run it at low idle. Check for leaks.

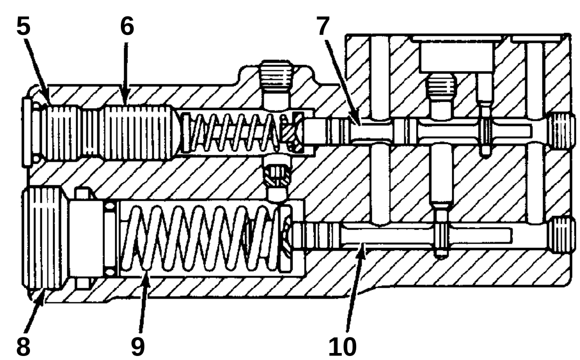
9. Warm up the hydraulic oil to 38 to 54°C (100 to 130°F). Check for leaks.

10. Raise the engine speed to high idle (2590 ± 50 rpm).

11. Move the blade control lever to a position that is between the HOLD and full LIFT positions. Read the pressure on the differential pressure gauge. The gauge should show a pressure differential of approximately 2070 ± 345 kPa (300 ± 50 psi). The value on the gauge is the margin pressure (the difference between pump discharge pressure and the signal pressure from the control valve).

NOTE: If margin pressure is not correct, refer to "Flow Compensator Spool Adjustment," in this section. Recheck the margin pressure after adjusting the flow compensator spool.

Compensator Valve Adjustment



(5) Plug. (6) Adjusting screw. (7) Flow compensator spool.
(8) Adjusting plug. (9) Spring. (10) Pressure compensator spool.

The high pressure stall test will tell if pressure compensator spool (10) needs to be adjusted. The margin pressure test and/or the low pressure standby test will tell if flow compensator spool (7) needs to be adjusted.

Pressure Compensator Spool Adjustment

Adjustments to the pressure compensator valve can be made on the machine. If the high pressure stall test indicates that an adjustment is needed, follow this procedure.

1. Lower the blade to the ground.

2. Shut off the engine, and move the blade control lever into and out of all positions to release system pressure.

3. Depress the brake pedal 120 times to release the pressure in the brake system accumulator.

4. Remove the lock wire and seal from adjusting plug (8).

NOTE: Remove adjusting plug (8) and apply 9S-3263 Compound to the threads before starting the procedure.

5. Turn adjusting plug (8) clockwise to increase the pressure setting. Turn adjusting screw (6) counterclockwise to decrease the pressure setting.

NOTE: When decreasing the pressure setting, make sure to turn adjusting plug (8) counterclockwise further than is necessary. Then turn the adjusting plug clockwise to the correct pressure setting. This method of adjusting the pressure eliminates any play in the threads.

6. Repeat the high pressure stall test to make sure the pressure setting is 20 670 kPa (3000 psi).

Flow Compensator Spool Adjustment

Adjustments to the flow compensator spool can be made on the machine. If the margin pressure test indicates that an adjustment is needed, follow this procedure:

1. Lower the blade to the ground.

2. Shut off the engine and move the blade control lever through all positions to release the system pressure.

3. Depress the brake pedal 120 times to release the pressure in the brake system accumulator.

4. Remove plug (5).

5. Turn adjusting screw (6) clockwise to increase the pressure setting. Turn the adjusting screw counterclockwise to decrease the setting.

NOTE: When decreasing the pressure setting, make sure to turn adjusting screw (6) counterclockwise further than is necessary. Then turn adjusting screw (6) clockwise to the correct pressure setting. This method of adjusting the pressure eliminates any free play in the threads.

6. Repeat the margin pressure test and the low pressure standby test.

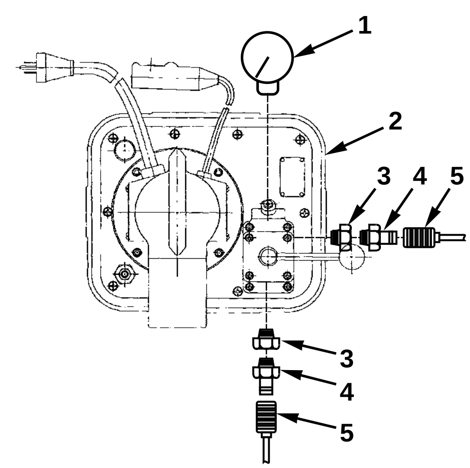
7. When the pressure is adjusted correctly, make sure the seal is good and in place. Replace plug (5).

Relief Valves

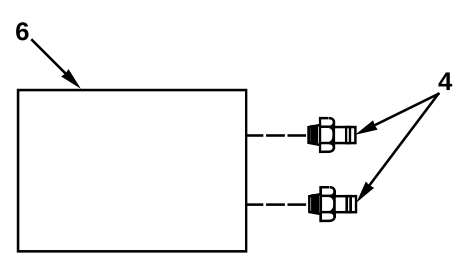
WARNING

Refer to WARNING on first page of "Testing and Adjusting."

Tools Needed		
1U-5216	Manifold	1
3B7722	Bushing	2
3S-6224	Electric Hydraulic Pump	1
177-7861	Hose Assembly	2
6V-3966	Nipple	4
8T-0820	Gauge	1



Assembly of Tooling to Electric Hydraulic Pump.
(1) 8T-0820 Gauge. (2) 3S-6224 Electric Hydraulic Pump. (3) 3B-7722 Bushing. (4) 6V-3966 Nipple. (5) 177-7860 Hose.



Assembly of Tooling to Manifold.
(4) 6V-3966 Nipple. (6) 1U-5216 Manifold.

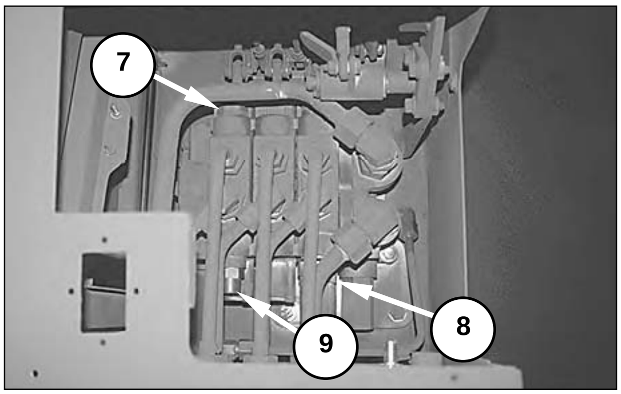
There is no main line relief valve. The pressure compensator valve acts as a main line relief valve and limits system pressure.

The pressure compensator can be checked while on the machine with the high pressure stall test.

The lift (rod end) and blade angle (rod and head ends) circuits have combination line relief and makeup valves. These relief valves are set higher than system pump pressure and require supplemental pump pressure for testing.

The correct pressure setting for the angle relief valves is 34 460 ± 350 kPa (5000 ± 50 psi).

The correct pressure setting for the lift (rod end) relief valve is 24 200 ± 350 kPa (3500 ± 50 psi).

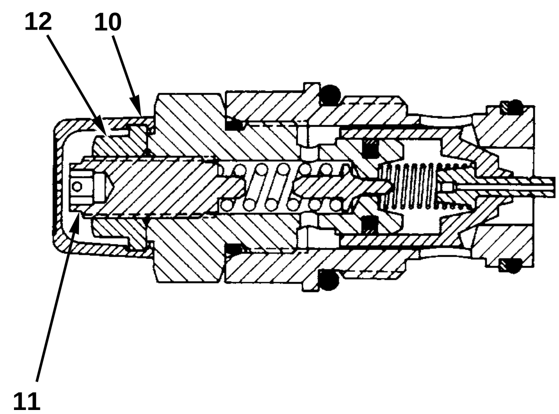


Front View of Blade Control Valve (Partially Assembled).
(7) Relief valve for rod end of left angle cylinder and head end of right angle cylinder. (8) Relief valve for rod end of lift cylinder. (9) Relief valve for rod end of right angle cylinder and head end of left angle cylinder.

Bench Test

1. Lower the blade to the ground.
2. Shut off the engine and move the blade control lever through all positions to release the pressure in the system.
3. Slowly open the hydraulic tank cap to release the pressure in the tank, and then close the cap.
4. Remove the relief valve that is to be tested.
5. Install the relief valve in the 1U-5216 Manifold.
6. Connect the electric hydraulic pump output hose to the tap installed in the "P" port on the manifold. Connect the electric hydraulic return hose to the "T" port on the manifold.
7. Slowly increase pressure. Note the pressure when the relief valve opens. Make an adjustment, if needed.
8. Reinstall the relief valve on the machine.

Relief Valve Adjustments



Line Relief and Makeup Valve.
(10) Cap. (11) Adjusting screw. (12) Lock nut.

1. Remove cap (10).
2. Loosen lock nut (12).
3. Turn adjusting screw (11) clockwise to increase the pressure setting. Turn the adjusting screw counterclockwise to decrease the pressure setting.
4. Tighten lock nut (12) and recheck the pressure setting.
5. Repeat steps 3 and 4 until the correct pressure is obtained.
6. Install cap (10).

Cooling Fan System

Fan Speed Test

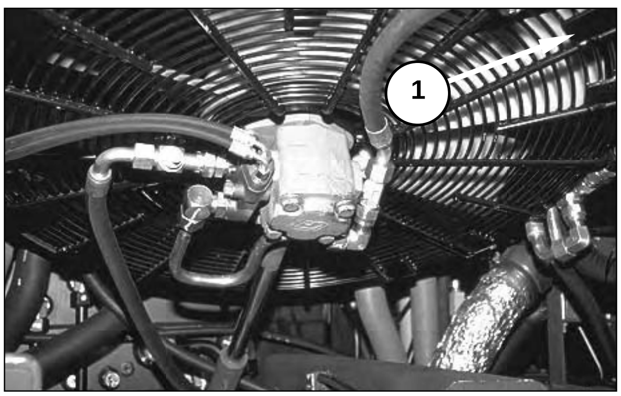
Tools Needed		
1U-6602	Stroboscopic Tachometer	1

WARNING

Refer to the WARNING on the first page of "Testing and Adjusting."

NOTE: Perform this procedure only after confirming that the temperature regulator is functioning properly.

1. Raise the radiator. Refer to "Operation Section, Maintenance Features, Radiator Tilt" in *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* for the procedure to raise the radiator.



Cooling Fan, Radiator Raised.
(1) Location to install pickup.

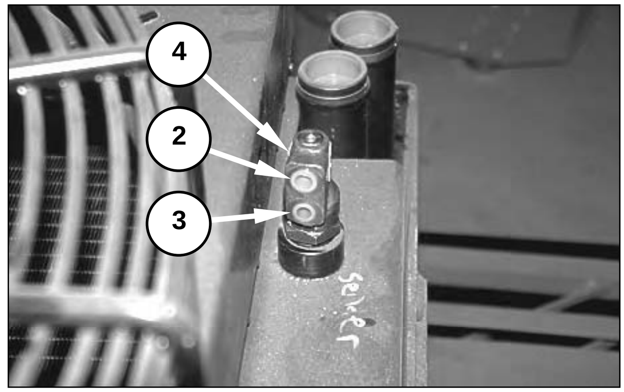
2. To read the fan speed, install the 1U-6602 Stroboscopic Tachometer on the fan grill.

NOTE: Place the reflective tape on the fan blade, close to the edge.

3. With the engine coolant temperature below 49°C (120°F), start the machine and operate the engine at full speed.

4. Measure the fan speed. The fan speed should be 375 to 750 rpm.

5. If the fan speed is too high, go to Step 6. If the fan speed is within specification, go to Step 10. If the fan speed is too low, go to Step 13.



Temperature Valve, Radiator Removed.
(2) Inlet line. (3) Outlet line. (4) Temperature valve.

6. Disconnect inlet line (2) and outlet line (3) from temperature valve (4). Use a short piece of hose with the appropriate couplings (or use a 6V-8729 Union with two 4J-5477 O-rings) to connect the hoses.

7. Start the machine and operate the engine at full speed.

8. The fan speed should be between 375 and 750 rpm.

9. If the fan speed is correct, replace the temperature valve, reconnect inlet line (2) and outlet line (3), and go to Step 10. If the fan speed is too high, reconnect inlet line (2) and outlet line (3), and go to Step 13.

10. Operate the engine until the engine coolant reaches normal operating temperature.

NOTE: The engine coolant temperature must be greater than 90°C (194°F).

11. While operating the engine at full speed, measure the fan speed. The fan speed should be between 622 rpm and 1900 ± 150 rpm.

NOTE: The fan speed depends on the temperature of the engine coolant. The fan operates at minimum speed when the engine coolant temperature is less than 90°C (194°F). The fan reaches the maximum speed (1900 ± 150 rpm) when the engine coolant temperature is approximately 96 to 98°C (206 to 209°F).

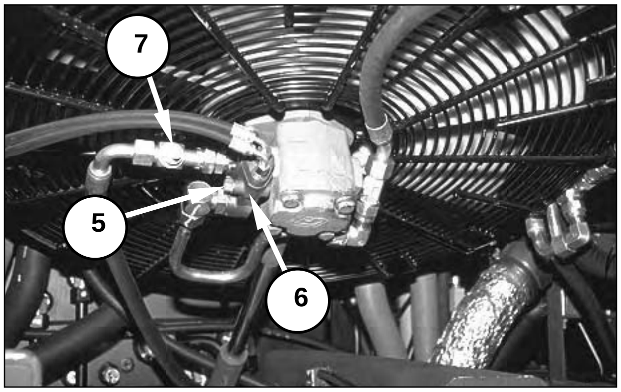
12. If the fan speed is within specifications, stop here; the fan is operating properly. If the fan continues to operate at minimum speed, continue this procedure.

13. Disconnect inlet line (2) from temperature valve (4). Cap the line and the port.

14. Start the engine.

15. While operating the engine at full speed, measure the fan speed. The fan speed should be 1900 ± 150 rpm.

16. If the fan speed is within specification, replace the temperature valve and repeat Steps 10-12. If the fan is less than the specification, continue this procedure.



Bypass Control Valve.
(5) Bypass relief valve. (6) Bypass control valve. (7) Pressure tap.

17. Remove bypass relief valve (5) from bypass control valve (6). Check the valve for contamination and/or damage. If damage is found, replace the bypass control valve. If no damage is found, clean and reassemble the bypass relief valve.

NOTICE

Do not misplace the shims that are between the spring and the cap when removing bypass relief valve (5). Reassemble the relief valve with the same number of shims which were originally installed. Changing the shim thickness will change the maximum fan speed.

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18. With the engine coolant at normal operating temperature and the engine at high idle, retest the fan speed. The fan speed should be 1900 ± 150 rpm.

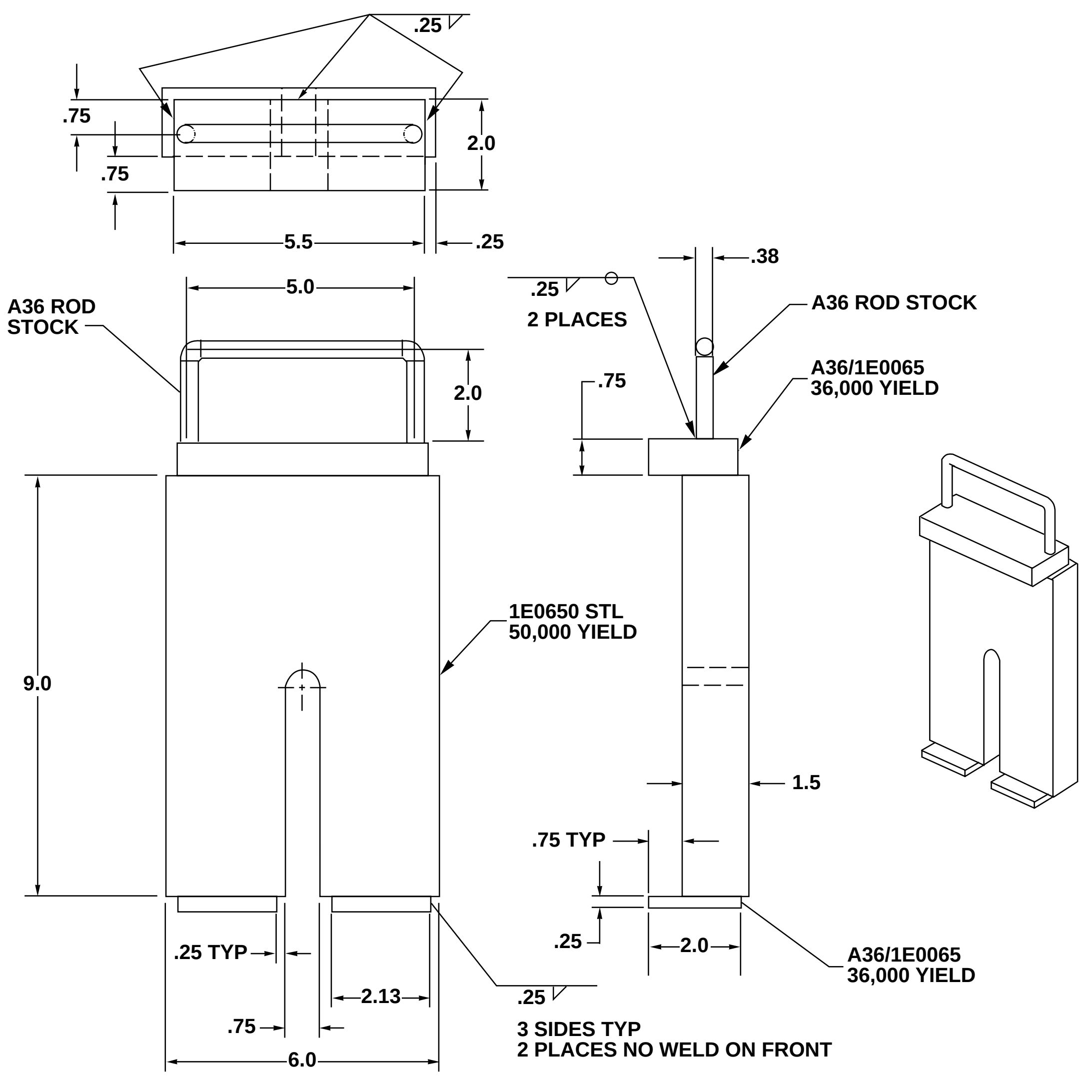
19. If the fan speed is within specification, reconnect line (2), and stop here; the fan is operating properly. If the fan continues to operate at minimum speed, replace the bypass control valve, and retest the fan speed.

NOTE: If the fan continues to operate outside the specification, the supply pressure should be checked at pressure tap (7). If fan speed is less than 375 rpm and the pressure is less than 2070 kPa (300 psi), the pump is faulty. If the fan speed is less than 375 rpm and the pressure is greater than 10 350 kPa (1500 psi), the motor is faulty.

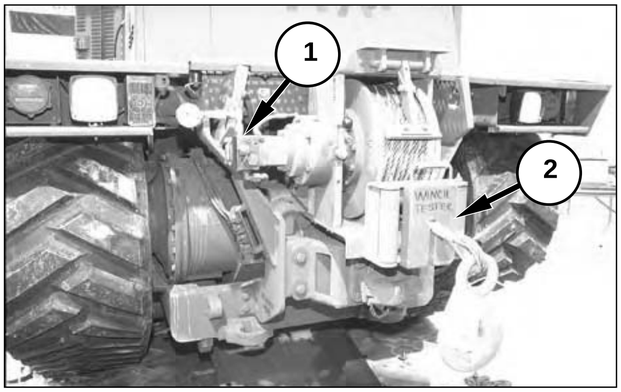
Winch Test

Tools Needed	A
1P-0510 Driver Group	1
1P-1857 Retaining Ring Pliers	

NOTE: A winch test block must be fabricated to the following specifications.



Winch Test Block (All Dimensions in Inches)



Winch.
(1) Supply line. (2) Winch test block.

1. Install a pressure gauge in winch supply line (1).

2. Place winch test block (2) over the cable, behind the swage block, and hang the winch block on the fairlead.

3. Engage the parking brake, and start the engine.

4. Move the winch enable switch to ON and the winch control switch to WINCH IN. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Machine Features, Winch Control Switches."

NOTE: Continue to hold the winch control switch in the WINCH IN position, even after the winch stalls.

WARNING

Do not place anything between the winch cable, winch test block, and/or the fairlead when the winch is in operation.

5. Read the pressure on the gauge. The pressure should be 20 700 ± 690 kPa (3000 ± 100 psi). If the pressure is within this specification, remove the tooling and stop here; the winch is operating within specification. If the pressure is not 20 700 ± 690 kPa (3000 ± 100 psi), go to Step 6.

6. Perform a high pressure stall test. Refer to "Instrument Tests, Blade Hydraulic System" in this module. If the high pressure stall pressure is not within the specification, make the necessary adjustments, and go back to Step 4. If the high pressure stall pressure is within specification, go to Step 7.

7. Remove the gauge from the supply port, but leave the gauge connected to the supply line (1). Plug the supply line, downstream from the gauge.

8. Move the winch enable switch to ON and the winch control switch to WINCH IN. Read the pressure on the gauge. The pressure should be 20 700 ± 690 kPa (3000 ± 100 psi). If the pressure is within this specification, the counterbalance valve in the winch motor, the winch motor, and/or the winch gear train is not operating properly. If the pressure is not 20 700 ± 690 kPa (3000 ± 100 psi), the winch control valve in the multifunction control valve is not operating properly.

9. Remove the tooling.

TM5-2430-200-24

Schematic

Deployable Universal Combat Earthmover (DEUCE)

Hydraulic Schematic

PIN: 7RR00003-Up

Important Safety Information

Most accidents involving product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “WARNING” as shown below.

The meaning of this safety alert symbol is as follows:

⚠ WARNING

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning, explaining the hazard, can be either written or pictorially presented.

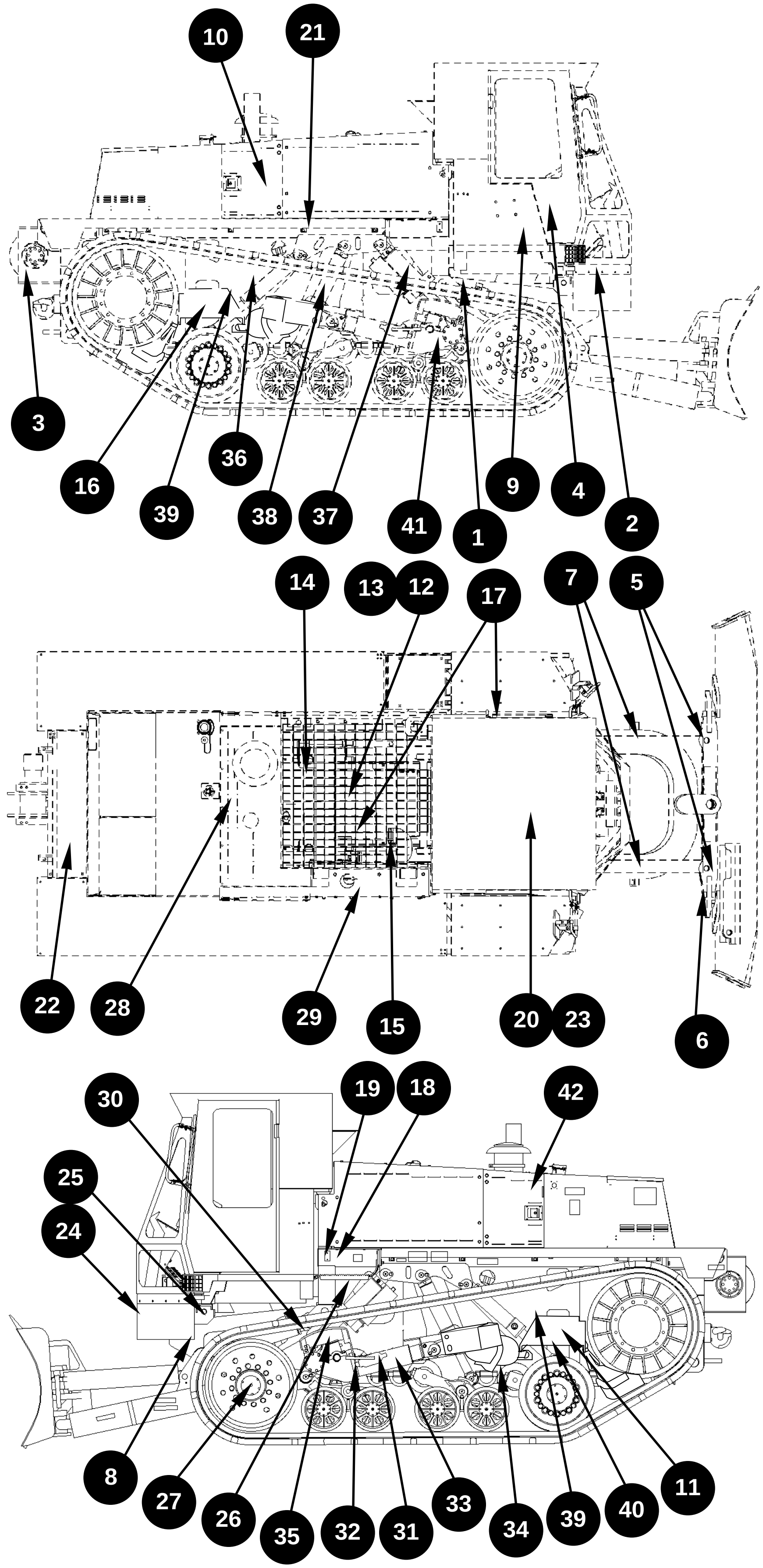
Operations that may cause product damage are identified by NOTICE labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are therefore not all inclusive. If a tool, procedure, work method or operating technique not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and others. You should also ensure that the product will not be damaged or made unsafe by the operation, lubrication, maintenance or repair procedures you choose.

The information, specifications, and illustrations in this publication are on the basis of information available at the time it was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service given to the product. Obtain the complete and most current information before starting any job. Caterpillar dealers have the most current information available. For a list of the most current publication form numbers available, see the Service Manual Contents Microfiche, REG1139F.

Hydraulic System Components	
Item	**Description**
1	Brake Accumulator
2	Brake Valve
3	Winch Motor
4	Blade Control Valve
5	Angle Cylinder
6	Tilt Cylinder
7	Lift Cylinder
8	Blade Down Lock Valve
9	Check Valve
10	Hydraulic Filter
11	Fan Pump
12	Fan Motor
13	Fan Motor Control Valve
14	Hydraulic Oil Cooler
15	Coolant Temperature Valve
16	Implement Pump
17	Cab and Radiator Lift Cylinder
18	Cab and Radiator Lift Valve
19	Cab and Radiator Lift Pump
20	Check Valve
21	Drain Valve
22	Steering Motor
23	Steering Pump
24	Steering Valve
25	Steering Control Solenoid Valve
26	Brake Return Strainer
27	Brake Group
28	Multifunction Valve Group
29	Hydraulic Tank
30	Check Valve
31	Bogie Cylinder Accumulator
32	Bogie Cylinder
33	Recoil Cylinder
34	Recoil Accumulator
35	Charge Valve
36	Middle Cylinder Accumulator
37	Front Cylinder
38	Middle Cylinder
39	Suspension Lock Valve
40	Front Cyl. Head End Accumulator
41	Rear Cylinder
42	Manifold
43	Front Cyl. Rod End Accumulator

NOTE: Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Transmission and Torque Converter* "Systems Operation" for information about the power train hydraulic system.



NOTE: See the Hydraulic Schematic on Foldout (FO) pages FO-1 and FO-3 in the back of this manual.

TM5-2430-200-24

Disassembly & Assembly

Deployable Universal Combat Earthmover (DEUCE)

Hydraulic System

PIN: 7RR00003-Up

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The message that appears under the warning, explaining the hazard, can be either written or pictorially presented.

Operations that may cause product damage are identified by NOTICE labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are therefore not all inclusive. If a tool, procedure, work method or operating technique not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and others. You should also ensure that the product will not be damaged or made unsafe by the operation, lubrication, maintenance or repair procedures you choose.

The information, specifications, and illustrations in this publication are on the basis of information available at the time it was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service given to the product. Obtain the complete and most current information before starting any job. Caterpillar dealers have the most current information available. For a list of the most current publication form numbers available, see the Service Manual Contents Microfiche, REG1139F.

Table of Contents

⚠ WARNING

At operating temperature, the hydraulic oil and components are hot. Any contact with the skin can cause severe burns. The hydraulic system may be pressurized. Sudden release of oil under pressure can cause injury to persons on or near the machine. To prevent possible injury, do the procedure that follows before any work is performed on components in the hydraulic system.

1. Move the machine into the service area, and lower the blade to the ground.

2. Permit only one operator on the machine. Keep all other personnel either away from the machine or in view of the operator.

2. Engage the parking brake, Stop the engine.

5. Move the hydraulic control levers into and out of all positions to release the pressure in the hydraulic system.

6. Depress the brake pedal 120 times or more to relieve the pressure in the brake system accumulator.

7. Carefully loosen the filler cap on the hydraulic tank to release the pressure in the tank.

8. Make sure all hydraulic pressure is released before any fitting, hose or component is loosened, tightened, removed, or adjusted.

9. Tighten the filler cap on the hydraulic tank.

Angle Cylinder

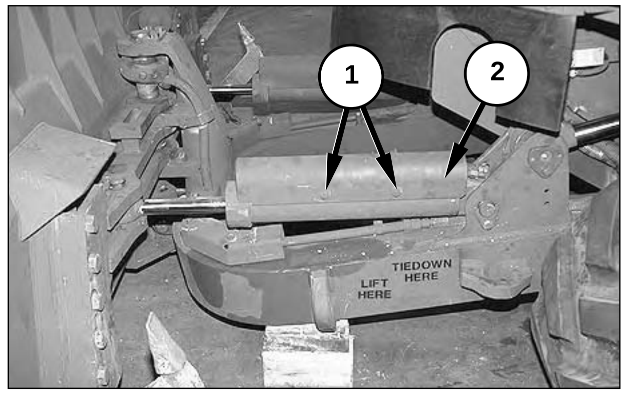
Remove and Install

NOTE: Group numbers related to this procedure include 8E-2737, 100-6174, and 133-4255.

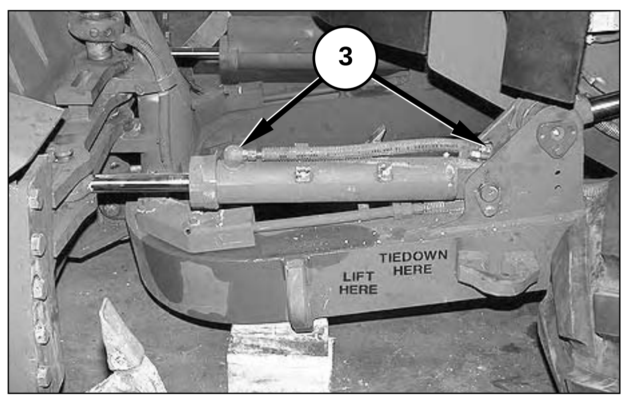
1. Lower the blade to the ground. Stop the engine, and cycle the blade controls and release any pressure remaining in the system. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE)* for information about machine operation.

⚠ WARNING

Refer to the WARNING on the Table of Contents page of this module.

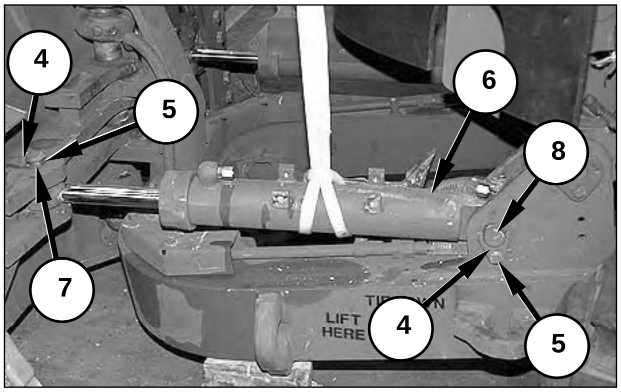


2. Remove four bolts (1) with the washers and cover (2).



3. Disconnect, cap and plug two lines (3).

NOTE: Make sure to cap and plug lines (3) quickly to minimize oil spillage. Catch any spilled oil in a suitable container, and discard the oil according to local regulations.



4. Fasten a hoist to angle cylinder (6). The weight of the angle cylinder is **50 kg (110 lb).**

5. Remove two bolts (4), and remove retainers (5). Upon reassembly, apply **4C-4030 Compound (Loctite™ 242)** to bolts (4).

6. Remove pin (7), and remove the three spacers from the joint (two spacers below and one spacer above the cylinder rod). Upon reassembly, coat the pin bore with **7X-7699 Grease**.

7. Remove pin (8), and remove the two spacers from the joint. Upon reassembly, coat the pin bore with **7X-7699 Grease**.

8. Remove angle cylinder (6). The weight of the angle cylinder is **50 kg (110 lb).**

NOTE: To install the angle cylinder, reverse the removal steps.

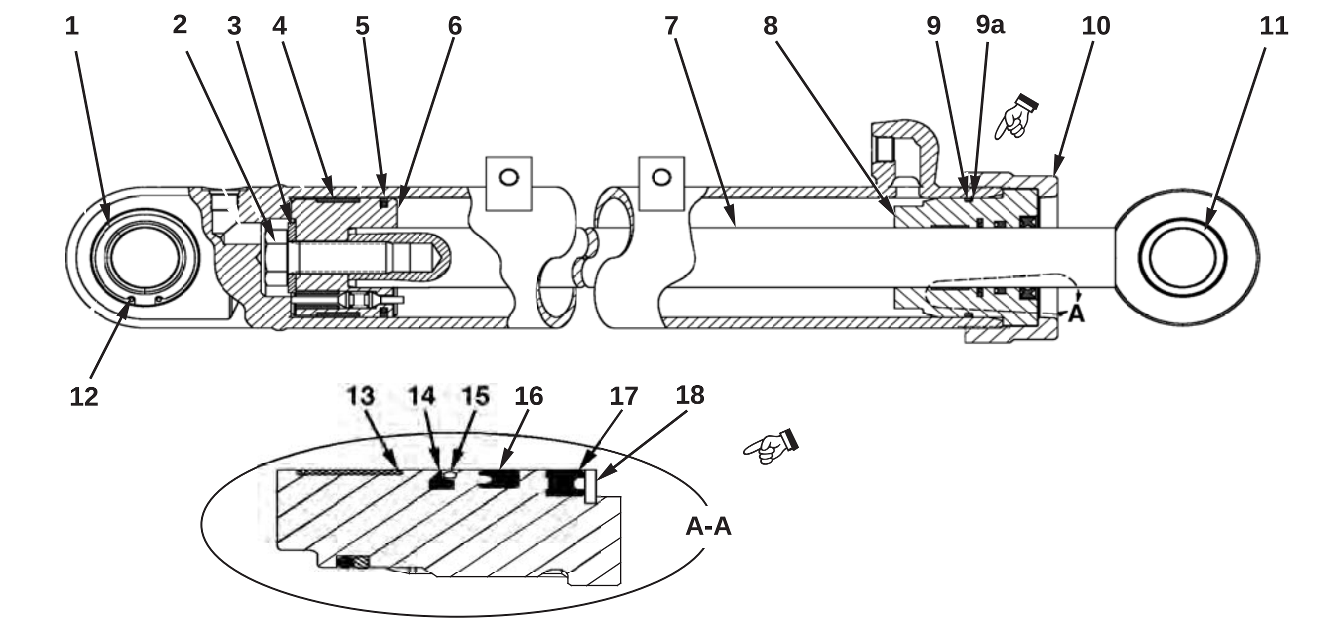
Disassemble and Assemble

Tools Needed	A
160-0261 Spanner Wrench	1

Start By:

a. Remove the angle cylinder.

NOTE: The group number related to this procedure is 100-6174.



1. Use Tooling (A) to remove crown (10). Upon reassembly, lubricate the threads with clean grease, and tighten the crown to a torque of **600 ± 130 N•m (450 ± 100 lb ft)**.

2. Remove cylinder rod (7) from the cylinder tube.

3. Remove bolt (2) and washer (3). Upon reassembly, lubricate the threads with clean grease, and tighten the bolt to a torque of **1125 ± 100 N•m (830 ± 75 lb ft)**.

4. Remove piston (6) with ring (4) and seal (5). Replace the seals if they are damaged or worn. Upon reassembly and prior to installation, lubricate the seals and ring with clean oil.

5. Remove head (8), O-ring (9), backup ring (9a), retaining ring (18), lip seal (17), U-cup seal (16), backup ring (15), buffer seal (14), and wear ring (13). Replace the seals and the rings if they are damaged or worn. Upon reassembly and prior to installation, lubricate the seals and rings with clean oil. Apply **7M-7456 Bearing Mount Compound** to the metal shell of lip seal (17) and to the counter bore of head (8).

6. Remove retaining ring (12) and bearing (1).

7. Use a press to remove bearing (11).

NOTE: To assemble the angle cylinder, reverse the disassembly steps.

End By:

a. Install the angle cylinder.

Blade Control Valve

Remove and Install

Start By:

a. Remove the cab assembly. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Machine Systems,* “Cab Assembly.”

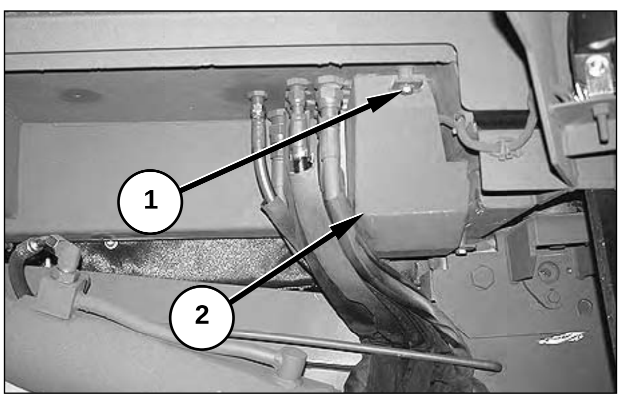
NOTE: Group numbers related to this procedure include 126-6569, 132-4498, and 145-0425.

WARNING

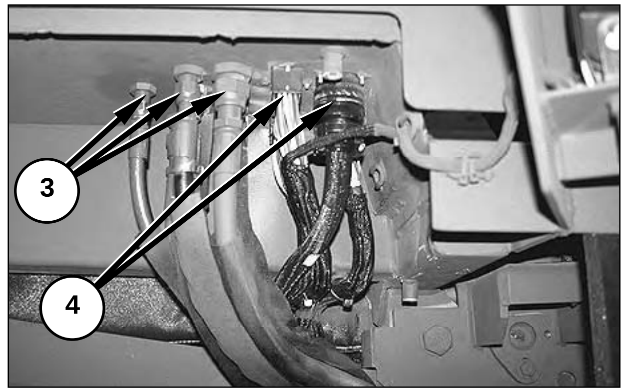
Refer to the WARNING on the Table of Contents page of this module.

1. Move the main disconnect switch to the OFF position. Refer to *Operator’s Manual, Deployable Universal Combat Earthmover (DEUCE),* “Operation Section, Machine Features, Main Disconnect Switch.”

2. Drain the hydraulic tank. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE), Unit Level Maintenance,* “Every 1000 Service Hours or One Year, Hydraulic System, Change Oil and Clean Suction Screens.”

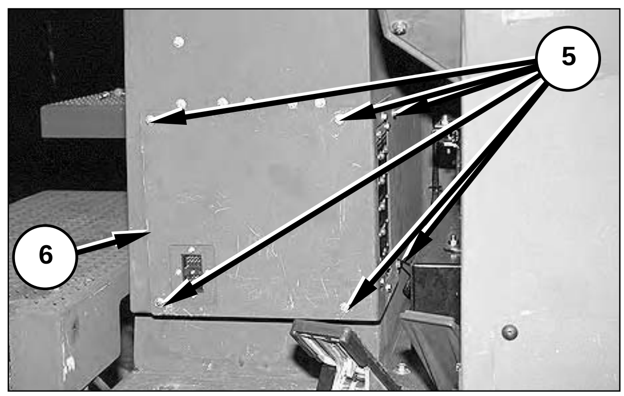


3. Remove three bolts (1) with the washers, and cover (2).

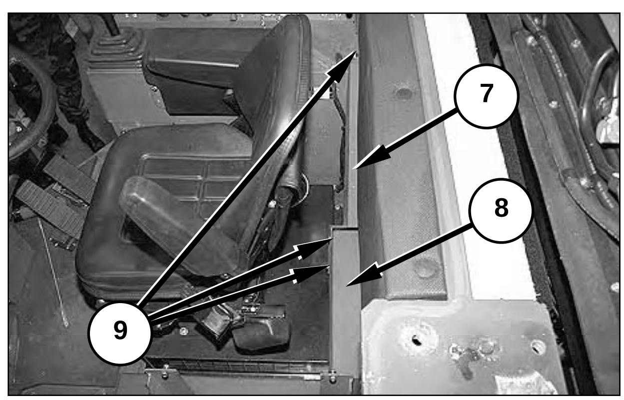


4. Disconnect three rectangular electrical connectors (only one visible in photo) and one round electrical connector (4). Disconnect nine hydraulic lines (3) (only three visible in photo). Mark the connectors and lines for correct connection during reassembly. Use a container to catch the oil, and dispose of the oil according to local regulations.

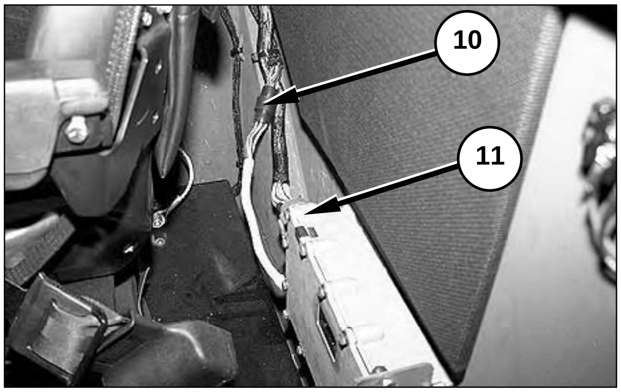
NOTE: The rectangular connector numbers are: front left—C103, rear left—C105, and rear right—C104.



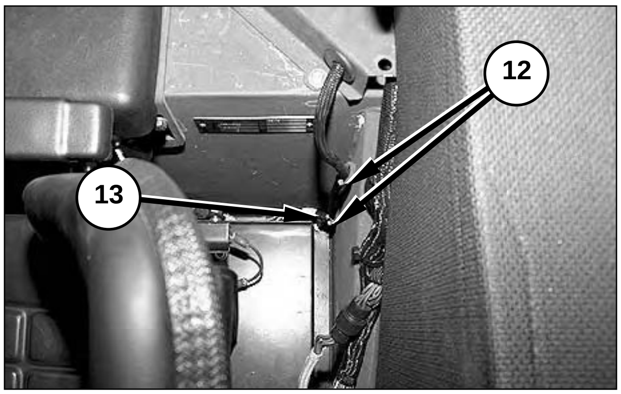
5. Remove eight bolts (5) and washers (only six visible in photo), and remove panel (6) from the right console.



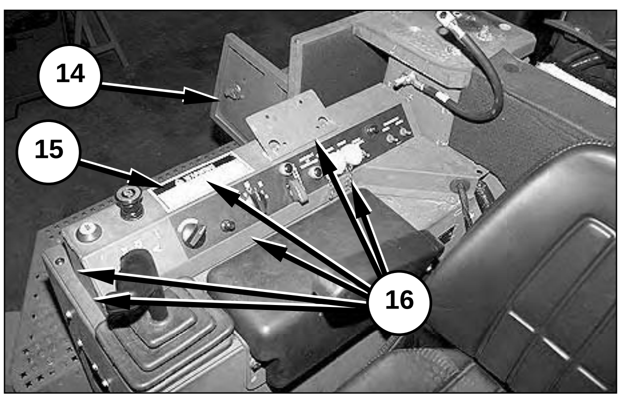
6. Remove eight bolts (9) with the washers (only three visible in photo) and covers (7) and (8).



7. Disconnect connectors C133 (10) and C123 (11).

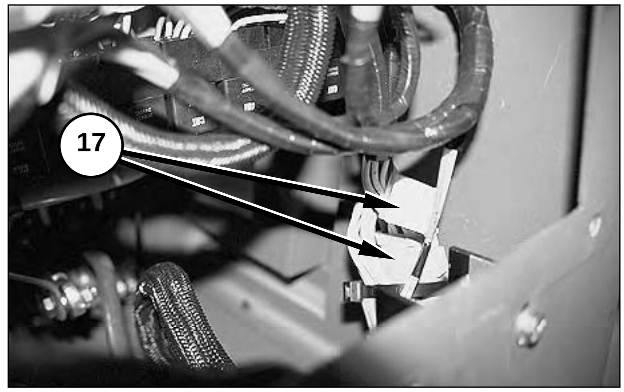


8. Remove two cable ties (12), and disconnect connector C157 (13).



9. Open blade control valve compartment door (14), and remove six screws (16) and washers. Lift operator console (15) out of the way.

NOTE: Six screws (16) are accessed from below, through the blade control valve compartment.



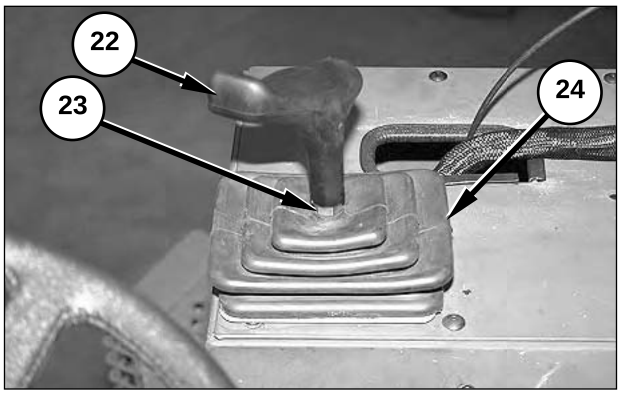
10. Remove the cable tie, and disconnect connectors C106 and C107 (17) from inside the compartment from which panel (6) was removed.

11. Disconnect connector C113 (18).

12. Loosen the set screw and remove switch knob (19).

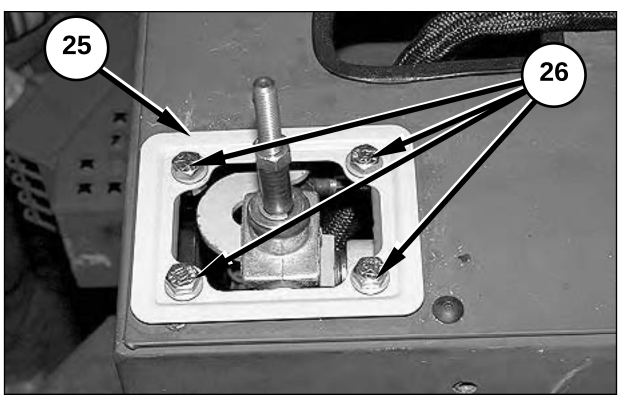
13. Remove the nut which fastens the switch to the console cover, and remove the switch from the console cover.

14. Remove two bolts (21) with the washers, and arm rest (20).

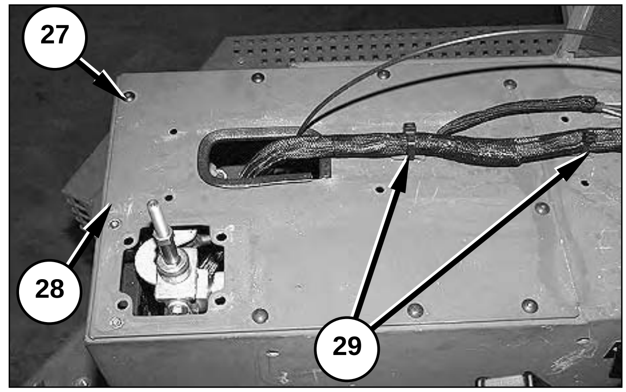


15. Loosen nut (23), and remove turn control handle (22) by turning the handle counterclockwise.

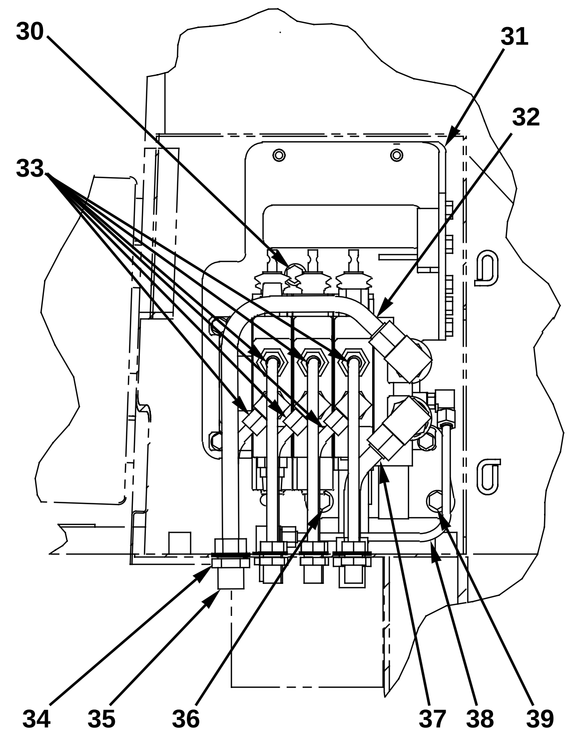
16. Remove rubber boot (24).



17. Remove four bolts (26) and plate (25).



18. Remove ten screws (27), two cable ties (29), and cover (28).



19. Remove tube (32) with shims. Mark the shims in order to keep them with the tube during reassembly.

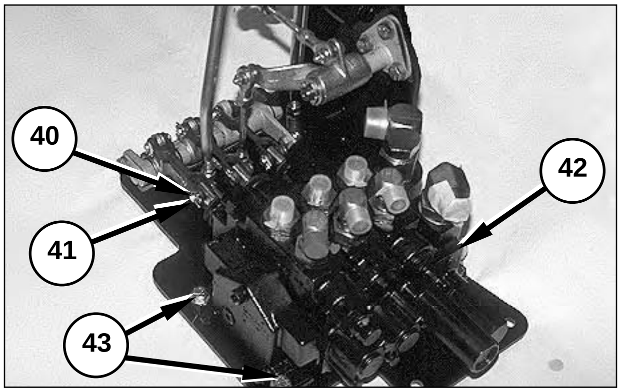
20. Remove six tubes (33) with shims. Mark the shims in order to keep them with the tubes during reassembly.

21. Remove tube (37) and tube (38), with the shims. Mark the shims to keep them with the tubes during reassembly.

NOTE: Loosening nut (34) and loosening or removing tube (35) may aid in the removal of the tubes connected to the blade valve. If the valve group or a tube is replaced, the tube may need to be reshimmed.

22. Fasten a hoist to blade control valve mounting assembly (31), and remove bolts (30), (36) and (39), with the washers. The weight of the blade control valve mounting assembly is approximately **55 kg (120 lb).**

23. Remove the blade control valve mounting assembly as a unit. The weight of the blade control valve mounting assembly is approximately **55 kg (120 lb).**



24. Remove three cotter pins (40) and three linkage pins (41).

25. Remove three bolts (43) (only two visible in photo) with washers, and blade control valve (42). The weight of the control valve is approximately **42 kg (93 lb).**

NOTE: To install the blade control valve, reverse the removal steps.

Disassemble and Assemble

Tools Needed	A	B
1P-0510 Driver Group	1	
1P-1857 Retaining Ring Pliers		1

Start By:

a. Remove the blade control valve.

NOTE: Group numbers related to this procedure include 9T-6697, 9T-9182, 9T-9183, and 1U-2745.

Valve Bank

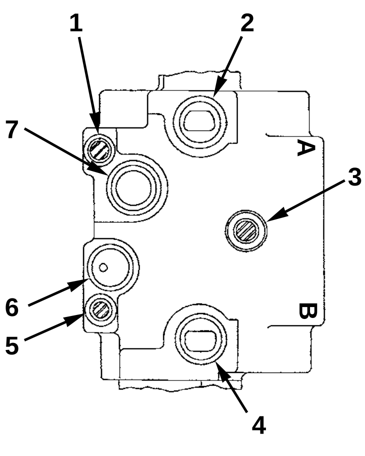
1. Remove three nuts (13), (16), and (19) with the washers, and remove cover (12). Upon reassembly, tighten the nuts to a torque of **25.5 ± 1.4 N•m (20 ± 4 lb ft).**

2. Separate angle valve (8), tilt valve (9), lift valve (10), and manifold (11).

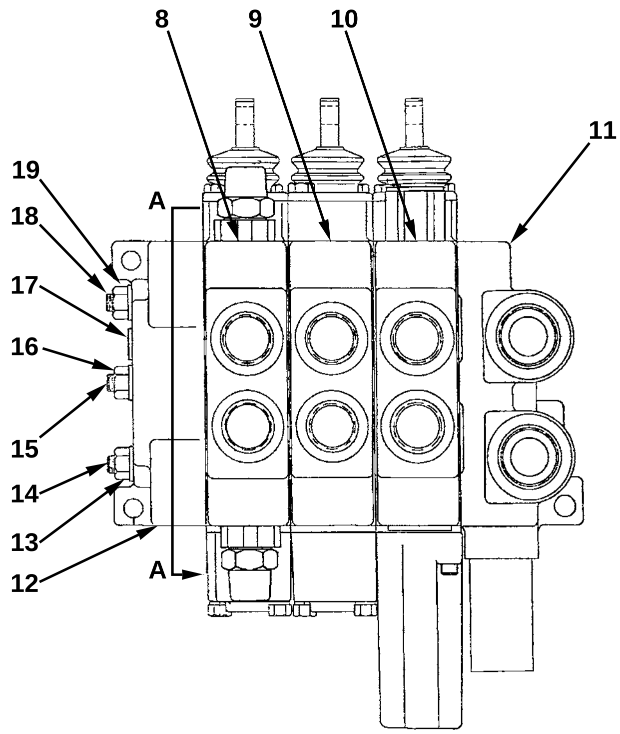
3. Remove O-ring seals (2), (4), (6), and (7), and remove shims (1), (3), and (5) from between each of the valves and the manifold.

4. Remove studs (14), (15), and (18).

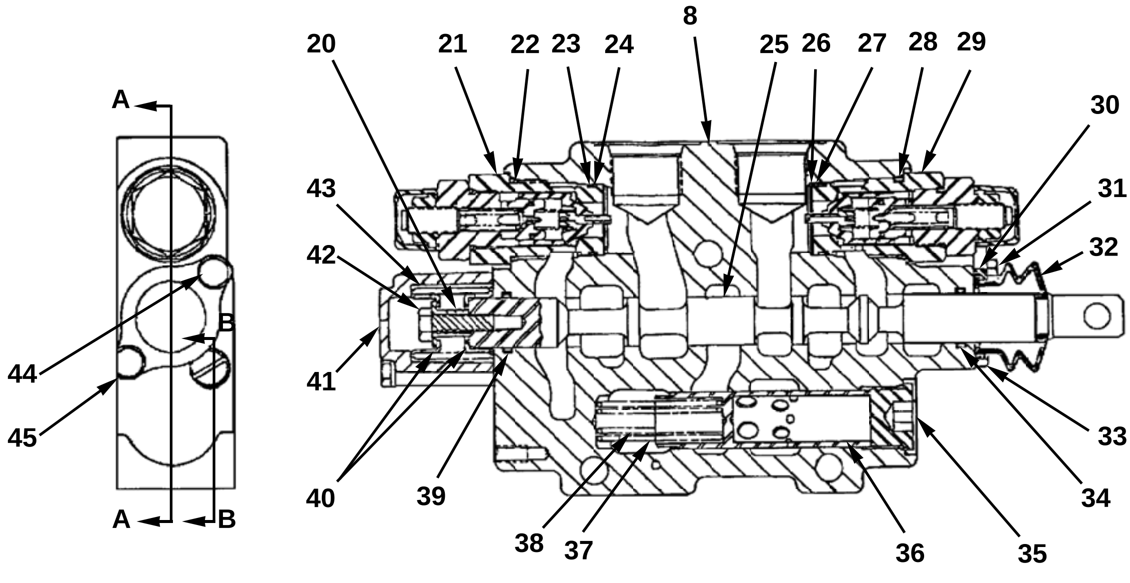
NOTE: To assemble the valve bank, reverse the disassembly steps.



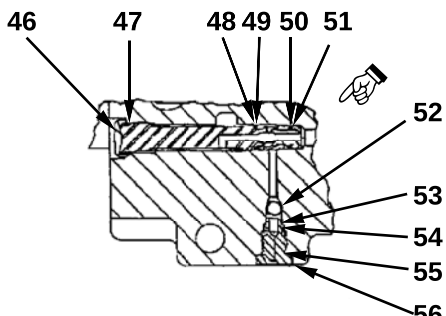
VIEW A-A



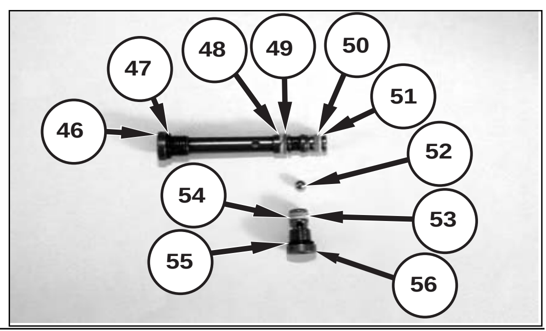
Angle Valve



SECTION A-A



SECTION B-B



5. Remove relief valves (21) and (29) from angle valve (8). If necessary, remove O-rings (24) and (26), backup rings (23) and (27), and O-rings (22) and (28).

NOTE: Remove relief valves (21) and (29) as units. The valve cartridges and the O-ring seals are the only serviceable items of the relief valves.

6. Remove plug (35), valve (36), and springs (37) and (38) from angle valve (8). Remove the O-ring seal from the plug.

7. Remove two bolts (31), retainer (33), guard (32), and filter (30) from angle valve (8).

8. Remove two bolts (44) and (45) with the washers, and then remove housing (41).

9. Remove spool (25) from angle valve (8).

10. Compress spring (43), and remove bolt (42) and spacer (20). Remove two retainers (40) and spring (43) from spool (25).

11. Remove valve (46) from angle valve (8). Remove O-ring seal (47), backup ring (48), O-ring seals (49) and (50), and backup seal (51) from the valve.

12. Remove seat (56) and ball (52) from angle valve (8), and remove O-ring seal (53), backup ring (54) and O-ring seal (55) from the seat.

13. If necessary, remove O-ring seals (34) and (39) from angle valve (8).

NOTE: The following steps describe the assembly process for angle valve (8).

14. If seals (34) and (39) were removed, install the seals in each end of angle valve (8).

15. Install O-ring seals (47), backup ring (48), O-ring seals (49) and (50), and backup ring (51) in position on valve (46), and install the valve in angle valve (8). Tighten valve (46) to a torque of **12 ± 1 N•m (108 ± 9 lb in)**.

16. Install O-ring seal (53), backup ring (54) and O-ring seal (55) on seat (56). Place ball (52) in position in angle valve (8), and install the seat. Tighten the seat to a torque of **12 ± 1 N•m (108 ± 9 lb in)**.

17. Put two retainers (40), spring (43), and spacer (20) in position on spool (25), and install bolt (42). Tighten the bolt to a torque of **11.0 ± 2.8 N•m (99 ± 25 lb in)**.

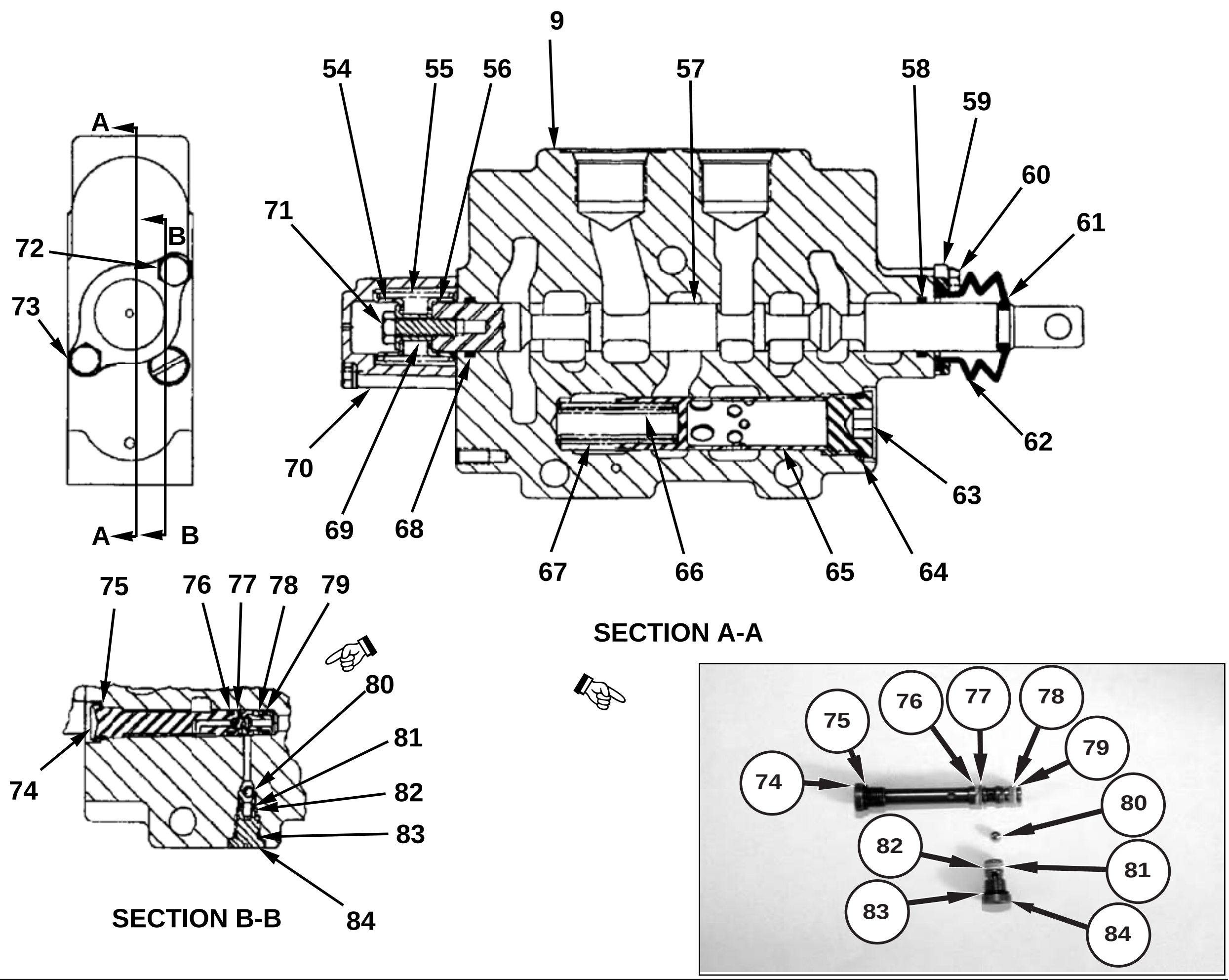
18. Install spool (25) in angle valve (8). Place housing (41) in position on the body, and install bolts (44) and (45) with the washers. Tighten the bolts to a torque of **11.0 ± 2.8 N•m (99 ± 25 lb in)**.

19. Put filter (30), guard (32), and retainer (33) in position on angle valve (8), and install two bolts (31). Tighten the bolts to a torque of **5.5 ± 1.4 N•m (49 ± 13 lb in)**.

20. Install the O-ring seal on plug (35). Place springs (37) and (38) and valve (36) in position in angle valve (8), and install the plug. Tighten the plug to a torque of **27 ± 3 N•m (20 ± 2 lb ft)**.

21. If O-rings (24) and (26), backup rings (23) and (27), and O-rings (22) and (28) were removed, install the rings on relief valves (21) and (29). Install the relief valves in angle valve (8), and tighten the relief valves to a torque of **27 ± 3 N•m (20 ± 2 lb ft)**.

Tilt Valve



22. Remove plug (63), valve (65), and springs (67) and (66) from tilt valve (9). Remove O-ring seal (64) from the plug.

23. Remove two bolts (60), retainer (59), guard (61), and filter (62) from tilt valve (9).

24. Remove two bolts (72) and (73) with the washers, and then remove housing (70).

25. Remove spool (57) from tilt valve (9).

26. Compress spring (55), and remove bolt (71) and spacer (69). Remove retainers (54) and (56), and the spring from spool (57).

27. Remove valve (74) from tilt valve (9). Remove O-ring seal (75), backup ring (76), O-ring seals (77) and (78), and backup ring (79) from the valve.

28. Remove seat (84) and ball (80) from tilt valve (9), and remove O-ring seal (81), backup ring (82) and O-ring seal (83) from the seat.

29. If necessary, remove O-ring seals (58) and (68) from tilt valve (9).

NOTE: The following steps describe the assembly process for tilt valve (9).

30. If seals (58) and (68) were removed, install the seals in each end of tilt valve (9).

31. Install O-ring seal (75), backup ring (76), O-ring seals (77) and (78), and backup ring (79) in position on valve (74), and install the valve in tilt valve (9). Tighten valve (74) to a torque of **12 ± 1 N•m (108 ± 9 lb in)**.

32. Install O-ring seal (83), backup seal (82) and O-ring seal (81) on seat (80). Place ball (80) in position in tilt valve (9), and install the seat. Tighten the seat to a torque of **12 ± 1 N•m (108 ± 9 lb in)**.

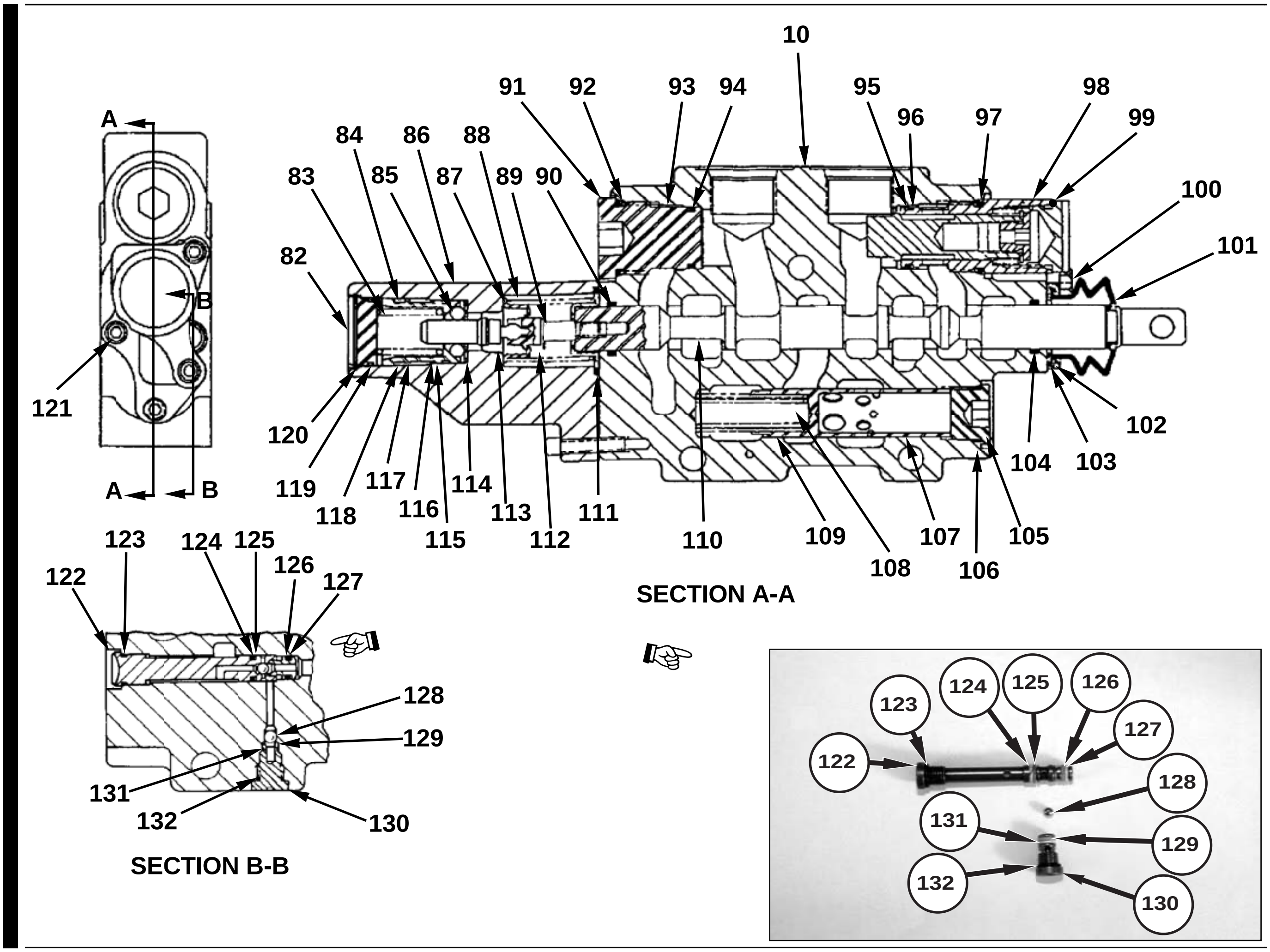
33. Place retainer (56), spring (55), spacer (69), and retainer (54) in position on spool (57), and install bolt (71). Tighten the bolt to a torque of **11.0 ± 2.8 N•m (99 ± 25 lb in)**.

34. Install spool (57) in tilt valve (9). Place housing (70) in position on the body, and install bolts (72) and (73) with the washers. Tighten the bolts to a torque of **11.0 ± 2.8 N•m (99 ± 25 lb in)**.

35. Place filter (62), guard (61), and retainer (59) in position on tilt valve (9), and install two bolts (60). Tighten the bolts to a torque of **5.5 ± 1.4 N•m (49 ± 13 lb in)**.

36. Install O-ring seal (64) on plug (63). Place springs (67) and (66) and valve (65) in position in tilt valve (9), and install the plug. Tighten the plug to a torque of **27 ± 3 N•m (20 ± 2 lb ft)**.

Lift Valve



37. Remove plug (105), valve (107) and springs (108) and (109) from lift valve (10). Remove O-ring seal (106) from the plug.

38. Remove check valve (98) from tilt valve (10). If necessary, remove O-rings (99), (97), and (95), and backup ring (96).

NOTE: Remove check valve (98) as a unit. The valve cartridge, the backup ring, and the O-ring seals are the only serviceable items of the check valve.

39. Remove two bolts (100), retainer (102), guard (101), and filter (103).

40. Use a press and Tooling (A), and hold retainer (82) in position. Use Tooling (B), and remove snap ring (120).

41. Remove retainer (82) and spring (83) from housing (86).

42. Remove piston (84) and eight balls (85) from housing (86). Remove guide washer (114) from the housing.

43. Remove three bolts (121) and housing (86). Remove O-ring seal (111) from the housing.

44. Remove O-ring seals (119), (117), and (116), and seals (118) and (115) from piston (84).

45. Remove spool (110) from lift valve (10).

46. Compress spring (88), and remove shaft (113) and coupling (112) from spool (110).

47. Remove retainers (87), spring (88), and spacer (89).

48. Remove valve (122) from lift valve (10). Remove O-ring seal (123), backup ring (124), O-ring seals (125) and (126), and backup ring (127) from the valve.

49. Remove seat (130) and ball (128). Remove O-ring seal (129), backup ring (131), and O-ring seal (132) from the seat.

50. If necessary, remove O-ring seals (90) and (104) from each end of lift valve (10).

51. If necessary, remove plug (91) with O-ring seals (92), (93), and (94).

NOTE: The following steps describe the assembly process for lift valve (10).

52. If necessary, replace O-ring seals (92), (93), and (94), and install plug (91) in lift valve (10). Tighten the plug to a torque of **27 ± 3 N•m (20 ± 2 lb ft)**.

53. If seals (90) and (104) were removed, install the seals in each end of lift valve (10).

54. Install O-ring seal (123), backup seal (124), O-ring seals (125) and (126), and backup ring (127) on valve (122). Install the valve in lift valve (10). Tighten valve (122) to a torque of **12 ± 1 N.m (108 ± 9 lb in)**.

55. Install O-ring seal (132), backup ring (131), and O-ring seal (129) on seat (131). Put ball (128) in position in lift valve (10), and install the seat. Tighten the seat to a torque of **12 ± 1 N•m (108 ± 9 lb in)**.

56. Put retainers (87), spacer (89), and spring (88) in position on spool (110), and install coupling (112) and shaft (113). Tighten the coupling to a torque of **6.8 ± 1.4 N•m (61 ± 13 lb in)**.

57. Install spool (110) in lift valve (10).

58. Install O-ring seal (111) in housing (86).

59. Install O-ring seals (119), (117), and (116), and seals (118) and (115) on piston (84).

60. Put housing (86) in position on lift valve (10), and install three bolts (121). Tighten the bolts to a torque of **11.0 ± 2.8 N•m (99 ± 25 lb in)**.

61. Install washer (114), eight balls (85), and piston (84) in housing (86).

62. Put spring (83) and retainer (82) in position in housing (86). Use a press and Tooling (A) to hold the spring and retainer in place, and install snap ring (120) with Tooling (B).

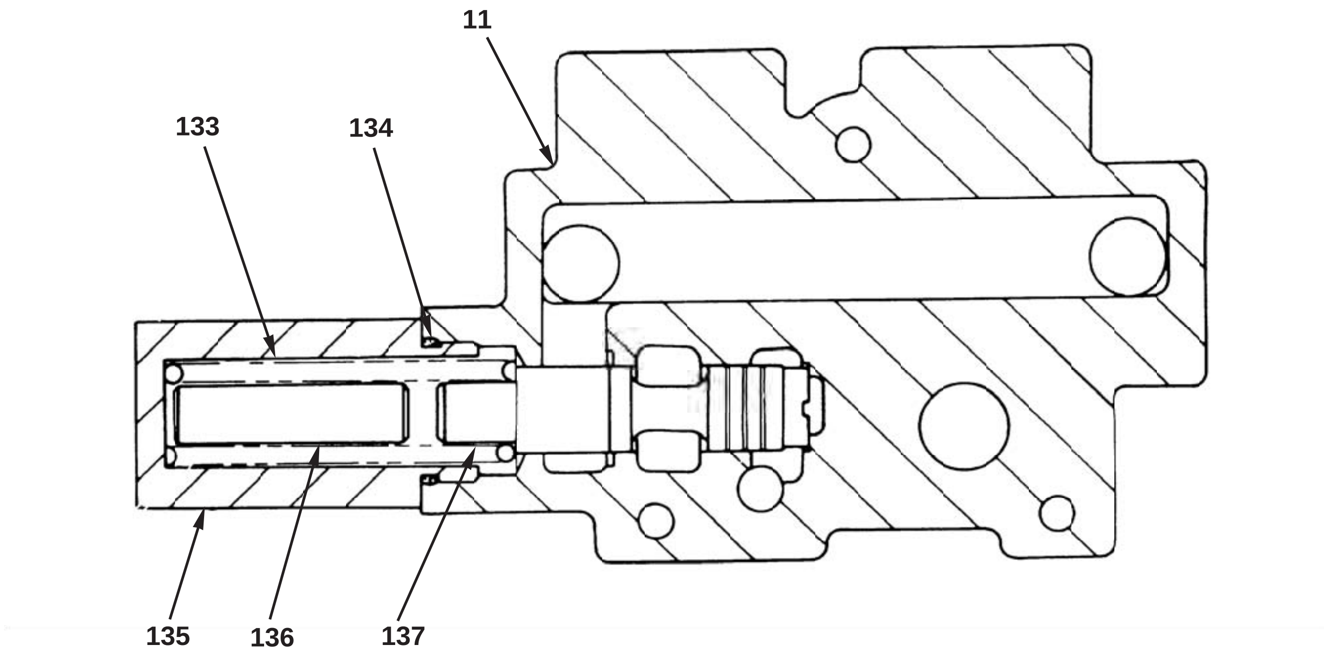
63. Put filter (103), guard (101), and retainer (102) in position on lift valve (10), and install two bolts (100). Tighten the bolts to a torque of **5.5 ± 1.4 N•m (49 ± 13 lb in)**.

64. Install backup ring (96), and O-rings (95), (97), and (99) on check valve (98).

65. Install check valve (98) in lift valve (10). Tighten the check valve to a torque of **27 ± 3 N•m (20 ± 2 lb ft)**.

66. Install O-ring seal (106) on plug (105). Put springs (109) and (108) and valve (107) in position in lift valve (10), and install the plug. Tighten the plug to a torque of **27 ± 3 N•m (20 ± 2 lb ft)**.

Manifold



67. Remove plug (135), O-ring (134), spring (133), and dowel (136) from manifold (11).

68. Remove spool (137) from manifold (11).

NOTE: The following steps describe the assembly process for manifold (11).

69. If necessary, replace O-ring seal (134).

70. Install spool (137) in manifold (11).

71. Install spring (133) and dowel (136), and install plug (135) with O-ring (134). Tighten the plug to a torque of **70 ± 7 N•m (52 ± 5 lb ft)**.

Blade Lock Valve

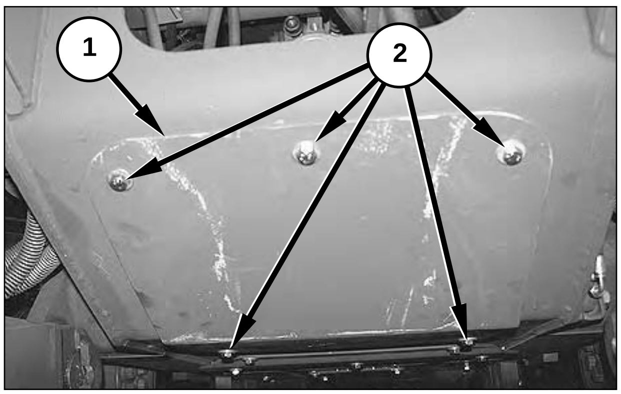
Remove and Install

NOTE: Group numbers related to this procedure include 132-1207 and 145-0073.

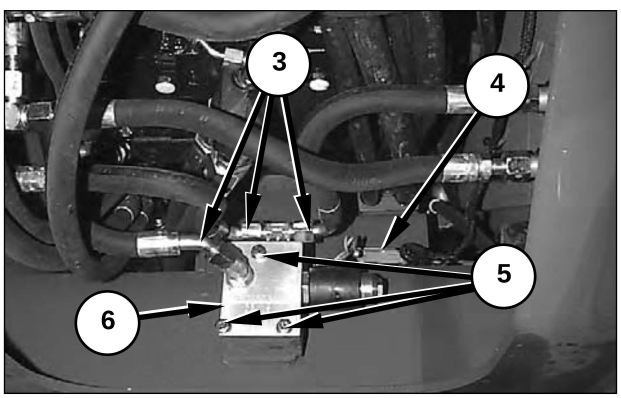
⚠ WARNING

Refer to the WARNING on the Table of Contents page of this module.

1. Turn the main disconnect switches to the OFF position. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Machine Features, Main Disconnect Switch."



2. Remove five bolts (2) with the washers, and cover (1).



3. Disconnect connector C129 (4).

4. Disconnect, cap and plug three lines (3). Mark the lines for correct positioning during reassembly.

NOTE: Make sure to cap and plug lines (3) quickly to minimize oil spillage. Catch any spilled oil in a suitable container, and discard the oil according to local regulations.

5. Remove three bolts (5) with the washers, and blade lock valve assembly (6).

NOTE: To install the blade lock valve, reverse the removal steps.

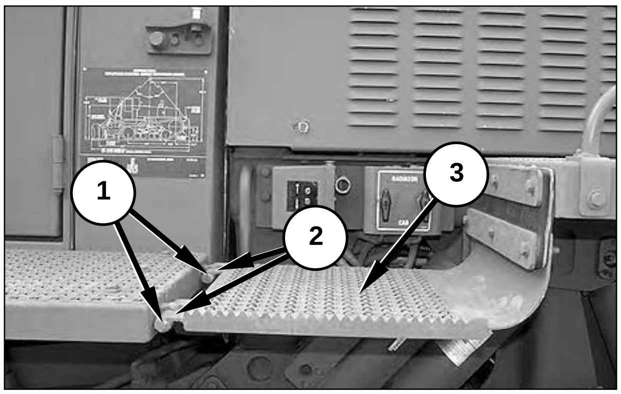
Cab and Radiator Tilt Control Valve

Remove and Install

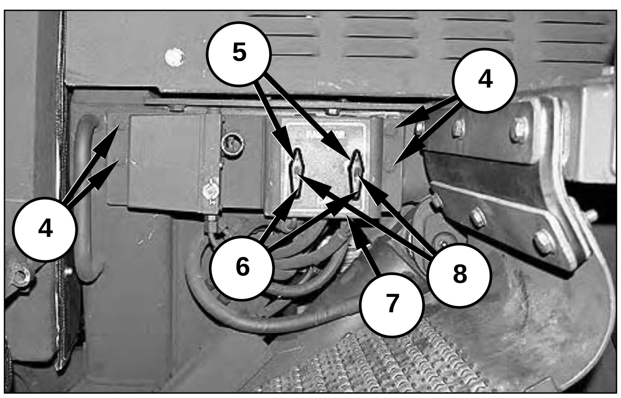
NOTE: Group numbers related to this procedure include 124-5847, 130-4551, and 161-8626.

⚠ WARNING

Do not perform this procedure with the radiator or cab tilted.



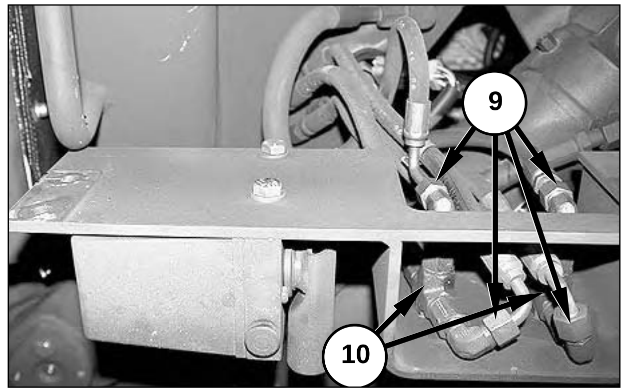
1. Remove two nuts (2) and bolts (1) with the washers, and allow walkway (3) to hang down.



2. Remove two set screws (5) and two knobs (6).

3. Remove two nuts (8).

4. Remove four bolts (4) with the washers, and allow mounting bracket (7) to hang down.



5. Disconnect, cap and plug four lines (9). Mark the lines for correction connection during reassembly.

NOTE: Make sure to cap and plug lines (9) quickly to minimize oil spillage. Catch any spilled oil in a suitable container, and discard the oil according to local regulations.

6. Remove control valves (10).

NOTE: To install the cab and radiator tilt control valve, reverse the removal steps.

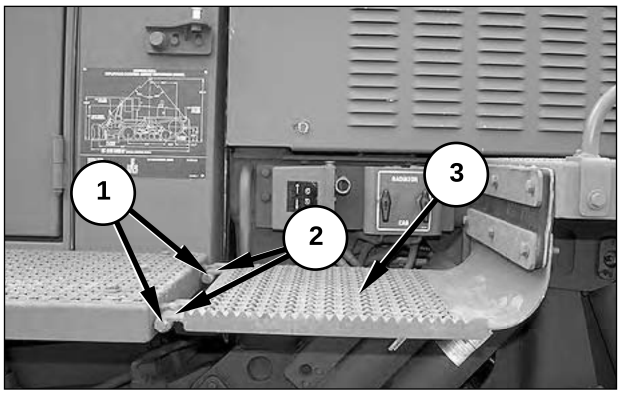
Cab and Radiator Tilt Pump

Remove and Install

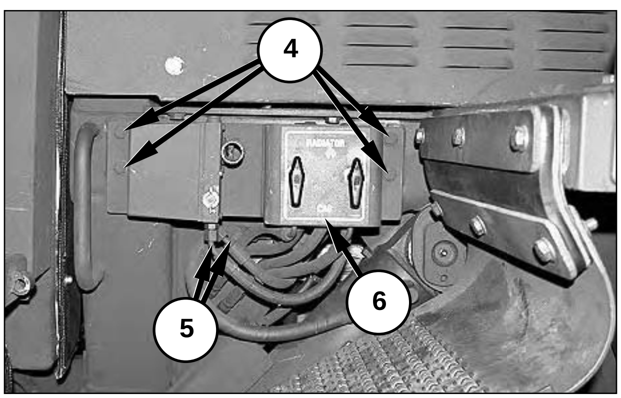
NOTE: The group number related to this procedure is 130-4551.

⚠ WARNING

Do not perform this procedure with the radiator or cab are tilted.



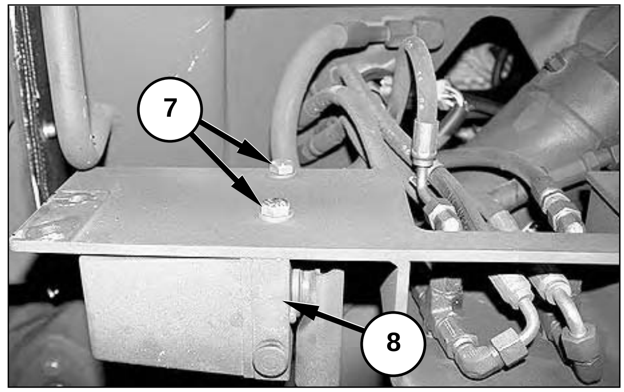
1. Remove two nuts (2), and bolts (1) with the washers, and allow walkway (3) to hang down.



2. Disconnect, cap and plug two lines (5).

NOTE: Make sure to cap and plug lines (5) quickly to minimize oil spillage. Catch any spilled oil in a suitable container, and discard the oil according to local regulations.

3. Remove four bolts (4) with the washers, and allow mounting bracket (6) to hang down.



4. Remove two bolts (7) with the washers, and pump (8).

NOTE: To install the cab and radiator tilt pump, reverse the removal steps.

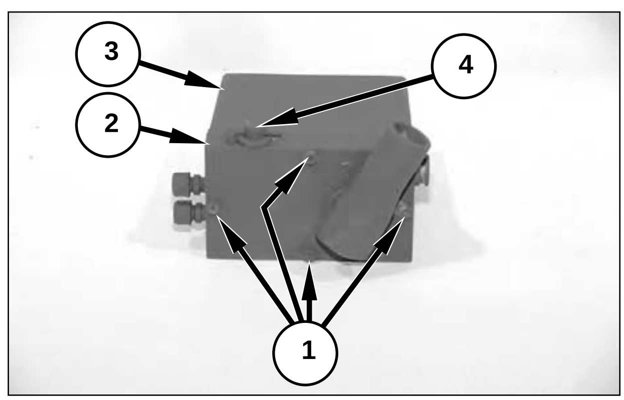
Disassemble and Assemble

Start By:

a. Drain the oil from the cab and radiator tilt pump. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE), Unit Level Maintenance,* “Maintenance Section, Maintenance Intervals, Every 2000 Service Hours or Two Years, Cab and Radiator Tilt Pump.”

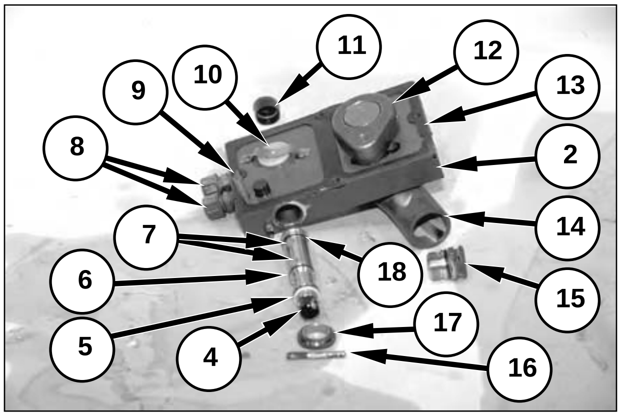
b. Remove the cab and radiator tilt pump.

NOTE: The group number related to this procedure is 147-2520.



1. Remove four screws (1), and separate pump housing (2) from reservoir (3).

2. Mark spool (4) and pump housing (2) for proper alignment during reassembly.



3. Remove gasket (13).

4. Remove screen (9) and valve disk assembly (10) from pump housing (2).

5. Remove plug (11) from pump housing (2).

6. Remove pin (16) from spool (4), and remove washer (17) with the O-ring seal.

7. Remove spool (4) from pump housing (2), and tilt the pump housing to remove the ball from inside the housing.

8. Remove backup ring and O-ring seal (5) from spool (4).

9. Remove O-ring seals (6) and (18) from spool (4).

10. Remove two inserts (7) from spool (4). Remove the plug with the O-ring seal from the end of the spool, and remove the spring and ball from inside the spool.

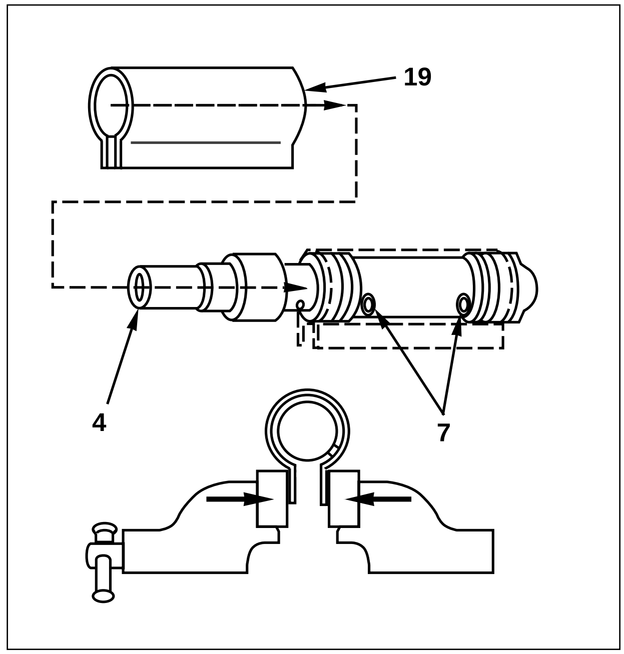
11. Remove fill plug (15) with the O-ring seal from pump housing (2).

12. Use a suitable puller to remove cam (12).

13. Remove pump handle (14) with the O-ring seal, V-ring, and washer, and then remove the plunger with the U-cup seal from pump housing (2).

14. Remove two couplings (8) from pump housing (2).

NOTE: To assemble the cab and radiator tilt pump, reverse the disassembly steps. When Step 10 is reached, follow the procedure in Step 15 to install inserts (7) in spool (4).



15. Install two inserts (7) in spool (4). Slide calibration tool (19), which is provided in the repair kit, over the spool, and place the tabs of the calibration tool in the jaws of a vise. Tighten the vise to squeeze the tabs of the calibration tool and seat the inserts in the spool. Do not overtighten. After the inserts have been seated, remove the calibration tool and spool from the vise. Use a flat screwdriver to pry the tabs of the calibration tool apart, and remove the spool from the calibration tool. Continue with the assembly process.

End By:

a. Replace the cab and radiator tilt pump.

b. Replace the oil in the cab and radiator tilt pump.

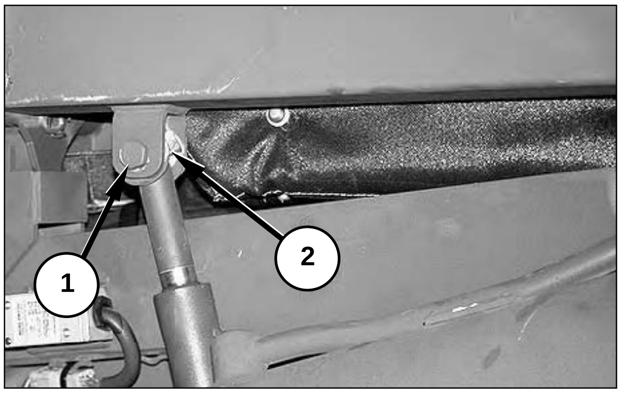
Cab Tilt Cylinder

Remove and Install

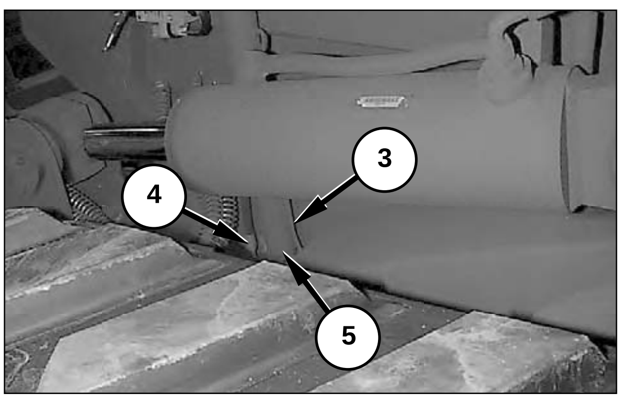
NOTE: The group number related to this procedure is 124-5853.

WARNING

Do not perform this procedure with the cab tilted.



1. Remove one bolt (1) with the nut and two hard washers, and remove two rubber spacers (2).



2. Disconnect, cap and plug two lines (4) (only one shown).

NOTE: Make sure to cap and plug lines (4) quickly to minimize oil spillage. Catch any spilled oil in a suitable container, and discard the oil according to local regulations.

3. Remove nut (5) with the bolt and washer, and remove cylinder (3).

NOTE: To install the cab tilt cylinder, reverse the removal steps.

Coolant Temperature Valve, Fan Motor

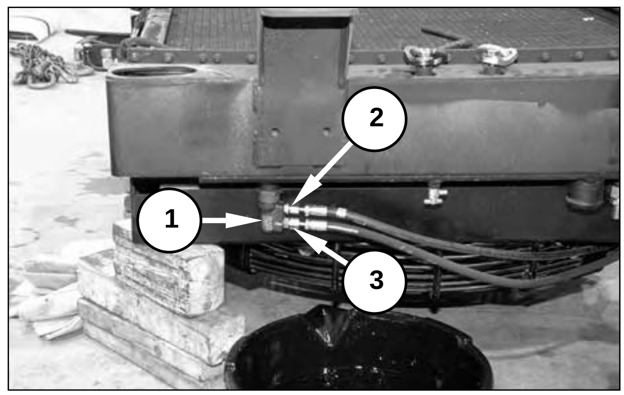
Remove and Install

NOTE: The group number related to this procedure is 125-5578.

WARNING

Refer to the WARNING on the Table of Contents page of this module.

1. Drain the coolant from the cooling system. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Every 2000 Service Hours or Two Years, Cooling System, Change Coolant/Clean System."



Cooling System Assembly Shown Removed for Photographic Purposes.

2. Disconnect, cap and plug inlet line (3) and outlet line (2) to fan motor coolant temperature valve (1).

NOTE: Make sure to cap and plug lines (2) and (3) quickly to minimize oil spillage. Catch any spilled oil in a suitable container, and discard the oil according to local regulations.

3. Remove coolant temperature valve (1).

NOTE: To install the coolant temperature valve, reverse the removal steps.

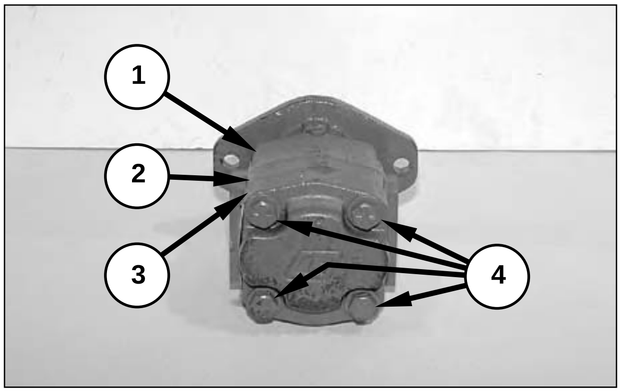
Fan Motor

Disassemble and Assemble

Start By:

a. Remove the fan motor and fan guard.

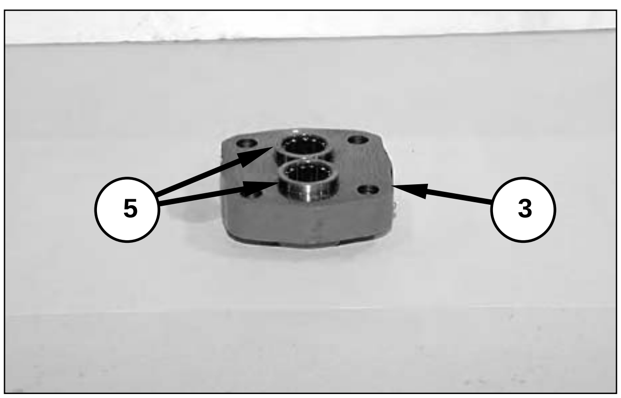
NOTE: The group number related to this procedure is 124-3903.



1. Mark end cap (3), gear housing (2), and shaft housing (1) for proper alignment during the assembly.

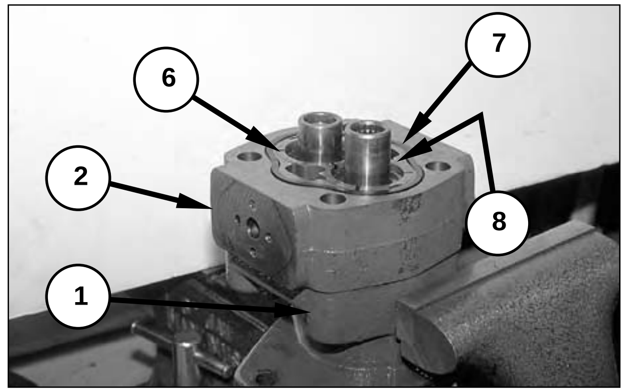
2. Place the motor in a vise with the output shaft down.

3. Remove four bolts (4) with the washers, and remove end cap (3).



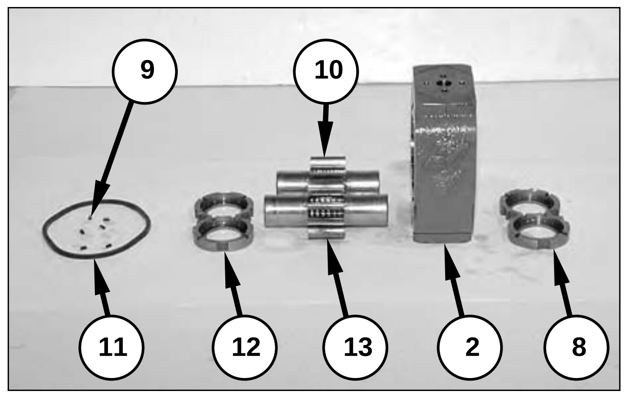
4. If necessary, use a suitable puller to remove bearings (5) from end cap (3). After the bearings are removed, remove the rings which are located under the bearings.

NOTE: The rings are not shown in this photo. The rings cannot be seen until after the bearings are removed.



5. Remove six pocket seals (6) from the notches in thrust plate (8), and remove seal (7) from gear housing (2).

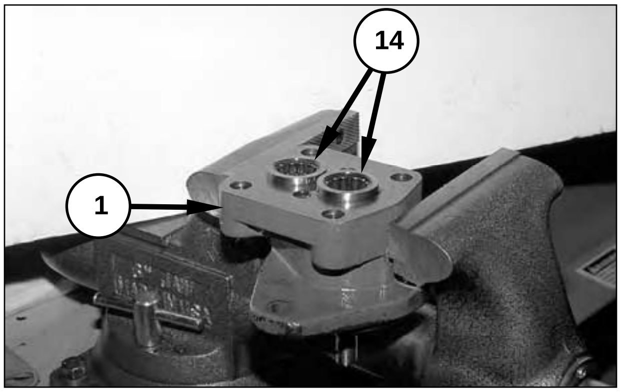
6. Remove gear housing (2) from shaft housing (1).



7. Remove six pocket seals (9) from thrust plate (12), and remove seal (11) from gear housing (2).

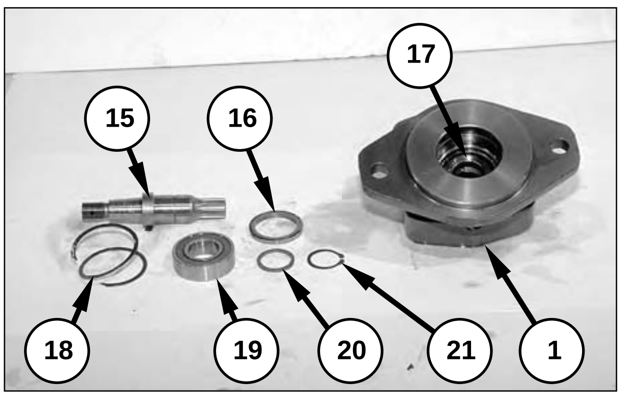
8. Use a rubber mallet or the end of a wooden hammer handle to remove thrust plate (12), drive gear (13), driven gear (10), and thrust plate (8) from gear housing (2).

NOTE: Make note of the position of thrust plates (8) and (12) for proper placement during assembly, if the plates are reused.



9. If necessary, use a suitable puller to remove bearings (14) from shaft housing (1). After the bearings are removed, remove the rings which are located under the bearings.

NOTE: The rings are not shown in this photo. The rings cannot be seen until after the bearings are removed.

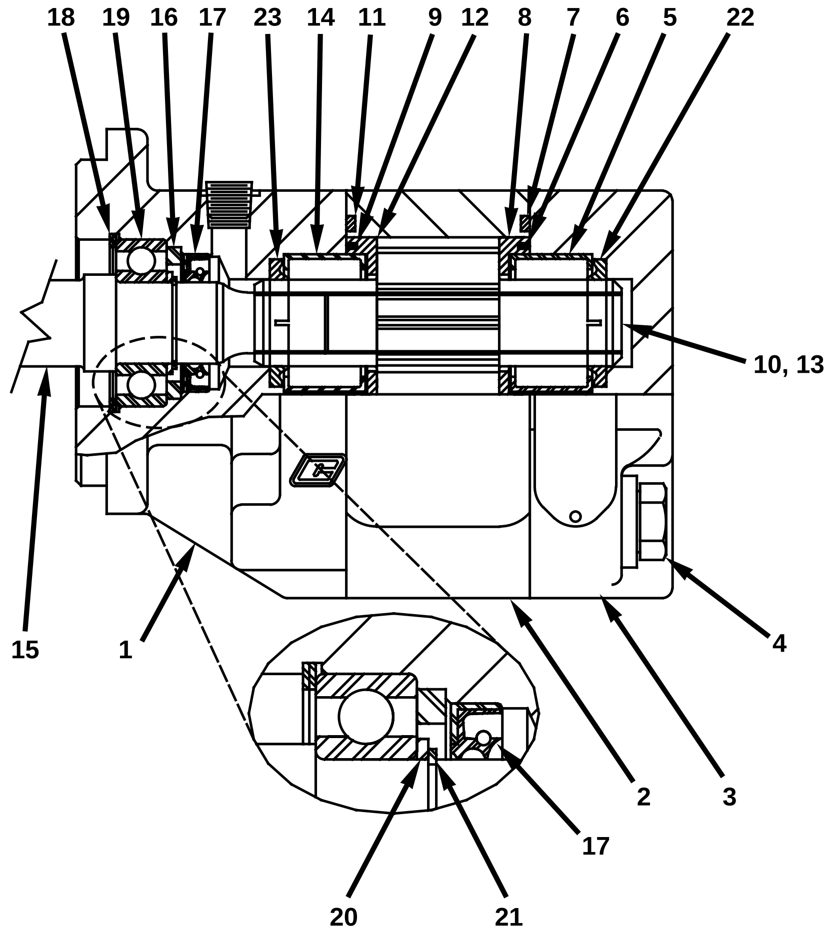


10. Place shaft housing (1) in the vise with output shaft (15) pointing up. Remove retaining ring (18), and remove output shaft (15) with bearing (19). Remove seal retainer (16).

11. Flip shaft housing (1) in the vise, and remove lip seal (17).

NOTE: The tip of a flat screwdriver can be bent to a 90-degree angle and used to remove lip seal (17). The bent end of the screwdriver can be placed in the notch between the lip seal and shaft housing (1), and a rubber mallet can be used to tap on the end of the screwdriver to drive the lip seal from the shaft housing.

12. If necessary, remove snap ring (21), spacer (20), and bearing (19) from output shaft (15).



NOTE: The following steps describe the motor assembly procedure.

13. If a bearing was removed from end cap (3) or shaft housing (1), deburr and thoroughly clean the bearing bore.

14. Install a replacement ring in the bearing bore, with the notched side of the ring facing the bearing.

15. Use an appropriate press to install the bearing in the bore.

16. If bearing (19) was removed from output shaft (15), install the bearing, spacer (20), and snap ring (21) on output shaft (15).

17. Place shaft housing (1) in the vise with the shaft side pointing up. Install lip seal (17) and seal retainer (16) in shaft housing (1).

18. Install output shaft (15) and retaining ring (18) in shaft housing (1).

19. Flip shaft housing (1) in the vise (output shaft facing down).

20. Cut two pocket seals (9) approximately **5.5 mm (0.219 in)** in length.

21. Apply a small amount of clean grease to the pocket seals, and place them into the middle slots of thrust plate (12).

22. Install thrust plate (12) on bearings (14) with the pocket seals facing down. Use a rubber mallet to tap the thrust plate to within approximately **0.8 mm (0.030 in)** of the face of shaft housing (1).

NOTE: Ensure that the pocket seals in the center slots remain in place during the installation of thrust plate (12).

23. Cut four pocket seals (9) approximately **6.4 mm (0.25 in)** in length.

24. Insert one pocket seal (9) in each remaining slot between thrust plate (12) and shaft housing (1). Ensure that the pocket seals are firmly seated against bearings (14).

25. Use a sharp knife to cut the pocket seals flush with thrust plate (12).

26. Install drive gear (13) and driven gear (10) in shaft housing (1).

27. Install seal (7) and seal (11) in gear housing (2).

28. Place gear housing (2) onto shaft housing (1), aligning the orientation marks which were made during disassembly.

29. Coat drive gear (13) and driven gear (10) with clean hydraulic oil.

30. Cut two pocket seals (6) approximately **5.5 mm (0.219 in)** in length.

31. Apply grease to the pocket seals, and place them into the middle slots of thrust plate (8).

32. Install thrust plate (8) on bearings (5) in end cap (3) with pocket seals (6) facing down. Use a rubber mallet to tap the thrust plate to within approximately **0.8 mm (0.030 in)** of the face of the end cap.

NOTE: Ensure that the pocket seals in the center slots remain in place during installation.

33. Cut four pocket seals (6) approximately **6.4 mm (0.25 in)** in length.

34. Insert one pocket seal (6) in each remaining slot between thrust plate (8) and end cap (3). Ensure that the pocket seals are firmly seated against bearings (5).

35. Use a sharp knife to cut the pocket seals flush with thrust plate (8).

36. Install end cap (3) on gear housing (2), aligning the orientation marks which were made during disassembly.

37. Install four bolts (4) and washers. Tighten the bolts in a cross pattern.

End By:

a. Install the fan motor and fan guard.

Fan Motor and Fan Guard

Remove and Install

Tools Needed	
138-7575 Link Bracket	2

NOTE: Group numbers related to this procedure include 125-5855, 144-8603, 145-0072, and 164-3014.

WARNING

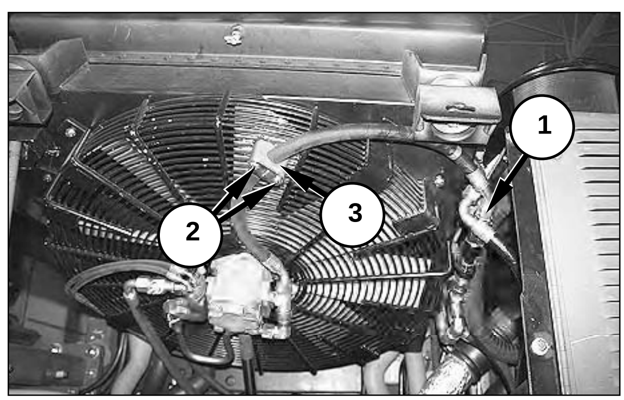
Refer to the WARNING on the Table of Contents page of this module.

1. Move the main disconnect switch to the OFF position. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Machine Features, Main Disconnect Switch."

2. Raise the radiator. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Radiator Tilt."

3. Raise the cab. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Cab Tilt."

4. Drain the hydraulic tank. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Every 1000 Service Hours or One Year, Hydraulic System, Change Oil and Clean Suction Screens."

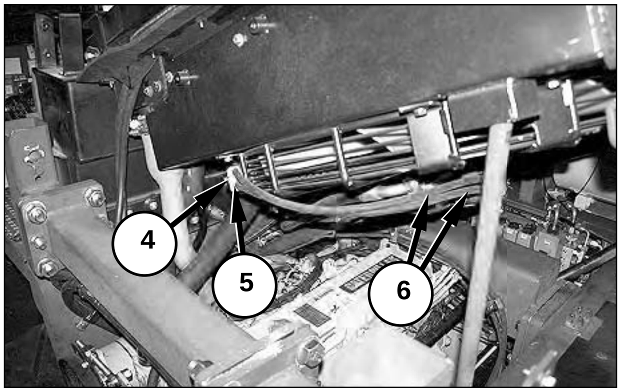


5. Disconnect, cap and plug fan motor return line (1). Mark the line for correct connection during reassembly.

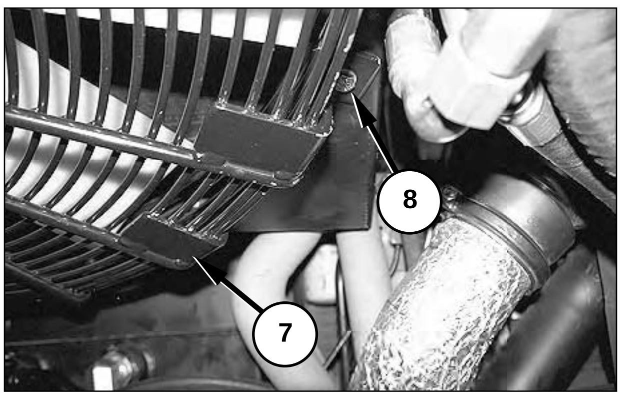
NOTE: Make sure to cap and plug line (1) quickly to minimize oil spillage. Catch any spilled oil in a suitable container, and discard the oil according to local regulations.

6. Remove two bolts (2) with the retainer and clamp halves (3).

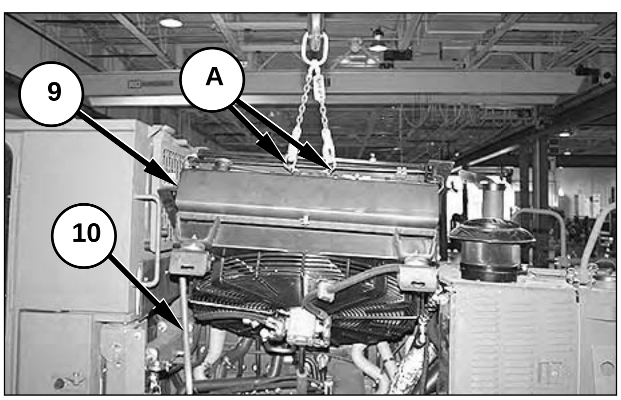
NOTE: At this point, the hydraulic lines described in Steps 20 and 21 can be loosened. However, do not remove the lines here.



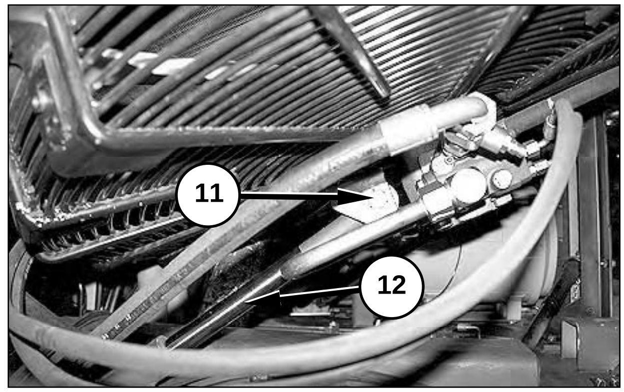
7. Remove bolt (4) with the retainer and clamp assembly (5) from fan pilot control lines (6).



8. Remove two bolts (8) (only one visible in photo) and washers from the right rear corner of fan guard (7).



9. Install Tooling (A), and support radiator assembly (9) with a hoist. Keep radiator support rod (10) in place until the radiator is lowered. The weight of the radiator assembly is **365 kg (800 lb).**



10. Remove bolt (11) with the locking nut and two washers from the rod end of radiator lift cylinder (12). Allow the radiator lift cylinder to rest against the top of the engine. Upon reassembly, tighten bolt (11) until the end of the bolt just begins to protrude through the locking nut.

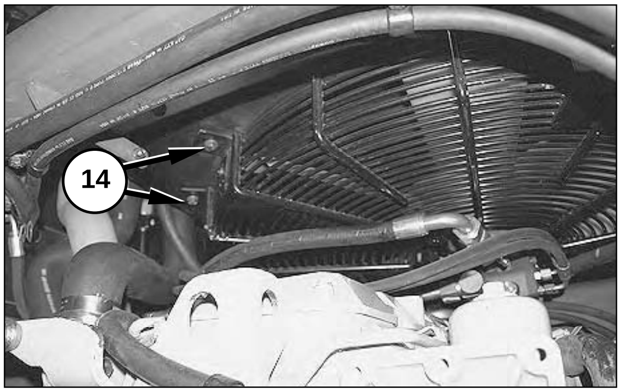
11. Retract radiator lift cylinder (12) using the cab and radiator tilt pump.

12. Lower the radiator assembly onto the radiator mounts using the hoist.

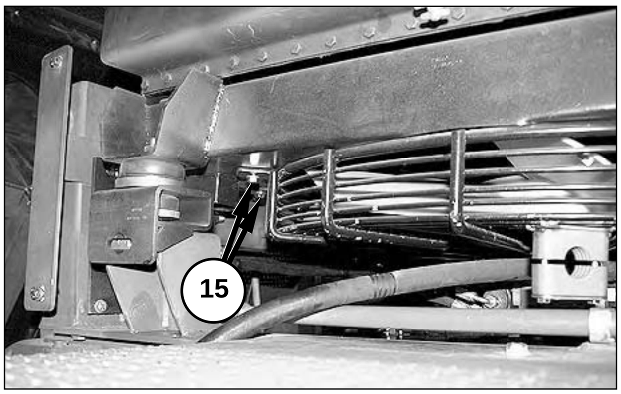
NOTICE

Watch below the radiator to be sure nothing is damaged when the radiator is lowered. Make sure the radiator lift cylinder is fully retracted and in alignment with the bracket on the fan guard.

13. Remove two bolts (13) and washers from the left rear corner of the fan guard.

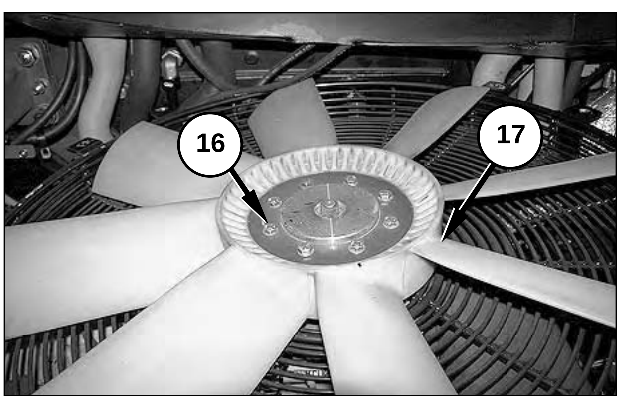


14. Remove two bolts (14) from the front right corner of the fan guard.

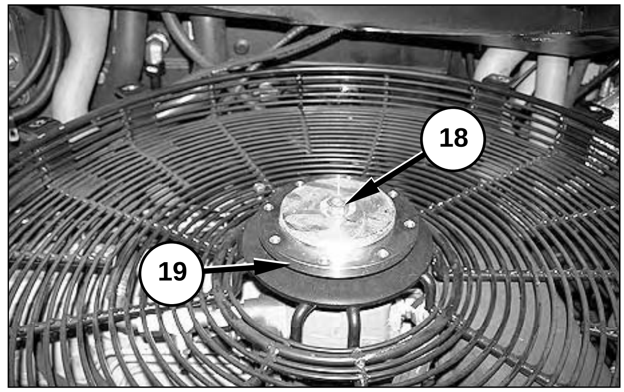


15. Remove two bolts (15) and washers from the front left corner of the fan guard. Allow the fan guard, fan and fan motor to rest as a unit on top of the engine.

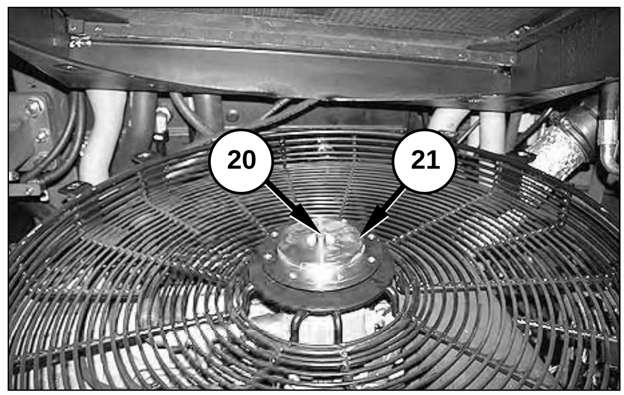
16. Slowly raise the radiator assembly with the hoist and allow the fan guard, fan and fan motor to rest on the engine. Continue to raise the radiator, and install the radiator support rod.



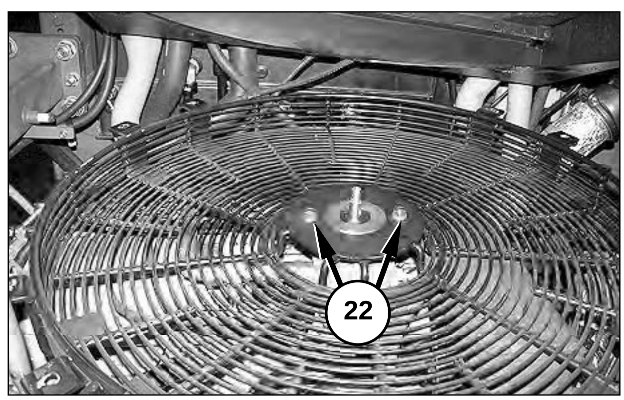
17. Remove eight bolts (16) with the washers, and fan (17). Make note of the orientation of the fan for correct installation during reassembly.



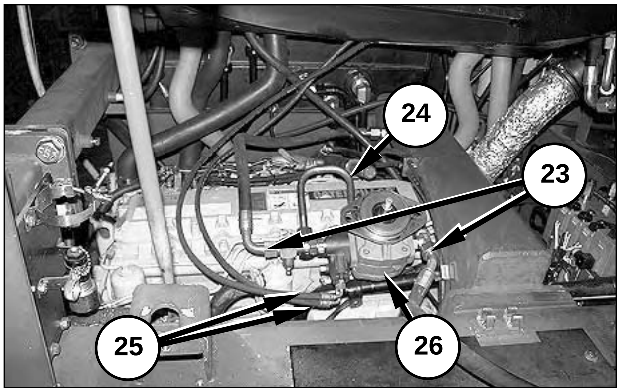
18. Remove nut (18) and the washer. Use an impact wrench, or hold hub (19) to remove the nut. Upon reassembly, tighten the nut to a torque of **115 ± 20 N•m (85 ± 15 lb ft).**



19. Use a suitable puller to remove collar (21) from fan motor shaft (20).



20. Remove two nuts (22) with the bolts and four washers, and use two people to remove fan guard (7). The weight of the fan guard is **23 kg (51 lb).**

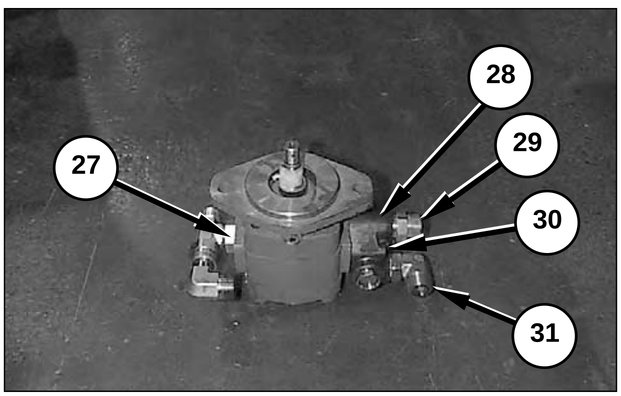


21. Disconnect, cap, and plug two lines (23) and two lines (25) from fan motor assembly (26). Mark the lines for correct connection during reassembly.

NOTE: Make sure to cap and plug lines (23) and (25) quickly to minimize oil spillage. Catch any spilled oil in a suitable container, and discard the oil according to local regulations.

22. Loosen two fittings and remove tube (24).

23. Remove fan motor assembly (26).



24. Remove fittings (29), (27) and (31).

25. Remove three bolts (30) and fan control valve (28) with the O-ring. Upon reassembly, tighten the three bolts to a torque of **22 ± 2 N•m (17 ± 2 lb ft).**

NOTE: One of three bolts (30) is longer than the others and is located inside the port where fitting (29) was removed.

NOTE: To install the fan motor and fan guard, reverse the removal steps.

Fan Pump

Remove and Install

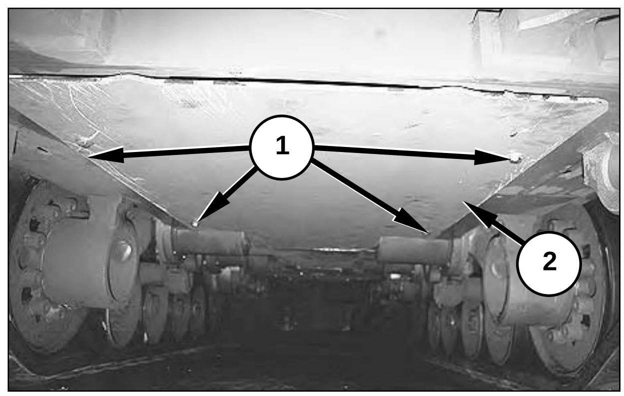
NOTE: Group numbers related to this procedure include 124-4623 and 144-8599.

WARNING

Refer to the WARNING on the Table of Contents page of this module.

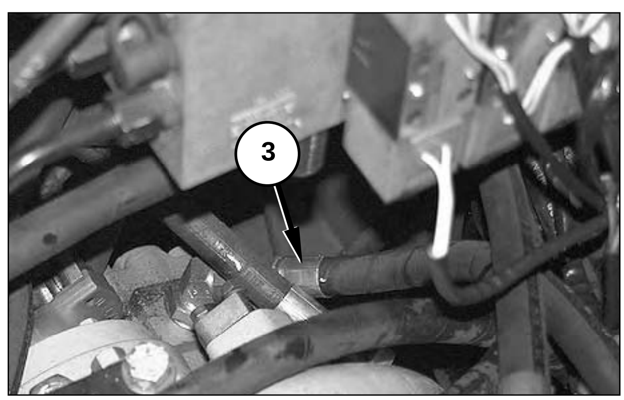
1. Raise the radiator. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Radiator Tilt."

2. Drain the hydraulic tank. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Every 1000 Service Hours or One Year, Hydraulic System, Change Oil and Clean Suction Screens."



3. Remove four bolts (1) with the washers, and remove cover (2). The weight of the cover is **56 kg (112 lb).**

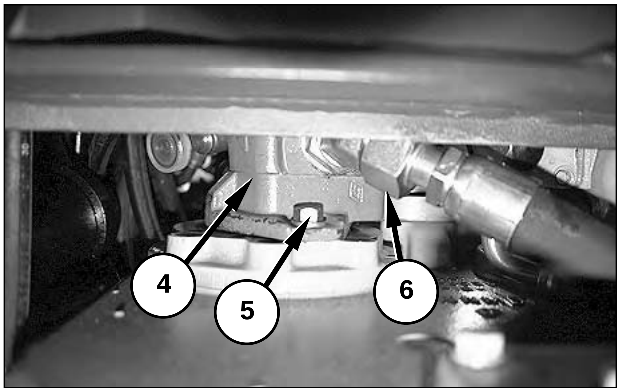
NOTE: Support cover (2) with a floor jack. Dirt can accumulate on the top of the cover and increase the weight of the cover.



4. Disconnect, cap and plug line (3).

NOTE: Make sure to cap and plug line (3) quickly to minimize oil spillage. Catch any spilled oil in a suitable container, and discard the oil according to local regulations.

NOTE: The pump is driven off of the left side of the torque converter.



5. Disconnect, cap and plug line (6).

NOTE: Make sure to cap and plug line (6) quickly to minimize oil spillage. Catch any spilled oil in a suitable container, and discard the oil according to local regulations.

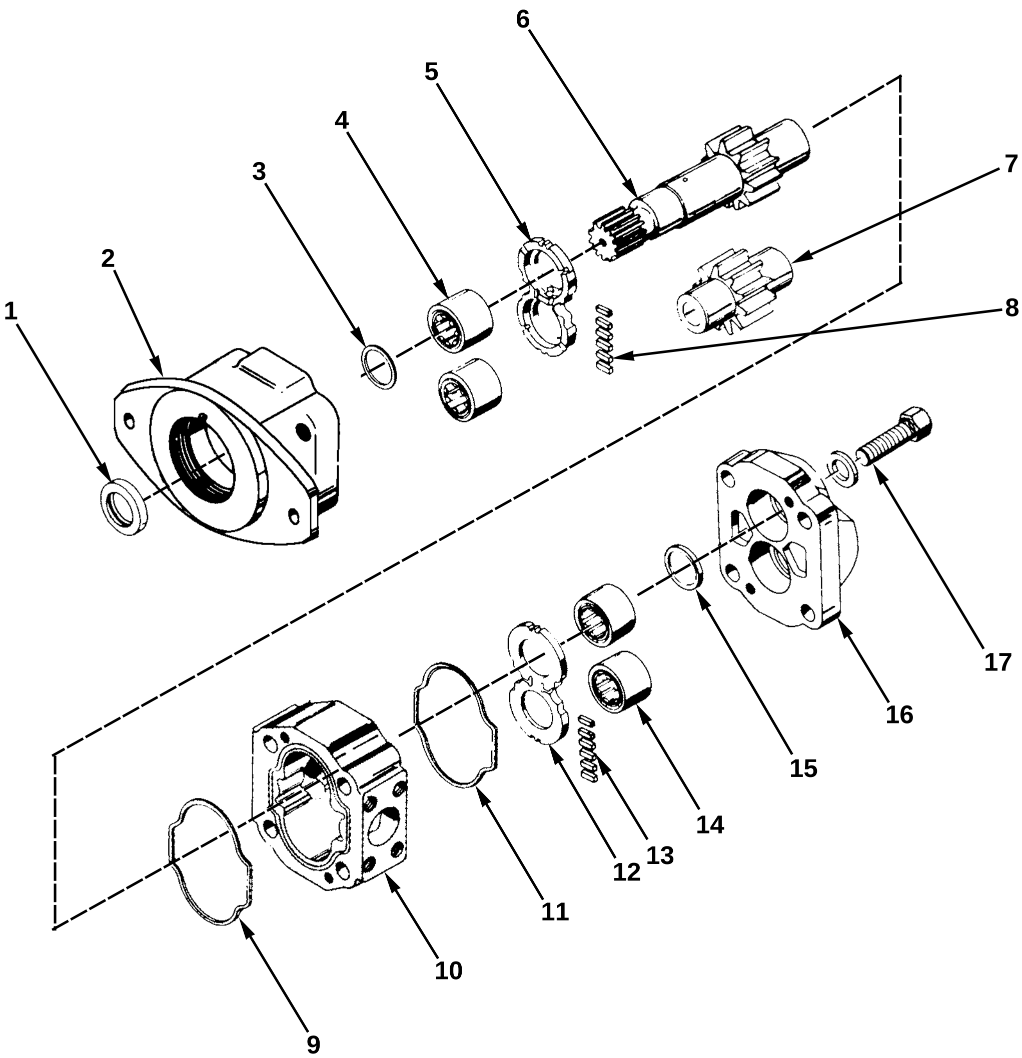
6. Remove two bolts (5) with the washers, and remove fan pump (4).

NOTE: To install the fan pump, reverse the removal steps.

Disassemble and Assemble

Start By:

a. Remove the fan pump.



1. Remove four bolts (17) with the washers, and cover (16).

2. If necessary, use a suitable puller to remove bearings (14) and seal (15) from cover (16). Replace the seal if there is damage or wear.

3. Remove thrust plate (12) with seals (13).

4. Remove seal (11). Replace the seal if there is damage or wear.

5. Remove driven gear (7) and drive gear (6).

6. Remove housing (10) and seal (9). Replace the seal if there is damage or wear.

7. Remove thrust plate (5) with seals (8).

8. If necessary, use a suitable puller to remove bearings (4) and seal (3). Relace the seal if there is damage or wear.

9. If necessary, remove seal (1) from housing (2). Replace the seal if there is damage or wear.

NOTE: To assemble the fan pump, reverse the disassembly steps.

End By:

a. Install the fan pump.

Hydraulic Oil Cooler

Remove and Install

NOTE: The photographs in this procedure show the cooling system assembly removed from the machine. This procedure can be performed while the cooling system assembly is installed on the machine.

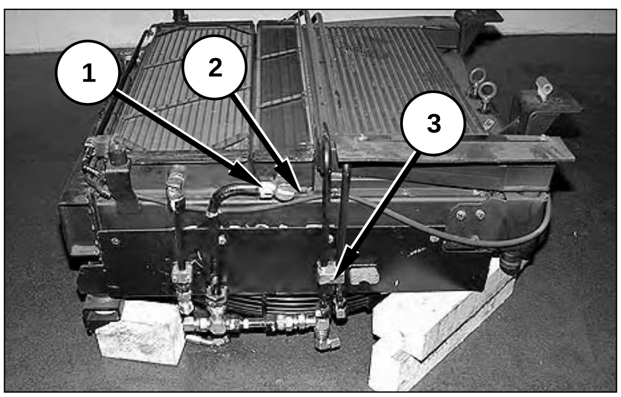
Start By:

a. Remove the air conditioning condenser. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Radiator Group.”

NOTE: Group numbers related to this procedure include 125-5578 and 125-5579.

WARNING

Refer to the WARNING on the Table of Contents page of this module.

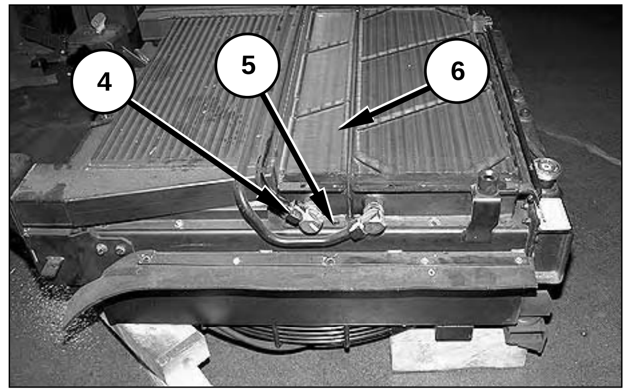


1. Disconnect, cap and plug line (1).

NOTE: Make sure to cap and plug line (1) quickly to minimize oil spillage. Catch any spilled oil in a suitable container, and discard the oil according to local regulations.

2. Remove two bolts (2) with the flat and lock washers.

3. Remove bolt (3) with the washer, retainer and clamp half.



4. Disconnect, cap and plug line (4).

NOTE: Make sure to cap and plug line (4) quickly to minimize oil spillage. Catch any spilled oil in a suitable container, and discard the oil according to local regulations.

5. Remove two bolts (5) and washers.

6. Remove hydraulic oil cooler (6).

NOTE: To install the hydraulic oil cooler, reverse the removal steps.

End By:

a. Install the air conditioning condenser.

Hydraulic Tank Group

Remove and Install

Tools Needed	
138-7575 Link Bracket	2

Start By:

a. Remove the radiator group. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Radiator Group."

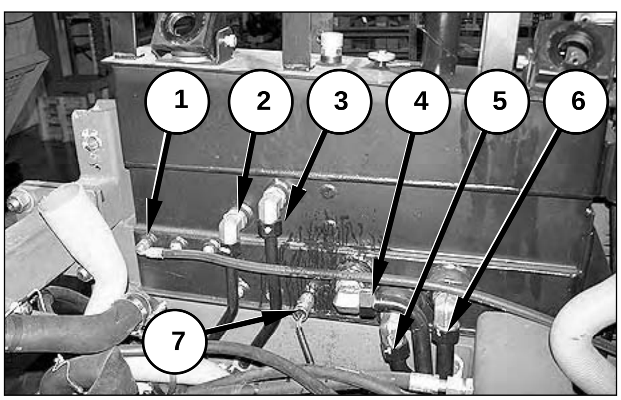
NOTE: Group numbers related to this procedure include 125-5578 and 125-5579.

WARNING

Refer to the WARNING on the Table of Contents page of this module.

1. Drain the hydraulic tank. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Every 1000 Service Hours or One Year, Hydraulic System, Change Oil and Clean Suction Screens."

2. Raise the cab. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Cab Tilt."



3. Disconnect, cap and plug hose (1). Mark the hose for correct location during reassembly. Cut tie wraps as necessary.

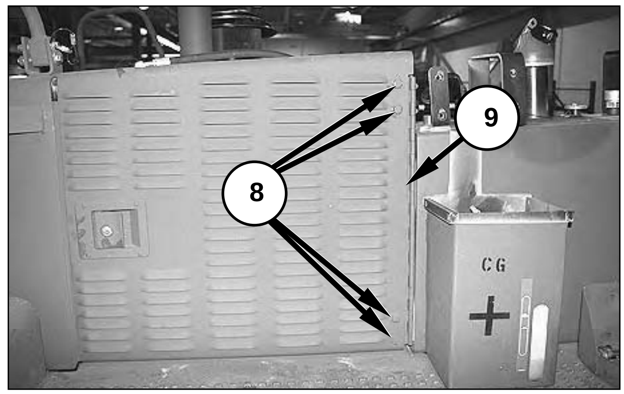
NOTE: Make sure to cap and plug line (1) quickly to minimize oil spillage. Catch any spilled oil in a suitable container, and discard the oil according to local regulations.

4. Disconnect, cap and plug five hard lines in the following order: (2), (3), (5), (6), and (4).

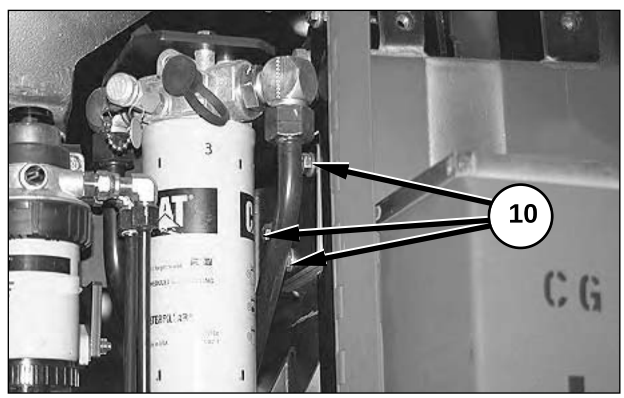
NOTE: Make sure to cap and plug the lines quickly to minimize oil spillage. Catch any spilled oil in a suitable container, and discard the oil according to local regulations.

5. Disconnect hydraulic temperature sensor connector (7). Mark the connector for correct location during reassembly.

NOTE: Hydraulic temperature sensor connector (7) is a three-pin connector with two wires. The wires in the connector are K980-PK and 200-BK.

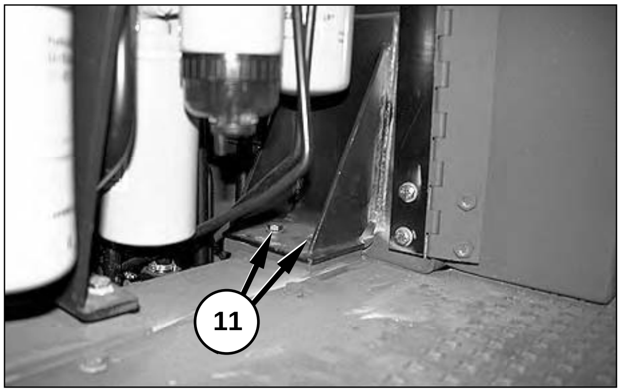


6. Remove four bolts (8) with the washers, and remove door assembly (9).

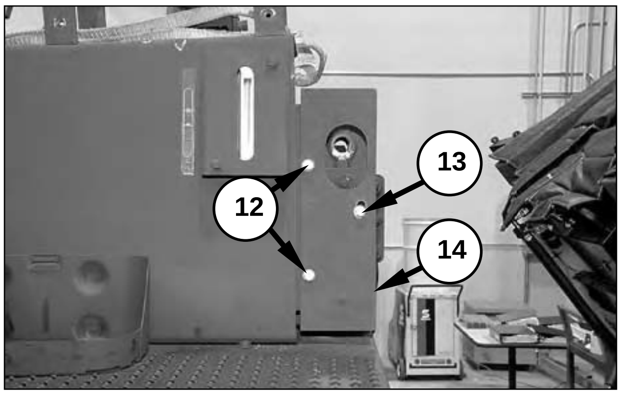


7. Remove three bolts (10) and washers.

NOTE: If necessary, loosen a hard line to provide enough room to remove the top bolt.

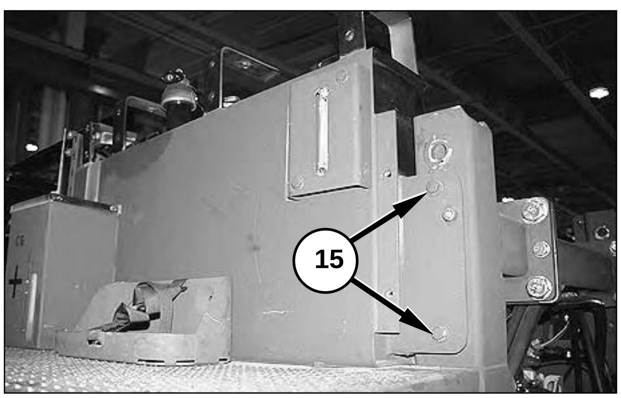


8. Remove two bolts (11) and washers.

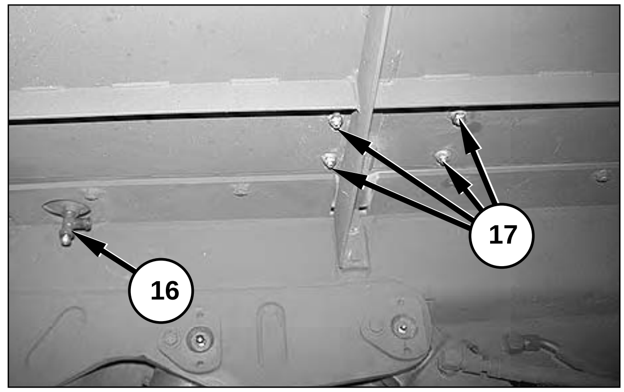


9. Remove two bolts (12) with the washers, and one bolt (13) with a washer and spacer.

10. Remove plate (14).

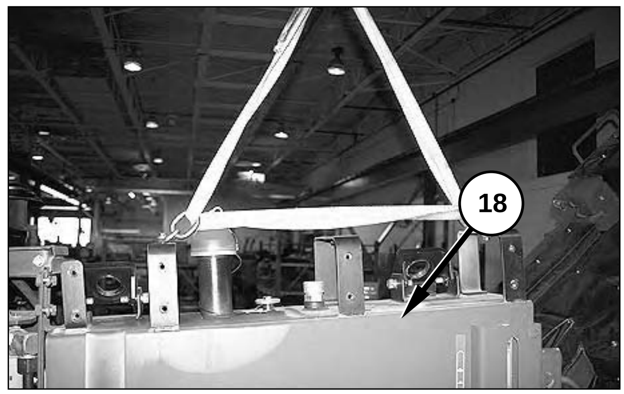


11. Remove two bolts (15) and washers.



12. Remove four nuts (17) with the bolts and washers, and remove the decontamination bracket.

13. Remove drain valve (16).



14. Install Tooling (A), and attach a hoist to hydraulic tank assembly (18), and remove the tank assembly. The weight of the hydraulic tank assembly is **113 kg (250 lb).**

End By:

a. Install the radiator group.

Hydraulic Tank Pressure Relief Valve

Remove and Install

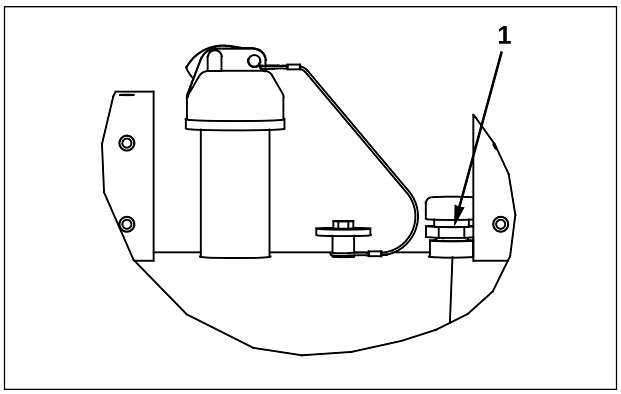
Start By:

a. Remove the hydraulic tank cover.

NOTE: The group number related to this procedure is 144-6666.

WARNING

Refer to the WARNING on the Table of Contents page of this module.



1. Turn relief valve (1) counterclockwise, and remove the valve with the O-ring seal. Replace the O-ring seal if there is damage or wear.

NOTE: To install the hydraulic tank pressure relief valve, reverse the removal steps.

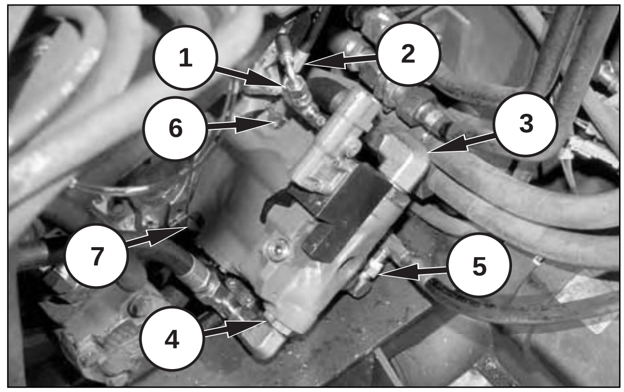
Implement Pump

Remove and Install

Start By:

a. Remove the differential steering unit. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Differential Steering Unit."

NOTE: Group number related to this procedure is 126-6567.



1. Disconnect, cap, and plug signal lines (1) and (2).

2. Disconnect, cap, and plug the suction line at elbow (3).

3. Disconnect, cap, and plug the tee at elbow (4).

4. Disconnect, cap, and plug the tee at elbow (5).

NOTE: Three case drain lines are disconnected from the pump during this step.

5. Remove mounting bolt (6) with the washer, and mounting bolt (7) with the washer. Remove the pump.

6. Pull the pump toward the rear of the machine until the shaft is completly clear of the splines.

7. Remove the pump with the large O-ring seal.

NOTE: To install the pump, reverse the removal steps.

End By:

a. Install the differential steering unit.

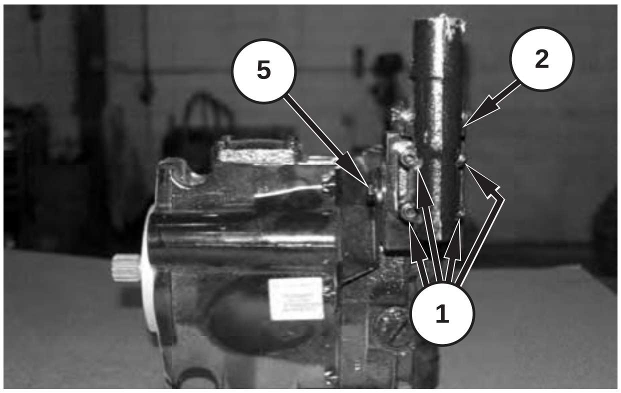
Disassemble and Assemble

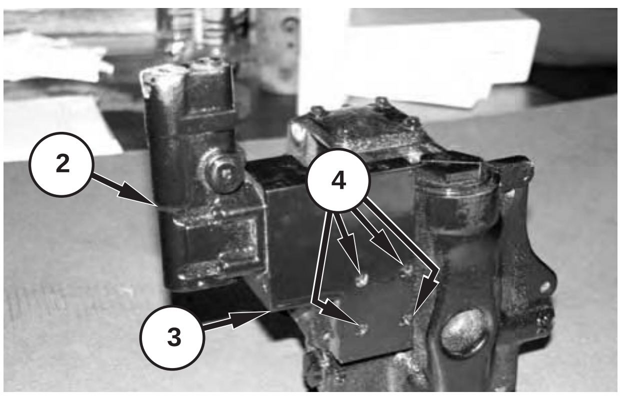
Tools Needed	A
1P-1858 Pliers	1

Start By:

a. Remove the implement pump.

NOTE: Group numbers related to this procedure include 124-3610 and 147-6712.





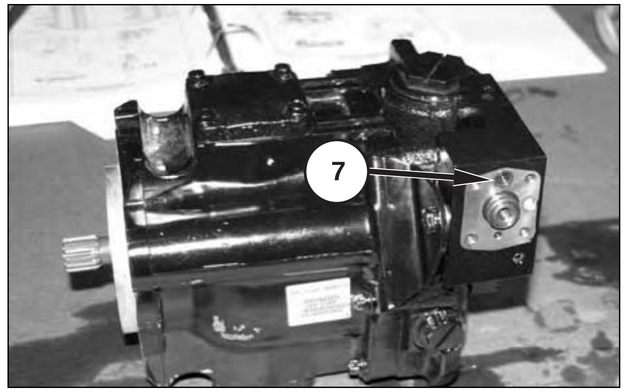
1. Remove four bolts (1), and separate the compensator valve (2) from manifold (3).

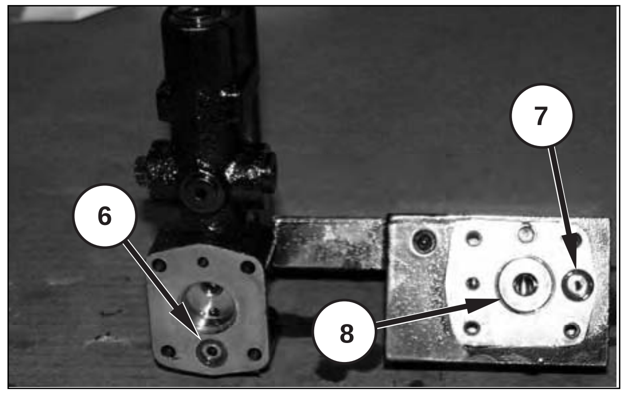
2. Remove four bolts (4), located on the front of manifold (3), and bolt (5) with shims, located on the rear. Separate manifold (3) from the implement pump.

NOTE: The number of shims removed during this step may vary slightly from the number used during reinstallation.

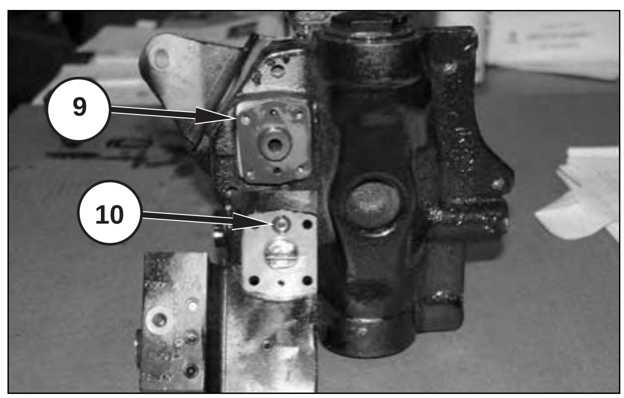
NOTICE

The free space between the manifold and support bracket should be shimmed as necessary to support the manifold alignment. Improper alignment may cause the manifold to leak.

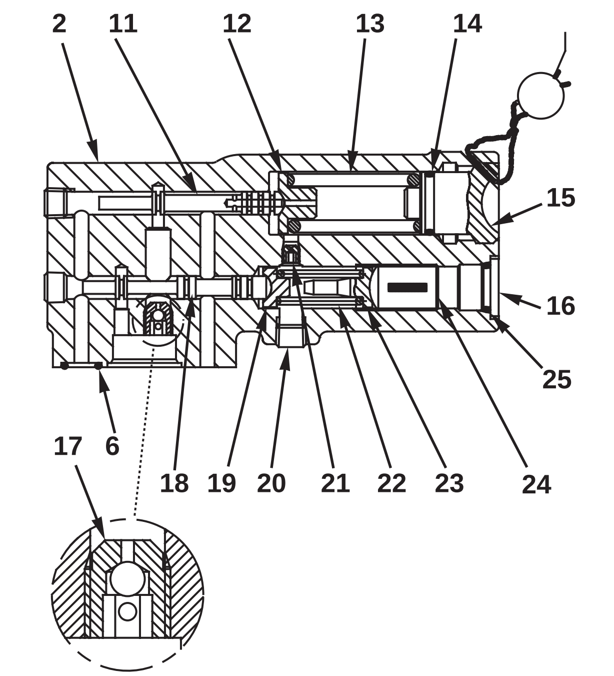




3. Remove O-ring seals (6), (7) and (8) from manifold face.



4. Remove gasket (9) from implement pump mating surface, and O-ring seal (10) from manifold face.



NOTE: If plug (15) and/or set screw (24) are moved, the compensator valve will require adjustment after the pump has been installed on the machine. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Implement and Fan Hydraulics,* "Testing and Adjusting, Instrument Tests, Blade Hydraulic System, Compensator Valve Adjustment."

3. Remove O-ring seal (6) from compensator valve (2).

4. Remove plug (15) with O-ring seal (14).

5. Remove spring (13), seat (12), and pressure compensator spool (11).

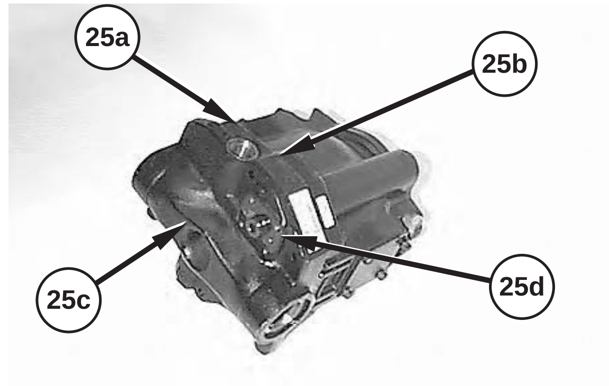
6. Remove plug (16) with O-ring seal (25). Upon reassembly, tighten the plug to a torque of **7.5 ± 1.5 N•m (67 ± 13 lb in)**.

7. Remove set screw (24), seat (23), and spring (22).

8. Remove seat (19) and flow compensator spool (18).

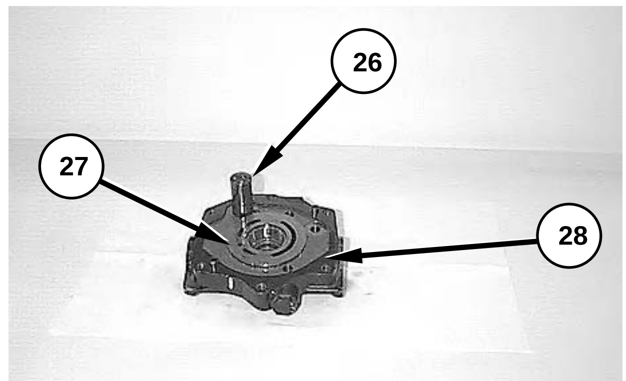
9. Remove check valve (17).

10. Remove plug (20), and plug orifice (21). Upon reassembly, tighten the plug and plug orifice to a torque of **2.0 ± 0.5 N•m (18 ± 4 lb in)**.



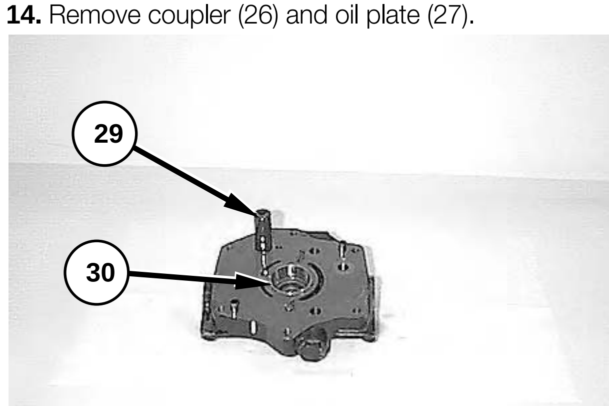
11. Remove six bolts (25b) with washers, and minifold bracket. Upon reassembly, tighten the bolts to a torque of **33 ± 2 N•m (24 ± 1 lb ft)**.

12. Separate housing (25c) from housing (25a).



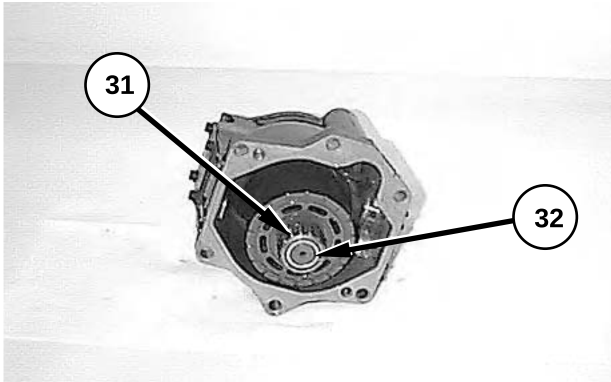
13. Remove gasket (28) and replace if there is damage or wear.

14. Remove coupler (26) and oil plate (27).



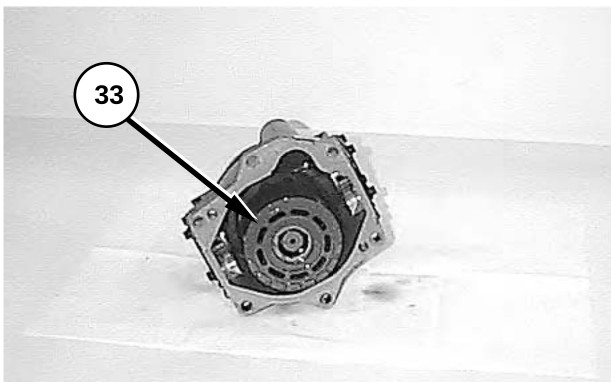
15. If necessary, remove bearing race (30).

16. Remove the retaining ring (not shown) on the opposite side of shaft (29). Then remove the shaft.

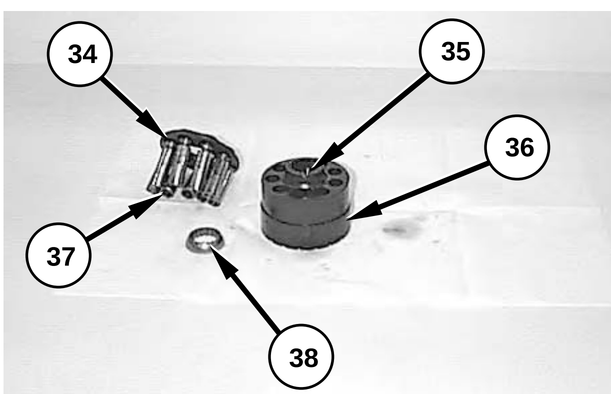


17. Remove thrust washer (32).

18. Remove bearing (31).

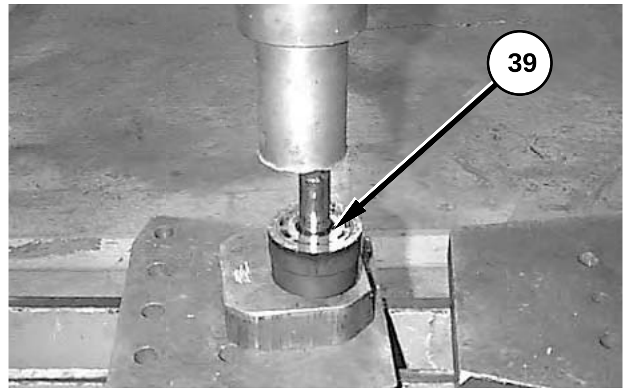


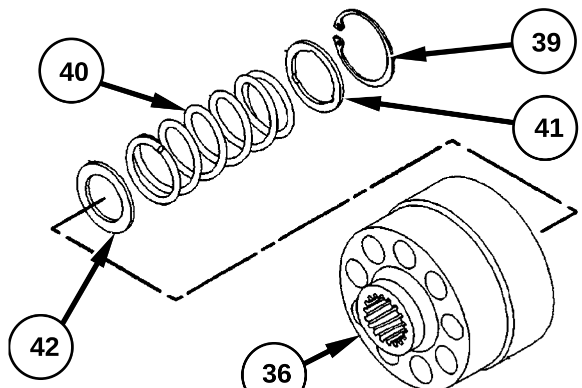
19. Remove rotating group (33) as a unit.



20. Remove piston retainer (34), pistons (37) and gear washer (38) from barrel (36).

21. Remove three pins (35), if necessary, from barrel (36).



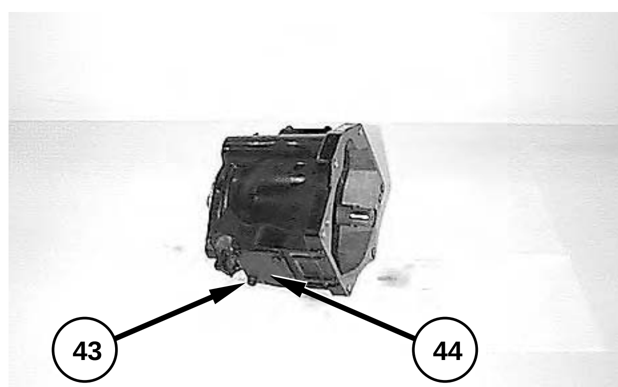


22. Place barrel (36) in a press and compress spring (40).

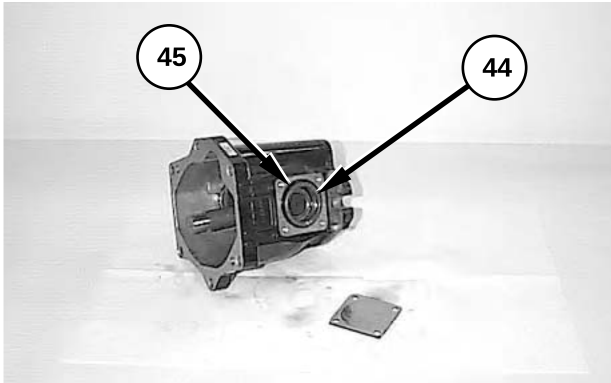
23. Use Tooling (A) to remove retaining ring (39).

24. Slowly release the pressure on spring (40).

25. Remove washer (41), spring (40) and spring seat (42) from barrel (36).



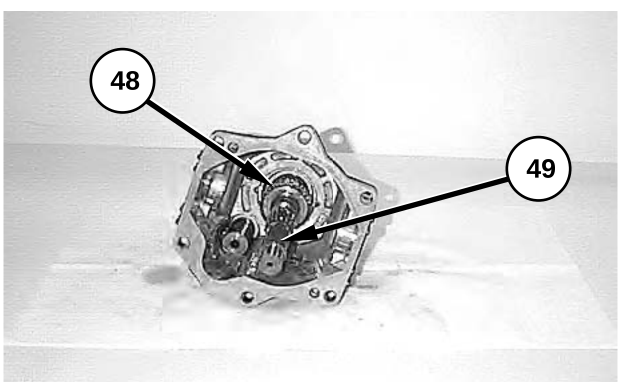
26. Remove four bolts (43) from cover (44), on each side of the pump housing. Upon reassembly, tighten the bolts to a torque of **20 ± 1 N•m (15 ± 1 lb in).**



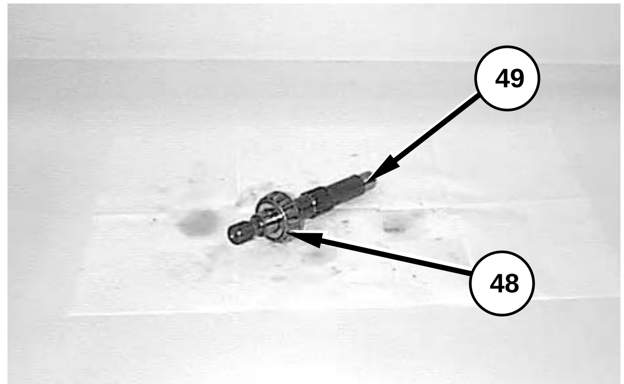
27. Remove two bearing assemblies (46) and O-ring seals (45) from each side of the housing. Replace the O-ring seals if they are worn or damaged.

NOTE: Do not allow the needle bearings to fall apart during the procedure.

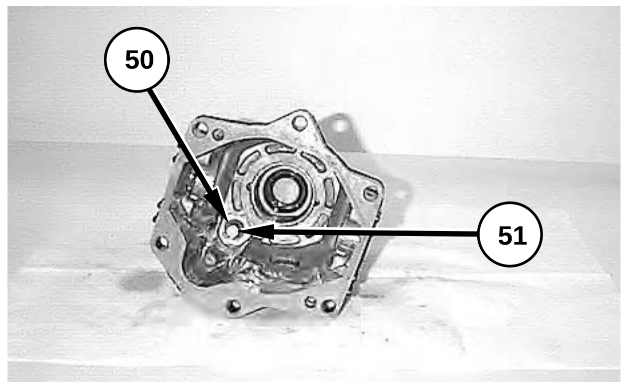
28. Remove swashplate (47).



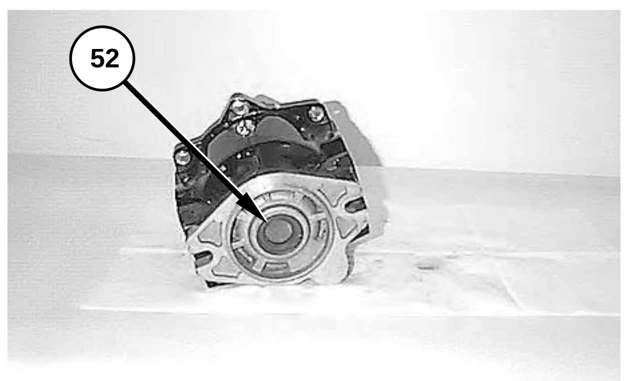
29. Remove shaft (49) and roller bearing assembly (48).



30. If necessary, press roller bearing assembly (48) off of shaft (49).



31. Remove spring seat (50) and bushing (51) from the housing.



32. Remove oil seal (52) from the housing.

NOTE: To assemble the implement pump, reverse the disassembly steps.

End By:

a. Install the implement pump.

Lift Cylinder

Remove and Install

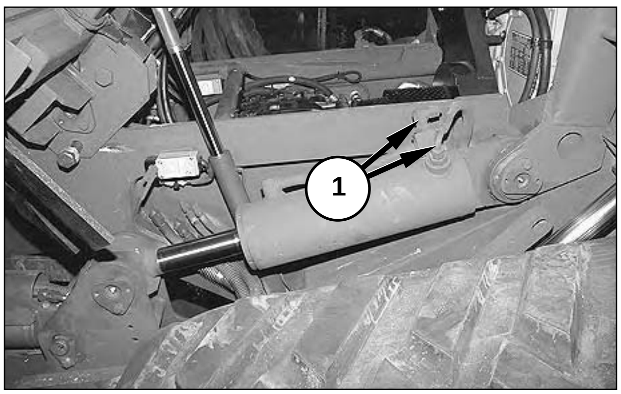
NOTE: Group numbers related to this procedure include 124-4622 and 126-5857.

WARNING

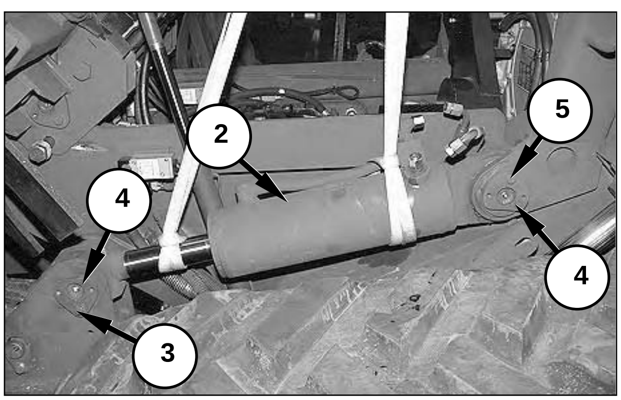
Refer to the WARNING on the Table of Contents page of this module.

1. Lower the blade to the ground. Stop the engine, and cycle the blade controls to release any pressure remaining in the system.

2. Raise the cab. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Cab Tilt."



3. Disconnect two lines (1). Plug and cap the lines immediately.



4. Support lift cylinder (2) with a hoist. The weight of the lift cylinder is **59 kg (130 lb).**

5. Remove bolt (3) with washer and sleeve, and remove bolt (5) with washer and spacer. Upon reassembly, apply **4C-4030 Thread Compound (Loctite™ 242)** to the threads of both bolts.

6. Remove two pins (4) with the shims, and remove lift cylinder (2). The weight of the lift cylinder is **59 kg (130 lb).** Upon reassembly, coat the pin bores with **4C-4030 Multipurpose Lubricant**.

NOTE: Upon reassembly, the rod end of the cylinders must be shimmed to remove the slack between the eye of the cylinder and the mount.

NOTE: If necessary, use the two M10 puller holes provided to remove pins (4).

NOTE: To install the lift cylinder, reverse the removal steps.

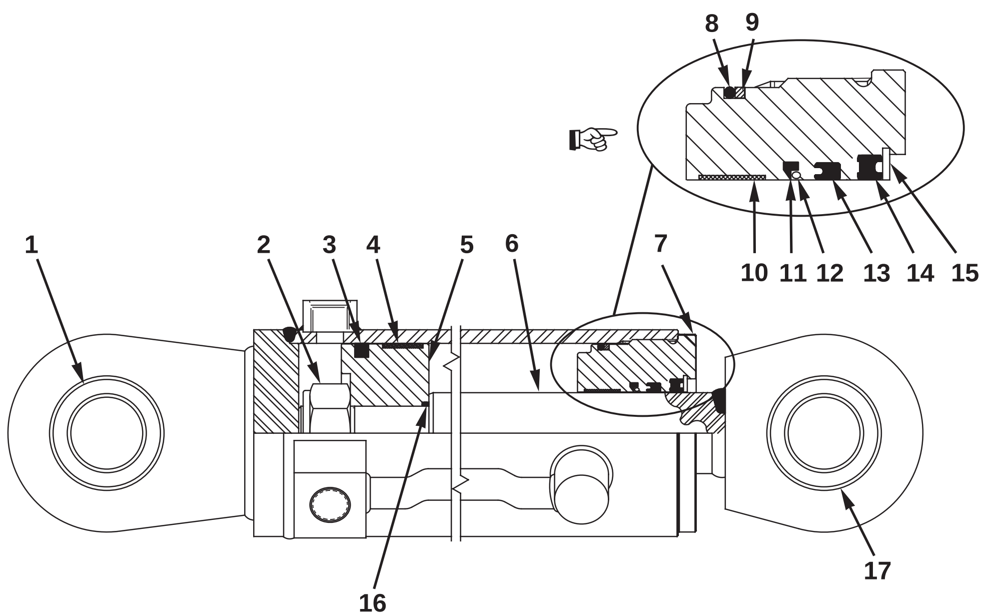
Disassemble and Assemble

Tools Needed	A
4C-8155 Spanner Wrench	1

Start By:

a. Remove the lift cylinder.

NOTE: The group number related to this procedure is 124-4622.



1. Use Tooling (A) to remove head (11) with rod (6). Upon reassembly, tighten the head to a torque of **508 ± 20 N•m (375 ± 15 lb ft).**

2. Remove nut (2) and piston (5) with O-ring seal (16). Replace the O-ring seal if there is damage or wear. Upon reassembly, replace nut (2), and tighten the new nut to a torque of **800 ± 27 N•m (590 ± 20 lb ft).**

3. Remove wear ring (4) from piston (5). Replace the wear ring if there is damage or wear. Upon reassembly, lubricate the wear ring with clean oil before installation.

4. Remove seal assembly (3). Replace the seals if there is damage or wear. Upon reassembly and before installation, lubricate the seal assembly with clean oil.

5. Remove head (7) from rod (6).

6. Remove O-ring (8), backup ring (9), retaining ring (15), lip seal (14), U-cup seal (13), backup ring and buffer seal (12) and (11), and wear ring (10). Replace the seals and the rings if they are damaged or worn. Upon reassembly and prior to installation, lubricate the seals and rings with clean oil. Apply **7M-7456 Bearing Mount Compound** to the metal shell of lip seal (14) and to the counter bore of head (7).

7. If necessary, use a suitable press to remove bearings (1) and (17).

NOTE: To assemble the lift cylinder, reverse the disassembly steps.

End By:

a. Install the lift cylinder.

Multifunction Control Valve

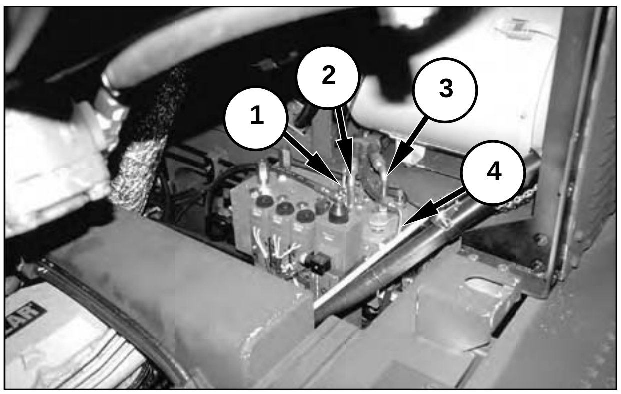
Remove and Install

NOTE: Group numbers related to this procedure include 126-6559, 144-8600, 144-8607, 144-8609, 144-8614, and 180-4169.

WARNING

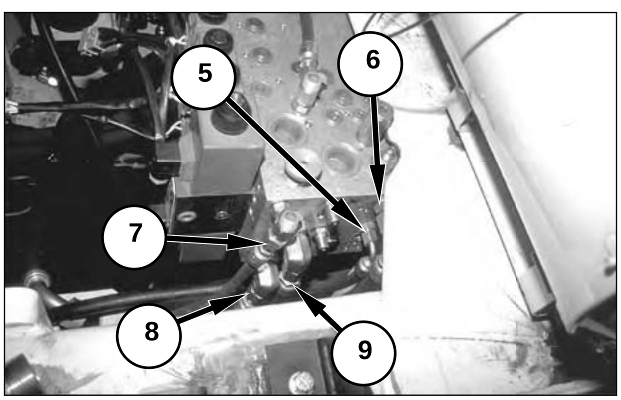
Refer to the WARNING on the Table of Contents page of this module.

1. Raise the radiator. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Radiator Tilt."



2. Disconnect, cap, and plug lines (1), (2), (3), and (4). Mark the lines for correct connection during reassembly.

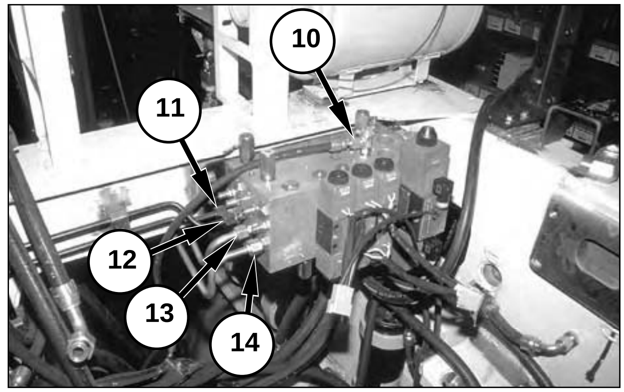
NOTE: Make sure to cap and plug the lines quickly to minimize oil spillage. Catch any spilled oil in a suitable container, and discard the oil according to local regulations.



Machine Partially Disassembled for Photographic Purposes.

3. Disconnect, cap, and plug lines (5), (6), (7), (8), and (9). Mark the lines for correct connection during reassembly.

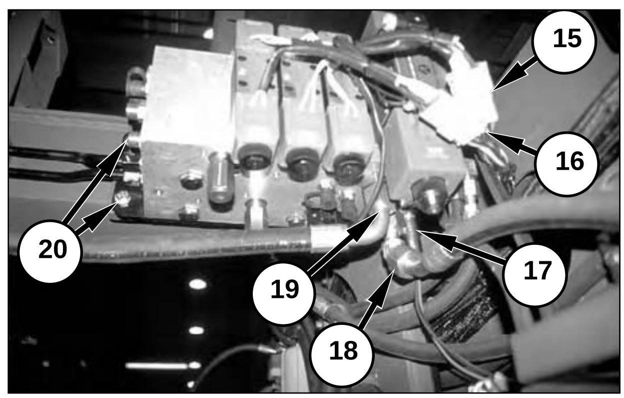
NOTE: Make sure to cap and plug the lines quickly to minimize oil spillage. Catch any spilled oil in a suitable container, and discard the oil according to local regulations.



Machine Partially Disassembled for Photographic Purposes.

4. Disconnect, cap, and plug lines (10), (11), (12), (13), and (14). Mark the lines for correct connection during reassembly.

NOTE: Make sure to cap and plug the lines quickly to minimize oil spillage. Catch any spilled oil in a suitable container, and discard the oil according to local regulations.



Machine Partially Disassembled for Photographic Purposes.

5. Disconnect, cap, and plug lines (18) and (19). Mark the lines for correct connection during reassembly.

NOTE: Make sure to cap and plug the lines quickly to minimize oil spillage. Catch any spilled oil in a suitable container, and discard the oil according to local regulations.

6. Disconnect harness connectors C204 (15) and C202 (16). Mark the harness connectors for correct connection during reassembly.

7. Disconnect the harness connector from low brake pressure switch (17). Mark the harness connector for correct connection during reassembly.

8. Remove two mounting bolts (20) with the washers from each side of the multifunction control valve (four mounting bolts total), and remove the valve. The weight of the multifunction valve is approximately **30 kg (66 lb).**

NOTE: To install the multifunction control valve, reverse the removal steps.

Radiator Tilt Cylinder

Remove and Install

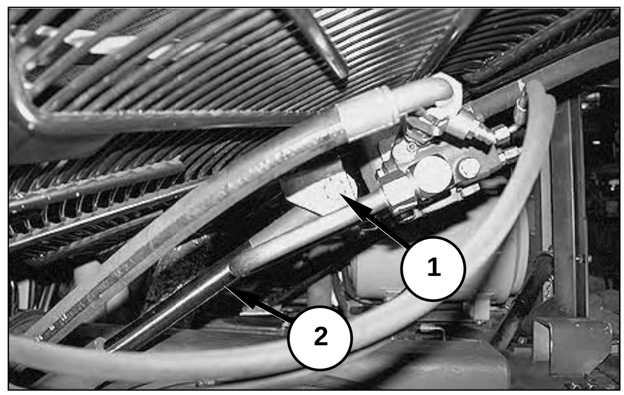
NOTE: Group numbers related to this procedure include 124-5847 and 124-5855.

WARNING

Refer to the WARNING on the Table of Contents page of this module.

1. Raise the radiator. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* “Radiator Tilt.”

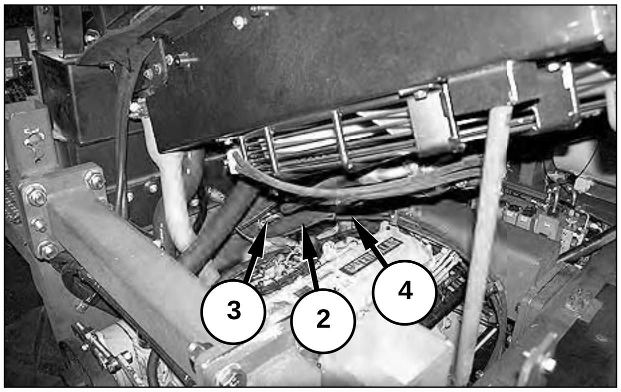
2. Raise the cab. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* “Cab Tilt.”



3. Remove bolt (1) with nut and washers. Upon reassembly, tighten bolt (1) to a torque of **125 ± 20 N•m (92.5 ± 14.8 lb ft)**.

4. Allow radiator tilt cylinder (2) to rest against the top of the engine.

5. Use the cab and radiator tilt pump to retract the radiator tilt cylinder. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE), “*Radiator Tilt.”



6. Disconnect, cap and plug two lines (4) (only one shown).

NOTE: Make sure to cap and plug lines (4) quickly to minimize oil spillage. Catch any spilled oil in a suitable container, and discard the oil according to local regulations.

7. Remove bolt (3) with nut and washers. Upon reassembly, tighten bolt (3) to a torque of **200 ± 40 N•m (148 ± 29.6 lb ft)**.

8. Remove radiator tilt cylinder (2).

NOTE: To install the radiator tilt cylinder, reverse the removal steps.

Remote Tool Manifold Valve

Remove and Install

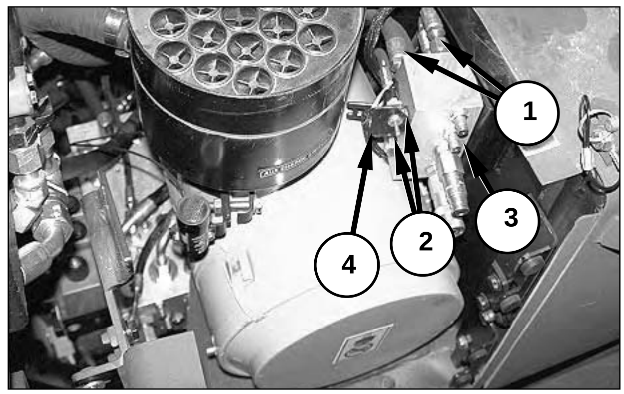
Start By:

a. Remove the middle top cover.

NOTE: The group number related to this procedure is 144-9734.

WARNING

Refer to the WARNING on the Table of Contents page of this module.



1. Disconnect cap and plug five lines (1) (only two visible in photo). Mark the lines for correct connection during reassembly.

NOTE: Make sure to cap and plug lines (1) quickly to minimize oil spillage. Catch any spilled oil in a suitable container, and discard the oil according to local regulations.

2. Remove two bolts (2) with washers, and remove remote tool manifold valve (3).

3. Remove switch assembly (4).

NOTE: To install the remote tool manifold valve, reverse the removal steps.

End By:

a. Install the middle top cover.

Return Filter Base

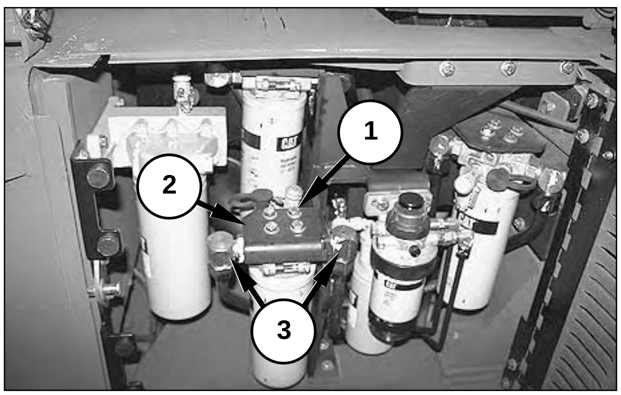
Remove and Install

NOTE: The group number related to this procedure is 126-6626.

WARNING

Refer to the WARNING on the Table of Contents page of this module.

1. Drain the hydraulic tank. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Every 1000 Service Hours or One Year, Hydraulic System, Change Oil and Clean Screens."



2. Disconnect, cap and plug two lines (3).

NOTE: Make sure to cap and plug lines (3) quickly to minimize oil spillage. Catch any spilled oil in a suitable container, and discard the oil according to local regulations.

3. Remove four bolts (1) (only one visible in this photo) and washers, and remove filter base (2).

NOTE: To install the return filter base, reverse the removal steps.

Tilt Cylinder

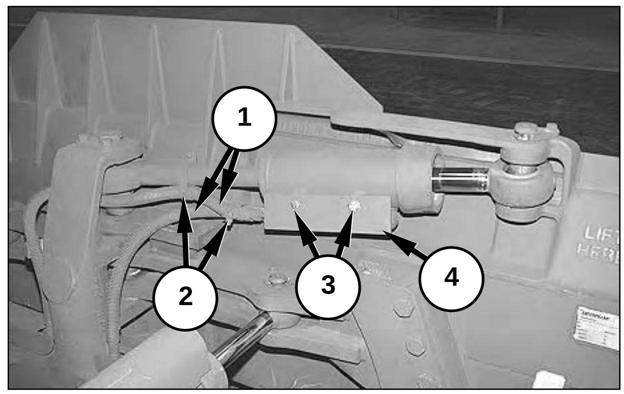
Remove and Install

NOTE: Group numbers related to this procedure include 9T-9557, 126-6557, and 129-9252.

WARNING

Refer to the WARNING on the Table of Contents page of this module.

1. Lower the blade to the ground. Stop the engine, and cycle the blade controls to release any pressure remaining in the system.

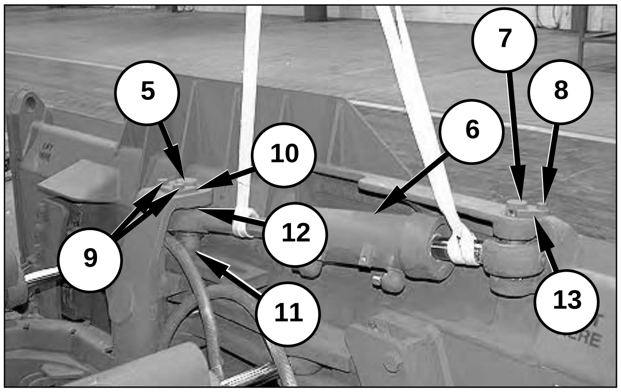


2. Remove two bolts (3) with washers, and remove cover (4).

3. Remove two bolts (2) with nuts and washers, and remove the clamps.

4. Disconnect and cap two hoses (1). Mark the hoses for reassembly. Pull the hoses back and out of the way so that the cylinder can be removed.

NOTE: Make sure to cap and plug hoses (1) quickly to minimize oil spillage. Catch any spilled oil in a suitable container, and discard the oil according to local regulations.



5. Fasten a hoist to cylinder (6). The weight of the cylinder is approximately **50 kg (110 lb).** Remove bolt (8) with washer, retainer (13), and pin (7) from the rod end of the cylinder. Also remove the two sleeves which are around pin (7).

6. Remove two bolts (9) and retainer (10).

7. Remove pin (5), short spacer (12) and long spacer (11) from the head end of the cylinder.

8. Remove cylinder (6). The weight of the cylinder is approximately **50 kg (110 lb).**

NOTE: To install the tilt cylinder, reverse the removal steps.

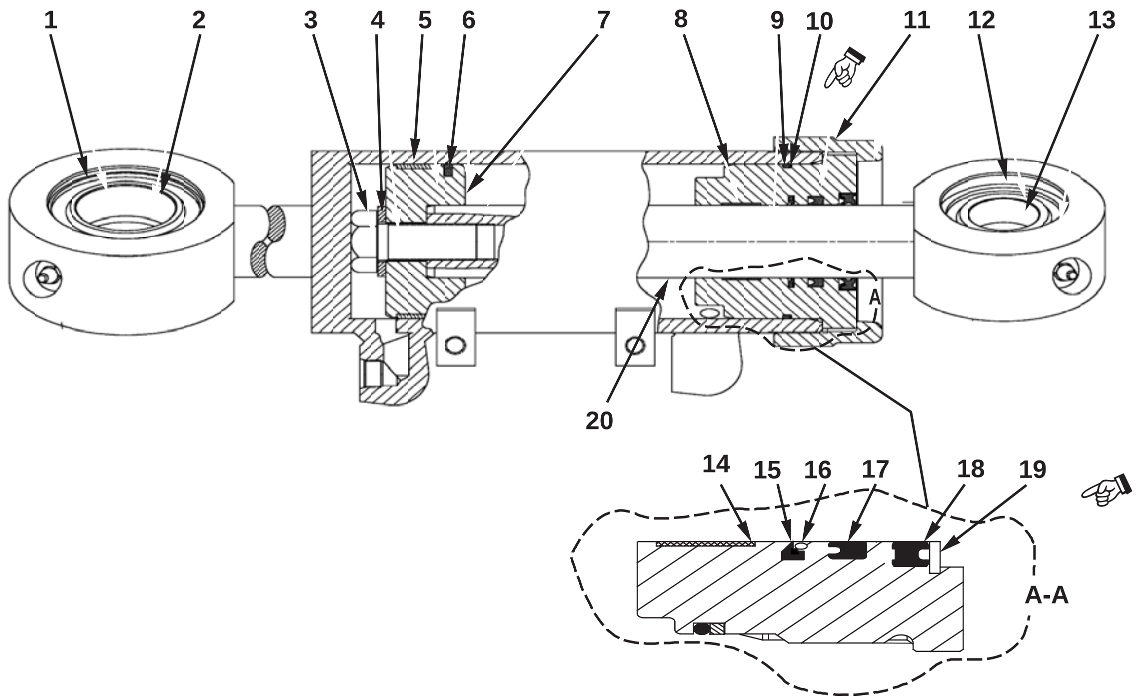
Disassemble and Assemble

Tools Needed	A
160-0261 Spanner Wrench	1

Start By:

a. Remove the tilt cylinder.

NOTE: The group number related to this procedure is 9T-9557.



1. Use Tooling (A) to remove crown (11). Upon reassembly, lubricate the threads with clean grease, and tighten the crown to a torque of **600 ± 130 N•m (445 ± 95 lb ft)**.

2. Remove bolt (3) with washer (4). Upon reassembly, lubricate the threads with clean grease, and tighten the bolt to a torque of **1125 ± 100 N•m (830 ± 75 lb ft)**.

3. Remove piston (7) with wear ring (5) and seal assembly (6). Replace the wear ring and seal assembly if they are damaged or worn. Upon reassembly and before installation, lubricate the wear ring and seal assembly with clean oil.

4. Remove head (8) from rod (20).

5. Remove O-ring (9), backup ring (10), retaining ring (19), lip seal (18), U-cup seal (17), backup ring (16) buffer seal (15), and wear ring (14). Replace the seals and rings if they are damaged or worn. Upon reassembly and prior to installation, lubricate the seals and rings with clean oil. Apply **7M-7456 Bearing Mount Compound** to the metal shell of lip seal (14) and to the counter bore of head (7).

6. Remove retaining rings (1) and (12), and remove bearings (2) and (13).

NOTE: To assemble the tilt cylinder, reverse the disassembly steps.

End By:

a. Install the tilt cylinder.

Winch Assembly

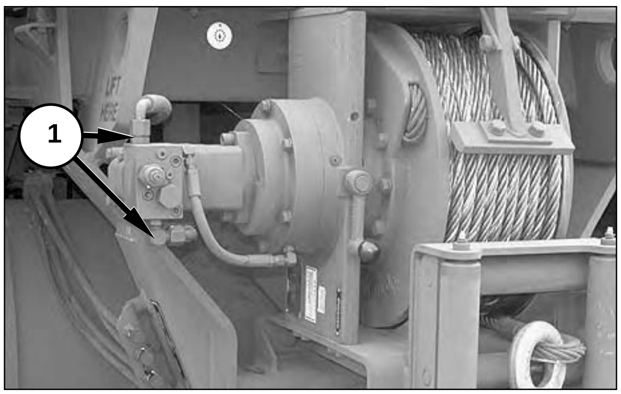
Disassemble and Assemble

Tools Needed	
138-7575 Link Bracket	2

NOTE: Group numbers related to this procedure include 145-0099 and 147-3025.

⚠ WARNING

Refer to the WARNING on the Table of Contents page of this module.

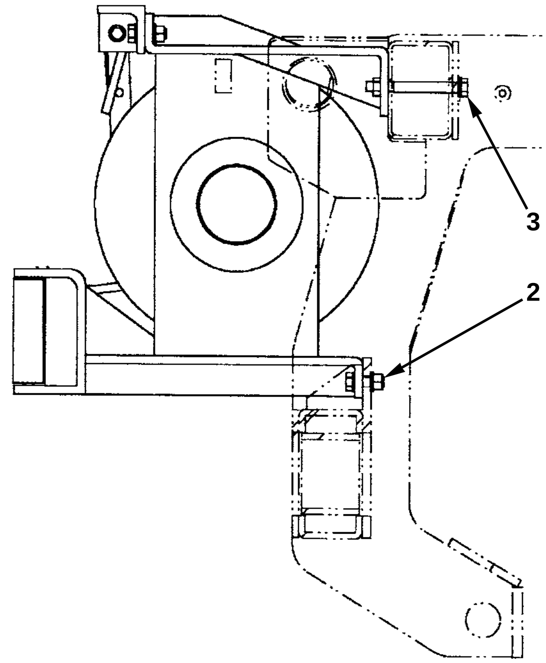


1. Disengage the winch clutch, and remove the cable from the drum. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Equipment Controls, Winch Controls."

2. Drain the oil from the winch gearbox. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Maintenance Intervals, Every 2000 Service Hours or Two Years, Winch Gearbox."

3. Disconnect, cap, and plug two winch supply lines (1). Mark the lines for correct connection during reassembly.

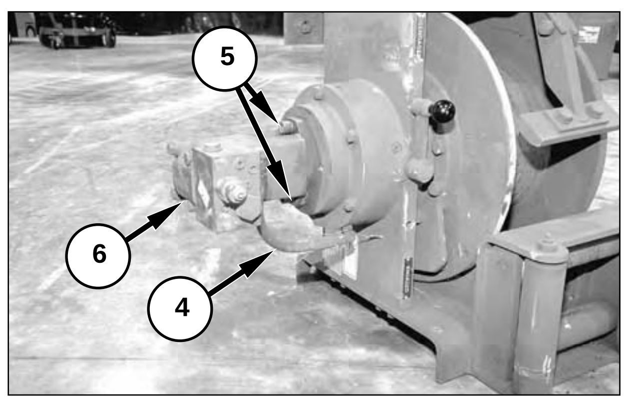
NOTE: Make sure to cap and plug lines (1) quickly to minimize oil spillage. Catch any spilled oil in a suitable container, and discard the oil according to local regulations.



4. Use a suitable lifting device to support the winch group. The winch assembly weighs approximately **171 kg (377 lb)**.

5. Remove four bolts (2), with four nuts and eight washers.

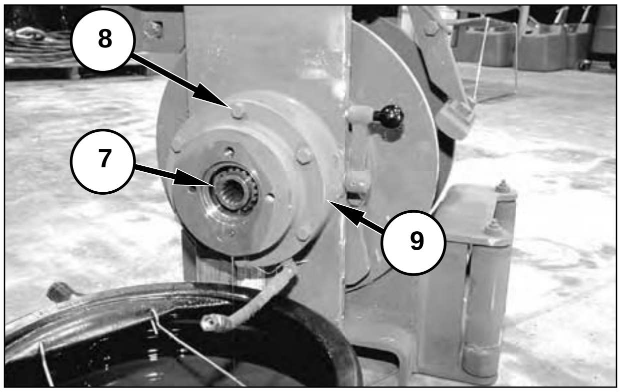
6. Remove four bolts (3) with four washers, and set the winch assembly on the ground.



7. Disconnect, cap, and plug line (4).

NOTE: Make sure to cap and plug line (4) quickly to minimize oil spillage. Catch any spilled oil in a suitable container, and discard the oil according to local regulations.

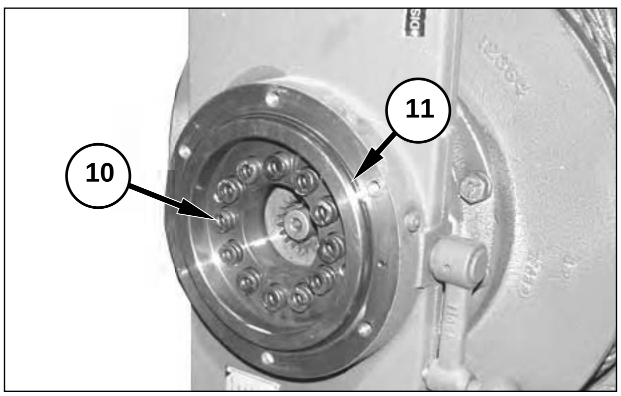
8. Remove two bolts (5) and washers, and remove winch motor (6) with the O-ring seal. Replace the O-ring seal if it is worn or damaged.



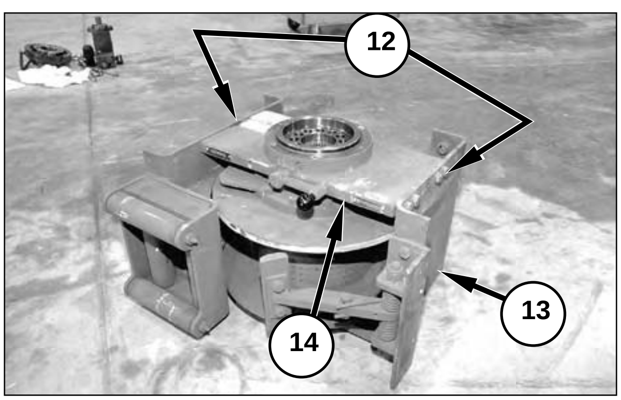
9. Remove sun gear (7).

10. Loosen six bolts (8) evenly until the spring force against cover (9) is relieved.

11. Remove six bolts (8) with washers, and remove cover (9).



12. Remove O-ring seal (11) and 12 springs (10). Replace the O-ring seal if it is worn or damaged.

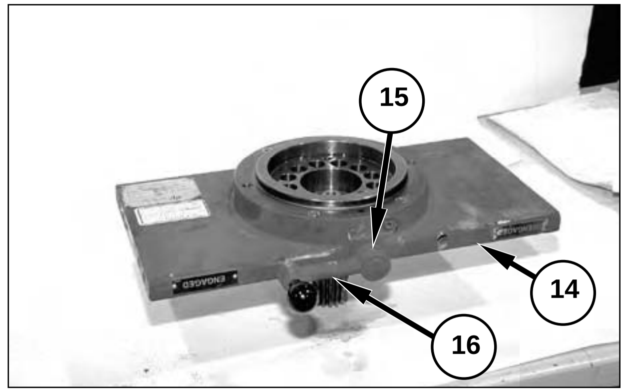


13. Use a suitable lifting device to turn the winch assembly onto its side (as shown). The winch assembly weighs approximately **171 kg (377 lb)**.

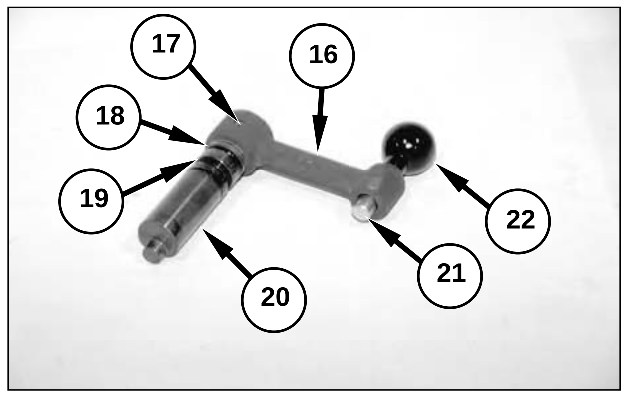
14. Remove eight bolts (12) with lockwashers.

15. Loosen, but do not remove, four bolts (13).

16. Use a suitable lifting device to remove housing (14) with the O-ring seal. Replace the O-ring seal if it is worn or damaged. The housing weighs approximately **27 kg (60 lb).**



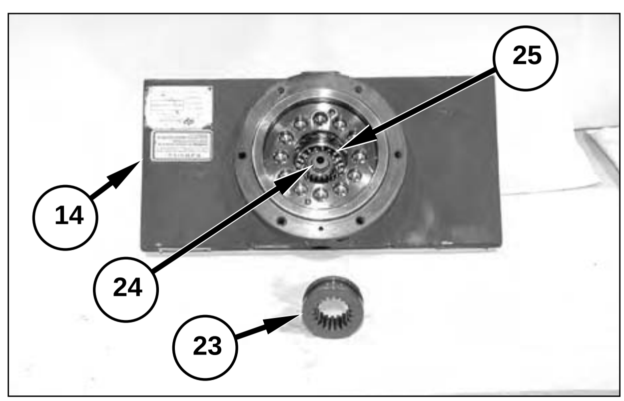
17. Remove pin spring (15), and remove arm (16) from housing (14).



18. Remove O-ring seals (18) and (19) from shaft (20). Replace the O-rings if they are worn or damaged.

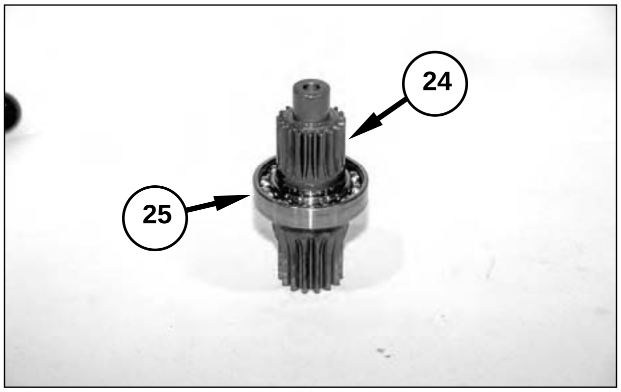
19. Drive spring pin (17) from arm (16), and separate the arm and shaft (20).

20. Unscrew knob (22) from pin locator (21), and remove the pin locator with the spring.

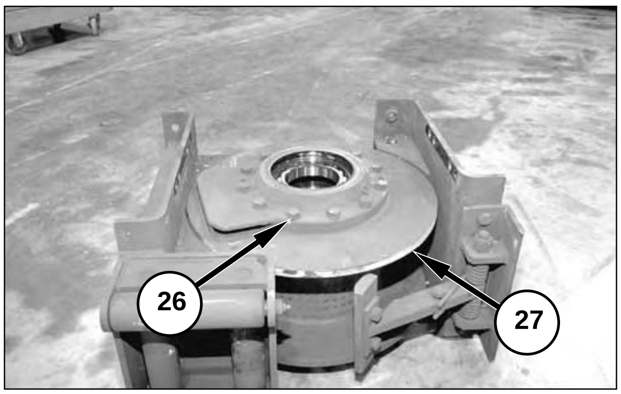


21. Turn housing (14) over, and remove drive gear (23) from sun gear (24).

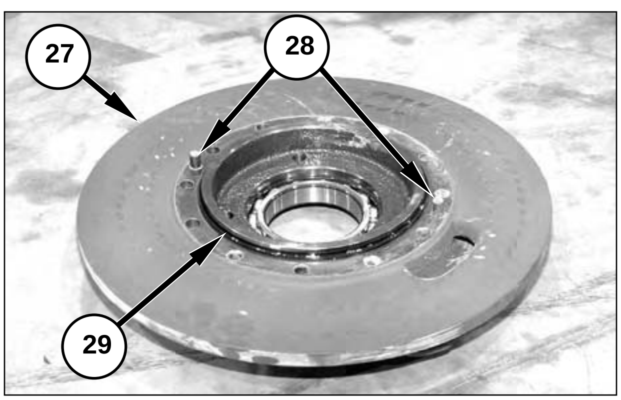
22. Use a suitable press to push sun gear (24) and bearing (25) from housing (14).



23. Use a suitable puller to remove bearing (25) from sun gear (24).

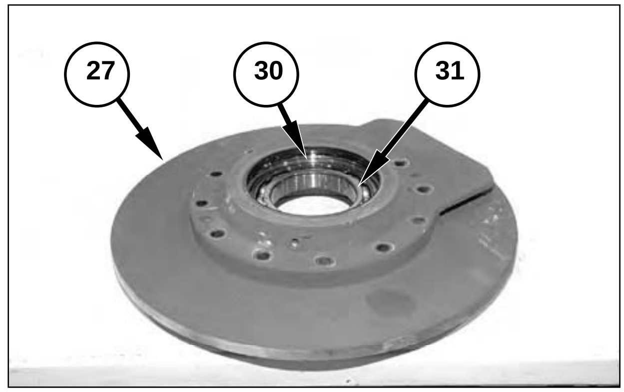


24. Remove 12 bolts (26) and washers, and use a suitable lifting device to remove flange (27). The flange weighs approximately **27 kg (60 lb).** Upon reassembly, tighten bolts evenly.



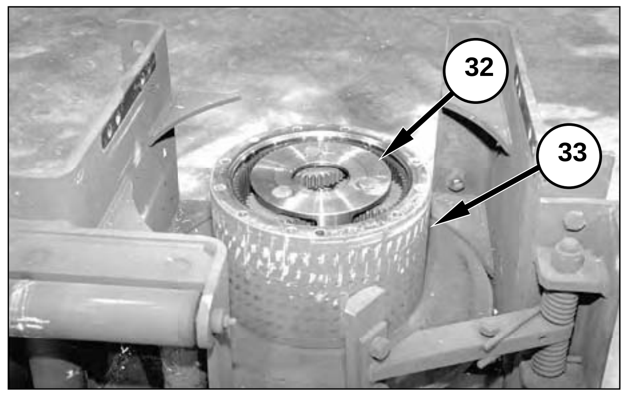
25. Remove O-ring seal (29) from flange (27). Replace the O-ring seal if it is damaged or worn.

26. If necessary, remove alignment dowels (28) from flange (27).

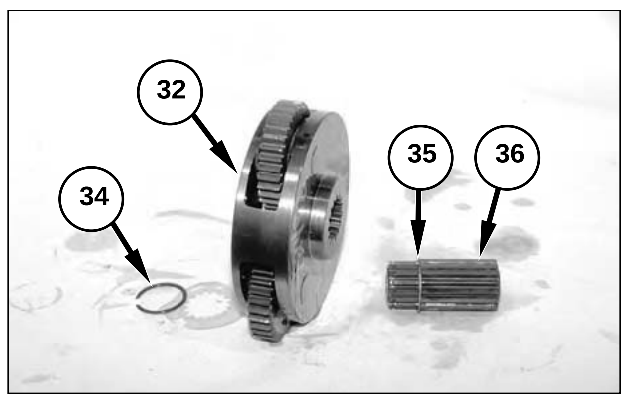


27. Turn flange (27) over, and remove seal (30).

28. Use a suitable press to remove bearing (31) from flange (27).



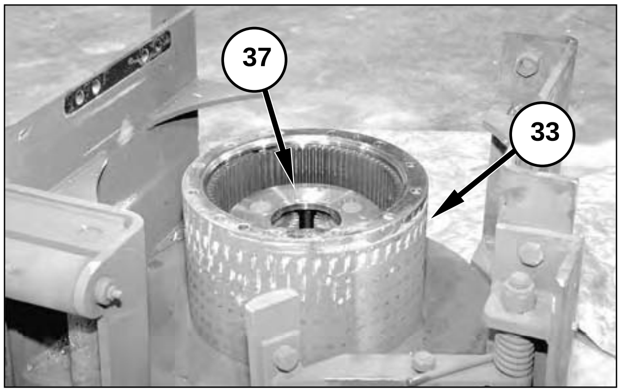
29. Remove planet carrier (32) from housing (33).



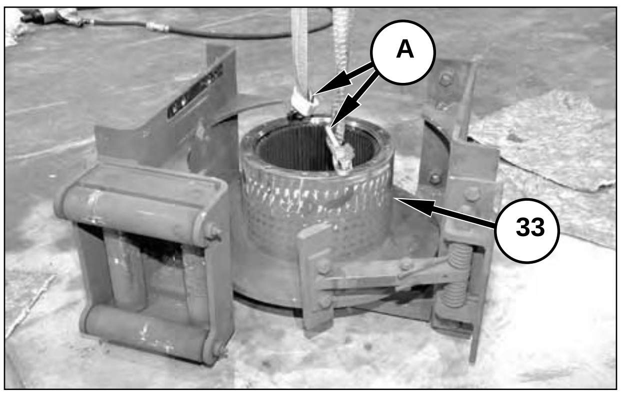
30. Remove retaining ring (34) from sun gear (36).

31. Remove sun gear (36) with retaining ring (35) from planet carrier (32).

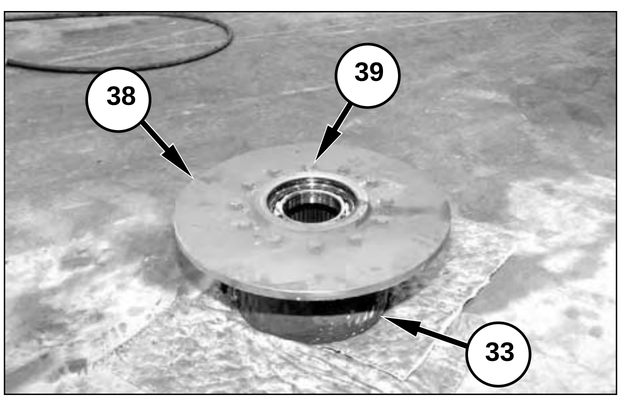
32. Remove retaining ring (35) from sun gear (36).



33. Remove planet carrier (37) from housing (33). Upon reassembly, replace the planet carrier with the thrust washer facing down.

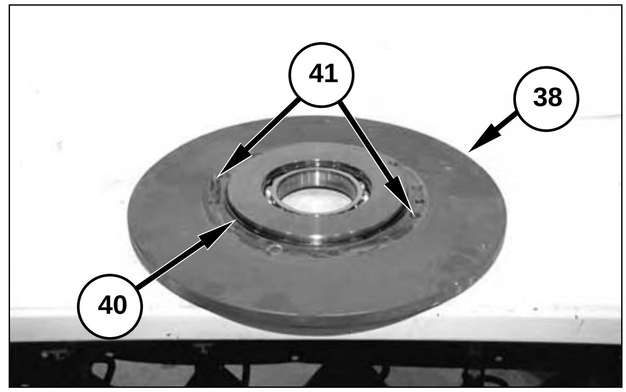


34. Install Tooling A, and use a suitable lifting device to remove housing (33) with the flange. The weight of the housing and flange is approximately **50 kg (110 lb).**



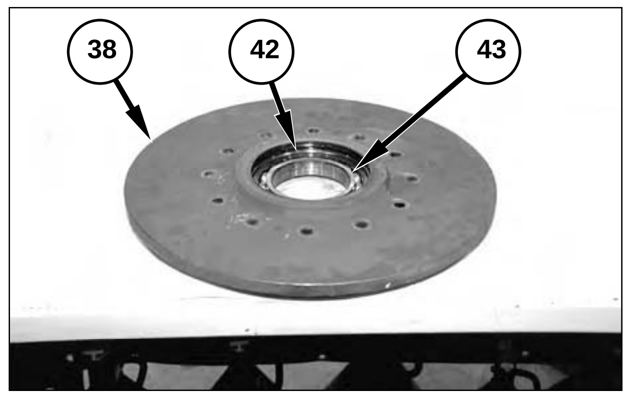
35. Remove Tooling A, and use a suitable lifting device to set housing (33) as shown.

36. Remove 12 bolts (39) and washers, and use a suitable lifting device to remove flange (38) from housing (33). The flange weighs approximately **23 kg (50 lb).** Upon reassembly, tighten all bolts evenly.



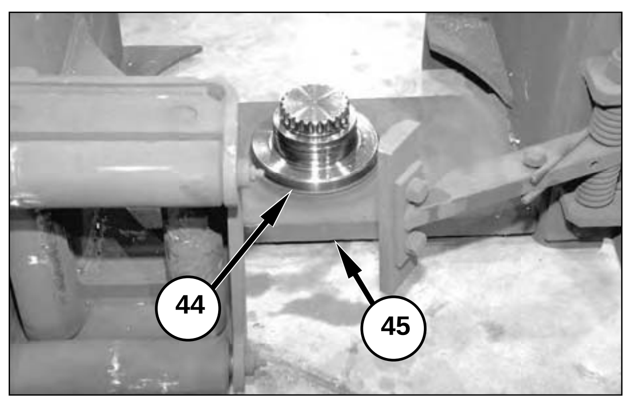
37. Remove O-ring seal (40) from flange (38). Replace the O-ring seal if it is damaged or worn.

38. If necessary, remove alignment dowels (41) from flange (38).

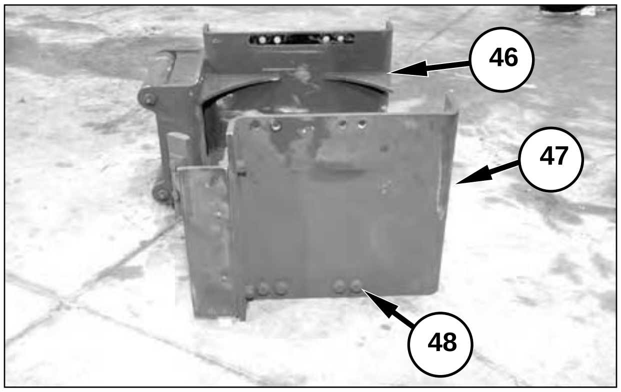


39. Turn flange (38) over, and remove seal (42). Replace the seal if it is worn or damaged.

40. Use a suitable press to remove bearing (43) from flange (38).

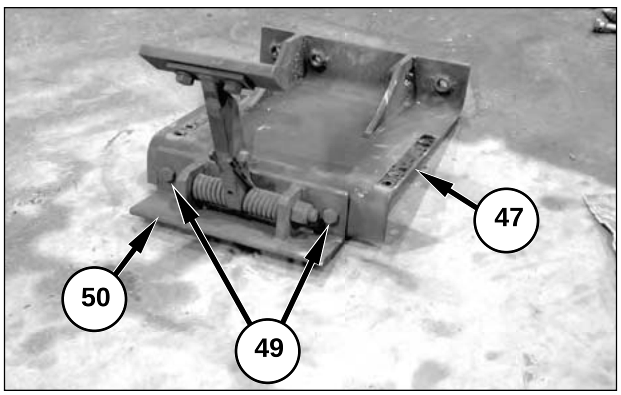


41. Remove O-ring seal (44) from end (45).



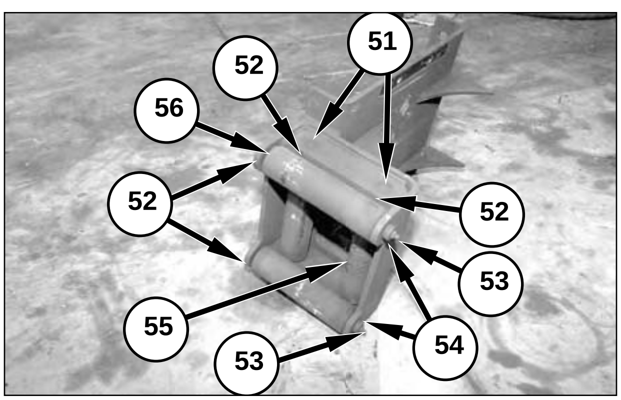
42. Remove four bolts (48) and washers from rear mount base (47), and four bolts and washers (not shown) from front mount base (46). Separate the front mount base and rear mount base from end (45).

NOTE: Upon reassembly, position end (45) with the bevel pointing towards the front of the machine.



43. Remove two bolts (49) with nuts and washers, and remove cable retainer (50) from rear mount base (47).

NOTE: Upon reassembly, place the washers next to the nuts.



44. Remove one fitting (53) from each roller. There are a total of four fittings.

45. Drive shafts (54) from vertical rollers (56), shearing off one spring pin (52) in each shaft. Remove the vertical rollers with the bushings. Replace the bushings if necessary.

46. Drive shafts (51) from horizontal rollers (55), shearing off one spring pin (52) in each shaft. Remove the horizontal rollers with the bushings. Replace the bushings if necessary.

NOTE: To assemble the winch assembly, reverse the disassembly steps.

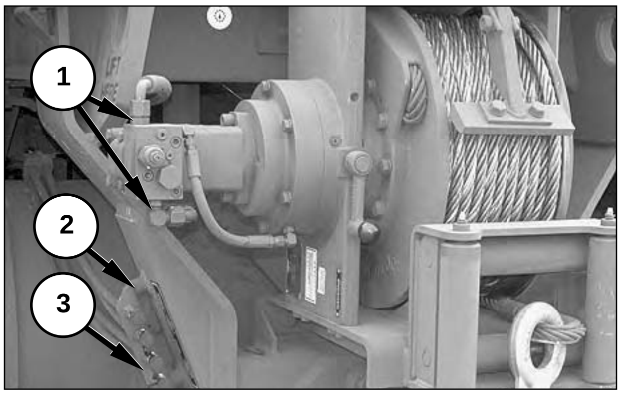
Winch Bracket With Winch Assembly

Remove and Install

NOTE: The group number related to this procedure is 145-0074.

WARNING

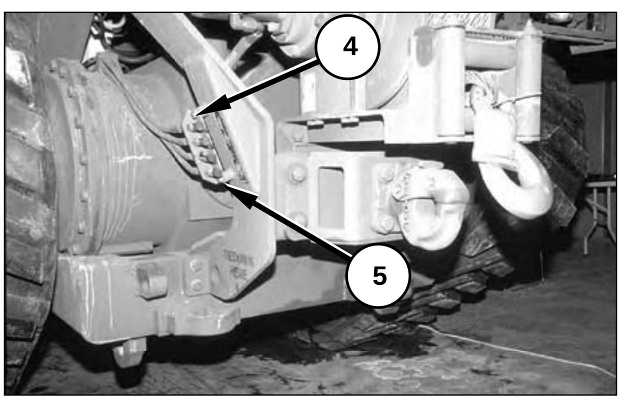
Refer to the WARNING on the Table of Contents page of this module.



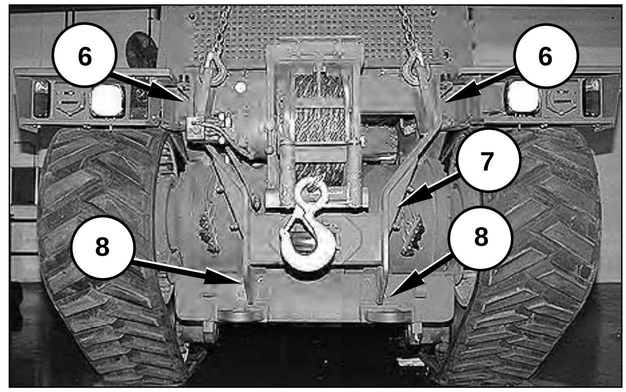
1. Disconnect, cap and plug two winch supply lines (1). Mark the lines for correct connection during reassembly.

NOTE: Make sure to cap and plug lines (1) quickly to minimize oil spillage. Catch any spilled oil in a suitable container, and discard the oil according to local regulations.

2. Remove two bolts (2) (only one visible in photo) with washers, and allow bracket (3) to hang down out of the way.



3. Remove two bolts (4) with washers, and allow bracket (5) to hang down out of the way.



4. Attach a hoist to the mount of winch (7). The weight of the winch is approximately **260 kg (573 lb).**

5. Remove eight bolts (8) with nuts and washers. Upon reassembly, tighten the bolts to a torque of **270 ± 40 N•m (200 ± 30 lb ft)**.

6. Remove four bolts (6) (only two visible in the photo) with nuts and washers, cut the wire ties on the rear lights harnesses, and remove the plates. Upon reassembly, tighten the bolts to a torque of **270 ± 40 N•m (200 ± 30 lb ft)**.

7. Remove the winch bracket with the winch assembly.

NOTE: To install the winch, reverse the removal steps. Replace wire ties as needed.

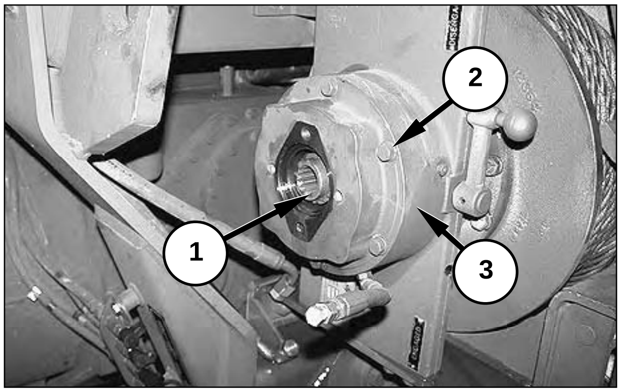
Winch Brake Assembly

Remove and Install

Start by:

a. Remove the winch motor.

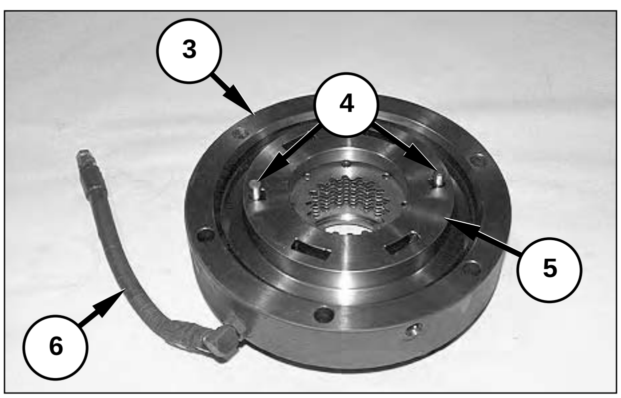
NOTE: The group number related to this procedure is 147-3025.



1. Remove sun gear (1).

2. Loosen six bolts (2) evenly until the spring force against cover (3) is relieved.

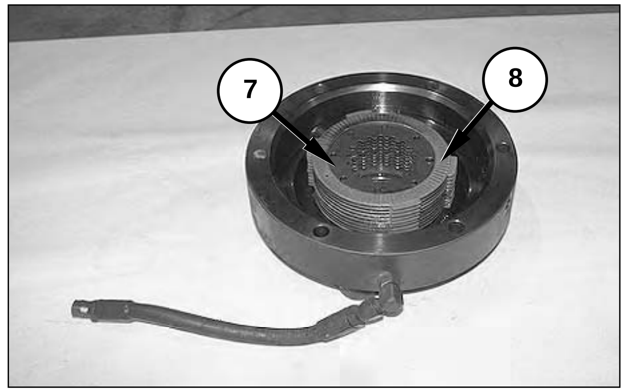
3. Remove six bolts (2) with washers, and cover (3).



4. Remove two alignment pins (4).

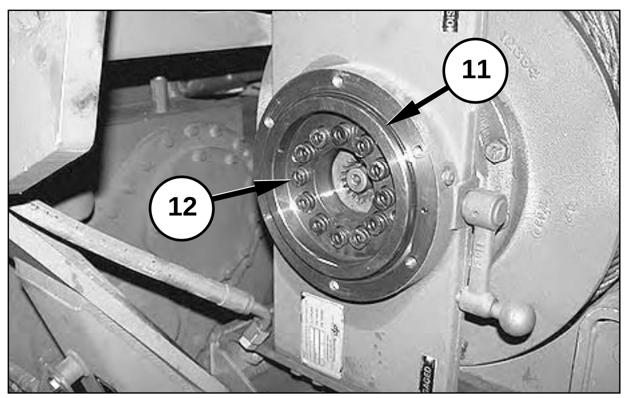
5. Remove brake piston (5).

NOTE: If necessary, use air pressure in brake hose (6) to aid in popping the brake piston out of cover (3).



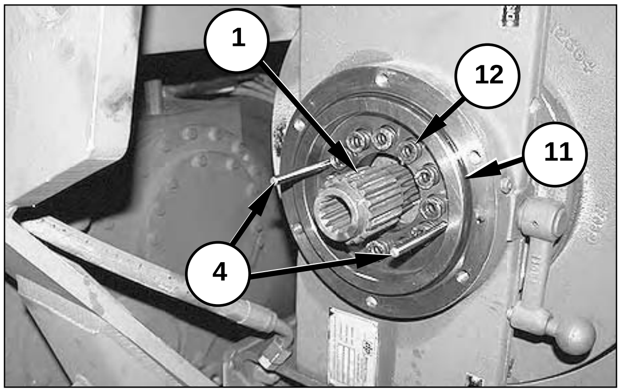
6. Remove nine plates (8) and ten disks (7).

7. Replace two backup rings (9) and two O-ring seals (10) if they are worn or damaged.



8. Remove twelve springs (12) and O-ring seal (11).

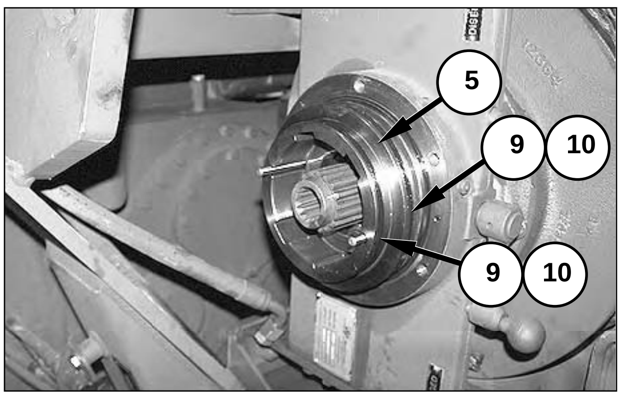
NOTE: Perform the following steps to reassemble the winch brake.



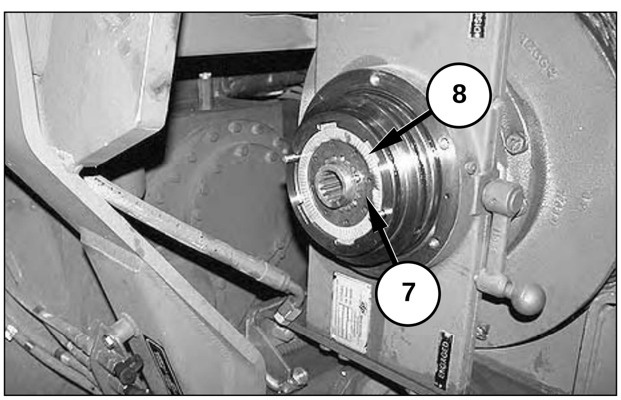
9. Install sun gear (1), and O-ring seal (11).

10. Install two pins (4) and 12 springs (12).

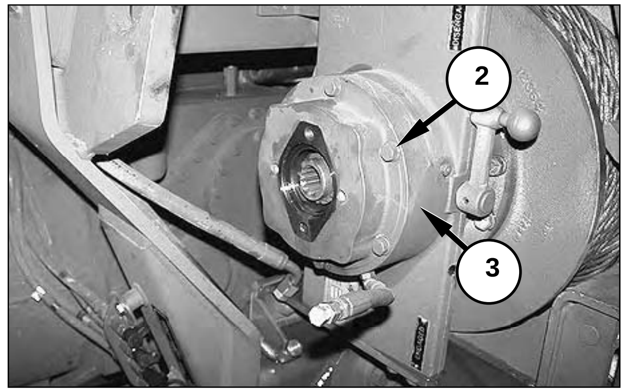
NOTE: Install pins (4) with the rounded end facing outward towards the cover.



11. Install two O-ring seals (10) and two backup rings (9), and install brake piston (5).



12. Alternately install ten brake disks (7) and nine plates (8). Start and end with a disk.



13. Install cover (3) and six bolts (2) with washers. Tighten the bolts until the cover just comes into contact with the springs.

14. Continue tightening six bolts (2) evenly until cover (3) comes into full contact with the housing. Tighten the six bolts to a torque of **68 ± 14 N•m (50 ± 10 lb ft).**

End By:

a. Install the winch motor.

Winch Control Valve

Remove and Install

NOTE: The group number related to this procedure is 124-4624.

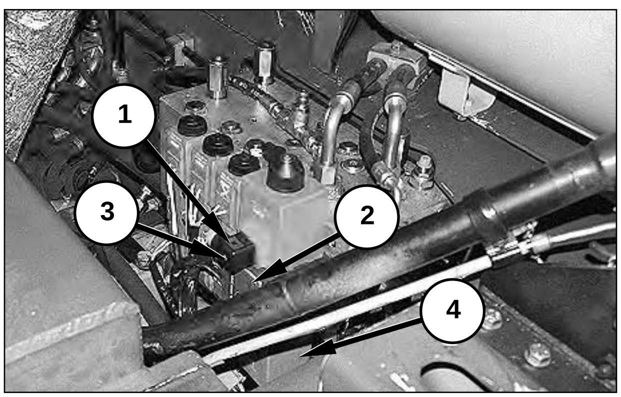
WARNING

Refer to the WARNING on the Table of Contents page of this module.

1. Drain the hydraulic tank. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),*"Every 1000 Service Hours or One Year, Hydraulic System, Change Oil and Clean Screens."

2. Raise the radiator. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Radiator Tilt."

3. Move the main disconnect switch to the OFF position. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Machine Features, Main Disconnect Switch."



4. Loosen retaining screw (3) on two connectors (1) on the winch solenoid, and disconnect the connectors. Mark the connectors for correct connection during reassembly.

5. Remove four screws, and remove cover plate (2).

6. Remove four bolts, and remove winch control valve (4) with four O-rings. Upon reassembly, tighten the four bolts to a torque of **13 N•m (115 lb in).**

NOTE: To install the winch control valve, reverse the removal steps.

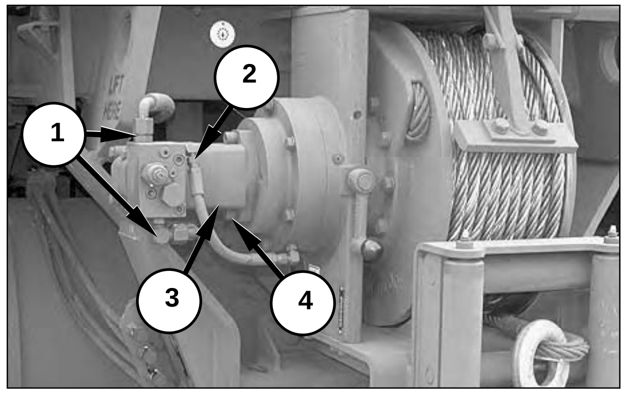
Winch Motor

Remove and Install

NOTE: Group numbers related to this procedure include 144-8609 and 147-3025.

WARNING

Refer to the WARNING on the Table of Contents page of this module.



1. Disconnect, cap and plug two winch supply lines (1) and one winch brake line (2).

NOTE: Make sure to cap and plug lines (1) and (2) quickly to minimize oil spillage. Catch any spilled oil in a suitable container, and discard the oil according to local regulations.

2. Remove two bolts (4) with washers, and remove winch motor (3) with the O-ring seal. Replace the O-ring seal if there is damage or wear.

NOTE: A small quantity of gear oil from the winch drum may run out of the winch motor mounting hole. Use a container to catch the oil, and dispose of the oil according to local regulations.

NOTE: If the sun gear which is splined to the winch motor comes out, make sure the winch clutch is in the engaged position before reinstalling the sun gear.

NOTE: To install the winch motor, reverse the removal steps.

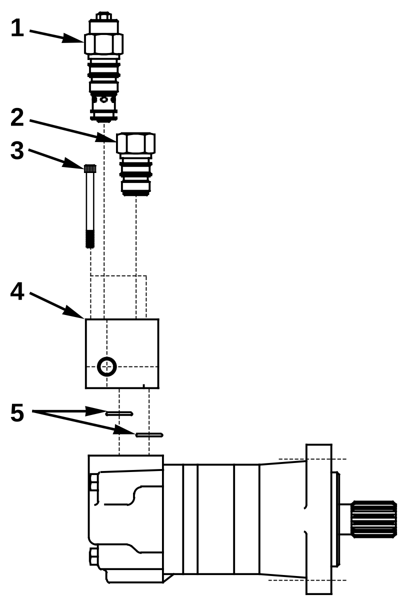
Disassemble and Assemble

Start By:

a. Remove the winch motor.

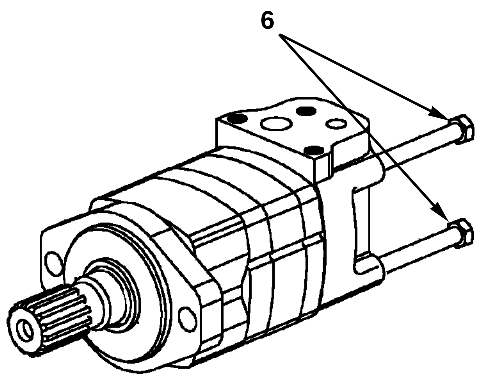
NOTE: The group number related to this procedure is 147-3025.

NOTE: Disassemble and assemble the winch motor while the motor is secured in a vise with the input shaft pointing downward.

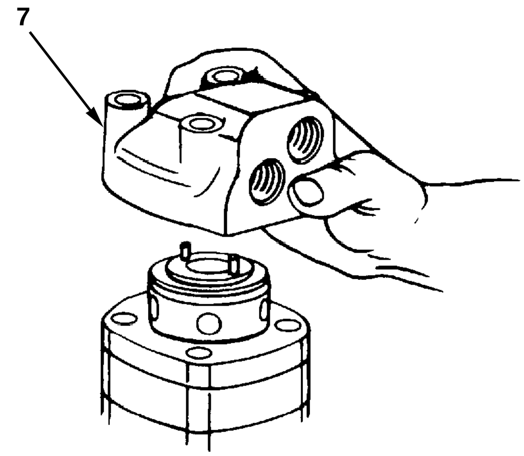


1. Remove cartridge (1) and plug (2) from counterbalance valve block (4).

2. Remove three bolts (3), and remove counterbalance valve block (4) with two O-rings (5).

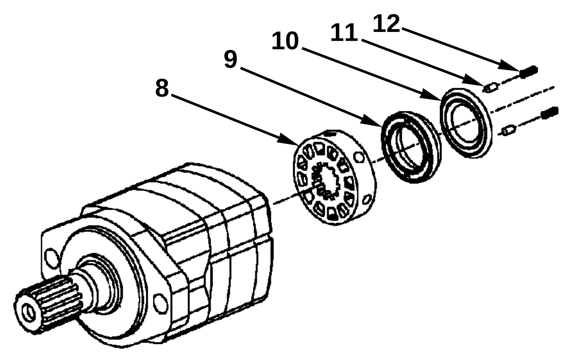


3. Scribe a line on the side of the motor to ensure the motor sections are correctly aligned during reassembly. Remove four bolts (6) (only two visible in graphic).



4. Carefully remove valve housing (7), with the O-ring seal. Replace the O-ring seal if there is damage or wear.

NOTE: Pins (11) and springs (12), shown in Step 5, may fall out of housing (7) when the housing is removed.

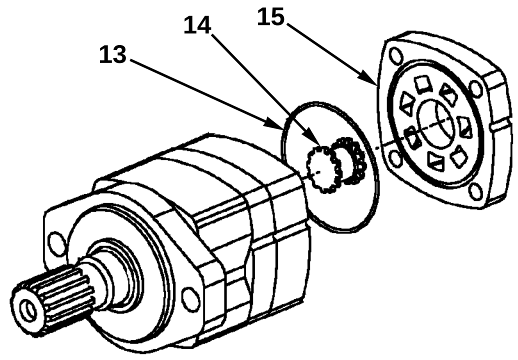


5. Remove two springs (12) and pins (11).

6. Remove inner and outer face seals (10).

7. Remove balance ring (9).

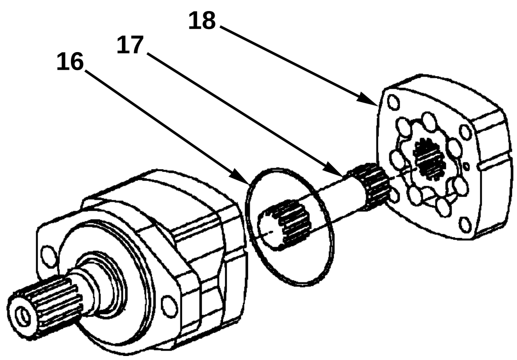
8. Remove valve (8).



9. Remove valve plate (15).

10. Remove O-ring seal (13). Replace the seal if there is damage or wear.

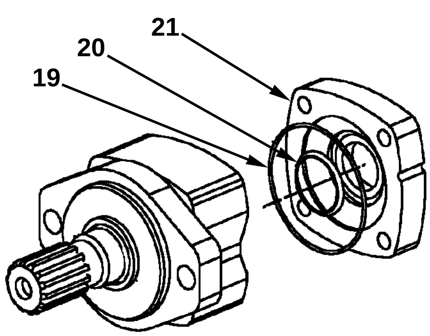
11. Remove valve drive (14).



12. Remove gerotor (18). Take care to retain the rollers in the outer ring if they are loose.

13. Remove drive (17).

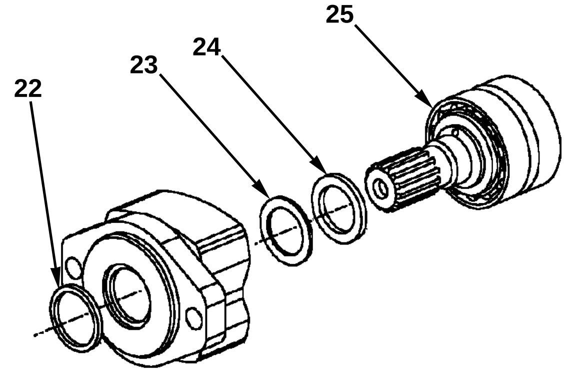
14. Remove O-ring seal (16). Replace the O-ring seal if there is damage or wear.



15. Remove wear plate (21).

16. Remove seal (20). Replace the seal if there is damage or wear.

17. Remove O-ring seal (19). Replace the O-ring seal if there is damage or wear.

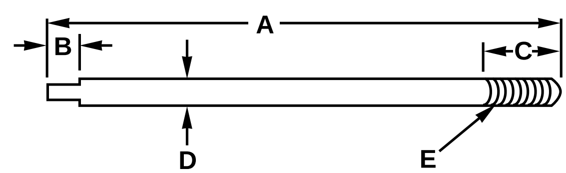


18. Use a press to remove shaft and bearing assembly (25).

19. Use a small screwdriver to remove shaft seal (24) with backup washer (23), and seal (22).

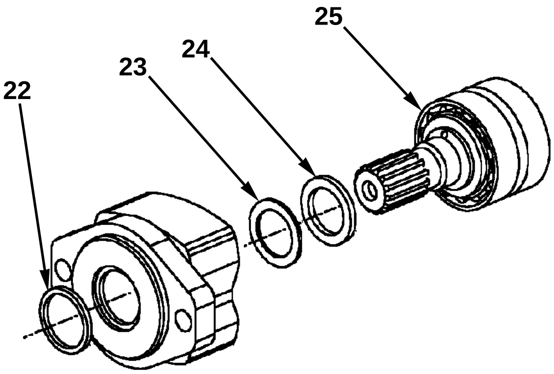
NOTE: The following steps are for the assembly of the winch motor.

NOTE: Disassemble and assemble the winch motor while the motor is secured in a vise with the input shaft pointing downward.



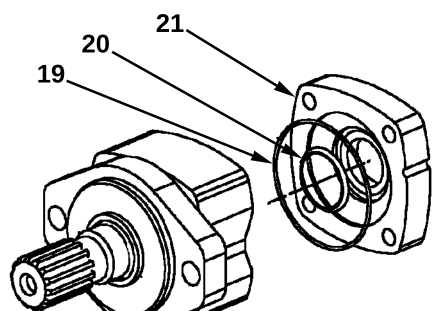
A. 200 mm (8.0 in). B. 13 mm (0.5 in). C. 25 mm (1.0 in). D 8 mm (0.32 in). E. 3/8-24 UNF.

20. Fabricate two alignment dowels as shown. Install the dowels in opposite corners of the housing to assist in aligning the components as the motor is assembled.



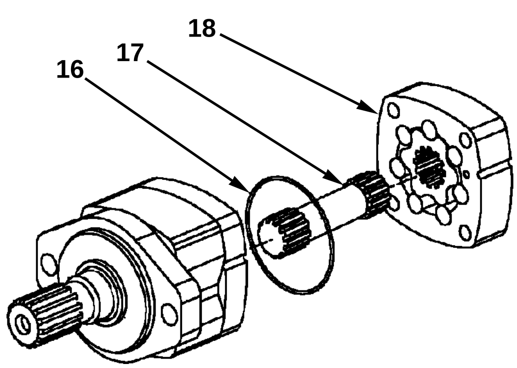
21. Install seal (22), backup washer (23) and shaft seal (24) in the motor housing.

22. Apply tape to the shaft spline on shaft and bearing assembly (25) to protect the seals during installation. Install the shaft and bearing assembly. Remove the tape from the splines after the shaft and bearing assembly is installed.



23. Install O-ring seal (19) and seal (20).

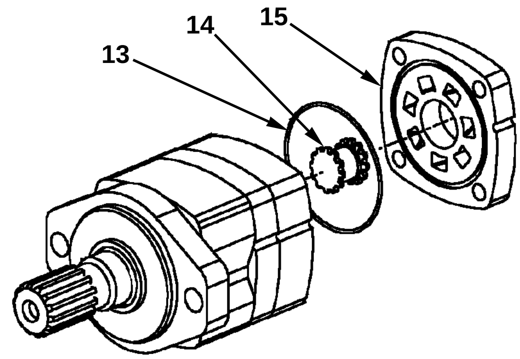
24. Install the fabricated alignment dowels in opposite corners of the motor housing, and install wear plate (21).



25. Install drive (17).

26. Install O-ring seal (16).

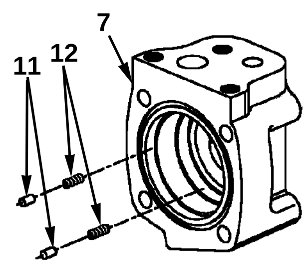
27. Install gerotor (18). Take care to retain the rollers in the outer ring.



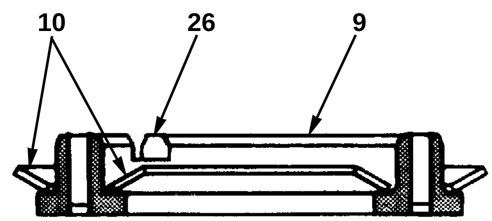
28. Install valve drive (14).

29. Install O-ring seal (13).

30. Install valve plate (15).

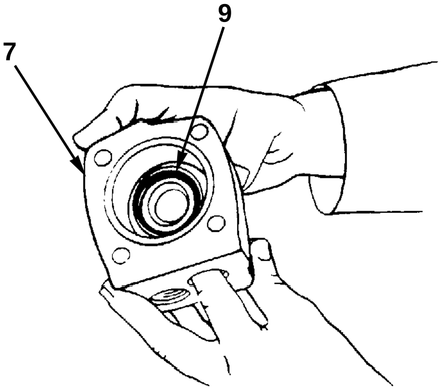


31. Apply petroleum jelly, or clean, light grease, to two springs (12) and pins (11), and install the pins and springs into valve housing (7).

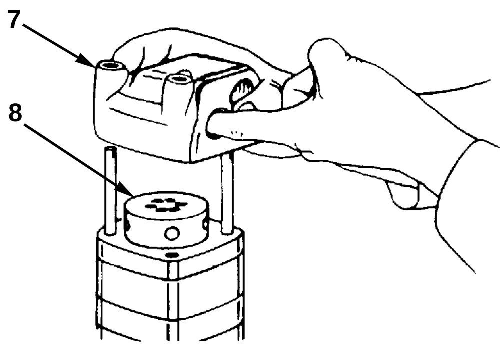


32. Apply petroleum jelly, or clean, light grease, to inner and outer face seals (10) and balance ring (9). Assemble the balance ring and seals as shown.

NOTE: Do not force or bend inner and outer face seals (10) or balance ring (9). Any damaged to these components will cause the motor to malfunction. Make note of the location of pin slots (26).

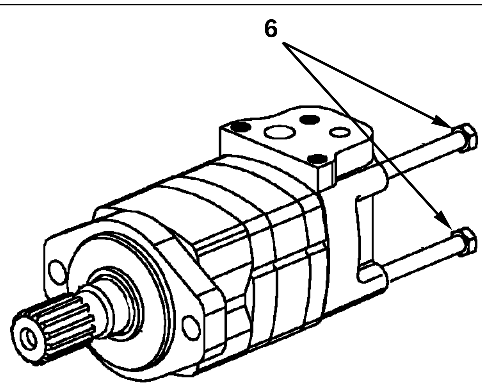


33. Install balance ring (9) with inner and outer face seals (10) to valve housing (7). Use your finger to align pin slots (26) with pins (11).

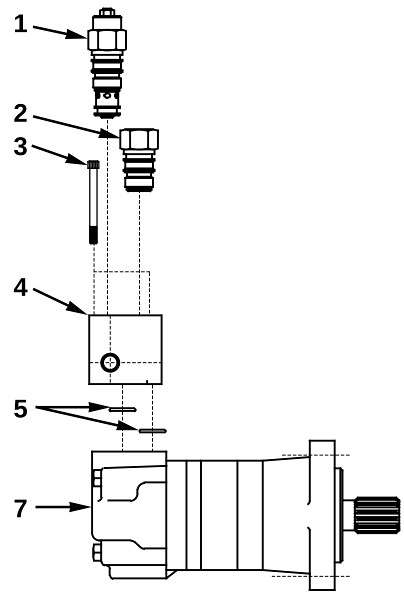


34. Install valve (8) and valve housing (7). Use your finger to keep balance ring (9) with pins (11) and springs (12) in place while installing housing (7).

NOTE: If the housing and balance ring assembly has been installed correctly, there will be a slight spring force when the housing is pushed down.



35. Install two of four bolts (6). Remove the alignment dowels and install the remaining two bolts. Tighten the bolts in a diagonal cross pattern to a torque of **50 N•m (37 lb ft).**



36. Install two O-ring seals (5) and counterbalance valve block (4) on valve housing (7). Install three bolts (3) to secure the counterbalance valve block to the valve housing.

37. Install cartridge (1) and plug (2) in counterbalance valve block (4).

End By:

a. Install the winch motor.

TM5-2430-200-24

Specifications
Systems Operation
Testing & Adjusting

Deployable Universal Combat Earthmover (DEUCE)

Machine Systems

PIN: 7RR00003-Up

Important Safety Information

Most accidents involving product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product until you have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “WARNING,” as shown below.

The meaning of this safety alert symbol is as follows:

WARNING

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning, explaining the hazard, can be either written or pictorially presented.

Operations that may cause product damage are identified by NOTICE labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are therefore not all inclusive. If a tool, procedure, work method or operating technique not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and others. You should also ensure that the product will not be damaged or made unsafe by the operation, lubrication, maintenance or repair procedures you choose.

The information, specifications, and illustrations in this publication are on the basis of information available at the time it was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service given to the product. Obtain the complete and most current information before starting any job. Caterpillar dealers have the most current information available. For a list of the most current publication form numbers available, see the Service Manual Contents Microfiche, REG1139F.

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Specifications

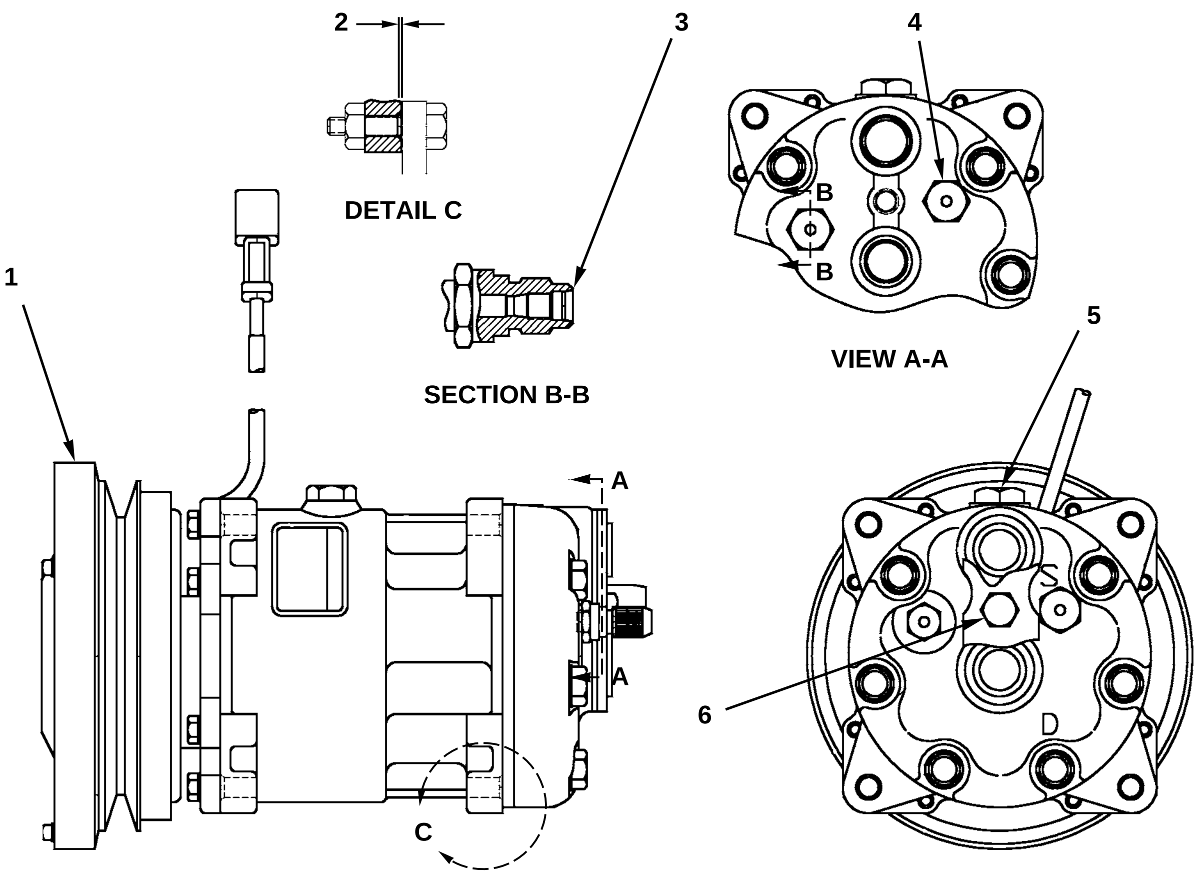
Systems Operation

Testing and Adjusting

Specifications

Air Conditioning

Refrigerant Compressor



(1) Compressor:

Clutch coil resistance.............................17.6 ± 0.6 Ω
Compressor oil type..
....................Poly Alkaline Glycol (PAG) Oil (4C-2959)
Compressor oil capacity ....300 mL (10 fl oz)
Refrigerant type..R134a
Refrigerant capacity..............................1.5 kg (3.2 lb)

(2) Maximum clearance between compressor mounting brackets and compressor mounting surface..............
....0.381mm (0.015 in)

(3) Tighten pressure switch to a torque of.......................
....................................8.0 ± 1.5 N•m (71 ± 13 lb in)

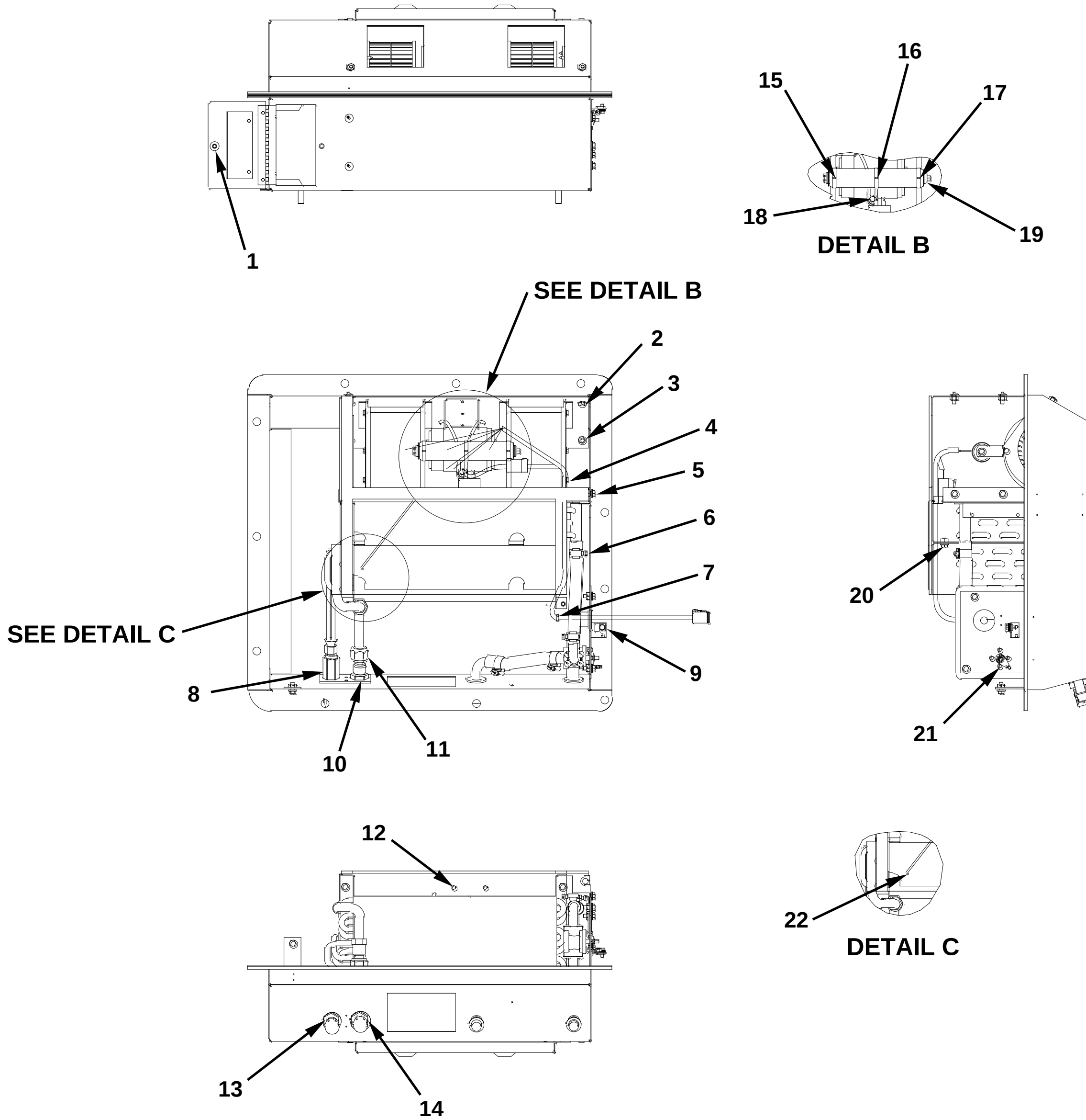
(4) Relief valve opening pressure ....3800 ± 300 kPa
....(550 ± 43 psi)

(5) Tighten plug to a torque of......................10 ± 2 N•m
....(90 ± 18 lb in)

NOTE: The oil plug is pressurized.

(6) Final installation, tighten bolt to a torque of ....
......................................25 ± 7 N•m (220 ± 62 lb in)

Cab Group



(1) Tighten screw to a torque of ....12 ± 3 N•m ....(9 ± 2 lb ft)

(2) Tighten screw to a torque of ....12 ± 3 N•m ....(9 ± 2 lb ft)

(3) Tighten lock nut to a torque of ....8 ± 3 N•m ....(6 ± 2 lb ft)

(4) Tighten screw to a torque of ....1.2 ± 0.2 N•m ....(10.5 ± 1.5 lb in)

(5) Tighten screw to a torque of ....12 ± 3 N•m ....(9 ± 2 lb ft)

(6) Tighten hose clamp to a torque of ......4.5 ± 0.5 N•m ....(40 ± 4.5 lb in)

(7) Install cable tie with tensile load of.....3 N•m (27 lb in)

(8) Tighten orifice tube fitting to a torque of ....12 ± 3 N•m (9 ± 2 lb ft)
Clean and lubricate fitting and seal with refrigerant oil.

(9) Tighten screw to a torque of ....12 ± 3 N•m ....(9 ± 2 lb ft)

(10) Tighten fitting to a torque of ....68 ± 10 N•m ....(50 ± 7 lb ft)
Clean and lubricate fitting and seal with refrigerant oil.

(11) Tighten tube assembly to a torque of....12 ± 3 N•m ....(9 ± 2 lb ft)
Clean and lubricate fitting and seal with refrigerant oil.

(12) Tighten screw to a torque of ....1.2 ± 0.2 N•m ....(10.5 ± 1.5 lb in)

(13) Tighten nut to a torque of....................42 ± 10 N•m ....(31 ± 7 lb ft)

(14) Tighten nut to a torque of....................54 ± 10 N•m ....(40 ± 7 lb ft)

(15) Blower low speed connection 517-BU-14

(16) Blower medium speed connection 516-GN-14

(17) Blower high speed connection...............515-GY-14

(18) Tighten screw to a torque of ....4.5 ± 0.5 N•m ....(40 ± 4.5 lb in)

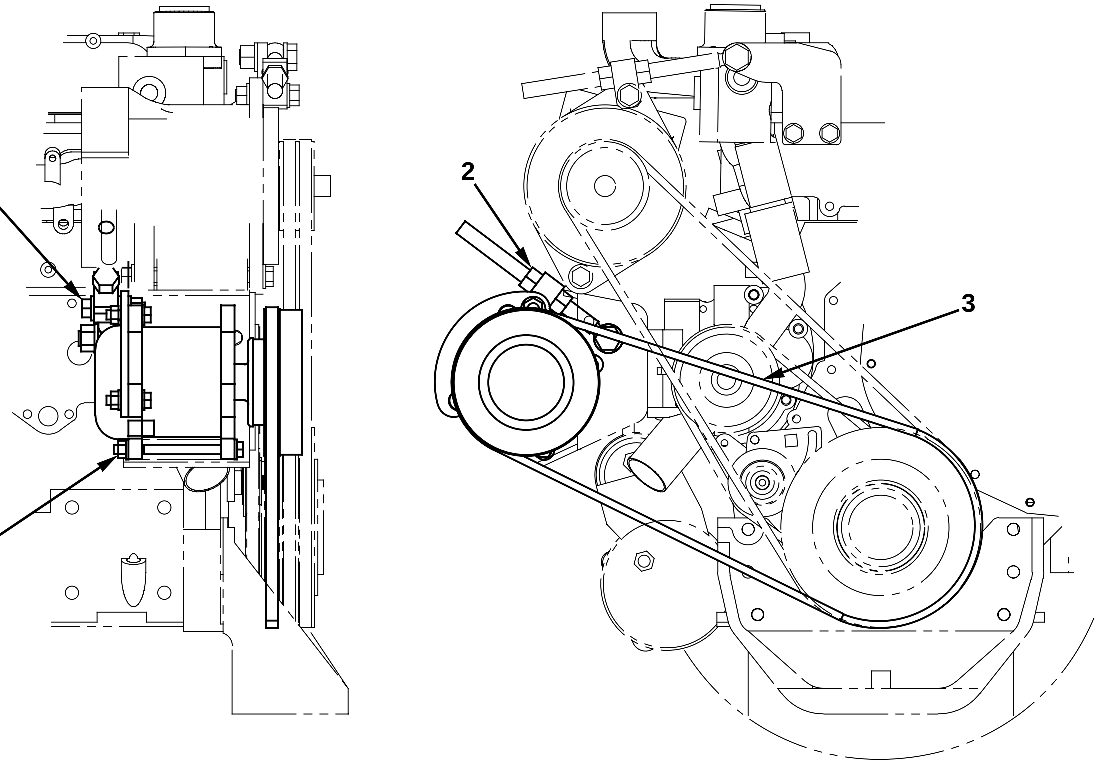
(19) Tighten screw until resistor is snug between rubber washers but can still be turned by hand.

(20) Tighten screw to a torque of ....12 ± 3 N•m ....(9 ± 2 lb ft)

(21) Tighten screw to a torque of ....1.2 ± 0.2 N•m ....(10.5 ± 1.5 lb in)

(22) Insert cap tube of freeze switch between rows two and three of evaporator coil to a depth of ....230 ± 10 mm (9 ± 0.4 in)

Compressor Installation



(1) Tighten nut to a torque of....................105 ± 20 N•m
....(77 ± 22 lb ft)

(2) Tighten nut to a torque of....................115 ± 20 N•m
....(85 ± 15 lb ft)

(3) Belt tension with BT–33–97 Gauge:

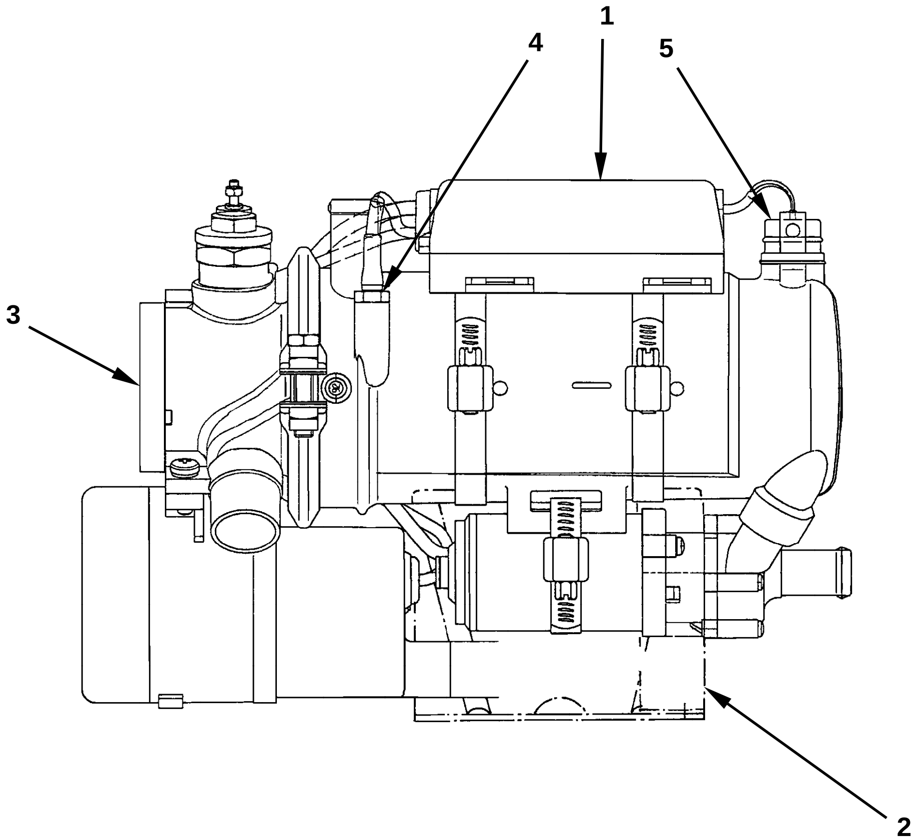
New belt ....534 ± 22 N (120 ± 5 lb)
Used belt ....400 ± 44 N (90 ± 10 lb)

NOTE: Use the “used belt” specification for a belt that has been running at rated speed for 30 minutes or more.

(4) Tighten nut to a torque of........................30 ± 7 N•m
....(22 ± 5 lb ft)

Engine Coolant Heater

Heater Group



(1) Operating voltage range.................21.0 to 28.0 DCV
Current during starting.................22.0 ± 2.2 amps/hr
Current in high heat mode...........3.8 ± 0.38 amps/hr
Current in low heat mode..............2.0 ± 0.2 amps/hr
Fuel consumption in high heat mode ....
..............0.90 ± 0.045 L/hr (0.24 ± 0.012 U.S. gal/hr)
Fuel consumption in low heat mode ....
..............0.22 ± 0.011 L/hr (0.06 ± 0.003 U.S. gal/hr)

(2) Coolant pump flow...........................1600 ± 160 L/hr
....(420 ± 42 U.S. gal/hr)

(3) Flame sensor:

Resistance at -25°C (-13°F).............................900 Ω
Resistance at 25°C (77°F)..............................1100 Ω

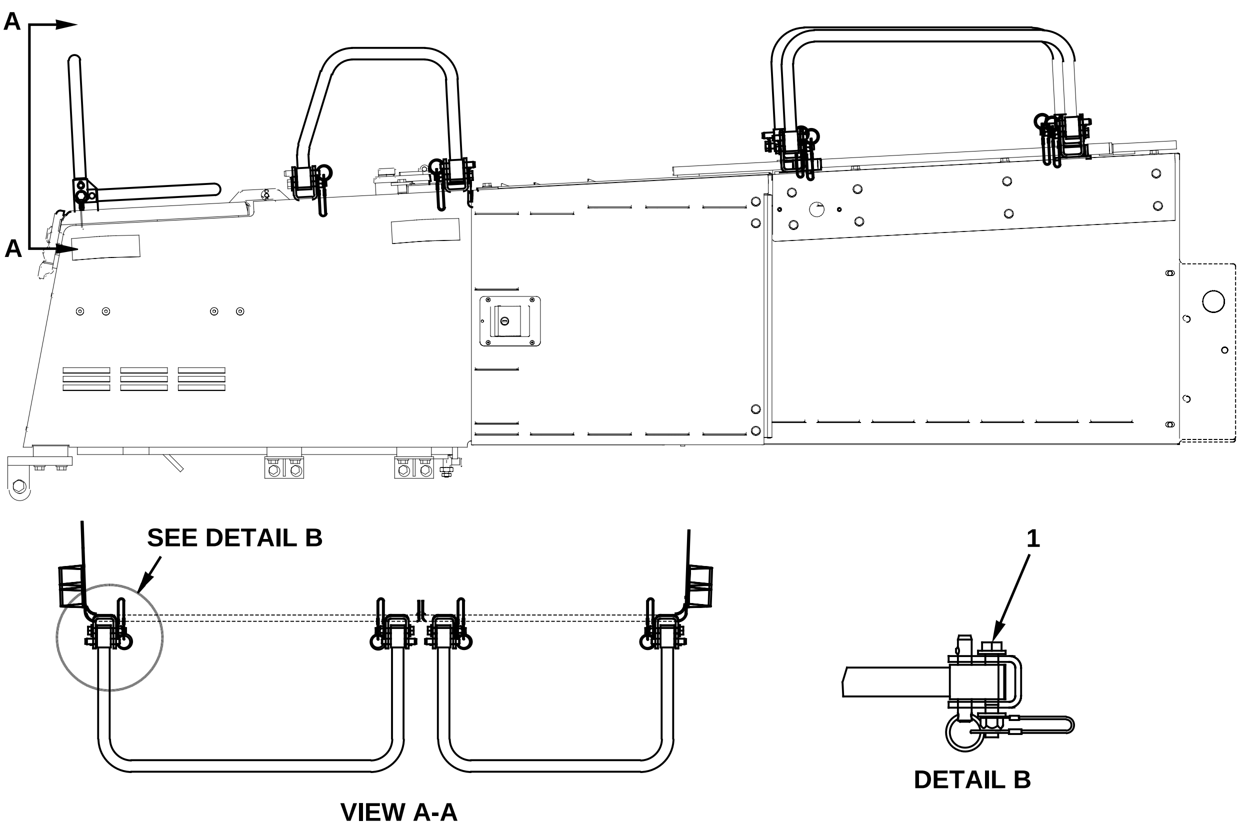
(4) Temperature sensor:

Resistance at -25°C (-13°F).............................650 Ω
Resistance at 25°C (77°F)..............................1000 Ω

(5) Thermal cut out switch opening temperature.............
.....................................135 ± 13.5°C (275 ± 27.5°F)

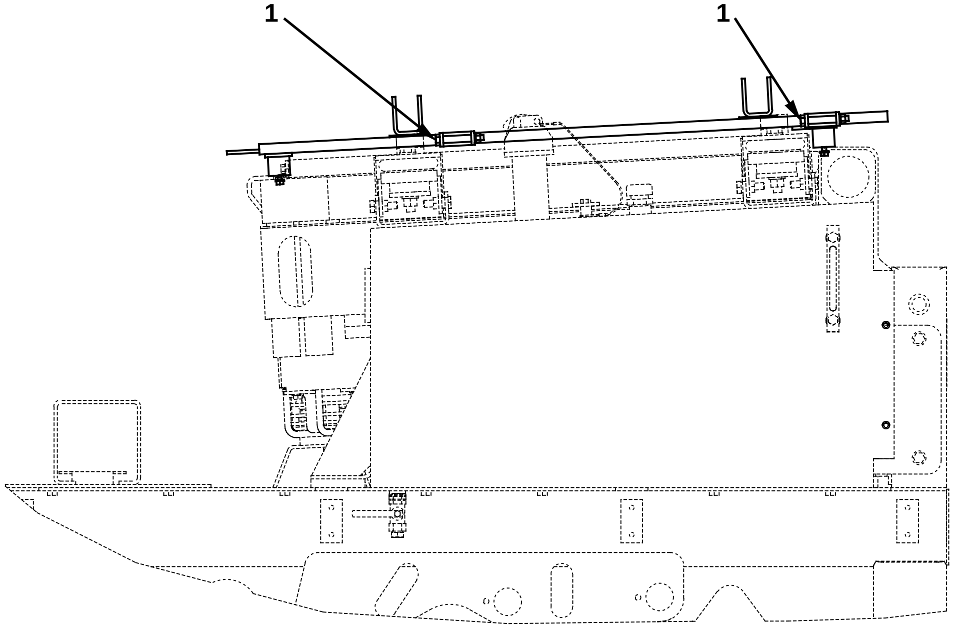
Chassis Arrangement

Handrail Group



(1) Tighten handrail bolts to a torque of...........................
.....................................30 ± 5 N•m (22.1 ± 3.7 lb ft)

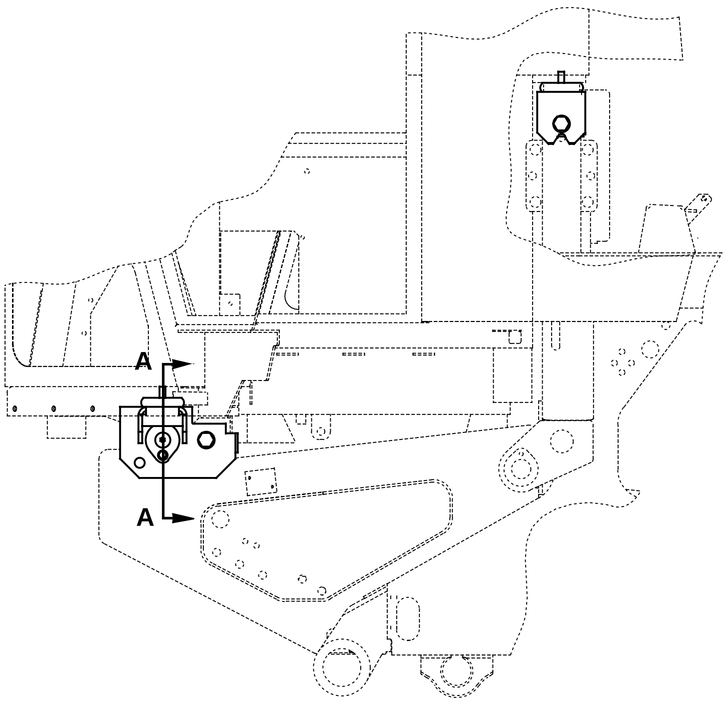
Radiator Grill Group



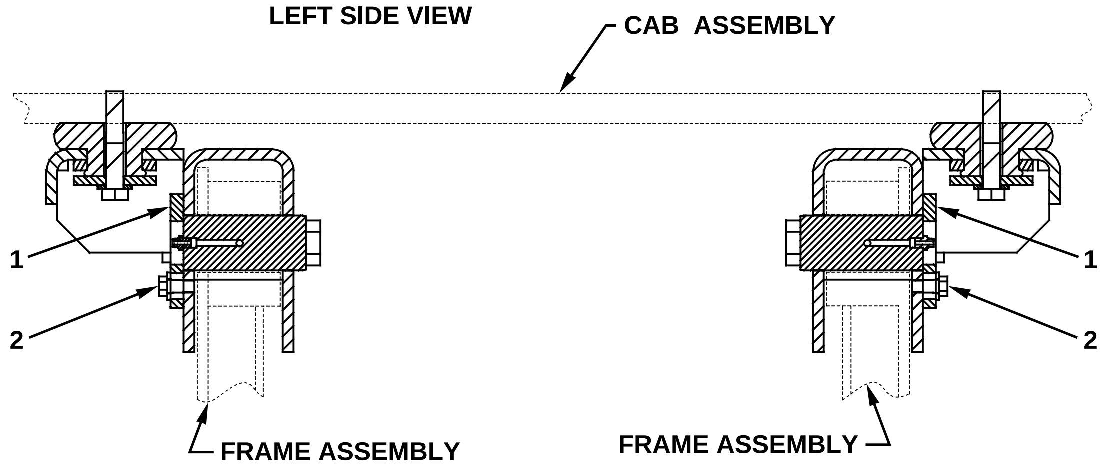
(1) Apply thin coat of 5P-0960 Multipurpose Grease to bolts at assembly.

Operator Arrangement

Mounting Group



LEFT SIDE VIEW



SECTION A-A

(1) Apply thin coat of 5P-0960 Multipurpose Grease to pin at assembly.

(2) Apply 4C-4030 Thread Compound (Loctite™ 242) to threads.

Systems Operation

Air Conditioning and Heating Systems

Safety Requirements

WARNING

The air-conditioning system is charged with an air-conditioning refrigerant. Inhaling the refrigerant through a lit cigarette could cause violent illness. This system is under pressure at all times, whether the engine is running or not. Heat should never be applied to a charged system.

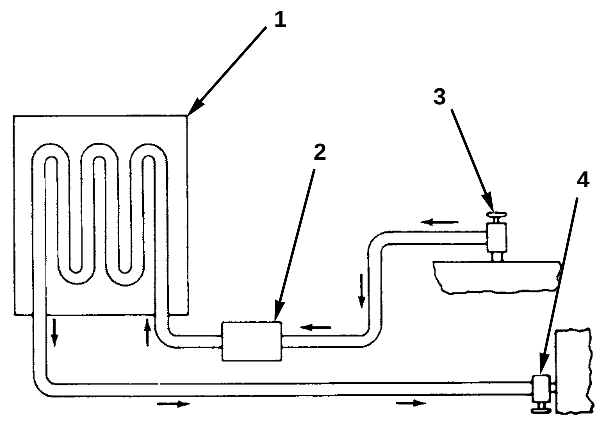
Before any checks of the air conditioning and heating system are made, move the machine to a smooth, horizontal surface. Lower all implements to the ground. Make sure the transmission is in NEUTRAL and the parking brake is engaged. Keep all other personnel either away from the machine or where they can be seen by the operator.

Before any problem solving procedures are done, read “Troubleshooting the Air-Conditioning System” in the “Testing and Adjusting” section of this module; then make a visual inspection of the complete air conditioning and heating system.

- All charging and leak testing must be done in a well-ventilated area.
- Avoid any physical contact with refrigerant. Contact can cause frost bite.
- Always wear goggles when working on or testing any part of the system which contains refrigerant.
- Place a clean cloth over, or cap, any valve or connection that has been opened.
- Never weld, solder, torch or steam clean charged air conditioner components.
- Do not smoke when charging the system or performing a leak test.
- Do not leave refrigerant drums in direct sunlight, or carry them in the passenger compartment of a machine.
- Dispose of any Poly Alkaline Glycol (PAG) oil that has been opened but not used. PAG oil absorbs moisture easily. The moisture will contaminate the unused oil and the air-conditioning system.

Heating System

The heating system provides warm air to the operator's compartment for heating and defrosting.



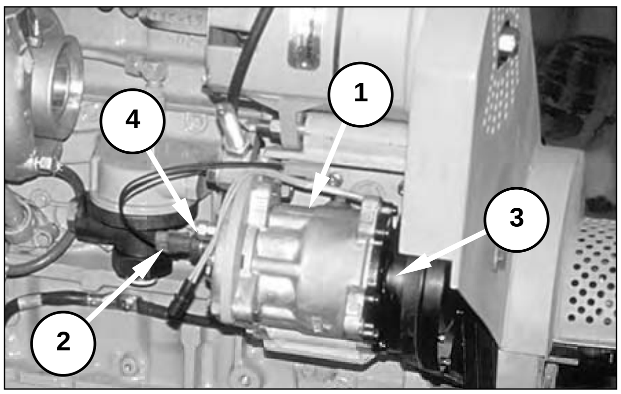
Heating System.
(1) Heater coil. (2) Ball valve. (3) Outlet supply connection for coolant. (4) Return connection for coolant.

The heating system uses coolant from the engine cooling system. Ball valve (2) is connected to the temperature control knob in the cab. With the knob in the COLD position, the heater control valve prevents the flow of coolant through heater coil (1). When the control knob is moved from the COLD position, the control valve opens to allow warm coolant to flow from outlet supply connection (3) through the control valve to heater coil (1). As the warm coolant flows through the heater coil, the temperature of the air flowing across the coil increases.

The amount of coolant flowing through the coil controls the air temperature increase. The greater the amount of coolant flowing through the heater coil, the greater the temperature of the air that flows across the heater coil. The coolant from the heater coil then flows to return connection (4). From the return connection, the coolant is sent back through the engine cooling system.

Air-Conditioning System Component Location

The air-conditioning system is a closed-circuit system that uses refrigerant under pressure to cool the interior of the cab. This machine is equipped with an orifice tube air-conditioning system. The five main components of the orifice tube system are: the compressor, condenser coil, accumulator, orifice tube, and evaporator coil. Other important components of the air-conditioning system are: the blower motor circuit breaker, blower switch, thermostat control knob, capillary tube and freeze control switch, clutch and clutch solenoid, pressure relief valve, and pressure switch.

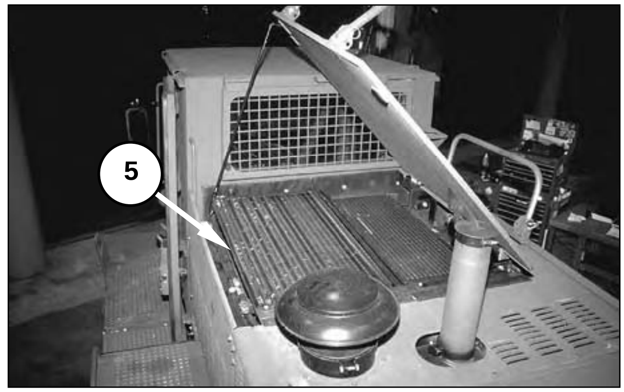


Right Side of Engine.
(1) Compressor. (2) Pressure switch. (3) Clutch and clutch solenoid. (4) Pressure relief valve.

Compressor (1) is located on the right side of the engine. The compressor increases the pressure of the gas in the air-conditioning system.

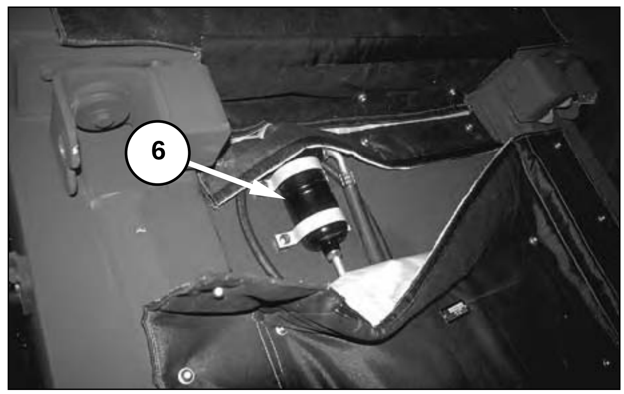
Pressure switch (2) is attached to compressor (1). The pressure switch monitors the pressure in the system to control activation of clutch solenoid (3). The clutch solenoid engages the clutch to activate the compressor.

Pressure relief valve (4) limits the maximum pressure in the air-conditioning circuit to 3800 ± 300 kPa (550 ± 43 psi).



Under Radiator Guard.
(5) Condenser coil.

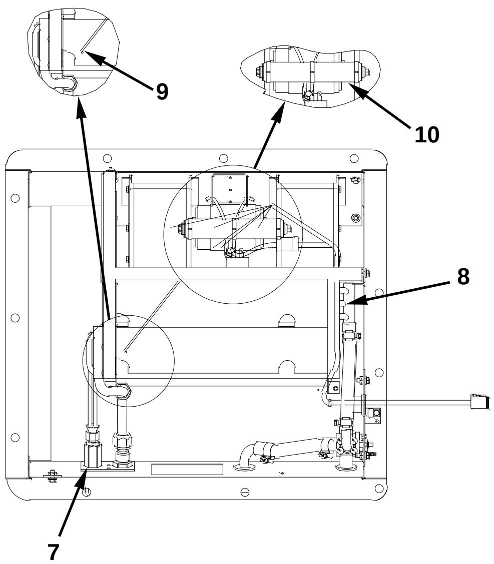
Condenser coil (5) is under the radiator guard. The condenser coil changes the refrigerant from a gas to a liquid by removing heat from the refrigerant.



Behind Cab, Left Side of Machine.
(6) Accumulator.

Accumulator (6) is located behind the cab. The accumulator separates liquid refrigerant from the circuit and acts as a storage area for a small amount of liquid refrigerant. The accumulator contains a desiccant which removes moisture from the system.

View of Air-Conditioning Unit in Cab (arrow).

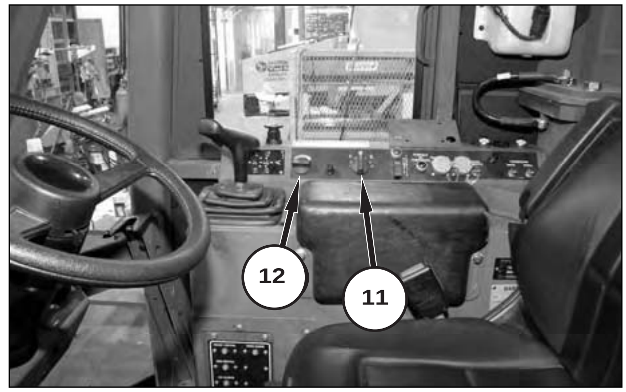


View of Inside Air-Conditioning Unit.
(7) Orifice tube assembly. (8) Evaporator coil. (9) Capillary tube and freeze control switch. (10) Resistor.

Orifice tube assembly (7) is located in the inlet line of evaporator coil (8). The evaporator coil changes the refrigerant from a liquid to a gas by adding heat to the refrigerant. The orifice tube meters the flow of refrigerant between the high and low pressure sides of the system.

Capillary tube and freeze control switch (9) prevent the condensation formed on evaporator coil (8) from freezing by monitoring the temperature of the air flowing through the evaporator coil. The freeze control switch is a nonadjustable thermostat. The capillary tube is the probe for the freeze control switch. If the air temperature falls below -1.1°C (30°F), the freeze control switch interrupts the electrical signal which energizes the compressor clutch solenoid. This prevents the compressor from operating. When the temperature of the air flowing through the evaporator coil raises to 2.2°C (36°F), the freeze control switch closes, allowing the compressor to operate.

Resistor (10) controls the blower motor speed by decreasing the voltage available at the blower motor. The voltage drop across the resistor depends on the position of the blower switch in the cab. The resistor provides a maximum of two voltage drops, giving a total of three blower speeds.



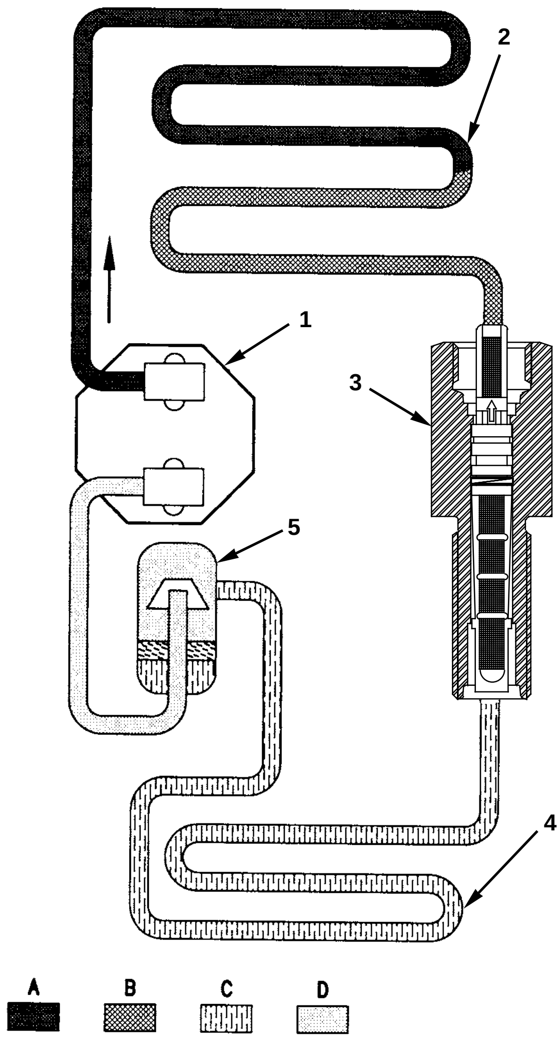
Console to Right of Operator's Seat.
(11) Blower switch. (12) Thermostat control knob.

Blower switch (11) and thermostat control knob (12) are in the console, to the right of the operator's seat. The blower switch controls the blower for the heat and air-conditioning systems. The blower operates in three speeds for both the heating system and the air-conditioning system.

Thermostat control knob (12) operates a ball valve in the heater coil. The position of the thermostat control knob controls the amount of coolant allowed through the heater coil. Heated air from the heating system combines with cool air from the air-conditioning system to control the temperature of the air flowing into the cab through the air conditioner vents.

Air-Conditioning System Operation

NOTE: For information about the electrical operation of the air-conditioning system, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* "Systems Operation, Blower, Air Conditioner and Washer and Wiper Circuit."



Refrigerant Flow Through Air-Conditioning System.
(1) Compressor. (2) Condenser coil. (3) Orifice tube assembly.
(4) Evaporator coil. (5) Accumulator.
(A) Refrigerant as a high pressure, high temperature gas.
(B) Refrigerant as a high pressure, high temperature liquid.
(C) Refrigerant as a low pressure, low temperature liquid.
(D) Refrigerant as a low pressure, low temperature gas.

Compressor (1) generates the flow of refrigerant through the air-conditioning system. The primary purpose of the compressor is to change the refrigerant from a low pressure, low temperature vapor to a high pressure, high temperature vapor. As the compressor pumps refrigerant, the pressure in the system increases. The increased pressure causes the refrigerant temperature to rise.

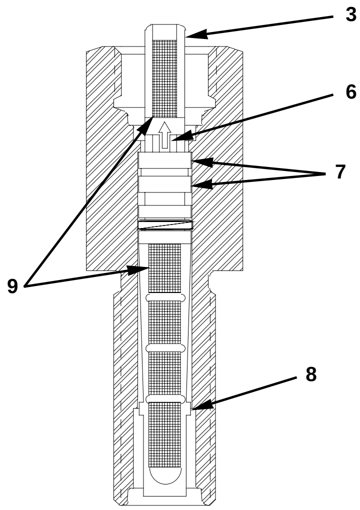
Refrigerant leaves compressor (1) as a high pressure, high temperature gas. As the refrigerant flows through condenser coil (2), the latent heat of condensation is removed from the refrigerant. This changes the refrigerant from a high temperature, high pressure vapor to a high pressure, high temperature liquid. The heat removed from the refrigerant is transferred to the air through the fins of the condenser coil.

Refrigerant, as a high pressure, high temperature liquid, flows from condenser coil (2) to orifice tube assembly (3). The orifice tube assembly creates a decrease in the downstream pressure of the refrigerant, causing the refrigerant which reaches evaporator coil (4) to be a low pressure, low temperature liquid.

Evaporator coil (4) collects the latent heat of evaporation from the refrigerant by transferring heat from air in the cab to the refrigerant, as the refrigerant flows through the evaporator coil. This action cools the air from the cab. The blower recirculates the cold air into the cab.

Refrigerant leaves evaporator coil (4) after absorbing heat from the cab air and enters accumulator (5) as a low pressure, low temperature gas. The accumulator separates the liquid refrigerant from the gaseous refrigerant and stores the liquid. The accumulator contains desiccant which removes moisture from the refrigerant.

Orifice Tube



View of Orifice Tube Assembly.
(3) Orifice tube assembly. (6) Orifice (brass) tube. (7) O-ring seals. (8) Tab. (9) Screens.

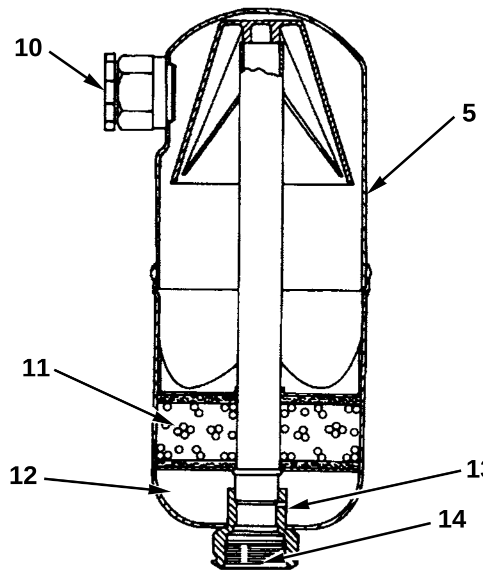
Orifice tube assembly (3) consists of a plastic body, screens (9), and a small, brass orifice tube (6) which runs down the center of the body. Two O-rings (7) seal against leakage.

NOTE: The parts inside orifice tube assembly (3) are not serviceable. If a component inside the orifice tube assembly is damaged, the entire assembly must be replaced.

Orifice tube assembly (3) changes the high temperature, high pressure refrigerant liquid to a low pressure, low temperature liquid. Orifice tube (6) creates a restriction which allows the high pressure liquid to be reduced to a low pressure liquid. However, the flow rate control is determined by pressure differences across the orifice and by subcooling. The flow rate is more sensitive to subcooling than to pressure differences.

NOTE: Subcooling is the additional cooling of the refrigerant in the bottom of the condenser after the refrigerant has changed from vapor to liquid.

Accumulator



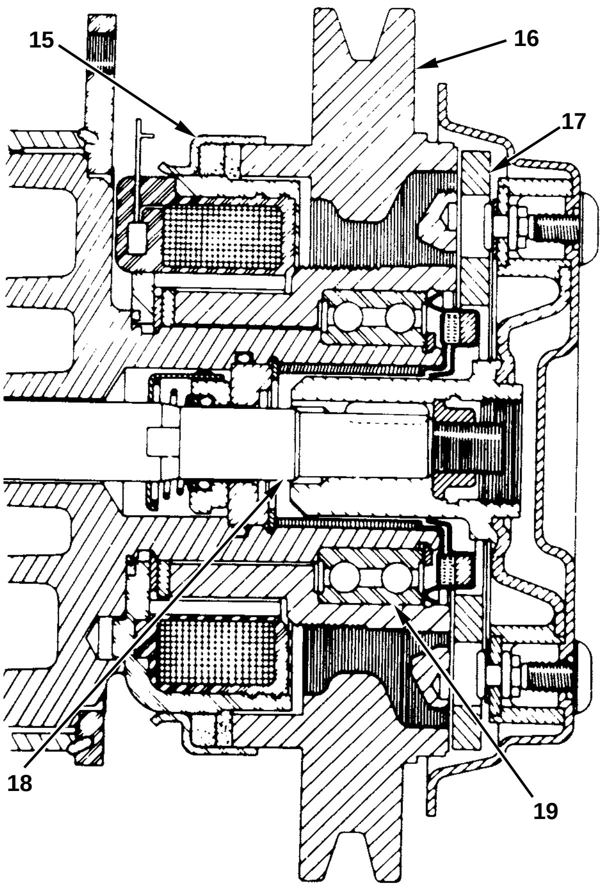
View of Accumulator.
(5) Accumulator. (10) Inlet. (11) Desiccant. (12) Liquid refrigerant and refrigerant oil. (13) Refrigerant oil bleed hole. (14) Outlet.

Accumulator (5) is located at the back of the cab. The accumulator's primary function is to separate vapor from the refrigerant liquid that has passed through the evaporator coil. The accumulator retains the separated liquid and releases the vapor to compressor (1).

Refrigerant oil bleed hole (13) is located in the bottom of accumulator (5). The refrigerant oil bleed hole bleeds separated oil, and some liquid refrigerant, to compressor (1). Thus, the flow out of the accumulator to the compressor is mostly vapor with some liquid refrigerant from the refrigerant oil bleed hole.

Desiccant (11) in the base of accumulator (5) collects moisture.

Air-Conditioning System Compressor



Magnetic Clutch.
(15) Coil assembly. (16) Clutch and pulley assembly. (17) Drive plate. (18) Compressor shaft. (19) Bearing.

The engine crank shaft drives compressor (1) through a belt around clutch and pulley assembly (16) on the magnetic clutch. Drive plate (17) is fastened to the shaft of the compressor. The clutch and pulley assembly turns on bearing (19) and is not connected to compressor shaft (18). The electric current from the thermostat causes a magnetic field in coil assembly (15).

The magnetic field pulls drive plate (17) against clutch and pulley assembly (16). The clutch and pulley assembly then turns compressor shaft (18) to operate the compressor. When the current to coil assembly (15) stops, the magnetic field is removed. This allows the drive plate to move away from the clutch and pulley assembly, permitting the assembly to turn freely on bearing (19).

The sequence of connecting and disconnecting the pulley to and from compressor shaft (18) is called "compressor cycling." Compressor cycling is controlled by the freeze control switch. The freeze control switch is controlled by a capillary tube, which is installed between the fins of evaporator coil (4).

Engine Coolant Heater

Safety Considerations

Improper use of the engine coolant heater (also referred to as “the heater”) can create a fire or cause an explosion. To guard against fire and/or explosions:

- Do not operate the engine coolant heater while refueling the machine.
- Do not place any combustible or heat sensitive material within 50.8 mm (2 in) of the heater’s exhaust system.
- Routinely inspect the fuel delivery system for leaks. Repair all leaks before operating the heater.

Operation of the heater produces harmful vapors which represent an asphyxiation hazard. To guard against asphyxiation:

- Do not operate the heater in an enclosed space.
- Ensure that no exhaust fumes enter the operator’s compartment.

Exhaust components can be extremely hot. Do not touch the exhaust components until the parts are cool.

To function properly, the heater requires engine coolant with a specific mix of water and antifreeze. Refer to *Operator’s Manual, Deployable Universal Combat Earthmover (DEUCE)*, “Maintenance Section, Cooling System Specifications,” for the antifreeze specifications.

NOTICE

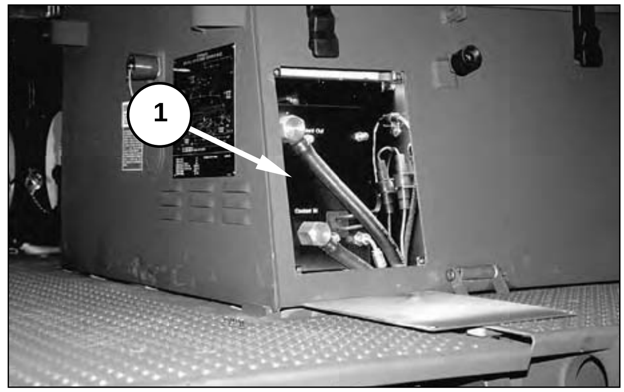
The engine coolant heater should be run for a minimum of 15 minutes, at least once every month.

Operating the heater with slushy or frozen coolant can cause pressure to build in the coolant circulation system. Increased pressure in the system can cause hoses to burst and/or separate at the connection points.

⚠ WARNING

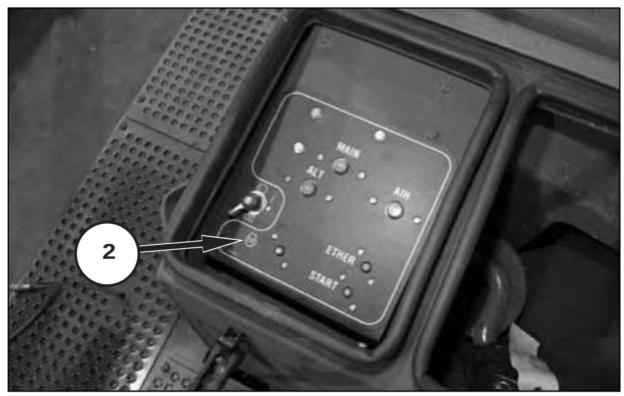
Failure to use the heater properly can result in injury or death. Read and understand all safety information in this module and in the *Operator’s Manual, Deployable Universal Combat Earthmover (DEUCE)*, “Safety,” before operating the heater.

Component Location



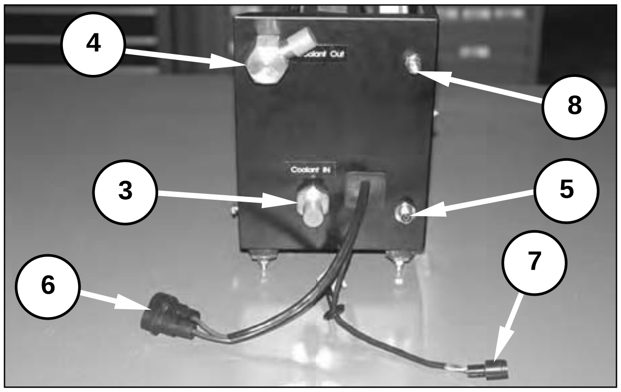
Rear of Machine, Cover Removed.
(1) Engine coolant heater.

Engine coolant heater (1) is in the far left compartment, at the rear of the machine (under the rear circuit breaker panel). The heater is a fuel-fired, computer-controlled unit which heats the engine coolant to assist with cold weather starting. The heater unit is a self-contained unit with most components assembled inside the heater box.



Circuit Breaker Panel, Rear of Machine, Far Left Compartment.
(2) Engine coolant heater circuit breaker.

Engine coolant heater circuit breaker (2), located in the rear circuit breaker panel, is part of the machine’s electrical system. The engine coolant heater circuit breaker is one of the two circuit breakers in the engine coolant heater circuit. This manual reset breaker is rated at 30 amps.

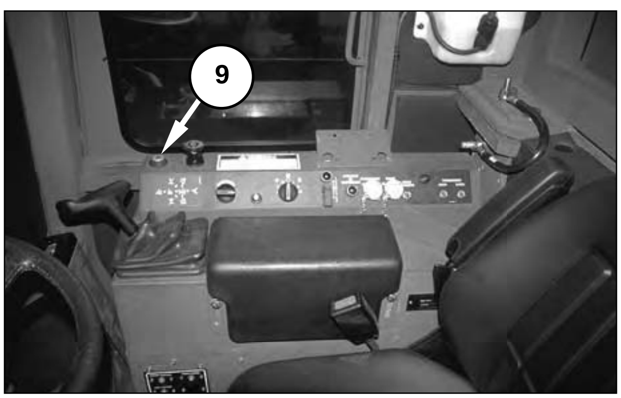


Engine Coolant Heater Box, Removed From Machine.
(3) Coolant inlet. (4) Coolant outlet. (5) Fuel inlet. (6) Power input connectors. (7) Control switch connector. (8) Main circuit breaker.

The heater draws coolant from the engine block through coolant inlet (3). After the heater warms the coolant, the coolant returns to the engine through coolant outlet (4). The heater receives fuel from the fuel tank through fuel inlet (5).

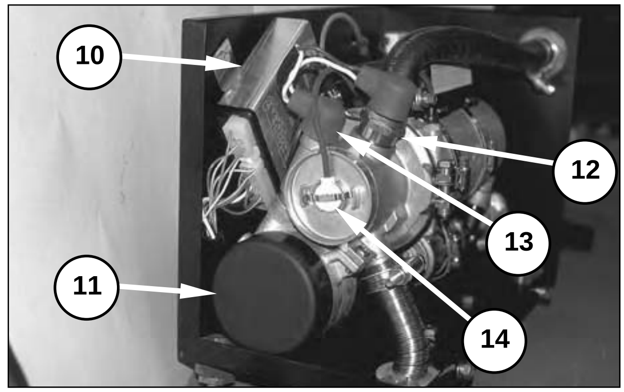
Power from the batteries reaches the heater through power input connectors (6). Input from engine coolant heater switch (9) (below) in the cab reaches the heater through control switch connector (7).

Main circuit breaker (8) is part of the heater unit. The main circuit breaker is rated at 25 amps and is one of two circuit breakers in the engine coolant heater circuit.



Console to Right of Operator.
(9) Engine coolant heater switch.

Engine coolant heater switch (9) activates and/or deactivates the heater. The switch is in the console to the right of the operator, inside the cab. A light in the switch illuminates when the heater is in operation.



Engine Coolant Heater Box, Removed From Machine.
(10) Heater control unit. (11) Blower. (12) Glow plug. (13) Series resistor. (14) Flame sensor.

Heater control unit (10) is the computer which controls the operation of the engine coolant heater. Sensors and switches in the heater send input signals to and receive output signals from the heater control unit. The input components monitor the heater's condition and send electrical signals to the heater control unit. This unit compares the input signals with information stored in its memory and then generates an output signal to match current heater conditions.

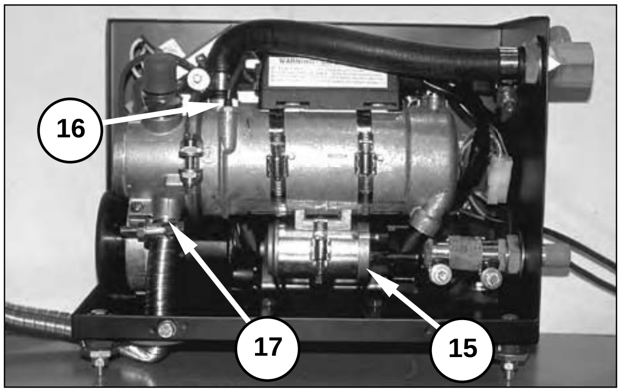
NOTICE

Heater control unit (10) must be disconnected before any electrical welding is done on the machine. Welding while the heater control unit is connected can damage the unit.

Blower (11) provides air to the combustion chamber. When energized, glow plug (12) heats the combustion chamber to ignite the fuel in the chamber. Series resistor (13) reduces the voltage reaching the glow plug to 12 volts.

Flame sensor (14) detects whether the fuel inside the combustion chamber has ignited. When the fuel is lit, the flame sensor sends an electrical signal to heater control unit (10), and the heater control unit de-energizes glow plug (12). If the fuel does not ignite, or if the flame extinguishes during operation, the control unit either attempts to restart the heater or turns the heater off, depending on the current condition.

To ensure that no residual fuel remains in the combustion chamber, heater control unit (10) energizes glow plug (12) for 15 seconds and operates the blower for three minutes after engine coolant heater switch (9) is moved to the OFF position.

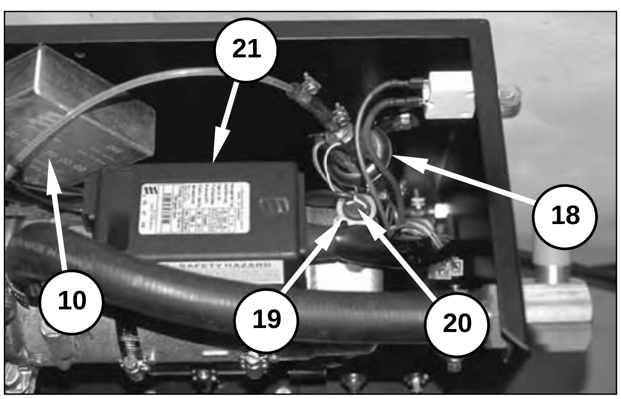


Engine Coolant Heater Box, Removed From Machine.
(15) Coolant pump. (16) Temperature sensor. (17) Exhaust port.

Coolant pump (15) circulates coolant through the heater. To cool the heater, heater control unit (10) continues to operate the coolant pump for three minutes after engine coolant heater switch (9) is moved to the OFF position.

Temperature sensor (16) monitors the temperature of the coolant flowing out of the heater. The temperature sensor sends an input signal to heater control unit (10). When the coolant temperature is below 90°C (194°F), the heater control unit operates the heater in high heat mode. When the temperature of the coolant is above 90°C (194°F), the heater control unit operates the heater in low heat mode. During operation in low heat mode, if the coolant temperature drops to 80°C (176°F), the heater control unit returns the heater to high heat mode.

Exhaust gasses are removed from the heater through exhaust port (17).



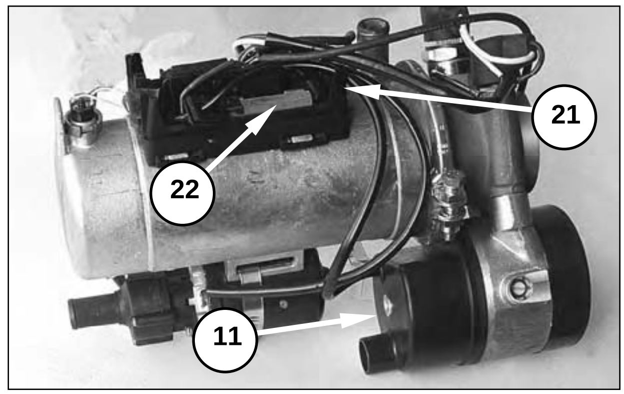
Engine Coolant Heater Box, Removed From Machine.
(10) Heater control unit. (18) Fuel pump. (19) Thermal cut out switch. (20) Reset button. (21) Twelve-pin connector.

Fuel pump (18) supplies fuel to the heater. Heater control unit (10) does not operate the fuel pump until glow plug (12) has preheated the combustion chamber.

Thermal cut out switch (19) prevents the coolant from overheating. The thermal cut out switch sends an input signal to heater control unit (10). If the coolant temperature reaches 94°C (201°F), the thermal cut out switch opens, and the heater control unit discontinues fuel delivery to the combustion chamber.

Thermal cut out switch (19) has reset button (20) in the center of the switch. If the coolant temperature reaches 135 ± 13.5°C (275 ± 27.5°F), the switch must be manually reset.

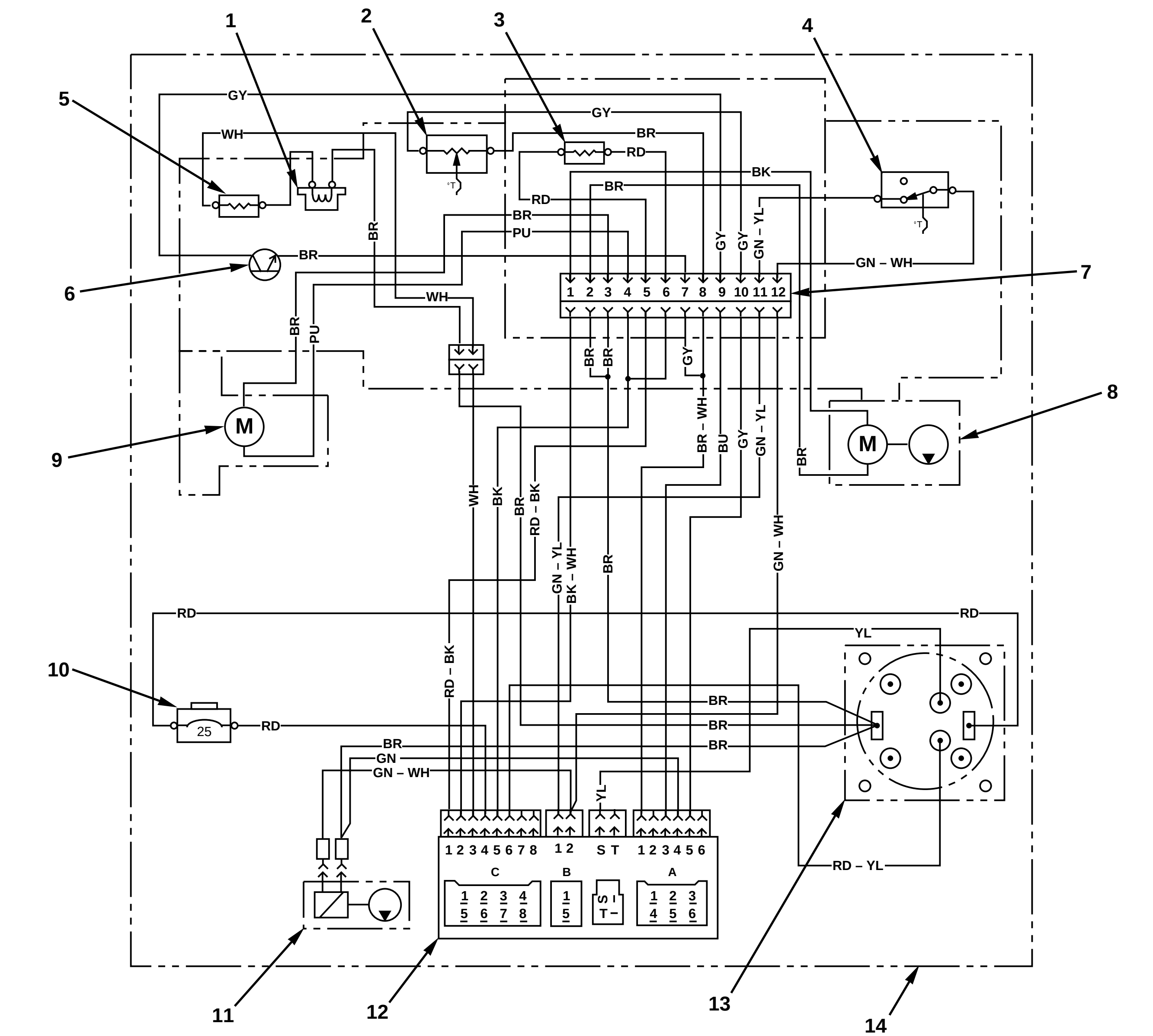
Twelve-pin connector (21) consolidates the wiring from the heater electrical components into a single wiring harness which connects to heater control unit (10).



Engine Coolant Heater, Removed From Box.
(11) Blower. (21) Twelve-pin connector. (22) Partial load resistor.

Partial load resistor (22) is located under the cover of twelve-pin connector (21). Heater control unit (10) routes the power for blower (11) and fuel pump (18) through the partial load resistor, when the heater is operating in low heat mode. The partial load resistor creates a voltage drop in the circuit, which causes the blower to operate at a lower speed, and the fuel pump to deliver less fuel to the heater.

System Operation

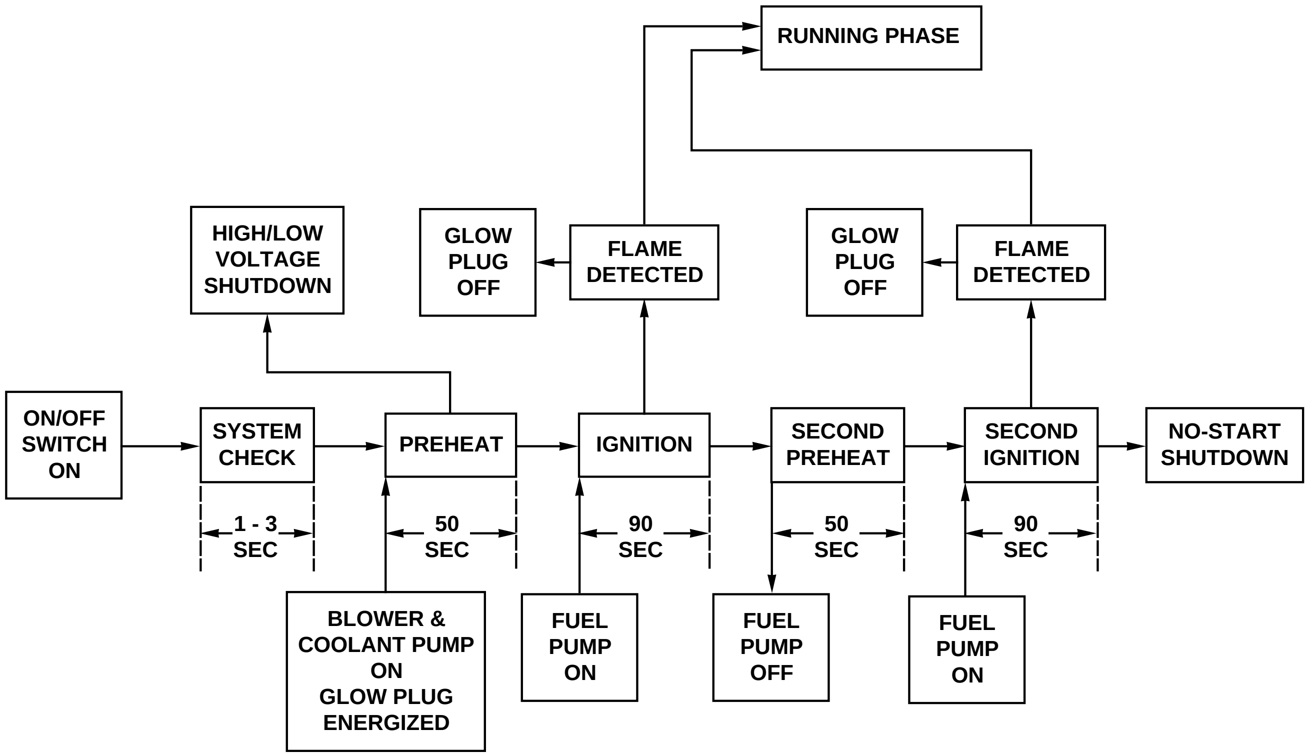


Engine Coolant Heater Electrical Schematic.
(1) Glow plug. (2) Temperature sensor. (3) Partial load resistor. (4) Thermal cut out switch. (5) Series resistor. (6) Flame sensor. (7) Twelve-pin connector. (8) Coolant pump. (9) Blower. (10) Main circuit breaker. (11) Fuel pump. (12) Heater control unit. (13) Power input and control switch connector. (14) Engine coolant heater box.

NOTE: The engine coolant heater electrical schematic shows the wiring inside engine coolant heater box (14). The wiring inside the heater box does not follow the Caterpillar corporate wiring system.

NOTE: The positive line from the batteries (RD-00 wire) is connected at pin 15 of power input and control switch connector (13); the negative battery line (200-BK) connects to pin 1. The three wires from the engine coolant heater switch, in the cab, connect to pin 1 (103-BR wire), pin 11 (102-RD wire), and pin 13 (104-YL wire) of connector (13). For more information about the machine's electrical system, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System*.

Starting Phase



Operational Flow Chart, Starting Phase.

When the engine coolant heater switch in the cab is moved to the ON position, heater control unit (12) initiates the system check. During the system check, the heater control unit ensures that the coolant temperature is below the thermal cut out setting and that the heater's electrical circuits are complete. The system check requires one to three seconds to complete. If the starting conditions are met, the heater control unit begins the preheat phase.

In the preheat phase, heater control unit (12) switches blower (9) and coolant pump (8) on, and energizes glow plug (1). The glow plug preheats the combustion chamber. The preheat phase requires approximately 50 seconds to complete.

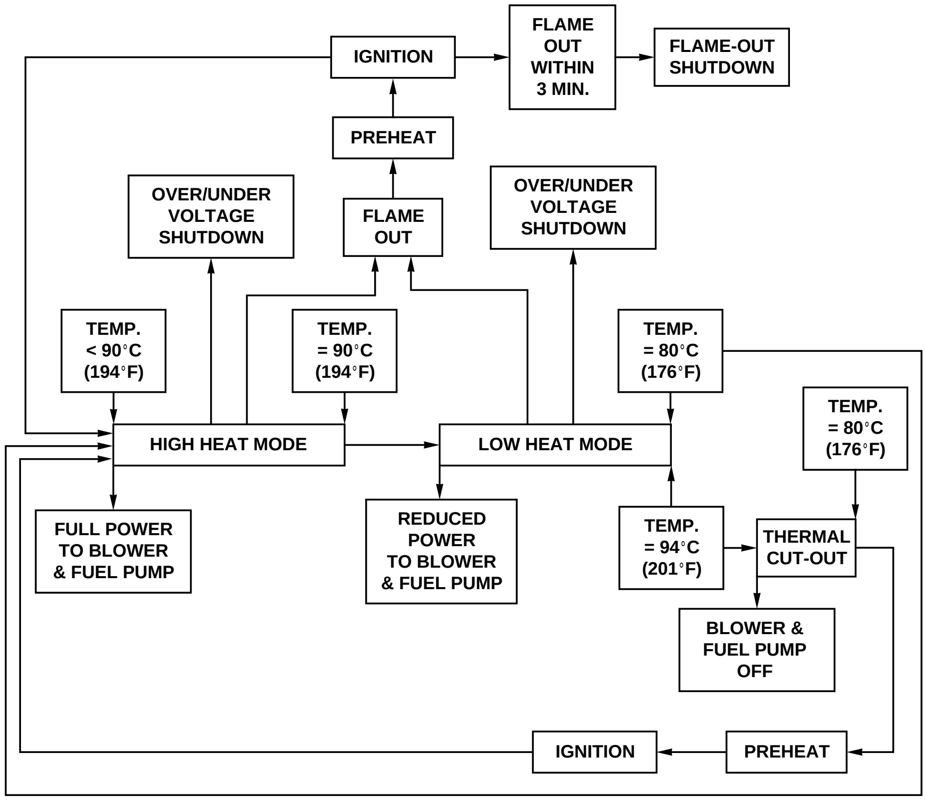
During the preheat phase, heater control unit (12) monitors the battery supply voltage. If the supply voltage drops below 20.0 volts or rises above 28.0 volts, the heater control unit initiates the preheat high or low voltage shutdown sequence.

After a successful preheat phase, heater control unit (12) begins the ignition phase. During this phase, the heater control unit switches fuel pump (11) on. The fuel pump delivers fuel to the combustion chamber. When the fuel in the combustion chamber ignites, flame sensor (6) signals the heater control unit. The heater control unit then de-energizes glow plug (1), and the heater enters the running phase. If the fuel does not ignite within 90 seconds from the beginning of the ignition phase, the heater control unit initiates a second preheat phase.

At the start of the second preheat phase, heater control unit (12) switches fuel pump (11) off. Blower (9) and coolant pump (8) remain on, and glow plug (1) remains energized during the second preheat phase. The second preheat phase continues for 50 seconds before the heater control unit initiates a second ignition phase.

During the second ignition phase, heater control unit (12) switches fuel pump (11) on. Flame sensor (6) signals the heater control unit when the fuel in the combustion chamber ignites. If the fuel ignites, the heater control unit de-energizes glow plug (1), and the heater enters the running phase. If, after 90 seconds, the fuel does not ignite, the control unit initiates the no-start shutdown sequence.

Running Phase



Operational Flow Chart, Running Phase.

The heater enters the running phase after completing a successful starting phase. During the running phase, heater control unit (12) operates coolant pump (8), blower (9), and fuel pump (11). The heater control unit constantly monitors the coolant temperature through temperature sensor (2).

While the coolant temperature is less than 90°C (194°F), heater control unit (12) operates the heater in high heat mode. During high heat mode, blower (9) provides more air, and fuel pump (11) provides more fuel, to the combustion chamber. Once the coolant temperature reaches 90°C (194°F), the heater control unit switches the heater to low heat mode.

In low heat mode, heater control unit (12) routes power going to blower (9) and fuel pump (11) through partial load resistor (3). The partial load resistor reduces the voltage available at the blower and fuel pump, causing the blower to supply less air and the fuel pump to deliver less fuel to the combustion chamber. Therefore, in low heat mode, the flame is reduced and the heater produces less heat. If the temperature of the coolant falls to 80°C (176°F,) while the heater is operating in low heat mode, the heater control unit returns the heater to high heat mode.

If, at any time, the temperature of the coolant rises to 94°C (201°F), thermal cut out switch (4) opens, prompting heater control unit (12) to switch blower (9) and fuel pump (11) off. Coolant pump (8) continues to operate and temperature sensor (2) continues to monitor the coolant temperature. When the coolant falls to 80°C (176°F), the heater control unit restarts the heater and operates the heater in high heat mode.

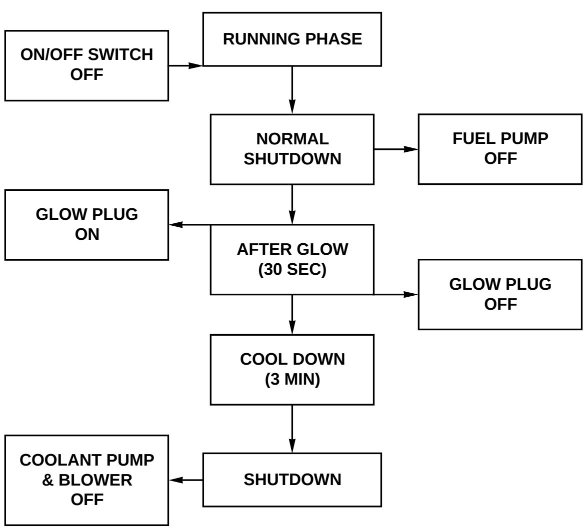
During operation in either high heat or low heat mode, if flame sensor (6) detects that the flame has gone out, heater control unit (12) will attempt to restart the heater one time. If the attempt is successful, the heater will resume operation in the mode which matches the current heater conditions. If the restart attempt is not successful, or if the attempt is successful but the flame goes out again within three minutes after the flame re-ignites, the heater control unit initiates the flameout shutdown sequence.

During the running phase, heater control unit (12) monitors the battery supply voltage. If the supply voltage drops below 20.0 volts, or rises above 28.0 volts and remains there for more than 20 seconds, the heater control unit initiates the high or low voltage shutdown sequence.

Shutdown Phase

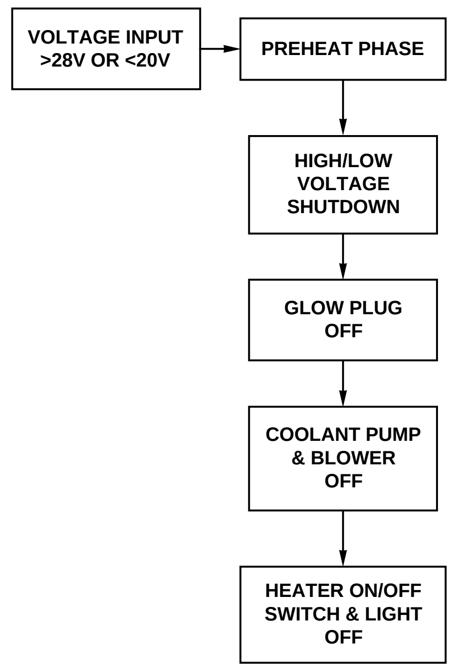
Heater control unit (12) initiates the shutdown phase in several situations:

- Normal shutdown occurs when the engine coolant heater switch in the cab is moved to the OFF position.
- Preheating high or low voltage shutdown occurs when supply voltage drops below 20.0 volts or rises above 28.0 volts during the preheat sequence in the starting phase.
- High or low voltage shutdown occurs when supply voltage drops below 20.0 volts or rises above 28.0 volts during the running phase, and remains there for more than 20 seconds.
- No-start shutdown occurs when the fuel does not ignite after 90 seconds during the second ignition phase.
- Flameout shutdown occurs if the restart attempt (after the flame has gone out) is not successful, or if the attempt is successful but the flame goes out again within three minutes of re-igniting.



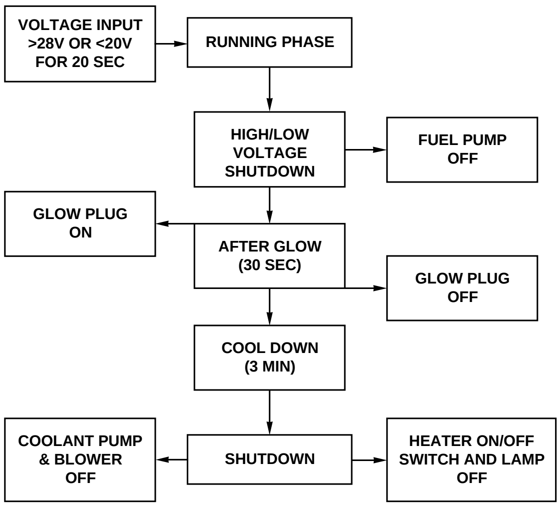
Operational Flow Chart, Normal Shutdown.

During the normal shutdown sequence, heater control unit (12) discontinues the operation of fuel pump (11). Coolant pump (8) and blower (9) remain on, and the heater control unit energizes glow plug (1) for 30 seconds to ignite the residual fuel in the combustion chamber. After 30 seconds elapse, the heater control unit de-energizes the glow plug. The coolant pump and blower remain on for a three-minute cool-down phase. After three minutes, the heater control unit stops the blower and coolant pump, and also turns off the light in the engine coolant heater switch, in the cab.



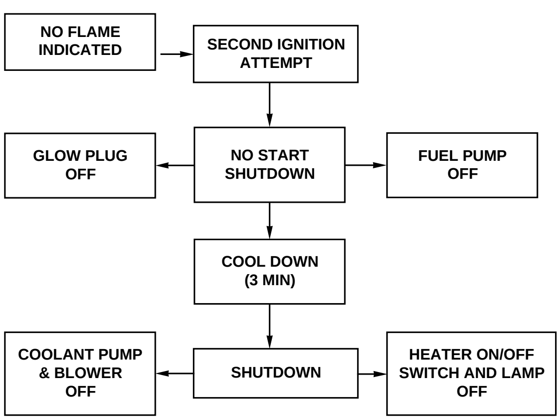
Operational Flow Chart, Preheat High or low Voltage Shutdown.

During the preheating high or low voltage shutdown sequence, heater control unit (12) de-energizes glow plug (1), switches coolant pump (8) and blower (9) off, and moves the engine coolant heater switch (in the cab) to the OFF position.



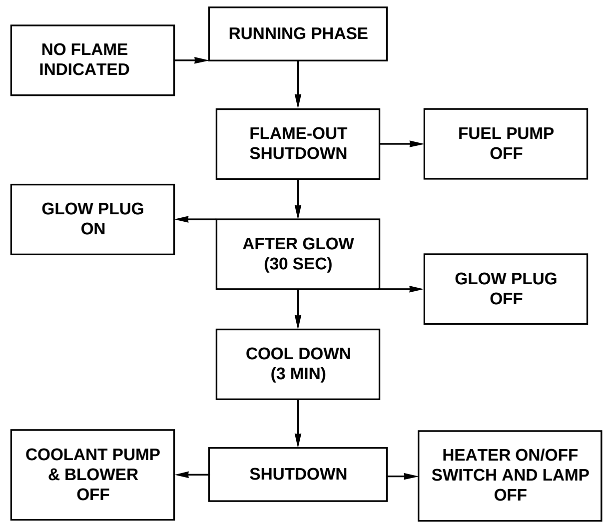
Operational Flow Chart, High or low Voltage Shutdown.

The high or low voltage shutdown sequence is the same as the normal shutdown sequence, except that the initiation of this shutdown sequence occurs when the voltage supply remains above 28.0 volts or below 20.0 volts for more than 20 seconds during heater operation.



Operational Flow Chart, No-Start Shutdown.

During the no-start shutdown sequence, heater control unit (12) switches fuel pump (11) off and de-energizes glow plug (1). Blower (9) and coolant pump (8) remain on for a three-minute cool-down phase. After three minutes, the heater control unit switches the blower and coolant pump off and also switches the engine coolant heater switch (in the cab) to the OFF position.



Operational Flow Chart, Flame-Out Shutdown.

The flameout shutdown sequence is the same as the normal shutdown sequence, except that the initiation of this shutdown sequence occurs when the flame sensor determines that the flame has extinguished during normal operation.

Testing and Adjusting

Troubleshooting the Air-Conditioning System

False Compressor Seizure

Tools Needed	
Part No.	**Description**
1U-8085	Vented Safety Glasses
1U-8590	Spanner Wrench

An air-conditioning compressor which has been unused for an extended period may experience slipping or broken air-conditioning drive belts, or scored clutch surfaces on initial start up. These problems indicate a seized compressor. However, replacement of the compressor may not be necessary.

During extended periods of inoperation, changes in temperature cause the refrigerant in the air-conditioning compressor to expand and contract. Lubricating oil carried by the refrigerant then tends to migrate from highly polished surfaces in the compressor. Without lubricating oil, these polished surfaces "wring" together and appear to be seized.

Before investing time and money in an overhaul, use the following checklist to determine if the compressor is actually seized:

1. With the spanner wrench on the clutch drive plate, rock the shaft in the opposite direction of normal rotation.

2. After breaking the compressor loose, rotate the compressor counterclockwise at least three complete turns.

3. Start the engine and operate the compressor for a minimum of one minute.

This procedure will not affect a compressor that is actually seized, but should be attempted before a compressor known to be idle for a month or longer is replaced.

Quick Check Procedures for the Air-Conditioning System

NOTE: This procedure does not call for the installation of the manifold gauge set. The procedure should only be used to indicate the actual system condition. For detailed troubleshooting procedures, refer to “Problem Solving for the Air-Conditioning System,” in this section.

NOTE: Ambient temperature (outside air) should be 21°C (70°F) or above when this procedure is used.

NOTE: This procedure requires that the machine be operated. Refer to *Operator’s Manual, Deployable Universal Combat Earthmover (DEUCE)* for information about machine operation.

1. Start the engine and run it at approximately 1000 rpm. Move the control knob to the MAXIMUM COOL position. Put the fan switch into HIGH position. Operate for a minimum of 10 minutes, to stabilize the system. Operate the engine at low idle.

2. Check for restrictions in the refrigerant lines which lead from the compressor to the orifice tube. The refrigerant lines and components from the outlet (discharge) side of the compressor to the inlet of the orifice tube are considered the high pressure, high temperature side of the system. The outlet (discharge) side will be warm during normal operation. Frost, or a drop in the temperature in a line or component on the high pressure side may indicate a restriction or blockage to refrigerant flow.

- If there is no evidence of a restriction in the condenser coil, the orifice tube, or refrigerant lines from the compressor to the orifice tube, go to Step 3.

- If a restriction is present in the condenser coil, the orifice tube, or refrigerant lines from the compressor to the orifice tube:

  a. Recover the refrigerant. Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Recovering the Refrigerant,” in this module.

  b. Remove the restriction or replace the component.

  c. Evacuate the system. Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Evacuating the System,” in this module.

  d. Charge the system with the correct amount of refrigerant. Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Charging the Air-Conditioning System,” in this module.

e. Do a leak test. Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting, Leak Test,” in this module.

f. Do a performance check. Refer to “Testing and Adjusting, Troubleshooting the Air-Conditioning System, Performance Checks for the Air-Conditioning System,” in this module.

3. If a low system charge is indicated, do a leak test. Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Leak Test,” in this module.

NOTE: If the system is very low on refrigerant, a partial charge may be needed before a leak test is performed.

• If no leaks are found in the system, go to Step 4.

• If leaks are found in the system:

a. Recover the remaining refrigerant. Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Recovering the Refrigerant,” in this module.

b. Repair all leaks.

c. Evacuate the system. Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Evacuating the System,” in this module.

d. Charge the system with the correct amount of refrigerant. Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Charging the Air-Conditioning System,” in this module.

e. Do a performance check. Refer to “Testing and Adjusting, Troubleshooting the Air-Conditioning System, Performance Checks for the Air-Conditioning System,” in this module.

4. Feel the low (suction) and high (discharge) pressure refrigerant lines at the compressor. The high pressure line to the condenser coil must be warm (hot), while the low pressure line from the evaporator coil must be cool (cold) to indicate normal system operation.

• If there is little or no temperature difference between the high and low pressure lines at the compressor, go to Step 5.

• If there is a definite temperature difference on the high and low pressure lines at the compressor, indicating correct system operation (high pressure, warm) (low pressure, cool), go to Step 6.

5. If the system is empty, or nearly empty, of refrigerant charge:

a. Stop the engine.

b. Do a partial charge of the system. Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Charging the Air-Conditioning System,” in this module.

c. Do a leak test. Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Leak Test,” in this module.

d. Repair leaks.

e. Evacuate the system. Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Evacuating the System,” in this module.

f. Charge the system with the correct amount of refrigerant. Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Charging the Air-Conditioning System,” in this module.

g. Do a performance check. Refer to “Testing and Adjusting, Troubleshooting the Air-Conditioning System, Performance Checks for the Air-Conditioning System,” in this module.

6. A system overcharge is possible, even though a definite temperature difference was felt at the low and high pressure lines.

a. Recover the refrigerant. Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Recovering the Refrigerant,” in this module.

b. Evacuate the system. Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Evacuating the System,” in this module.

c. Charge the system with the correct amount of refrigerant. Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Charging the Air-Conditioning System,” in this module.

d. Do a performance check. Refer to “Testing and Adjusting, Troubleshooting the Air-Conditioning System, Performance Checks for the Air-Conditioning System,” in this module.

7. Feel the accumulator inlet and outlet. If both are cool, the system is charged correctly. If the outlet is warmer than the inlet, the system may not contain enough refrigerant.

a. Recover the refrigerant. Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Recovering the Refrigerant,” in this module.

b. Evacuate the system. Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Evacuating the System,” in this module.

c. Charge the system with the correct amount of refrigerant. Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Charging the Air-Conditioning System,” in this module.

d. Perform a leak test. Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Leak Test,” in this module.

e. Do a performance check. Refer to “Testing and Adjusting, Troubleshooting the Air-Conditioning System, Performance Checks for the Air-Conditioning System,” in this module.

Performance Checks for the Air-Conditioning System

A performance check of the air-conditioning system must be made with a manifold gauge set connected to the service ports on the compressor.

NOTE: Before doing a performance check, these important items should be checked:

1. Check the condenser and evaporator for any type of restriction that will hamper air flow such as: dirt, bugs, plastic bags, etc. A clean condenser will lead to improved compressor life.

2. Check for a loose belt on the compressor.

3. Clean the fresh air and recirculation filters.

4. Check the evaporator condensate drain tube for restrictions.

NOTE: Refer to “Systems Operation, Air-Conditioning and Heating Systems, Safety Requirements” in this module before performing service work on the air-conditioning system.

5. Install the manifold gauge set as indicated in “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Installing the Manifold Gauge Set,” in this module.

6. Start and operate the engine at approximately 1000 rpm. Move the temperature control knob to the MAXIMUM COOL position. Put the fan switch into HIGH position, on the air conditioner side. Operate the system for a minimum of ten minutes to stabilize the system. Operate the engine at low idle.

During normal operation of the air-conditioning system, on a 21°C (70°F) day, the discharge pressure will be 820 to 1300 kPa (120 to 190 psi). The suction pressure will be 70 to 130 kPa (10 to 20 psi). Refer to the “Approximate Test Pressure” chart in “Testing and Adjusting, Troubleshooting the Air-Conditioning System, Problem Solving for the Air-Conditioning System,” in this module. The outside (ambient) temperature will affect the pressures (the higher the temperature, the higher the pressure).

On very hot days, the suction and discharge pressures will both be high. On cooler days, the suction pressure will be normal to low, and the discharge pressure will be low.

If suction and discharge pressures are not within the normal operating ranges, refer to “Testing and Adjusting, Troubleshooting the Air-Conditioning System, Problem Solving for the Air-Conditioning System,” in this module.

Problem Solving for the Air-Conditioning System

The following section aids in the identifications and correction of problems that may occur in the air-conditioning system. Since several problems have the same or a similar system condition, complete the diagnosis before starting the correction procedure.

To diagnose and correct problems, the manifold gauge set must be installed. The refrigerant lines will indicate problems with temperature differences from the high pressure side to the low pressure side, or cold spots (frost) in a line. The temperature of the air flowing from the evaporator will also indicate system problems. The condition of the entire system must be determined before a correct diagnosis can be made.

NOTE: Some of the procedures in this section require that the machine be operated. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE)* for information about machine operation.

Air Conditioning Problem List

Electrical System Problems

Heating System Problems

Refrigerant Circuit Problems

Problem Solving Procedure

1. Install the manifold gauge set as indicated in "Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Installing the Manifold Gauge Set," in this module.

2. Run the engine at 1000 rpm. Put the air conditioner temperature control knob into the MAXIMUM COOL position, and the fan switch into HIGH position, on the air conditioner side. Operate the engine for a minimum of ten minutes, to stabilize the system.

3. Adjust the engine speed to approximately 1300 to 1400 rpm. Make a note of the readings on the low pressure (suction) and high pressure (discharge) gauges. Gauge readings will be a partial indication of the system condition.

NOTE: A low pressure gauge reading of 70 to 138 kPa (10 to 20 psi) and a high pressure gauge reading of 820 to 1300 kPa (120 to 190 psi) are considered normal operating pressures for the air-conditioning system when the ambient (outside) temperature is above 21°C (70°F). On very hot days, the low and high pressure readings will be at the high end of the normal operating range. On cooler days, the low pressure reading will be in the middle to low end of the normal operating range, and the high pressure reading will be low. For correct gauge readings in relationship to outside air temperature, refer to the following "Approximate Test Pressure" chart.

Approximate Test Pressure		
Ambient (Outside Air) Temperature °C (°F)	**1 At High Pressure Test Fitting kPa (psi)**	**2 At Low Pressure Test Fitting kPa (psi)**
21 (70)	820-1300 (120-190)	70-138 (10-20)
27 (80)	950-1450 (140-210)	70-173 (10-25)
32 (90)	1175-1650 (170-240)	105-210 (15-30)
38 (100)	1300-1850 (190-270)	105-210 (15-30)
43 (110)	1450-2075 (210-300)	105-210 (15-30)

1 **Pressure may be slightly higher on very humid days or lower on very dry days.**
2 **Pressure just before clutch disengages.**

Electrical System Problems

Problem 1: No Air Flow to Operator's Compartment, or Evaporator Blower Motors Do Not Operate When Fan Switch Is Activated

1. Perform the following procedure:

a. Check the air conditioner blower motor circuit breaker for an open circuit. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* "Systems Operation, Blower, Air Conditioning, and Washer and Wiper Circuit."
b. Make a visual check of all wire connections. Refer to *Schematic, Deployable Universal Combat Earthmover (DEUCE), Electrical Schematic.*
c. Check for obstructions in the fan blades.

d. Check the fan switch in all positions. The evaporator blower motor should run in all positions and in both the air conditioning and heating modes.
e. Use a 5P-7277 Voltage Tester to check for voltage at all components of the air-conditioning electrical system. For additional information, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System* "Systems Operation, Blower, Air Conditioning, and Washer and Wiper Circuit."

2. Make repairs or replace components as necessary.

Heating System Problems

To make a performance check of the heating system, do the following procedure:

1. Run the engine at 1000 rpm.

2. Move the temperature control knob to the MAXIMUM HEAT position.

3. Put the fan switch into HIGH position, on the heat vent side.

4. With the engine coolant temperature in the normal operating range, the temperature of the air flowing from the louvers (air ducts) should be warm.

If the air flow temperature is not warm within 10 minutes of starting, go to the "Little or No Warm Air Flow From Heater Core."

Problem 1: Little or No Warm Air Flow From Heater Core

1. Perform the following procedure:

a. Check the engine coolant temperature. The temperature must be within normal operating range. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Monitoring Systems and Cab Features, Gauges."
b. The heater control valve must be operating correctly. Check for correct linkage adjustment from the temperature control lever to the heater control valve. The valve must open completely when the temperature control knob is in the MAXIMUM HEAT position.
c. Check for blockage or bends (kinks) in the heater hoses, which would stop the flow of coolant through the system.
d. Make a check of the petcocks that connect the heater hoses to the engine block to ensure that they are in the full OPEN position.

2. Make repairs, or replace components, as necessary.

Refrigerant Circuit Problems

Problem 1: Little or No Cool Air Flow From Evaporator

System Condition 1:

1. The low pressure gauge reading is below normal. For normal operating pressures refer to the "Approximate Test Pressure" chart in this section.

2. The high pressure gauge reading is below normal. For normal operating pressures refer to the "Approximate Test Pressure" chart in this section.

NOTE: Ambient (outside) temperature must be above 21°C (70°F).

3. Air flowing from the evaporator is only slightly cool.

Probable Cause(s):

- Leak(s) in refrigerant circuit cause the system to be low on refrigerant.

1. Leak(s) in refrigerant circuit cause the system to be low on refrigerant.

a. Perform a leak test. Refer to "Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Leak Test," in this module.

b. If leakage is found, recover the refrigerant from the system. Refer to "Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Recovering the Refrigerant," in this module.

c. Repair the leakage.

d. If a large amount of refrigerant was lost, check the compressor for a loss of oil.

e. Evacuate the system. Refer to "Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Evacuating the System," in this module.

f. Charge the system with the correct amount of refrigerant. Refer to "Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Charging the Air-Conditioning System," in this module.

g. Do a performance check after the system is charged and has been operating for a minimum of ten minutes. Refer to "Testing and Adjusting, Troubleshooting the Air-Conditioning System, Performance Checks for the Air-Conditioning System," in this module.

System Condition 2:

1. The low pressure gauge reading is above normal. For normal operating pressures, refer to the "Approximate Test Pressure" chart in this section.

2. The high pressure gauge reading is above normal. For normal operating pressures, refer to the "Approximate Test Pressure" chart in this section.

NOTE: Ambient (outside) temperature must be above 21°C (70°F).

3. Air flowing from the evaporator is warm.

Probable Cause(s):

- There is air or moisture (water) in system.

1. There is air or moisture (water) in system.

a. Recover the refrigerant from the system. Refer to "Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Recovering the Refrigerant," in this module.

b. Replace the accumulator. The desiccant may be full of moisture (water), which will release water into the system.

NOTE: Refer to "Systems Operation, Air Conditioning and Heating Systems, Air-Conditioning System Component Location," in this module, for the location of the accumulator. Two lines must be disconnected, and two clamps must be removed to remove the accumulator.

c. Evacuate the system. Refer to "Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Evacuating the System," in this module.

d. Charge the system with the correct amount of refrigerant. Refer to "Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Charging the Air-Conditioning System," in this module.

e. After the system is charged and allowed to operate for a minimum of ten minutes, do a performance check. Refer to "Testing and Adjusting, Troubleshooting the Air-Conditioning System, Performance Checks for the Air-Conditioning System," in this module.

System Condition 3:

1. The low pressure gauge reading is below normal. For normal operating pressures, refer to the "Approximate Test Pressure" chart in this section.

2. The high pressure gauge reading is normal to below normal. For normal operating pressures, refer to the "Approximate Test Pressure" chart in this section.

NOTE: Ambient (outside) temperature must be above 21°C (70°F).

3. The temperature or air flowing from the evaporator is only slightly cool.

4. The high side liquid line or orifice tube is frosted, or cool to the touch.

Probable Cause(s):

- There is a restriction in the high side liquid line or orifice tube. The restriction causes the refrigerant to be removed from the evaporator at a faster rate than the refrigerant can enter (starved evaporator). There may be restrictions to the air flow due to clogged filters, or a blower motor failure.

1. There is a restriction in the high side liquid line or orifice tube. The restriction causes the refrigerant to be removed from the evaporator at a faster rate than the refrigerant can enter (starved evaporator). There may be restrictions to the air flow due to clogged filters, or a blower motor failure.

NOTE: Restrictions to the refrigerant flow are identified by frost or cold spots in the line.

a. Recover the refrigerant from the system. Refer to "Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Recovering the Refrigerant," in this module.

b. Replace the orifice tube or liquid line where the restriction is found. Cap all open lines and fittings. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Machine Systems,* "Air-Conditioning Group."

c. Replace the filters and/or remove any restrictions. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, When Required, Cab Air System."

d. Evacuate the system. Refer to "Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Evacuating the System," in this module.

e. Charge the system with the correct amount of refrigerant. Refer to "Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Charging the Air-Conditioning System," in this module.

f. After the system is charged and allowed to operate for a minimum of ten minutes, do a performance check. Refer to “Testing and Adjusting, Troubleshooting the Air-Conditioning System, Performance Checks for the Air-Conditioning System,” in this module.

System Condition 4:

1. Cooling may be satisfactory during morning or evening hours, but the system does not cool the cab during the hot part of the day.

2. The low pressure gauge reading is normal, but may drop (move) into the vacuum range during a testing procedure. For normal operating pressures, refer to the “Approximate Test Pressure” chart near the beginning of this section.

3. The high pressure gauge reading is normal, but will drop (move) down to below normal when the low pressure gauge drops into vacuum. For normal operating pressures, refer to the “Approximate Test Pressure” chart near the beginning of this section.

NOTE: Ambient (outside) temperature must be above 21°C (70°F).

4. The air flowing from the evaporator is very cold, but will become warm when the low pressure gauge drops into vacuum.

Probable Cause(s):

- There is a large amount of moisture (water) in the system. The desiccant in the accumulator is full of water and releases water when ambient temperatures are high. Moisture collects and forms ice in the orifice tube, blocking the flow of refrigerant.

1. There is a large amount of moisture (water) in the system. The desiccant in the accumulator is full of water and releases water when ambient temperatures are high. Moisture collects and forms ice in the orifice tube, blocking the flow of refrigerant.

a. Recover the refrigerant from the system. Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Recovering the Refrigerant,” in this module.

b. Replace the orifice tube. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Machine Systems,* “Air-Conditioning Group.”

c. Remove the moisture from the system. Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Recovering the Refrigerant,” in this module.

d. Charge the system with the correct amount of refrigerant. Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Charging the Air-Conditioning System,” in this module.

e. After the system is charged and allowed to operate for a minimum of ten minutes, do a performance check. Refer to “Testing and Adjusting, Troubleshooting the Air-Conditioning System, Performance Checks for the Air-Conditioning System,” in this module.

NOTE: The low pressure (suction) drops into vacuum when ice forms in the expansion valve. High pressure (discharge) drops when low pressure drops into vacuum.

System Condition 5:

1. The low pressure gauge reading stays the same (pressure should rise when the compressor is not in operation). For normal operating pressures, refer to the “Approximate Test Pressure” chart near the beginning of this section.

2. The high pressure gauge reading is at the high end of the normal range. For normal operating pressures, refer to the “Approximate Test Pressure” chart near the beginning of this section.

NOTE: Ambient (outside) temperature must be above 21°C (70°F).

3. Air flowing from the evaporator is only slightly cool.

Probable Cause(s):

- There is air or moisture (noncondensible) in the system. The system does not contain a full refrigerant charge.

1. There is air or moisture (noncondensible) in the system. The system does not contain a full refrigerant charge.

a. Perform a leak test (carefully test around the compressor seal). Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Leak Test,” in this module.

b. Recover the refrigerant from the system. Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Recovering the Refrigerant,” in this module.

c. Repair any leaks.

d. Check the compressor for a loss of oil.

e. Evacuate the system.Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Evacuating the System,” in this module.

f. Charge the system with the correct amount of refrigerant. Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Charging the Air-Conditioning System,” in this module.

g. After the system is charged and allowed to operate for a minimum of ten minutes, do a performance check. Refer to “Testing and Adjusting, Troubleshooting the Air-Conditioning System, Performance Checks for the Air-Conditioning System,” in this module.

System Condition 6:

1. The low pressure reading is above normal. For normal operating pressures, refer to the “Approximate Test Pressure” chart near the beginning of this section.

2. The high pressure gauge reading is above normal. For normal operating pressures, refer to the “Approximate Test Pressure” chart near the beginning of this section.

NOTE: Ambient (outside) temperature must be above 21°C (70°F).

3. The high pressure liquid line is very hot.

4. The compressor is noisy, and the drive belt slips.

5. The compressor is not operating under extreme ambient temperatures or high humidity.

Probable Cause(s):

- The system is overcharged.
- The system has not been serviced for an extended period of time, or the system pressures are not within specifications.

1. The system is overcharged.

a. Recover the refrigerant. Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Recovering the Refrigerant,” in this module.

b. Charge the system with the correct amount of refrigerant. Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Charging the Air-Conditioning System,” in this module.

c. Do a performance check. Refer to “Testing and Adjusting, Troubleshooting the Air-Conditioning System, Performance Checks for the Air-Conditioning System,” in this module.

2. The system has not been serviced for an extended period of time, or the system pressures are not within specifications.

a. Recover the refrigerant from the system. Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Recovering the Refrigerant,” in this module.

b. Evacuate the system. Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Evacuating the System,” in this module.

c. Charge the system with the correct amount of refrigerant. Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Charging the Air-Conditioning System,” in this module.

d. After the system is charged and allowed to operate for a minimum of ten minutes, do a performance check. Refer to “Testing and Adjusting, Troubleshooting the Air-Conditioning System, Performance Checks for the Air-Conditioning System,” in this module.

System Condition 7:

1. The low pressure gauge reading is above normal. For normal operating pressures, refer to the “Approximate Test Pressure” chart near the beginning of this section.

2. The high pressure gauge reading is below normal. For normal operating pressures, refer to the “Approximate Test Pressure” chart near the beginning of this section.

NOTE: Ambient (outside) temperature must be above 21°C (70°F), and the system must have a full refrigerant charge.

3. Air flowing from the evaporator is only slightly cool.

Probable Cause(s):

- There is an internal leak in the compressor, from the reed valves or head gasket. The compressor pistons, rings or cylinders are worn.

1. There is an internal leak in the compressor, from the reed valves or head gasket. The compressor pistons, rings or cylinders are worn.

a. Check the compressor drive belt for correct tension. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* “Maintenance Section, Maintenance Intervals, Every 250 Service Hours or Monthly, Engine V-Belts.”

b. Perform a leak test, to isolate the problem to the compressor. Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Leak Test,” in this module.

c. If the leak is found to be internal, perform the following:

- Replace the compressor. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Air-Conditioning Compressor.”
- Evacuate the system. Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Evacuating the System,” in this module.
- Charge the system with the correct amount of refrigerant. Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Charging the Air-Conditioning System,” in this module.
- Do a performance check after the system is charged and allowed to operate for a minimum of ten minutes. Refer to “Testing and Adjusting, Troubleshooting the Air-Conditioning System, Performance Checks for the Air-Conditioning System,” in this module.

d. If the leak is found to be external (at a hose connection), do the following:

- Recover the refrigerant. Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Recovering the Refrigerant,” in this module.
- Repair any leak(s).
- If a large amount of refrigerant is lost, check the compressor for loss of oil.
- Evacuate the system. Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Evacuating the System,” in this module.
- Charge the system with the correct amount of refrigerant. Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Charging the Air-Conditioning System,” in this module.
- After the system is charged and allowed to operate for a minimum of ten minutes, do a performance check. Refer to “Testing and Adjusting, Troubleshooting the Air-Conditioning System, Performance Checks for the Air-Conditioning System,” in this module.

System Condition 8:

1. The low pressure gauge reading is too low. For normal operating pressures, refer to the “Approximate Test Pressure” chart near the beginning of this section.

2. The high pressure gauge reading is too low. For normal operating pressures, refer to the “Approximate Test Pressure” chart near the beginning of this section.

NOTE: Ambient (outside) temperature must be above 21°C (70°F).

3. Air flowing from the evaporator is warm or only slightly cool.

4. There may be moisture (water) or frost on the orifice tube assembly.

Probable Cause(s):

- The orifice tube does not operate properly, causing a restriction of the flow of refrigerant to the evaporator (clogged at inlet).

1. The orifice tube does not operate properly, causing a restriction of the flow of refrigerant to the evaporator (clogged at inlet).

a. Replace the orifice tube. *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Machine Systems,* “Air-Conditioning Group.”

b. Evacuate the system. Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Evacuating the System,” in this module.

c. Charge the system with the correct amount of refrigerant. Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Charging the Air-Conditioning System,” in this module.

d. Do a performance check to make sure that the system operation is correct. Refer to “Testing and Adjusting, Troubleshooting the Air-Conditioning System, Performance Checks for the Air-Conditioning System,” in this module.

System Condition 9:

1. The low pressure gauge reading is too high. For normal operating pressures, refer to the “Approximate Test Pressure” chart near the beginning of this section.

2. The high pressure gauge reading is too high. For normal operating pressures, refer to the "Approximate Test Pressure" chart near the beginning of this section.

NOTE: Ambient (outside) temperature must be above 21°C (70°F).

3. Air flowing from the evaporator is warm.

Probable Cause(s):

- The condenser is not functioning properly.

1. The condenser is not functioning properly.

NOTE: The system may have a normal amount, or an overcharge, of refrigerant.

1. Check for an obstruction in the flow of air through the condenser.

2. If an obstruction is found in the condenser, remove all obstructions and do a performance check to ensure proper system operation.

3. If the problem still exists, perform the following procedure:

⚠ WARNING

Do not operate the engine during this procedure.

a. Check the system for an overcharge of refrigerant.

b. Recover the refrigerant.

c. Evacuate the system.

d. Recharge the system with the correct amount of refrigerant.

NOTE: The normal gauge reading for the low pressure side is 70 to 138 kPa (10 to 20 psi). The normal gauge reading for the high pressure side is 820 to 1300 kPa (120 to 190 psi), with the ambient temperature above 21°C (70°F).

e. Do a performance check to ensure proper system operation.

4. If the low and high pressure gauge readings are still too high, do the following procedure:

a. Recover the refrigerant from the system. Refer to "Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Recovering the Refrigerant," in this module.

b. Evacuate the system.

c. Charge the system with the correct amount of refrigerant. Refer to "Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Charging the Air-Conditioning System," in this module.

d. After the system is charged and allowed to operate for a minimum of ten minutes, do a performance check.

Problem 2: Compressor Will Not Engage

System Condition:

1. The low pressure gauge reading is above normal. For normal operating pressures, refer to the "Approximate Test Pressure" chart near the beginning of this section.

2. The high pressure gauge reading is below normal. For normal operating pressures, refer to the "Approximate Test Pressure" chart near the beginning of this section.

NOTE: Ambient (outside) temperature must be above 21°C (70°F).

3. Warm air flows to the operator's compartment.

Probable Cause(s):

- The pressure switch is stuck (held) open, preventing the magnetic clutch from cycling the compressor. The wire leads on the switch or magnetic clutch are improperly connected.

1. The pressure switch is stuck (held) open, preventing the magnetic clutch from cycling the compressor. The wire leads on the switch or magnetic clutch are improperly connected.

a. Check the wire connectors on the pressure switch and magnetic clutch.

b. Check for broken insulation which may expose the wires from the switch to the magnetic clutch.

c. Check the pressure switch. Refer to *Specifications System Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* "Testing and Adjusting, Testing, Air Conditioning Pressure Switch Test."

d. Using a multimeter, check the resistance through the coil. Refer to "Specifications, Air Conditioning, Refrigerant Compressor" in this module, for resistance values.

e. Check for proper ground at the magnetic clutch.

f. Touch the two wires on the switch together to check for proper operation of the magnetic clutch.

If the problem is found to be a loose wire on the switch or magnetic clutch, or if the wires to the clutch were damaged, causing the switch to remain open, make repairs (as necessary), and do a performance check to ensure correct system operation.

Problem 3: Compressor Continues to Cycle or Clutch Will Not Disengage (Possible Evaporator Freeze Up Blocking Air Flow to Cab)

System Condition:

1. The low pressure gauge reading is below normal. For normal operating pressures, refer to the "Approximate Test Pressure" chart near the beginning of this section.

2. The high pressure gauge reading is below normal. For normal operating pressures, refer to the "Approximate Test Pressure" chart near the beginning of this section.

NOTE: Ambient (outside) temperature must be above 21°C (70°F).

3. The air flowing to the operator's compartment is very cold, or the air flow may be restricted completely at times.

Probable Cause(s):

- The thermostat switch is stuck (held) closed. There is a short in the wire to the magnetic clutch. The magnetic clutch sticks.

1. The thermostat switch is stuck (held) closed. There is a short in the wire to the magnetic clutch. The magnetic clutch sticks.

a. Check the wire to the magnetic clutch for a short.

b. Replace the thermostat switch. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Machine Systems,* "Air-Conditioning Group."

c. Make the necessary repairs to the magnetic clutch.

Problem 4: Insufficient Cooling (Compressor Clutch Engages)

Probable Cause(s):

- Compressor belt is loose or worn. There is a restriction or foreign material in the condenser.

- There is a missing orifice tube.

- There is a plugged orifice tube, or a restriction in the liquid line.

- The refrigerant charge is low.

1. To connect the manifold gauge set, refer to "Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Performance Checks for the Air-Conditioning System," in this module.

2. Start the engine. Operate the engine at 1400 rpm. Move the temperature control knob to the MAXIMUM position, and the fan to the HIGH position. Close all windows and doors. Operate for a minimum of ten minutes to stabilize the system.

NOTE: Ambient (outside) temperature must be above 21°C (70°F).

3. Feel the accumulator. The outlet should be cold. If not, check the readings on the manifold gauges.

- If the low side reading is above 345 kPa (50 psi), check for a missing orifice tube.

- If the low side reading is into vacuum, check for a plugged orifice tube or a restriction in the line. A restriction in the liquid line can be detected by running a hand along the line until a change in temperature is felt. This change in temperature will usually indicate the location of a restriction.

4. If the accumulator inlet and outlet are warm, refer to "Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Leak Test," in this module.

Troubleshooting the Engine Coolant Heater

A preliminary inspection of the engine coolant heater is the first step to perform when the heater does not function. If the problem is not found during the preliminary inspection, the problem can be diagnosed by observing the symptom during operation or by using a test light and interpreting the diagnostic flash codes.

NOTE: Troubleshooting using a test light and by interpreting the diagnostic flash codes is the most accurate and efficient method.

WARNING

Before performing any tests or adjustments on the engine coolant heater electrical components, ensure that the electrical disconnect switch is in the OFF position.

WARNING

Engine coolant heater components can be extremely hot. Do not touch the heater components until the parts are cool.

WARNING

Avoid prolonged skin contact with solvents. Avoid using solvents in areas without adequate ventilation. Do not smoke while using solvents. Do not use solvents near an open flame, welding operations, or heated surfaces.

Preliminary Inspection

1. Check the fuel tank for fuel.

2. Check for blockage in the exhaust pipe.

3. Reset the engine coolant heater circuit breaker in the rear circuit breaker panel; and remove the cover from the rear of the machine, and reset the main circuit breaker on the engine coolant heater.

4. Ensure that the three electrical connections at the heater unit are secure.

Troubleshooting by Symptom

Troubleshooting Problem List

Problem 1: Heater Runs for Five Seconds at Start Then Shuts Off

Probable Cause(s):

- Defective glow plug or carbon build up in combustion chamber
- Blocked blower air inlet or defective blower
- Harness to fuel pump not connected, or defective fuel pump
- Thermal cut out switch open
- Restriction in coolant line, or defective coolant pump
- Defective flame sensor

1. Defective glow plug or carbon build up in combustion chamber:

a. Remove the glow plug and inspect for carbon build up. Clean the glow plug if necessary.

b. Remove the glow plug screen. Clean the screen with a wire brush if necessary.

c. Use 138-8441 Brake Cleaner solvent and compressed air to clean carbon from the combustion chamber.

d. Inspect the glow plug coil. Replace the glow plug if the coil is damaged.

2. Blocked blower air inlet or defective blower:

a. Inspect the blower air inlet for an obstruction. Clear the obstruction.

b. Check the blower harness connection at the blower.

c. Check the blower harness connections at pin 3 (brown wire) and pin 4 (purple wire) of the twelve-pin connector.

d. Check the brown wire connection at pin 1 of the power input and control switch connector.

e. Check the black wire connection at terminal C-5 of the heater control unit.

f. If all wires are connected, the blower may need to be replaced. However, do not replace the blower until all other possible causes have been investigated.

3. Harness to fuel pump not connected, or defective fuel pump:

a. Check the green/white wire connection and the connection of the green and brown wires at the fuel pump.

NOTE: While scanning the end of the fuel pump clockwise, the green/white wire connection is the first pin. The green and brown wires connect to the second pin.

b. Check the green/white wire connection at terminal B-2 of the heater control unit.

c. Check the green wire connection at terminal A-4 of the heater control unit.

d. Check the brown wire connection at pin 1 of the power input and control switch connector.

e. If all wires are connected, the fuel pump may need to be replaced. However, do not replace the fuel pump until all other possible causes have been investigated.

4. Thermal cut out switch open:

a. Check the reset button of the thermal cut out switch. Reset the switch if necessary.

b. Check the coolant level in the radiator. Add coolant if necessary.

c. Bleed the coolant circuit. Refer to “Testing and Adjusting, Engine Coolant Heater Testing and Adjusting Procedures, Bleeding the Engine Coolant Heater System,” in this module.

5. Restriction in coolant line, or defective coolant pump:

a. Check the coolant line for a restriction. Remove the restriction and reset the thermal cut out switch.

b. Check the black wire at pin 1 and the brown wire at pin 2 of the twelve-pin connector.

c. Check the black/white wire at pin 1 of the twelve-pin connector and at terminal C-2 of the heater control unit.

d. Check the brown wire connection at pin 1 of the power input and control switch connector.

e. If all wires are connected, the coolant pump may need to be replaced. However, do not replace the coolant pump until all other possible causes have been investigated.

6. Defective flame sensor:

Test the flame sensor. Refer to “Testing and Adjusting, Engine Coolant Heater Testing and Adjusting Procedures, Flame Sensor Test,” in this module.

Problem 2: Heater Runs for 30 Seconds at Start Then Shuts Off

Probable Cause(s):

- Batteries do not produce sufficient voltage
- Batteries produce too much voltage
- Corroded electrical connections

1. Batteries do not produce sufficient voltage:

a. Using a 6V-7070 Digital Multimeter (or the equivalent), measure the voltage drop across terminal C-4 (red wire) and terminal A-4 (green and brown wires) of the heater control unit. If the voltage reading is less than 20.0 volts, the batteries may not be supplying sufficient voltage.

b. Check the battery open circuit voltage. For this procedure, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* “Testing and Adjusting, Battery Open Circuit Voltage Test.”

c. Charge or replace the batteries if necessary. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* “Batteries, Arctic” and/or “Batteries, Main.”

2. Batteries produce too much voltage:

a. Using a 6V-7070 Digital Multimeter (or the equivalent), measure the voltage drop across terminal C-4 (red wire) and terminal A-4 (green and brown wires) of the heater control unit. If the voltage reading is greater than 28.0 volts, the batteries are supplying too much voltage.

b. Check the machine charging system. For additional information, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System* "Systems Operation, Start, Charge and Stop Circuit."

c. Repair or replace the alternator if necessary. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Alternator."

3. Corroded electrical connections:

a. Check the battery posts for corrosion. Clean the posts if necessary.

b. Check the battery cables for proper connection. Tighten the cables if necessary.

c. Check the power input and control switch connector, the twelve-pin connector, and the connections at the heater control unit for corrosion and proper connections. Clean the connector pins and terminals, and/or reconnect loose wires if necessary.

Problem 3: Flame Goes Out in Low Heat Mode

Probable Cause(s):

- Heater not getting enough fuel
- Defective partial load resistor

1. Heater not getting enough fuel:

a. Check the fuel level in the fuel tank. Add fuel if necessary.

⚠ WARNING

Do not operate the engine coolant heater while refueling the machine.

b. Measure the fuel delivery quantity. Refer to "Testing and Adjusting, Engine Coolant Heater Testing and Adjusting Procedures, Fuel Quantity Test," in this module.

2. Defective partial load resistor:

a. Check the red/black wire at terminal C-1 and the black wire at terminal C-5 of the heater control unit.

b. Check the red wires at pins 5 and 6 of the twelve-pin connector.

c. Using a 6V-7070 Digital Multimeter (or equivalent), measure the resistance between the red wires. If the resistance reading shows OL (overload), replace the partial load resistor.

Problem 4: Flame Goes Out in High Heat Mode

Probable Cause(s):

- Heater not getting enough fuel
- Vapor lock in fuel line
- Defective flame sensor

1. Heater not getting enough fuel:

a. Check the fuel level in the fuel tank. Add fuel if necessary.

⚠ WARNING

Do not operate the engine coolant heater while refueling the machine.

b. Measure the fuel delivery quantity. Refer to "Testing and Adjusting, Engine Coolant Heater Testing and Adjusting Procedures, Fuel Quantity Test," in this module.

2. Vapor lock in fuel line:

Check the fuel line routing for proximity to a heat source. Reroute the fuel line if necessary.

3. Defective flame sensor:

Test the flame sensor. Refer to "Testing and Adjusting, Engine Coolant Heater Testing and Adjusting Procedures, Flame Sensor Test," in this module.

Problem 5: Heater Will Not Start After Second Ignition Attempt

Probable Cause(s):

- Fuel pump harness not connected, or fuel pump defective
- Fuel line not primed
- Heater not getting enough fuel

- Defective glow plug, or carbon build up in combustion chamber
- Defective heater control unit

1. Fuel pump harness not connected, or fuel pump defective:

a. Check the green/white wire connection and the connection of the green and brown wires at the fuel pump.

NOTE: While scanning the end of the fuel pump clockwise, the green/white wire connection is the first pin. The green and brown wires connect to the second pin.

b. Check the green/white wire connection at terminal B-2 of the heater control unit.

c. Check the green wire connection at terminal A-4 of the heater control unit.

d. Check the brown wire connection at pin 1 of the power input and control switch connector.

e. If all of the wires are connected, the fuel pump may need to be replaced. However, do not replace the fuel pump until all other possible causes have been investigated.

2. Fuel line not primed:

Attempt to restart the heater. If subsequent starting attempts fail, go to Step 3.

3. Heater not getting enough fuel:

a. Check the fuel level in the fuel tank. Add fuel if necessary.

WARNING

Do not operate the engine coolant heater while refueling the machine.

b. Measure the fuel delivery quantity. Refer to "Engine Coolant Heater Testing and Adjusting Procedures, Fuel Quantity Test," in this module.

4. Defective glow plug, or carbon build up in combustion chamber:

a. Remove the glow plug and inspect for carbon build up. Clean the glow plug if necessary.

b. Remove the glow plug screen. Clean the screen with a wire brush if necessary.

c. Use 138-8440 Brake Cleaner solvent and compressed air to clean carbon from the combustion chamber.

d. Inspect the glow plug coil. Replace the glow plug if the coil is damaged.

5. Defective heater control unit:

If no power is available at the fuel pump and the fault is not due to the wiring, replace the heater control unit. If power is available at the fuel pump, replace the fuel pump.

Problem 6: Heater Automatically Shuts Off After Operating for Three to Five Minutes

Probable Cause(s):

- Flame sensor leads reversed
- Defective flame sensor
- Heater not getting enough fuel

1. Flame sensor leads reversed:

a. Ensure that the brown wire is connected to pin 7 and the grey wire is connected to pin 9 of the twelve-pin connector. Switch the wires if necessary.

b. Ensure that the blue wire from terminal A-3 of the heater control unit is connected to pin 9 of the twelve-pin connector. Switch the wires if necessary.

c. Ensure that the grey wire (spliced into the brown/white wire from terminal A-1 of the heater control unit) is connected to pin 7 of the twelve-pin connector. Switch the wires if necessary.

2. Defective flame sensor:

Test the flame sensor. Refer to "Testing and Adjusting, Engine Coolant Heater Testing and Adjusting Procedures, Flame Sensor Test," in this module.

3. Heater not getting enough fuel:

a. Check the fuel level in the fuel tank. Add fuel if necessary.

WARNING

Do not operate the engine coolant heater while refueling the machine.

b. Measure the fuel delivery quantity. Refer to "Testing and Adjusting, Engine Coolant Heater Testing and Adjusting Procedures, Fuel Quantity Test," in this module.

Problem 7: Heater Intermittently Will Not Start

Probable Cause(s):

- Heater in cool down mode when failed starting attempts are made
- Coolant temperature above 80°C (176°F) when failed starting attempts are made
- Defective temperature sensor

1. Heater in cool down mode when failed starting attempts are made:

Wait for the three-minute cool-down period to elapse before attempting to restart the heater.

2. Coolant temperature above 80°C (176°F) when failed starting attempts are made:

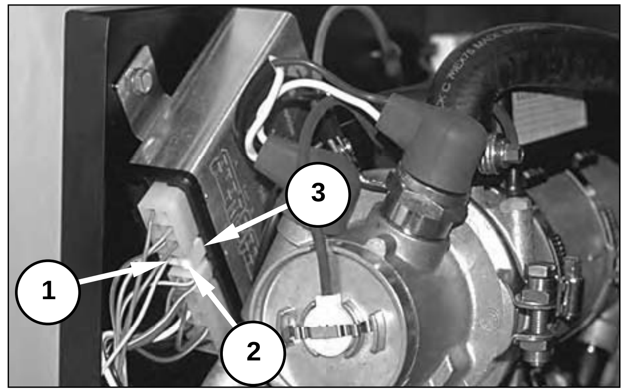
Wait for the coolant temperature to fall below 80°C (176°F) before attempting to restart the heater.

3. Defective temperature sensor:

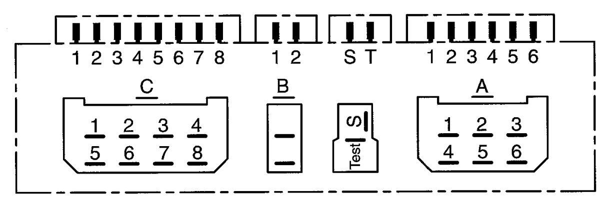
Test the temperature sensor. Refer to "Testing and Adjusting, Engine Coolant Heater Testing and Adjusting Procedures, Temperature Sensor Test," in this module.

Troubleshooting Using Test Light and Flash Codes

The heater control unit provides automatic test capabilities. A test light can be connected to the heater control unit to display coded fault information. This method of testing is the most efficient and accurate way to troubleshoot the engine coolant heater.



View Inside Heater Control Unit.
(1) S-terminal. (2) T-terminal. (3) Heater control unit connector.



Heater Control Unit Connector

To display the diagnostic flash codes, connect a test light across S-terminal (1) and T-terminal (2) of heater control unit connector (3), and operate the heater. The diagnostic flash codes will be displayed on the test light through light bursts of different durations: short, medium, and long.

The short burst of light is approximately 0.3 seconds in duration; the medium burst of light is approximately 1.6 seconds in duration; and the long burst of light is approximately 7.2 seconds in duration. The diagnostic flash code sequence cycles approximately every 9 seconds.

NOTE: If the test light does not illuminate, check the connection to the heater control unit, and check the bulb in the light. If the light illuminates and remains lit (no flashing), the heater is operating normally.

Problem Number	Fault Description	Flashing Code	Page
1	Preheating Overvoltage or Undervoltage		9-42
2	Overvoltage Switch-Off		9-43
3	Undervoltage Switch-Off		9-43
4	Overheating or Temperature at Heat Exchanger Too High		9-43
5	Glow Plug Defect		9-43
6	Blower Does Not Rotate		9-43
7	Coolant Pump Does Not Rotate		9-44
8	Short Circuit in Fuel Pump		9-44
9	Flame Sensor Defect		9-44
10	No-Start Shutdown		9-44
11	Flame Out in Low Heat Mode		9-45
12	Flame Out in High Heat Mode		9-45
13	Water Temperature Rises Too Quickly		9-46
14	Interruption in Temperature Sensor Circuit or Short Circuit in Temperature Sensor		9-46
15	Interruption in Flame Sensor Circuit or Short Circuit in Flame Sensor		9-46
16	Heater Control Unit Harness Defect or Heater Control Unit Defect		9-47
17	External Interference Voltage		9-47

The above chart shows the diagnostic flash codes and their associated problem numbers. After connecting the test light and recording the displayed diagnostic flash code, use the above chart to determine the problem number. Read the problem description and possible cause(s) to determine the repair procedure.

Problem 1: Preheating Overvoltage or Undervoltage

Probable Cause(s):

- Corroded electrical connectors
- Voltage at control unit greater than 28.0 volts during preheat phase
- Voltage at control unit less than 20.0 volts during preheat phase

1. Corroded electrical connectors:

Check the electrical connections at the batteries and at the heater control unit for corrosion. Using a 6V-7070 Digital Multimeter (or the equivalent), measure the voltage drop across terminal C-4 (red wire) and terminal B-2 (green and brown wires) of the heater control unit. If the voltage reading is greater than 28.0 volts, go to Step 2. If the voltage reading is less than 20.0 volts, go to Step 3.

2. Voltage at control unit greater than 28.0 volts during preheat phase:

a. Check the machine charging system.

b. Repair or replace the alternator if necessary.

3. Voltage at control unit less than 20.0 volts during preheat phase:

a. Check the battery open circuit voltage. For this procedure, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System*, “Testing and Adjusting, Testing, Battery Open Circuit Voltage Test.”

b. Charge or replace the batteries if necessary.

Problem 2: Overvoltage Switch Off

Probable Cause(s):

- Voltage at control unit greater than 28.0 volts for more than 20 seconds during heater operation

1. Voltage at control unit greater than 28.0 volts for more than 20 seconds during heater operation:

a. Check the machine charging system. For additional information, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System* “Systems Operation, Start, Charge and Stop Circuit.”

b. Repair or replace the alternator if necessary. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Alternator.”

Problem 3: Undervoltage Switch Off

Probable Cause(s):

- Voltage at control unit less than 20.0 volts for more than 20 seconds during heater operation

1. Voltage at control unit less than 20.0 volts for more than 20 seconds during heater operation:

a. Check the battery open circuit voltage. For this procedure, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* “Testing and Adjusting, Testing, Battery Open Circuit Voltage Test.”

b. Charge or replace the batteries if necessary.

Problem 4: Overheating, or Temperature at Heat Exchanger Too High

Probable Cause(s):

- Thermal cut out switch open
- Not enough coolant in radiator, or coolant lines to the heater restricted
- Flame sensor reported temperature greater than 560°C (1040°F)

1. Thermal cut out switch open:

Check the reset button of the thermal cut out switch. Reset the switch if necessary.

2. Not enough coolant in radiator, or coolant lines to the heater restricted:

a. Check the coolant level in the radiator. Add coolant if necessary.

b. Check the coolant inlet and outlet lines from the heater for a restriction. Remove any restriction.

3. Flame sensor reported temperature greater than 560°C (1040°F):

Test the flame sensor. Refer to “Testing and Adjusting, Engine Coolant Heater Testing and Adjusting Procedures, Flame Sensor Test,” in this module.

Problem 5: Glow Plug Defect

Probable Cause(s):

- Faulty wiring to glow plug
- Defective glow plug, and/or carbon build up in combustion chamber

1. Faulty wiring to glow plug:

a. Check the brown wire at pin 1 of the power input and control switch connector.

b. Check the brown and white wires at the glow plug connector.

c. Check the white wire between terminal C-3 of the heater control unit and the glow plug for a short to ground.

2. Defective glow plug, and/or carbon build up in combustion chamber:

a. Remove the glow plug and inspect for carbon build up. Clean the glow plug if necessary.

b. Remove the glow plug screen. Clean the screen with a wire brush if necessary.

c. Use 138-8441 Brake Cleaner solvent and compressed air to clean carbon from the combustion chamber.

d. Inspect the glow plug coil. Replace the glow plug if the coil is damaged.

Problem 6: Blower Does Not Rotate

Probable Cause(s):

- Wiring to blower contains open circuit
- Defective blower

1. Wiring to blower contains open circuit:

a. Check the blower harness connection at the blower.

b. Check the blower harness connections at pin 3 (brown wire) and pin 4 (purple wire) of the twelve-pin connector.

c. Check the brown wire connection at pin 1 of the power input and control switch connector.

d. Check the black wire connection at terminal C-5 of the heater control unit.

e. If all wires are connected, use a 6V-7070 Digital Multimeter (or equivalent), to check the blower wires for an open circuit.

2. Defective blower:

If the wiring is not the cause of the fault, replace the blower.

Problem 7: Coolant Pump Does Not Rotate

Probable Cause(s):

- Wiring to coolant pump contains open circuit
- Defective coolant pump

1. Wiring to coolant pump contains open circuit:

a. Check the black wire and the black/white wire connections at pin 1 of the twelve-pin connector.

b. Check the brown wire connection at pin 2 of the twelve-pin connector.

c. Check the black/white connection at terminal C-2 of the heater control unit.

d. Check the brown wire connection at pin 1 of the power input and control switch connector.

e. If all wires are connected, use a 6V-7070 Digital Multimeter (or equivalent), to check the coolant pump wires for an open circuit.

2. Defective coolant pump:

If the wiring is not the cause of the fault, replace the coolant pump.

Problem 8: Short Circuit in Fuel Pump

Probable Cause(s):

- Wiring to fuel pump contains short circuit
- Defective fuel pump

1. Wiring to fuel pump contains short circuit:

a. Check the green/white wire connection and the connection of the green and brown wires at the fuel pump.

NOTE: While scanning the end of the fuel pump clockwise, the green/white wire connection is the first pin, and the green and brown wires connect to the second pin.

b. Check the green/white wire connection at terminal B-2 of the heater control unit.

c. Check the green wire connection at terminal A-4 of the heater control unit.

d. Check the brown wire connection at pin 1 of the power input and control switch connector.

e. If the wires are connected, use a 6V-7070 Digital Multimeter (or equivalent), to check the green/white wire between the fuel pump and the heater control unit for a short to ground.

2. Defective fuel pump:

If the wiring is not the cause of the fault, replace the fuel pump.

Problem 9: Flame Sensor Defect

Probable Cause(s):

- Temperature reading at flame sensor does not fall below 80°C (176°F)

1. Temperature reading at flame sensor does not fall below 80°C (176°F):

Test the flame sensor. Refer to “Testing and Adjusting, Engine Coolant Heater Testing and Adjusting Procedures, Flame Sensor Test,” in this module.

Problem 10: No Start Shutdown

Probable Cause(s):

- Blocked exhaust system
- Blower inlet to combustion chamber blocked
- Glow plug not heating
- Temperature reading at flame sensor does not rise above 90°C (194°F)
- Heater not getting enough fuel

1. Blocked exhaust system:

Check the exhaust system for a restriction. Remove any restriction.

2. Blower inlet to combustion chamber blocked:

Check the blower inlet for a restriction. Remove any restriction.

3. Glow plug not heating:

Check the glow plug for damaged coils. Replace the glow plug if necessary.

4. Temperature reading at flame sensor does not rise above 90°C (194°F):

Test the flame sensor. Refer to "Testing and Adjusting, Engine Coolant Heater Testing and Adjusting Procedures, Flame Sensor Test," in this module.

5. Heater not getting enough fuel:

a. Check the fuel level in the fuel tank. Add fuel if necessary.

⚠ WARNING

Do not operate the engine coolant heater while refueling the machine.

b. Measure the fuel delivery quantity. Refer to "Testing and Adjusting, Engine Coolant Heater Testing and Adjusting Procedures, Fuel Quantity Test," in this module.

Problem 11: Flame Out in Low Heat Mode

Probable Cause(s):

- Heater not getting enough fuel
- Blocked exhaust system
- Blower inlet to combustion chamber blocked
- Defective partial load resistor

1. Heater not getting enough fuel:

a. Check the fuel level in the fuel tank. Add fuel if necessary.

⚠ WARNING

Do not operate the engine coolant heater while refueling the machine.

b. Measure fuel delivery quantity. Refer to "Testing and Adjusting, Engine Coolant Heater Testing and Adjusting Procedures, Fuel Quantity Test," in this module.

2. Blocked exhaust system:

Check the exhaust system for a restriction. Remove any restriction.

3. Blower inlet to combustion chamber blocked:

Check the blower inlet for a restriction. Remove any restriction.

4. Defective partial load resistor:

a. Check the red and black wire at terminal C-1 and the black wire at terminal C-5 of the heater control unit.

b. Check the red wires at pins 5 and 6 of the twelve-pin connector.

c. Using a 6V-7070 Digital Multimeter (or the equivalent), measure the resistance between the red wires. If the resistance reading shows OL (overload), replace the partial load resistor.

Problem 12: Flame Out in High Heat Mode

Probable Cause(s):

- Heater not getting enough fuel
- Vapor lock in fuel line
- Blocked exhaust system
- Blower inlet to combustion chamber blocked
- Defective flame sensor

1. Heater not getting enough fuel:

a. Check the fuel level in the fuel tank. Add fuel if necessary.

⚠ WARNING

Do not operate the engine coolant heater while refueling the machine.

b. Measure the fuel delivery quantity. Refer to "Testing and Adjusting, Engine Coolant Heater Testing and Adjusting Procedures, Fuel Quantity Test," in this module.

2. Vapor lock in fuel line:

Check the fuel line routing for proximity to a heat source. Reroute the fuel line if necessary.

3. Blocked exhaust system:

Check the exhaust system for a restriction. Remove any restriction.

4. Blower inlet to combustion chamber blocked:

Check the blower inlet for a restriction. Remove any restriction.

5. Defective flame sensor:

Test the flame sensor. Refer to “Testing and Adjusting, Engine Coolant Heater Testing and Adjusting Procedures, Flame Sensor Test,” in this module.

Problem 13: Water Temperature Rises Too Quickly

Probable Cause(s):

- Not enough coolant in radiator, or restricted coolant lines
- Defective temperature sensor
- Defective coolant pump

1. Not enough coolant in radiator, or restricted coolant lines:

a. Check the coolant level in the radiator. Add coolant if necessary.

b. Check the coolant inlet and outlet lines from the heater for a restriction. Remove any restriction.

2. Defective temperature sensor:

Test the temperature sensor. Refer to “Testing and Adjusting, Engine Coolant Heater Testing and Adjusting Procedures, Temperature Sensor Test,” in this module.

3. Defective coolant pump:

Check the coolant pump flow rate. Replace the coolant pump if necessary.

Problem 14: Interruption in Temperature Sensor Circuit or Short Circuit in Temperature Sensor

Probable Cause(s):

- Temperature sensor wiring contains fault
- Faulty temperature sensor

1. Temperature sensor wiring contains fault:

a. Check the grey wire connections at the temperature sensor, pin 10 of the twelve-pin connector, and terminal A-5 of the heater control unit.

b. Check the brown wire connections at the temperature sensor and at pin 8 of the twelve-pin connector.

c. Check the brown/white wire connections at pin 8 of the twelve-pin connector and terminal A-1 of the heater control unit.

d. If the connections are secure, use a 6V-7070 Digital Multimeter (or equivalent), to check the temperature sensor wires for an open or short circuit.

2. Faulty temperature sensor:

Test the temperature sensor. Refer to “Testing and Adjusting, Engine Coolant Heater Testing and Adjusting Procedures, Temperature Sensor Test,” in this module.

Problem 15: Interruption in Flame Sensor Circuit or Short Circuit in Flame Sensor

Probable Cause(s):

- Flame sensor wiring contains short circuit
- Faulty flame sensor

1. Flame sensor wiring contains short circuit:

a. Check the brown wire connection at pin 7 and the grey wire connection at pin 9 of the twelve-pin connector.

b. Ensure that the blue wire from terminal A-3 of the heater control unit is connected to pin 9 of the twelve-pin connector.

c. Ensure that the grey wire (spliced in the brown/white wire from terminal A-1 of the heater control unit) is connected to pin 7 of the twelve-pin connector.

d. If the connections are secure, use a 6V-7070 Digital Multimeter (or equivalent) to check the flame sensor wires for an open or short circuit.

2. Faulty flame sensor:

Test the flame sensor. Refer to “Testing and Adjusting, Engine Coolant Heater Testing and Adjusting Procedures, Flame Sensor Test,” in this module.

Problem 16: Heater Control Unit Harness Defect or Heater Control Unit Defect

Probable Cause(s):

- Heater control unit harness not connected to heater control unit
- Heater control unit contains internal fault

1. Heater control unit harness not connected to heater control unit:

Check the heater control unit harness connections. Repair the harness if necessary. Refer to the schematic in "Systems Operation, Engine Coolant Heater, System Operation," in this module.

2. Heater control unit contains internal fault:

If the harness connections are secure, replace the heater control unit.

Problem 17: External Interference Voltage

Probable Cause(s):

- Supply voltage not correct

1. Supply voltage not correct:

a. Check the battery open circuit voltage. For this procedure, refer to *Specifications, Systems Operation,Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electrical System*, "Testing and Adjusting, Testing, Battery Open Circuit Voltage Test."

b. Replace the batteries if necessary.

Air Conditioning Testing and Adjusting Procedures

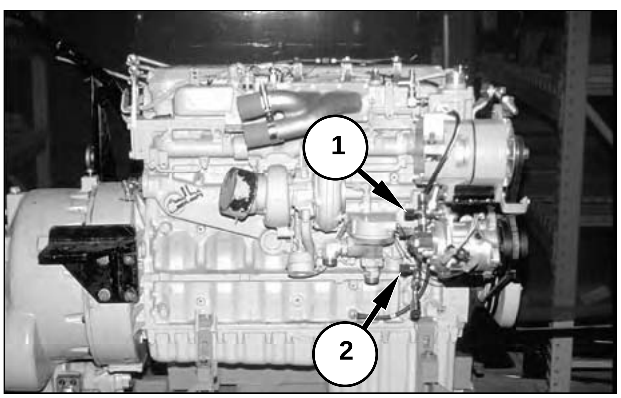
R-134a Air Conditioning Charging and Testing Tools

Tools Needed	
Part No.	**Description**
9U-6498	110 V/60 Hz Recovery/ Recycling Unit
9U-6618	220-240 V/50 Hz Recovery/ Recycling Unit
9U-6619	220-240 V/50 Hz Recovery/ Recycling Unit for Australia and New Zealand
9U-6499	110 V/60 Hz Recovery/ Recycling/Recharging Unit
9U-6616	220-240 V/50 Hz Recovery/ Recycling/Recharging Unit
9U-6617	220-240 V/50 Hz Recovery/ Recycling/Recharging Unit for Australia and New Zealand
9U-6507	115 V/60 Hz Charging Scale
9U-6621	220-240 V/50 Hz Charging Scale
9U-6622	110 V/ 50-60 Hz Charging Scale (Metric)
9U-6623	110 V/ 60 Hz Charging Station
9U-6624	220-240 V/50 Hz Charging Station
9U-6510	Compound Gauge (pounds)
9U-6511	Compound Gauge (metric)
9U-7938	Charging Cylinder - 110 V/60 Hz, 10 lb, Heated
9U-6493	Charging Cylinder - 220-240 V/50 Hz, 10 lb, Heated
9U-6505	Dryer Filter
9U-6508	Manifold Gauge Assembly
9U-6509	Manifold Gauge Assembly
4C-2964	Leak Detector
9U-6494	Oil Injector
9U-6513	Pressure Gauge (psi)
9U-6515	Pressure Gauge (kPa)
9U-6495	Smart Cart (110 V/60 Hz)
9U-6620	Smart Cart (220-240 V/50 Hz)
9U-6496	Tank - 13.6 Kg (30.00 lb)
9U-6506	Tank - 22.7 Kg (50.00 lb)
9U-6464	Vacuum Pump - 1.2 CFM, 110-115 V/50-60 Hz
9U-6465	Vacuum Pump - 4 CFM, 115 V/60 Hz
9U-6490	Vacuum Pump - 1.2 CFM, 220 V/50-60 Hz
9U-6491	Vacuum Pump - 4 CFM, 220-250 V/50-60 Hz
1U-8085	Vented Safety Glasses

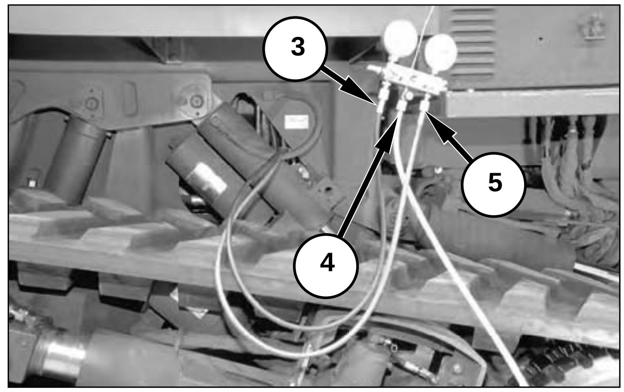
Tools Needed (Cont'd)	
Part No.	Description
9U-6512	Hose (Yellow)
9U-6516	Hose (Red)
9U-6514	Hose (Blue)
5P-7277	Voltage Tester
8T-0500	Continuity Testing Light
9U-5325	Thermometer
4C-2985	Coupler (High Side)

Installing the Manifold Gauge Set

Tools Needed	
Part No.	Description
4C-2984	Coupler (Low Side)
9U-6061	Thermistor Electronic Vacuum Gauge
9U-6510	Compound Gauge (pounds)
9U-6511	Compound Gauge (metric)
9U-6508	Manifold Gauge Assembly
9U-6509	Manifold Gauge Assembly
9U-6513	Pressure Gauge (psi)
9U-6515	Pressure Gauge (kPa)
1U-8085	Vented Safety Glasses
9U-6512	Hose (Yellow)
9U-6516	Hose (Red)
9U-6514	Hose (Blue)
4C-2985	Coupler (High Side)
4C-2984	Coupler (Low Side)



Right Side of Engine, Engine Removed From Machine for Photographic Purposes.
(1) Suction service port. (2) Discharge service port.



Right Side of Machine.
(3) Blue hose. (4) Yellow charging hose. (5) Red hose.

1. Connect the manifold gauge set to discharge (high pressure) service port (2) and suction (low pressure) service port (1) on the compressor. Connect blue hose (3) from the left gauge to the service port on the suction side of the compressor. Connect red hose (5) from the right gauge to the service port on the discharge side of the compressor. Make sure the service coupling valves are turned counterclockwise for installation. Then, turn the service coupling valves clockwise to open them.

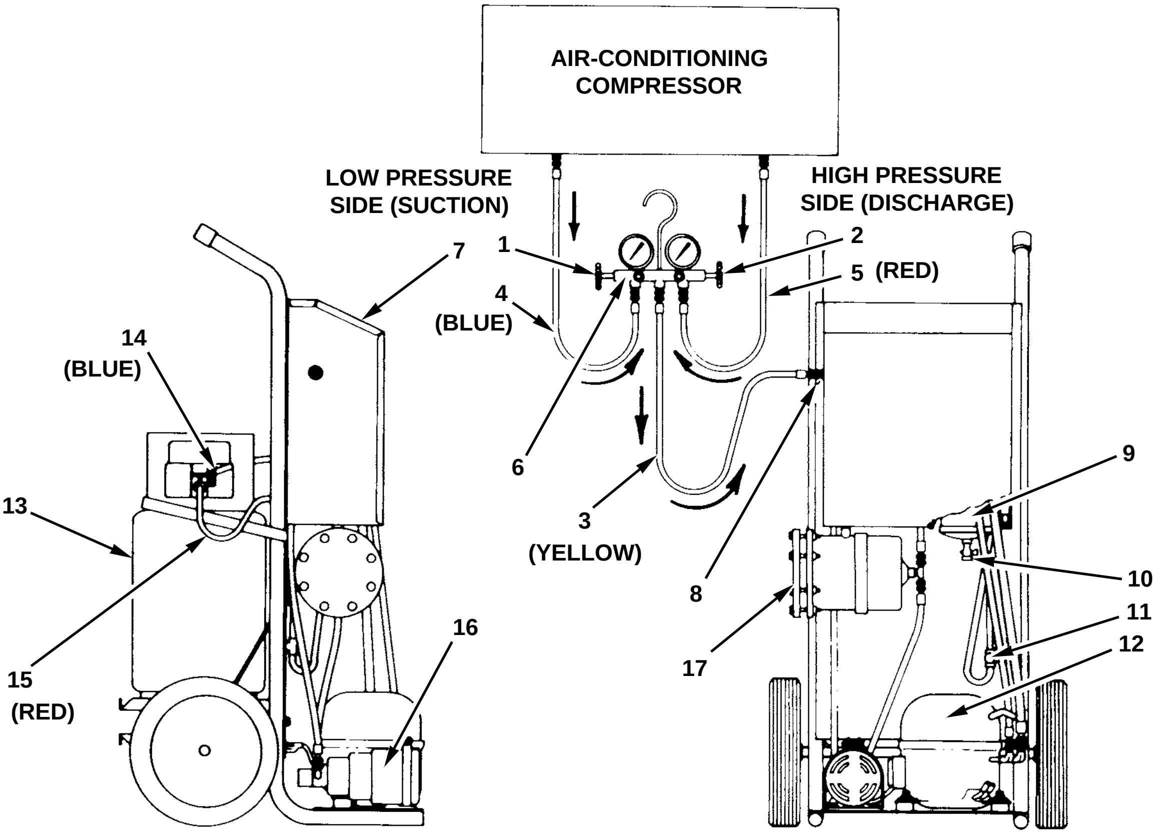
2. Make sure both hand valves on the manifold gauge set are closed (turned clockwise).

3. Put a clean rag over the fitting of yellow charging hose (4) at the manifold gauge set. This will prevent compressor oil from spraying. Open the left-hand valve (suction side) about one-half turn for two or three seconds to release the air from the blue hose and the manifold gauge set. Close the hand valve. Repeat this for the right-hand valve (discharge side) to release the air from the red hose. Tighten the yellow charging hose fitting at the manifold gauge set.

Recovering the Refrigerant

Tools Needed	
Part No.	**Description**
9U-6498	110V/60 Hz Recovery/ Recycling Unit
9U-6618	220-240V/50 Hz Recovery/ Recycling Unit
9U-6619	220-240V/50 Hz Recovery/ Recycling Unit for Australia and New Zealand
9U-6499	110V/60 Hz Recovery/ Recycling/Recharging Unit
9U-6616	220-240V/50 Hz Recovery/ Recycling/ Recharging Unit
9U-6617	220-240/50 Hz Recovery/ Recycling/ Recharging Unit for Australia and New Zealand
9U-6510	Compound Gauge (pounds)
9U-6511	Compound Gauge (metric)
9U-6505	Dryer Filter
9U-6508	Manifold Gauge Assembly
9U-6509	Manifold Gauge Assembly
9U-6513	Pressure Gauge (psi)
9U-6515	Pressure Gauge (kPa)
9U-6496	Tank - 13.6 Kg (30.00 lb)
9U-6506	Tank - 22.7 Kg (50.00 lb)
1U-8085	Vented Safety Glasses
9U-6512	Hose (Yellow)
9U-6516	Hose (Red)
9U-6514	Hose (Blue)
4C-2985	Coupler (High Side)
4C-2984	Coupler (Low Side)

If the air-conditioning system requires service work, the refrigerant must be recovered first; use the procedure on the following page:



Recovering the Refrigerant.
(1) Low pressure hand valve. (2) High pressure hand valve. (3) Yellow charging hose. (4) Blue hose. (5) Red hose. (6) Manifold gauge set. (7) Control panel. (8) Station inlet. (9) Accumulator/oil separator. (10) Oil drain valve. (11) Accumulator pressurizing valve. (12) Compressor. (13) Refrigerant tank. (14) Blue hose. (15) Red hose. (16) Refrigerant pump. (17) Filter dryer.

1. Install manifold gauge set (6). Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Installing the Manifold Gauge Set” in this module. Make sure low pressure hand valve (1) and high pressure hand valve (2) are closed (turned clockwise).

WARNING

Do not operate the engine during this procedure.

2. Attach yellow charging hose (3) of manifold gauge set (6) to station inlet (8) of the air-conditioning recovery and recycling cart.

3. Slowly open hand valves (1) and (2), and release the air from yellow charging hose (3) of manifold gauge set (6). Make certain the “vapor” and “liquid” valves in refrigerant tank (13) are open.

4. Plug the recovery station into an electrical outlet and turn on the main power switch, located on control panel (7).

5. Press the compressor start switch, located on control panel (7). The amber "compressor on" light will illuminate and compressor (12) will start. The compressor will shut off automatically when the recovery is complete.

6. To drain accumulator/oil separator (9) of refrigerant oil, open accumulator pressurizing valve (11) long enough to allow some compressor discharge pressure back into the accumulator/oil separator. Open oil drain valve (10) slowly, and drain the oil from the accumulator/oil separator into a measuring container. Do not allow the accumulator/oil separator to completely depressurize. When the oil stops draining, close the oil drain valve.

7. If over 15 mL (0.5 fl oz) of compressor oil is lost during the recovery procedure, new oil must be added to keep the correct amount of oil in the system. Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Compressor Oil Check,” in this module.

Evacuating the System

Tools Needed	
Part No.	**Description**
9U-6498	110V/60 Hz Recovery/ Recycling Unit
9U-6618	220-240V/50 Hz Recovery/ Recycling Unit
9U-6619	220-240V/50 Hz Recovery/ Recycling Unit for Australia and New Zealand
9U-6499	110V/60 Hz Recovery/ Recycling/Recharging Unit
9U-6616	220-240V/50 Hz Recovery/ Recycling/ Recharging Unit
9U-6617	220-240V/50Hz Recovery/Recycling/Recharging Unit for Australia and New Zealand
9U-6623	110V/60 Hz Charging Station
9U-6624	220-240V/50 Hz Charging Station
9U-6510	Compound Gauge (pounds)
9U-6511	Compound Gauge (metric)
9U-6508	Manifold Gauge Assembly
9U-6509	Manifold Gauge Assembly
9U-6513	Pressure Gauge (psi)
9U-6515	Pressure Gauge (kPa)
9U-6495	Smart Cart (110 V/60 Hz)
9U-6620	Smart Cart (220-240 V/50 Hz)
9U-6464	Vacuum Pump - 1.2 CFM, 110-115V/50-60 Hz
9U-6465	Vacuum Pump - 4 CFM, 115V/60 Hz
9U-6490	Vacuum Pump - 1.2 CFM, 220V/50-60 Hz
9U-6491	Vacuum Pump - 4 CFM, 220-250V/50-60 Hz
1U-8085	Vented Safety Glasses
9U-6512	Hose (Yellow)
9U-6516	Hose (Red)
9U-6514	Hose (Blue)
4C-2985	Coupler (High Side)
4C-2984	Coupler (Low Side)
9U-6061	Thermistor Electronic Vacuum Gauge

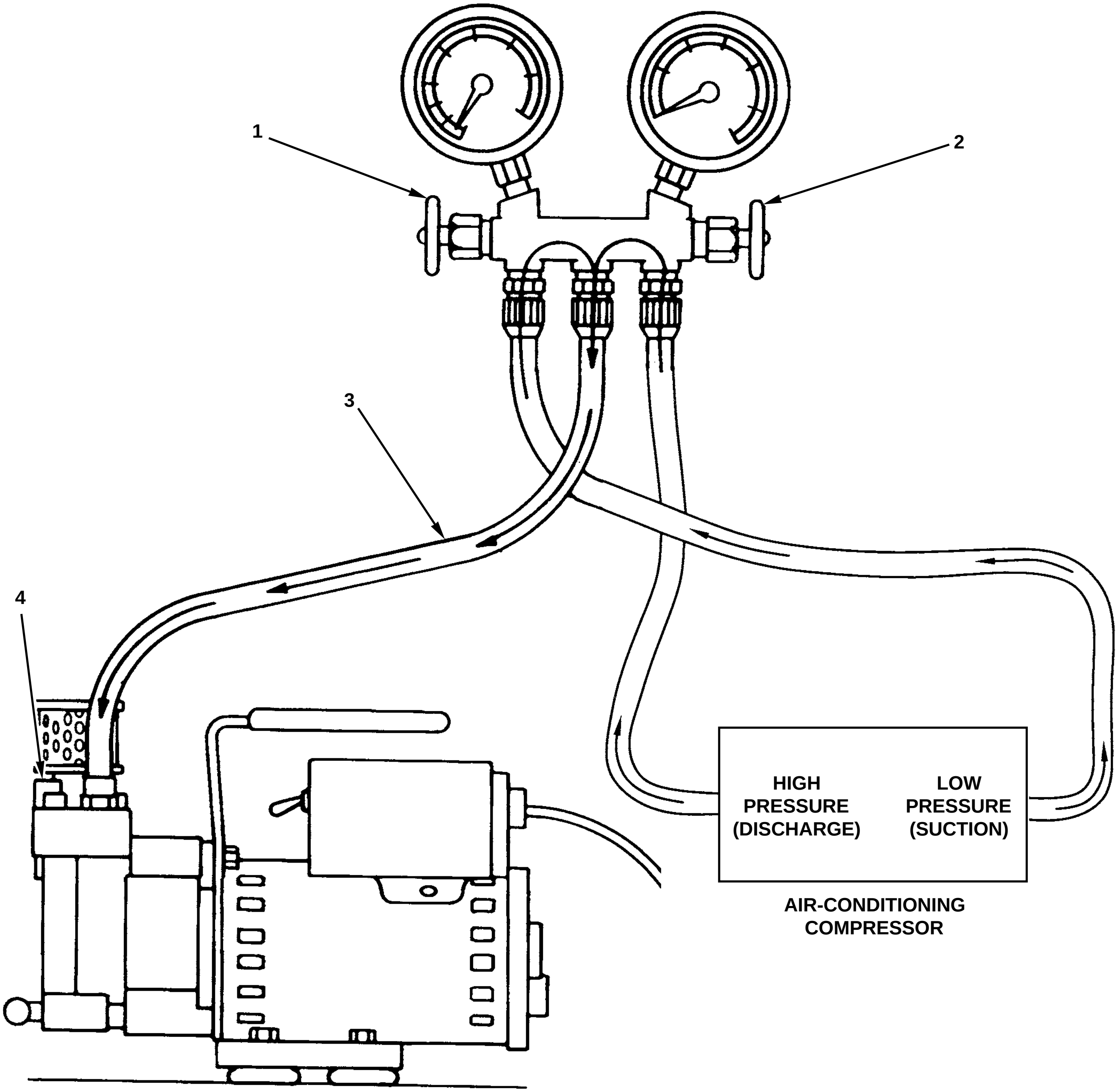
If component replacement or repair makes recovering the refrigerant necessary, or if the system has lost its charge after a long period of time, perform the evacuating procedure to rid the system of all air and moisture. A system should never be completely charged before the evacuating procedure is performed. Before evacuating the system, refer to "Leak Test," "Recovering the Refrigerant" and "Compressor Oil Check" in "Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures," in this module.

If the system has been exposed to air or moisture (left open for more than one-half hour), install a new accumulator with desiccant. Moisture, combined with the metals in the refrigeration system, produces highly corrosive by-products such as oxides, iron hydroxide, and aluminum hydroxide. Moisture can freeze the expansion valve and orifice tube. Any water in the system must be removed by pulling a vacuum and boiling the water. Refer to the "Boiling Point of Water Under Vacuum" chart, below.

Boiling Point of Water Under Vacuum	
Temperature of Work Area C (F)	**Vacuum Required to Boil Water in System m bar (in Hg)**
38 (100)	948 (28.0)
32 (90)	965 (28.5)
27 (80)	975 (28.8)
21 (70)	988 (29.2)

NOTICE

All refrigerant must be recovered before the evacuating procedure is started. Never discharge refrigerant through the vacuum pump.



Evacuating the System.
(1) Low pressure hand valve. (2) High pressure hand valve. (3) Yellow charging hose. (4) Vacuum pump exhaust valve.

1. After completing the recovery procedure, make sure hand valves (1) and (2) are closed (turned clockwise). Disconnect yellow charging hose (3) of the manifold gauge set from the air-conditioning recovery and reclamation cart.

2. Check the oil level in the vacuum pump. If oil is needed, or if contamination is indicated, add to or change the oil.

3. Connect the vacuum pump electrical plug to the power source.

4. Connect yellow charging hose (3) to the inlet fitting on the vacuum pump, as shown.

5. Completely open (turn counterclockwise) hand valves (1) and (2) on the manifold gauge set.

6. Turn the power switch to the ON position, to start the pump motor.

7. Turn vacuum pump exhaust valve (4) counterclockwise (one complete turn) to open.

NOTE: Vacuum pump exhaust valve (4) must not be opened before the pump is started.

8. Operate the vacuum pump until the low pressure gauge reading indicates 948 to 981 m bar (28 to 29 in Hg) vacuum (at sea level). After the vacuum in the system reaches 948 to 981 m bar (28 to 29 in Hg), close vacuum pump exhaust valve (4) to allow the vacuum pump to operate for an additional 90 minutes (minimum), if a four-cubic-foot pump is used. Make allowances for pumps that have a smaller than four-cubic-foot capacity.

NOTE: The required specification at sea level is 948 to 981 m bar (28 to 29 in Hg). For every 304.8 m (1000 ft) above sea level, decrease the required specification 33.9 m bar (1 in Hg). The higher the elevation (altitude) the less vacuum required.

9. If the specified vacuum cannot be reached, the system may have a leak. Perform the procedures indicated in “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Leak Test,” in this module. Repair all leaks, and repeat Step 1 of the evacuating procedure.

NOTE: The evacuating procedure removes air and moisture from the system. The vacuum pump should not to be used to indicate a system leak.

10. After 948 to 981 m bar (28 to 29 in Hg) vacuum has been reached and held for an additional 90 minutes, close hand valves (1) and (2) completely, and turn the power switch on the vacuum pump to the OFF position. The maximum amount of vacuum loss in five minutes must not be more than 67.7 m bar (2 in Hg). Excessive vacuum loss is an indication of a possible leak in the system. Perform the procedures indicated in “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Leak Test,” in this module. Repair all leaks and repeat Step 1 of the evacuating procedure.

11. If the vacuum loss does not exceed 67.7 m bar (2 in Hg) in five minutes, the system is then ready for a complete charge. Perform the procedures indicated in “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Charging the Air Conditioner System,” in this module.

Flushing the System

Tools Needed	
Part No.	**Description**
9U-6498	110V/60 Hz Recovery/ Recycling Unit
9U-6618	220-240V/50 Hz Recovery/ Recycling Unit
9U-6619	220-240V/50 Hz Recovery/ Recycling Unit for Australia and New Zealand
9U-6499	110V/60 Hz Recovery/ Recycling/Recharging Unit
9U-6616	220-240V/50 Hz Recovery/ Recycling/ Recharging Unit
9U-6617	220-240V/50 Hz Recovery/ Recycling/Recharging Unit for Australia and New Zealand
9U-6510	Compound Gauge (pounds)
9U-6511	Compound Gauge (metric)
9U-6505	Dryer Filter
9U-6508	Manifold Gauge Assembly
9U-6509	Manifold Gauge Assembly
9U-6513	Pressure Gauge (psi)
9U-6515	Pressure Gauge (kPa)
9U-6496	Tank - 13.6 Kg (30.00 lb)
9U-6506	Tank - 22.7 Kg (50.00 lb)
9U-6464	Vacuum Pump - 1.2 CFM, 110-115V/50-60 Hz
9U-6465	Vacuum Pump - 4 CFM, 115V/60 Hz
9U-6490	Vacuum Pump - 1.2 CFM, 220V/50-60 Hz
9U-6491	Vacuum Pump - 4 CFM, 220-250V/50-60 Hz
1U-8085	Vented Safety Glasses
9U-6512	Hose (Yellow)
9U-6516	Hose (Red)
9U-6514	Hose (Blue)
4C-2985	Coupler (High Side)
4C-2984	Coupler (Low Side)

If a component failure causes metal particles or other foreign material to circulate through the system, the system must be cleaned and flushed.

Debris in the system can cause the compressor to fail. Use the following procedure to clean and flush the system.

1. Recover the refrigerant. Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Recovering the Refrigerant,” in this module.

2. Remove the compressor. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Air-Conditioning Compressor.”

NOTICE

Do not use solvents or compressed air to clean any system component.

3. Replace any failed component, and flush the system with R-134a.

4. Install a new compressor. New compressors are shipped with the correct amount of oil inside.

NOTE: New or remanufactured compressors come with the correct amount of refrigerant oil for the system.

5. Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Evacuating the System,” in this module.

6. Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Charging the Air Conditioner System,” in this module.

7. Refer to “Testing and Adjusting, Troubleshooting the Air-Conditioning System, Performance Checks for the Air-Conditioning System,” in this module, to make sure the system operation is correct.

Leak Test

Tools Needed	
Part No.	**Description**
9U-6510	Compound Gauge (pounds)
9U-6511	Compound Gauge (metric)
9U-6508	Manifold Gauge Assembly
9U-6509	Manifold Gauge Assembly
4C-2964	Leak Detector
9U-6513	Pressure Gauge (psi)
9U-6515	Pressure Gauge (kPa)
1U-8085	Vented Safety Glasses
9U-6512	Hose (Yellow)
9U-6516	Hose (Red)
9U-6514	Hose (Blue)
4C-2985	Coupler (High Side)
4C-2984	Coupler (Low Side)

Since the air-conditioning system is a closed circuit system, finding and repairing refrigerant leaks is important.

The 4C-2964 Leak Detector is designed to detect leaks as small as 12 mL (0.4 oz) of refrigerant per year in the air-conditioning system. Perform the following leak test procedure to determine if the system has a leak:

The system must contain at least 0.4 kg (15 oz) of refrigerant. Install the manifold gauge set to determine if pressure exists in the system. If the system indicates pressure, there is enough refrigerant to perform a leak test.

NOTE: Refrigerant vapor is heavier than air. For the best results, place the sensor tip directly below any possible leaks.

1. Move the sensor tip along the possible leakage points at a rate of one inch per second.

Leaks in the high pressure side of the system are more easily found if the air conditioner is operated for a few minutes and the leak test is performed immediately after the unit is turned OFF (before system pressures equalize). Leaks in the low pressure side of the system are more easily found if the air conditioner has been turned OFF for several minutes before the leak test is performed (this allows system pressures to equalize).

2. If the leak is found at a loose fitting or connection, it may not be necessary to recover the refrigerant from the system. Tighten the loose connection, refer to and perform “Testing and Adjusting, Troubleshooting the Air-Conditioning System, Performance Checks for the Air-Conditioning System,” in this module. If additional refrigerant is necessary, refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Charging the Air Conditioner System,” in this module.

3. If the repair of a leak calls for the removal or replacement of a component, refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Machine Systems*.

Compressor Oil Check

Tools Needed	
Part No.	**Description**
9U-6498	110V/60 Hz Recovery/ Recycling Unit
9U-6618	220-240V/50 Hz Recovery/ Recycling Unit
9U-6619	220-240V/50 Hz Recovery/ Recycling Unit for Australia and New Zealand
9U-6499	110V/60 Hz Recovery/ Recycling/Recharging Unit
9U-6616	220-240V/50 Hz Recovery/ Recycling /Recharging Unit
9U-6617	220-240V/50 Hz Recovery/ Recycling/Recharging Unit for Australia and New Zealand
9U-6507	115V/60 Hz Charging Scale
9U-6621	220-24 V/50 Hz Charging Scale
9U-6622	110V/ 50-60 Hz Charging Scale (Metric)
9U-6623	110V/ 60 Hz Charging Station
9U-6624	220-240V/50 Hz Charging Station
9U-6510	Compound Gauge (pounds)
9U-6511	Compound Gauge (metric)
9U-7938	Charging Cylinder - 110V/60 Hz, 10 lb, Heated
9U-6493	Charging Cylinder - 220-240V/50 Hz, 10 lb, Heated
9U-6505	Dryer Filter
9U-6508	Manifold Gauge Asembly
9U-6509	Manifold Gauge Assembly
4C-2964	Leak Detector
9U-6494	Oil Injector
9U-6513	Pressure Gauge (psi)
9U-6515	Pressure Gauge (kPa)
9U-6495	Smart Cart (110V/60 Hz)
9U-6620	Smart Cart (220-240V/50 Hz)
9U-6496	Tank - 13.6 Kg (30.00 lb)
9U-6506	Tank - 22.7 Kg (50.00 lb)
9U-6464	Vacuum Pump - 1.2 CFM, 110-115V/50-60 Hz
9U-6465	Vacuum Pump - 4 CFM, 115V/60 Hz
9U-6490	Vacuum Pump - 1.2 CFM, 220V/50-60 Hz
9U-6491	Vacuum Pump - 4 CFM, 220-250V/50-60 Hz
1U-8085	Vented Safety Glasses
9U-6512	Hose (Yellow)
9U-6516	Hose (Red)
9U-6514	Hose (Blue)
4C-2985	Coupler (High Side)
4C-2984	Coupler (Low Side)

A special refrigerant oil is used in the air-conditioning system. This oil mixes completely with the refrigerant to lubricate the components in the system. The amount of refrigerant oil in the compressor will indicate the amount of oil in the system.

Refer to "Specifications, Air Conditioning, Refrigerant Compressor," in this module, for approved refrigerant oils.

NOTE: Generally, compressor oil is only checked in the following situations: there is evidence of a major oil loss from broken refrigerant hoses; a large loss of refrigerant due to hose fitting leaks; a badly leaking compressor seal; or damage to a particular component in the system (which requires replacement of the component).

Complete Check of Compressor Oil

Before replacing a component, perform the procedure that follows to find out how much refrigerant oil needs to be replaced in the compressor.

NOTE: This procedure requires that the machine be operated. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE)* for information about machine operation.

1. Operate the engine at low idle with the temperature control knob in the MAXIMUM COOL position and the fan switch in the HIGH position, for a minimum of ten minutes, to stabilize the system.

2. Stop the engine, and remove the refrigerant charge from the system. Refer to "Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Recovering the Refrigerant," in this module.

3. Remove the compressor from the machine and put protective caps on the suction and discharge hoses and fittings. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Air-Conditioning Compressor."

4. Put the compressor into the horizontal position with the oil plug down. Remove the oil plug, and drain the oil into a clean measuring container. Tip the compressor back and forth, and rotate (turn) the compressor shaft to let all the oil drain from the oil sump in the compressor. Make a note of the amount of oil in the container. Inspect the oil for contaminants, metal chips, rubber particles or any other foreign material. Dispose of the old oil in a suitable container. Add 177 to 237 mL (6 to 8 fl oz) of new refrigerant oil to the compressor.

If a component failure allows metal particles or other foreign material to enter the system, the system must be cleaned and flushed. Refer to "Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Flushing the System," in this module.

If the amount of oil in the system is above 325 mL (11 fl oz), too much oil will circulate with the refrigerant, and the cooling capacity of the system will be reduced. If the amount of oil in the system is insufficient, the compressor will not get the necessary lubrication, and the compressor will fail.

NOTE: Add oil to the compressor through the oil plug opening. Place the compressor in a position that will prevent the refrigerant oil from flowing out of the suction or discharge service valves. Do not put the compressor on the shaft end. Turn the compressor shaft by hand when filling the compressor with new refrigerant oil. The oil will flow into the compressor slowly.

NOTICE

Only use approved and recommended refrigerant oil.

5. After the correct amount of new refrigerant oil has been added to the system, install the compressor and drive belt. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Air-Conditioning Compressor.” Perform the following procedure “Charging the Air-Conditioning System.”

Charging the Air-Conditioning System

Temperature—Pressure Relation for R-134a Refrigerant

Temperature—Pressure Relation Chart For R-134a Refrigerant									
Temp. °C (°F)	Pressure kPa (psig)	Temp. °C (°F)	Pressure kPa (psig)	Temp. °C (°F)	Pressure kPa (psig)	Temp. °C (°F)	Pressure kPa (psig)	Temp. °C (°F)	Pressure kPa (psig)
-18 (0)	44 (6.4)	2 (35)	209 (30.3)	16 (60)	394 (57.2)	29 (85)	654 (94.8)	43 (110)	1004 (145.6)
-17 (2)	51 (7.4)	2 (36)	215 (31.2)	16 (61)	403 (58.2)	30 (86)	666 (96.6)	44 (111)	1020 (147.9)
-16 (4)	59 (8.5)	3 (37)	221 (32.1)	17 (62)	412 (59.8)	31 (87)	678 (98.4)	44 (112)	1036 (150.3)
-14 (6)	66 (9.6)	3 (38)	228 (33.0)	17 (63)	421 (61.1)	31 (88)	691 (100.2)	45 (113)	1053 (152.7)
-13 (8)	74 (10.7)	4 (39)	234 (34.0)	18 (64)	430 (62.4)	32 (89)	703 (102.0)	46 (114)	1069 (155.1)
-12 (10)	82 (11.9)	4 (40)	241 (34.9)	18 (65)	440 (63.8)	32 (90)	716 (103.8)	46 (115)	1087 (157.6)
-11 (12)	90 (13.1)	5 (41)	248 (35.9)	19 (66)	450 (65.2)	33 (91)	729 (105.7)	47 (116)	1103 (160.0)
-10 (14)	99 (14.3)	6 (42)	254 (36.9)	19 (67)	459 (66.6)	33 (92)	742 (107.6)	47 (117)	1120 (162.5)
-9 (16)	108 (15.6)	6 (43)	261 (37.9)	20 (68)	469 (68.0)	34 (93)	755 (109.5)	48 (118)	1138 (165.1)
-8 (18)	117 (17.0)	7 (44)	263 (38.9)	21 (69)	478 (69.4)	34 (94)	768 (111.4)	48 (119)	1156 (167.6)
-7 (20)	127 (18.4)	7 (45)	275 (39.9)	21 (70)	488 (70.9)	35 (95)	782 (113.4)	49 (120)	1173 (170.2)
-6 (21)	132 (19.1)	8 (46)	283 (41.0)	22 (71)	498 (72.3)	36 (96)	796 (115.4)	49 (121)	1191 (172.8)
-6 (22)	137 (19.8)	8 (47)	290 (42.0)	22 (72)	509 (73.9)	36 (97)	809 (117.4)	50 (122)	1209 (175.4)
-5 (23)	141 (20.5)	9 (48)	297 (43.1)	23 (73)	519 (75.3)	37 (98)	823 (119.4)	51 (123)	1228 (178.1)
-4 (24)	147 (21.3)	9 (49)	305 (44.2)	23 (74)	530 (76.9)	37 (99)	838 (121.5)	51 (124)	1247 (180.8)
-4 (25)	152 (22.0)	10 (50)	312 (45.3)	24 (75)	540 (78.3)	38 (100)	852 (123.5)	52 (125)	1265 (183.5)
-3 (26)	157 (22.8)	11 (51)	320 (46.4)	24 (76)	551 (79.9)	38 (101)	866 (125.6)	52 (126)	1285 (186.3)
-3 (27)	163 (23.6)	11 (52)	328 (47.5)	25 (77)	562 (812.5)	39 (102)	881 1227.8)	53 (127)	1304 (189.1)
-2 (28)	168 (24.4)	12 (53)	336 (48.7)	26 (78)	573 (983.1)	39 (103)	896 (129.9)	53 (128)	1323 (191.9)
-2 (29)	174 (25.2)	12 (54)	344 (49.9)	26 (79)	584 (84.7)	40 (104)	911 (132.1)	54 (129)	1342 (194.7)
-1 (30)	179 (26.0)	13 (55)	352 (51.0)	27 (80)	595 (86.3)	41 (105)	926 (134.3)	54 (130)	1362 (197.6)
-1 (31)	185 (26.8)	13 (56)	360 (52.2)	27 (81)	607 (88.0)	41 (106)	941 (136.5)	54 (131)	1382 (200.5)
0 (32)	191 (27.7)	14 (57)	369 (53.5)	28 (82)	618 (89.7)	42 (107)	956 (138.7)	55 (132)	1402 (203.4)
1 (33)	197 (28.5)	14 (58)	377 (54.7)	28 (83)	630 (91.4)	42 (108)	972 (141.0)	56 (133)	1422 (206.3)
1 (34)	203 (29.4)	15 (59)	385 (55.9)	29 (84)	642 (93.1)	43 (109)	988 (143.3)	57 (134)	1443 (209.3)

This chart can be used to determine the pressure of a container of refrigerant. The chart also applies to an air-conditioning system that is not in operation.

Charging the System

Tools Needed	
Part No.	**Description**
9U-6499	110V/60 Hz Recovery/ Recycling/Recharging Unit
9U-6616	220-240V/50 Hz Recovery/ Recycling /Recharging Unit
9U-6617	220-240V/50 Hz Recovery/ Recycling/ Recharging Unit for Australia and New Zealand
9U-6507	115V/60 Hz Charging Scale
9U-6621	220-240V/50 Hz Charging Scale
9U-6622	110V/50-60 Hz Charging Scale (Metric)
9U-6623	110V/60 Hz Charging Station
9U-6624	220-240V/50 Hz Charging Station
9U-6510	Compound Gauge (pounds)
9U-6511	Compound Gauge (metric)
9U-7938	Charging Cylinder - 110 V/60 Hz, 10 lb, Heated
9U-6493	Charging Cylinder - 220-240 V/50 Hz, 10 lb, Heated
9U-6505	Dryer Filter
9U-6508	Manifold Gauge Assembly
9U-6509	Manifold Gauge Assembly
4C-2964	Leak Detector
9U-6494	Oil Injector
9U-6513	Pressure Gauge (psi)
9U-6515	Pressure Gauge (kPa)
9U-6495	Smart Cart (110V/60 Hz)
9U-6620	Smart Cart (220-240V/50 Hz)
9U-6496	Tank - 13.6 Kg (30.00 lb)
9U-6506	Tank - 22.7 Kg (50.00 lb)
1U-8085	Vented Safety Glasses
9U-6512	Hose (Yellow)
9U-6516	Hose (Red)
9U-6514	Hose (Blue)
9U-5325	Thermometer
4C-2985	Coupler (High Side)
4C-2984	Coupler (Low Side)

WARNING

When working on the air-conditioning system, keep all other personnel either away from the machine or within view.

WARNING

Never charge liquid or gas through the discharge (high) side of the system with the engine running.

NOTE: If the engine is running, charge the air-conditioning system with gas through the low side. Never charge liquid refrigerant through the suction (low side) of the air-conditioning system. If the engine is not running, charge the air-conditioning system with liquid or gas through the high side.

NOTE: Before charging the system, check the following items:

1. Check the condenser and evaporator for any type of restriction that will hamper air flow, such as dirt or other foreign material. Check the condenser coil for restrictions. A clean condenser will lead to improved compressor life.

2. Check for a loose belt on the compressor. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* “Maintenance Section, Maintenance Intervals, Every 250 Service Hours or Monthly, Engine V-Belts.”

3. Clean the fresh air and recirculation filters.

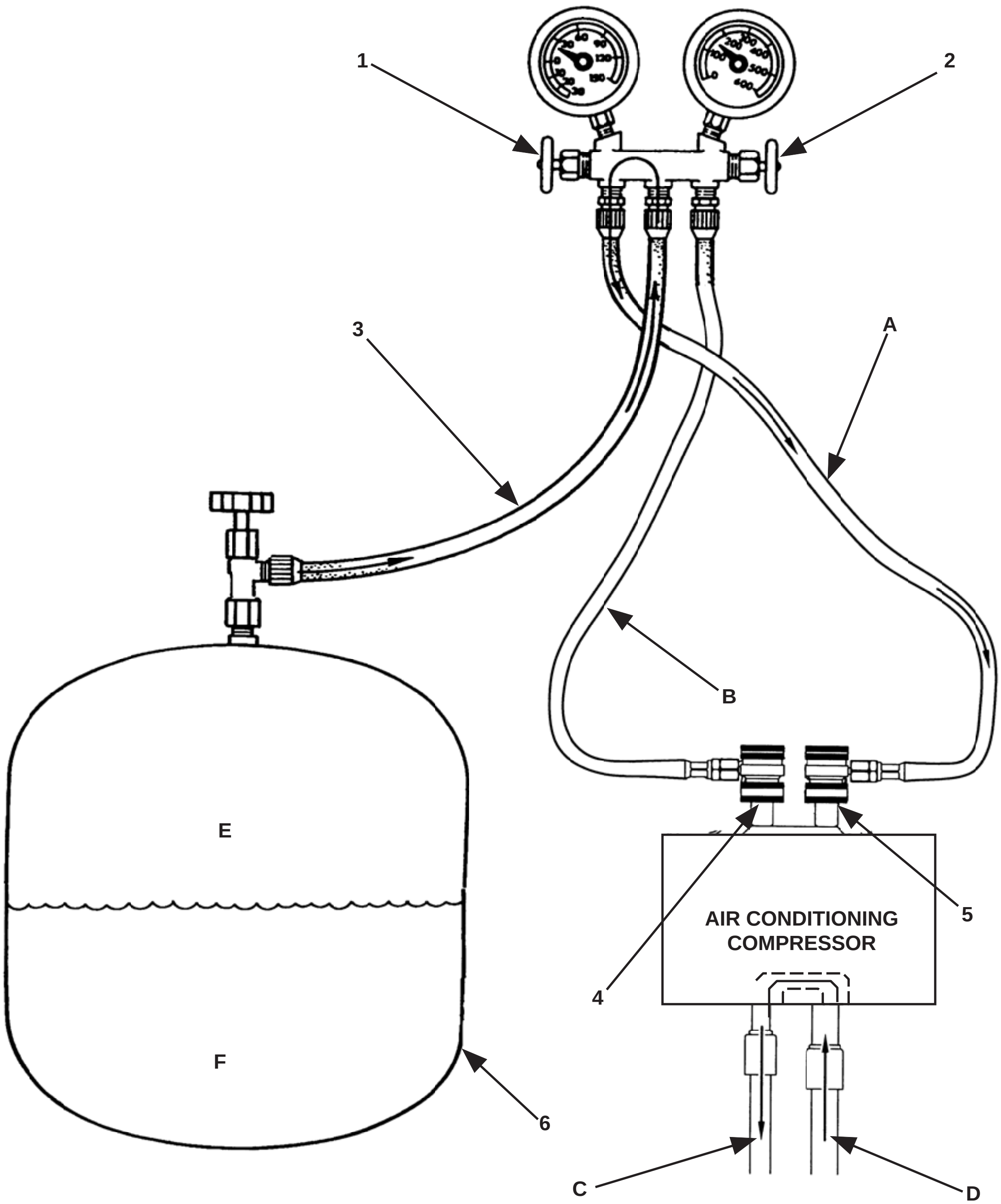
4. Check the evaporator condensate drain tube for restrictions.

Refer to “Systems Operation, Air Conditioning and Heating Systems, Safety Requirements,” in this module, before performing service work on the air-conditioning system.

NOTE: The preferred method for charging any air-conditioning system is to recover the refrigerant, evacuate the system, and then charge the system with the correct amount of refrigerant. Refer to “Specifications, Air Conditioning, Refrigerant Compressor,” in this module, for system capacity.

Use the following procedure when adding additional refrigerant to an air-conditioning system that is not fully charged.

Adding Additional Refrigerant to an Air-Conditioning System That Is Not Fully Charged



Gas Charging Through the Low Pressure (Suction) Side of the Compressor (Low Pressure Valve Open, High Pressure Valve Closed, With Engine Running).
(1) Suction valve. (2) Discharge valve. (3) Yellow charging hose. (4) Discharge service valve. (5) Suction service valve. (6) Supply tank.
(A) Blue hose. (B) Red hose. (C) Line to condenser coil. (D) Line from evaporator coil. (E) Vapor. (F) Liquid.

NOTE: This procedure will apply only if the inlet air temperature at the condenser is 21°C (70°F) or higher.

NOTICE

If the system has no refrigerant, always evacuate the system before charging.

NOTE: This procedure requires that the machine be operated. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE)* for information about machine operation.

1. Connect the manifold gauge set to the discharge and suction service ports on the compressor. Refer to "Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Installing the Manifold Gauge Set," in this module.

2. Make sure suction valve (1) and discharge valve (2) on the manifold gauge set are closed (turned clockwise).

3. Turn the tank valve completely out (counterclockwise) to release the refrigerant vapor to yellow charging hose (3).

NOTE: Make sure the cylinder of refrigerant is in the upright position (as shown). This allows the refrigerant to enter the system as a gas.

4. Release the air from yellow charging hose (3) by loosening the hose connection at the manifold gauge set for two to three seconds, and then tighten the connection.

5. Start and operate the engine at low idle.

6. Move the temperature control knob to the MAXIMUM COOL position and the fan switch to the HIGH position.

NOTE: The preferred method for charging the air-conditioning system is to recover the refrigerant, evacuate the system, and then charge the system with the correct amount of refrigerant. Refer to "Specifications, Air Conditioning, Refrigerant Compressor," in this module, for system capacity.

7. Open (turn counterclockwise) suction valve (1), on the manifold gauge set, to release refrigerant into blue hose (A), which connects to suction service valve (5) on the compressor. Note the gauge readings. The gauge reading should not exceed normal operating ranges during this procedure. Slowly add refrigerant until the inlet and outlet to the accumulator are cool. The louver temperatures should drop during this procedure. Close (turn clockwise) the suction valve to prevent the additional flow of refrigerant to the compressor. Allow the system to stabilize for five minutes, and then check to see if the inlet and outlet to the accumulator are cool. If the inlet and outlet are cool, add an additional 0.25 kg (0.5 lb) of refrigerant. This will give the air-conditioning system the correct charge.

8. Close (turn clockwise) suction valve (1) to prevent the additional flow of refrigerant to the compressor.

NOTE: If suction valve (1) is opened completely, the low pressure gauge reading will appear excessively high until the system becomes fully charged.

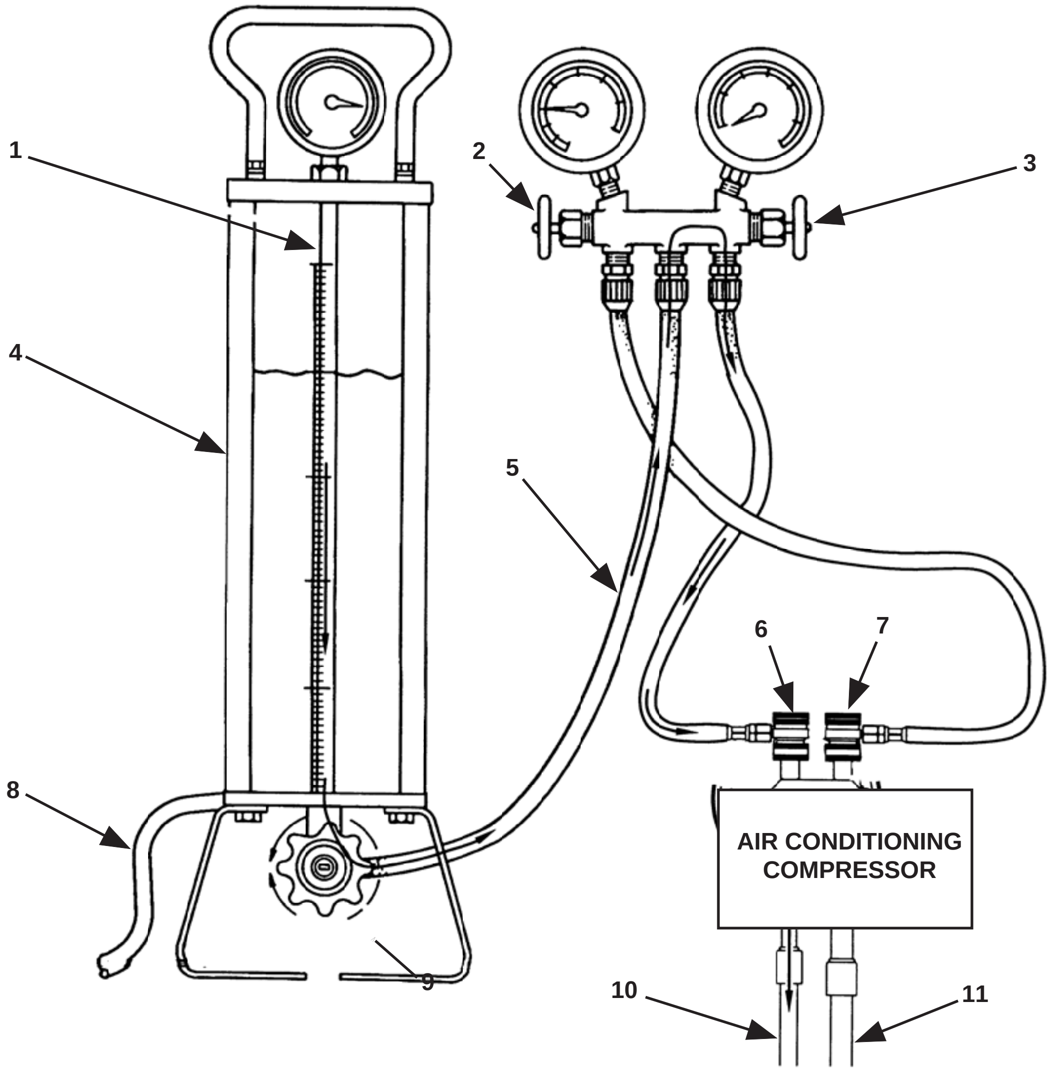
9. If the reading on the low pressure (suction) gauge is not 121 ± 17 kPa (17.5 ± 2.5 psi) and/or the reading on the high pressure (discharge) gauge is not 1818 ± 93 kPa (263.5 ± 13.5 psi) after charging is complete, go to Step 12.

10. If the suction and discharge pressures become too high, an overcharge is indicated. Completely close (turn clockwise) the hand valve on supply tank (6) to shut off the flow of refrigerant to yellow charging hose (3). Shut down the engine. Remove the refrigerant tank valve from the yellow charging hose.

11. Move the air-conditioning controls to the OFF position, and stop the engine.

12. Remove the manifold gauge set.

Charging the System With Charging Cylinders



Liquid Charging Through High Pressure Side of Compressor (High Pressure Valve Open, Low Pressure Valve Closed, Engine Not Running). (1) Sight glass. (2) Low pressure hand valve. (3) High pressure hand valve. (4) Plastic cover. (5) Yellow charging hose. (6) Discharge service coupling. (7) Suction service coupling. (8) Electrical plug. (9) Valve. (10) Line to condenser coil. (11) Line from evaporator coil.

⚠ WARNING

Never charge liquid or gas through the discharge (high) side of the system with the engine running.

NOTE: Always evacuate the system before charging.

NOTE: If the engine is running, charge the air-conditioning system with gas through the low side. Never charge liquid refrigerant through the suction (low) side of the air-conditioning system. If the engine is not running, charge the air-conditioning system with liquid or gas through the high side.

The procedure that follows explains a method for charging the system. The use of the 9U-6493 or 9U-7938 Charging Cylinders is a fast, safe, and accurate method.

NOTE: Make sure all valves are closed (turned clockwise) before the procedure is started.

1. Connect the manifold gauge set to the discharge and suction service ports on the compressor. Refer to “Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Installing the Manifold Gauge Set,” in this module. Turn the vacuum pump control switch to the OFF position, and remove the hose from the vacuum pump.

2. Use yellow charging hose (5) and the dispensing valve to connect a supply tank of refrigerant to valve (9) at the bottom of the charging cylinder (hand tighten).

NOTE: Do not connect the electrical plug for the heater.

3. Turn the supply tank so that the dispensing valve is at the bottom (this will allow the refrigerant to enter the charging cylinder as a liquid).

4. Open (turn counterclockwise) the dispensing valve on the supply tank. Open valve (9) at the bottom of the charging cylinder. Open the valve at the top of the charging cylinder (behind the pressure gauge), slightly, to release the air from the cylinder, and then close (turn clockwise) the valve. When a small amount of refrigerant can be seen in sight glass (1), close valve (9) at the bottom of the charging cylinder to prevent the flow of refrigerant from the supply tank. Make a note of the gauge reading on the top of the charging cylinder. The gauge gives the pressure reading of the refrigerant inside the charging cylinder.

5. Rotate (turn) plastic cover (4) on the charging cylinder until the pressure reading on the gauge is found on the scale for refrigerant. Turn the plastic cover until the correct scale is over sight glass (1) inside the cylinder.

NOTE: Make sure the correct scale for the refrigerant is used when the refrigerant in the cylinder is measured. The 9U-6493 and 9U-7938 Charging Cylinders will have additional scales for measuring refrigerant other than R-134a.

6. Open valve (9) at the bottom of the charging cylinder, to allow refrigerant to flow from the supply tank to the charging cylinder. Close (turn clockwise) valve (9) when the liquid level in sight glass (1) is in alignment with the mark (on the plastic cover) which equals the capacity of the system being charged. The capacity of this system is 1.5 kg (3.2 lb).

NOTE: During filling, the valve at the top of the charging cylinder must be opened and closed several times to lower the pressure in the cylinder.

7. Close (turn clockwise) the dispensing valve on the supply tank.

8. Disconnect yellow charging hose (5) from valve (9) at the bottom of the charging cylinder. Connect and hand tighten the yellow charging hose from the manifold gauge set to valve (9). Open the valve at the bottom of the charging cylinder to release refrigerant into the yellow charging hose. Loosen the yellow charging hose connection at the manifold gauge set, for two to three seconds, to purge the air from the line. Tighten the connection by hand.

⚠ WARNING

Do not run the engine when charging with a liquid. The compressor will pump the refrigerant back into the charging cylinder, which could cause the cylinder to rupture (explode).

9. Connect electrical plug (8) for the charging cylinder heater into an electrical outlet to raise the pressure in the cylinder. When the pressure in the cylinder reaches 655 to 758 kPa (95 to 110 psi), the refrigerant is ready to be added to the system.

NOTE: The heating element in the charging cylinder will not overheat the cylinder and build up excessive pressure, or cause damage to the cylinder if left on for an indefinite time. The heating process raises the pressure of the refrigerant in the charging cylinder and prevents the system and cylinder pressures from equalizing. The refrigerant can not flow from the charging cylinder to the air-conditioning system if the two pressures (system and cylinder) equalize.

10. Open high pressure hand valve (3) on the manifold gauge set to allow the liquid charge to flow into the system through the high pressure (discharge) side of the compressor.

11. Quickly close high pressure hand valve (3) and valve (9) on the bottom of the charging cylinder when the level of liquid refrigerant in sight glass (1) is at zero.

12. Perform the “Testing and Adjusting, Performance Checks for the Air-Conditioning System” to ensure correct system operation.

Complete Charge of System From a Refrigerant Supply Tank Using a Scale

To charge the system using a supply tank and a scale, use the following procedure.

1. Find the capacity of the system. Refer to “Specifications, Air Conditioning, Refrigerant Compressor,“ in this module, for system capacity.

2. Connect and tighten yellow charging hose (5) from the manifold gauge set directly to the dispensing valve on the supply tank. Open the dispensing valve to allow the flow of refrigerant through the yellow charging hose to the manifold gauge set.

3. Loosen yellow charging hose (5) at the manifold gauge set for two to three seconds to purge the air from the line. Retighten the connection by hand.

4. Place the supply tank on the scale so that the dispensing valve is at the bottom. Note the weight of the tank.

WARNING

Do not run the engine when charging with a liquid. The compressor will pump the refrigerant back into the charging cylinder, which could cause the cylinder to rupture (explode).

5. Open high pressure hand valve (3) on the manifold gauge set to allow the liquid refrigerant to charge the system through the high pressure (discharge) side of the compressor.

6. Check the weight of the supply tank often. The weight will decrease as the refrigerant leaves the tank and enters the system. When the 1.5 kg (3.2 lb) of refrigerant (system capacity) has entered the system, close the dispensing valve, and high pressure hand valve (3) to stop the flow of refrigerant.

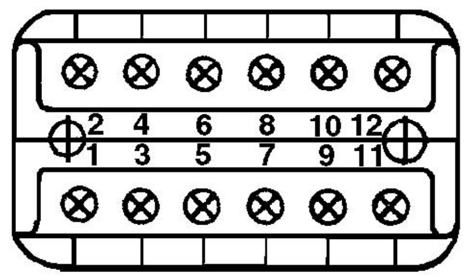
7. Disconnect yellow charging hose (5) from the supply tank, and do the “Testing and Adjusting, Performance Checks for the Air-Conditioning System,” in this section, to ensure correct system operation.

Engine Coolant Heater Testing and Adjusting Procedures

Flame Sensor Test

NOTE: Remove the engine coolant heater from its compartment, place the heater on the rear fender, remove the cover from the unit, and reconnect all hoses and electrical connections before starting this procedure. If necessary, fabricate extensions for the hoses and/or electrical connections. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Machine Systems,* “Engine Coolant Heater.”

1. Let the heater cool to ambient temperature. Measure the ambient temperature.



2. Disconnect the grey wire from pin 9 and the brown wire from pin 7 of the twelve-pin connector.

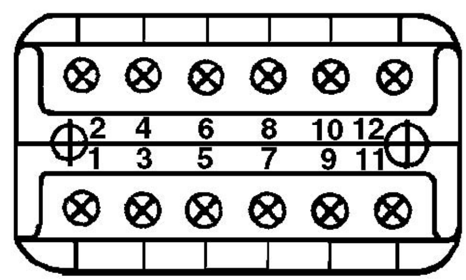
3. Using a 6V-7070 Digital Multimeter (or the equivalent), measure the resistance between the grey wire and the brown wire. Repeat the measurement several times for consistency.

4. Plot the temperature and resistance measurements on the following graph.

Temperature Sensor Test

NOTE: Remove the engine coolant heater from its compartment, place the heater on the rear fender, remove the cover from the unit, and reconnect all hoses and electrical connections before starting this procedure. If necessary, fabricate extensions for the hoses and/or electrical connections. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Machine Systems,* "Engine Coolant Heater."

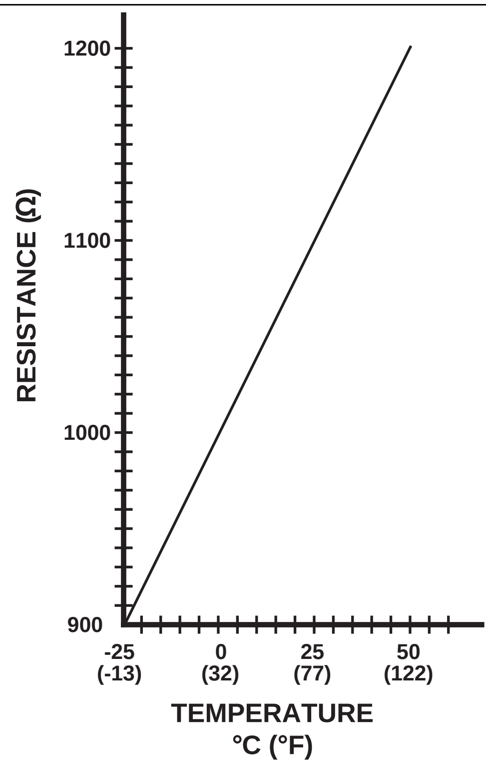
1. Let the heater cool to ambient temperature. Measure the ambient temperature.



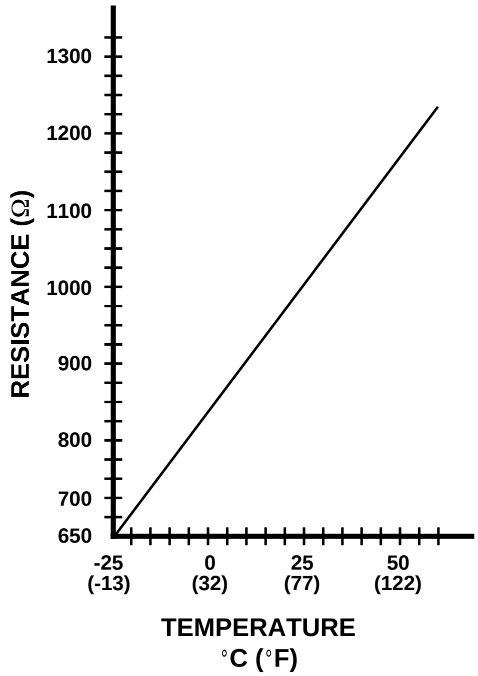
2. Disconnect the brown wire from pin 8 and the grey wire from pin 10 of the twelve-pin connector.

3. Using a 6V-7070 Digital Multimeter (or equivalent), measure the resistance between the grey wire and the brown wire. Repeat the measurement several times for consistency.

4. Plot the temperature and resistance measurements on the following graph.



5. If the measured points does not fall near the line, replace the flame sensor. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Machine Systems,* "Engine Coolant Heater."

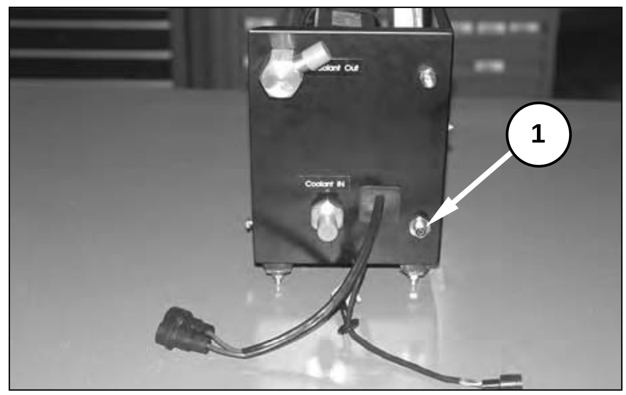


5. If the measured points does not fall near the line, replace the temperature sensor. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Machine Systems,* “Engine Coolant Heater.”

Fuel Quantity Test

NOTE: The batteries must produce a minimum of 22 volts and a maximum of 26 volts during this test. A test light, a stop watch (or a watch with a sweeping second hand), a measuring glass, and a 6V-7070 Digital Multimeter (or the equivalent) are necessary to complete this procedure.

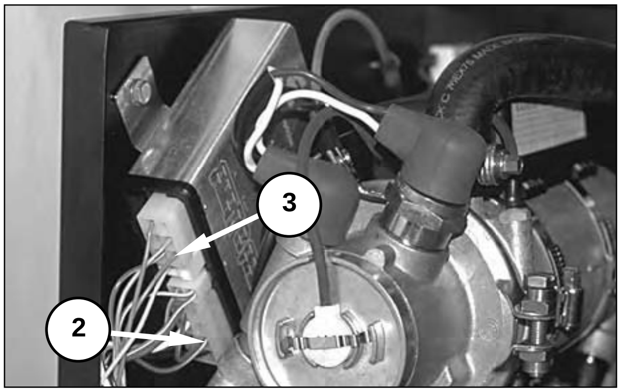
NOTE: Remove the engine coolant heater from its compartment, place the heater on the rear fender, remove the cover from the unit, and reconnect all hoses and electrical connections before starting this procedure. If necessary, fabricate extensions for the hoses and/or electrical connections. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Machine Systems,* “Engine Coolant Heater.”



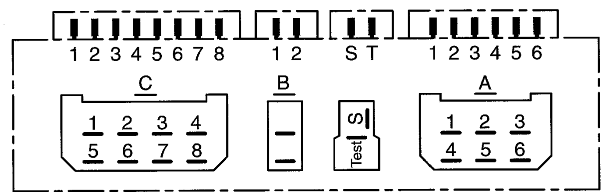
Engine Coolant Heater Assembly.
(1) Fuel port.

1. Disconnect the fuel line at fuel port (1) from the heater.

2. Insert the fuel line into a measuring glass (at least 50 mL [1.69 fl oz]).

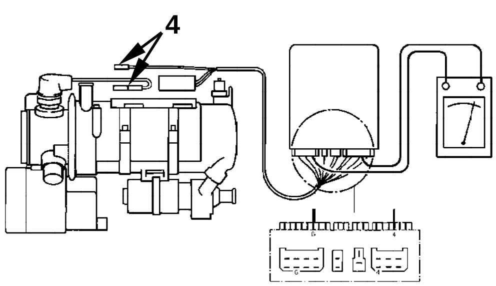


Location of Heater Control Unit.
(2) Terminal C-6. (3) Terminal A-4.



3. Connect the positive lead of the 6V-7070 Digital Multimeter (or equivalent) to terminal C-6 (2) of the heater control unit connector.

4. Connect the negative lead of the 6V-7070 Digital Multimeter (or equivalent) to terminal A-4 (3) of the heater control unit connector.



Test Schematic.
(4) Glow plug leads.

5. Disconnect glow plug leads (4) from the glow plug and connect a test light across the two leads.

6. Switch the heater ON, and allow the fuel line to bleed for approximately 25 to 55 seconds.

7. Switch the heater OFF, and empty the measuring glass.

NOTE: Always dispose of fuel in an environmentally sound manner.

8. Place the fuel line back into the measuring glass.

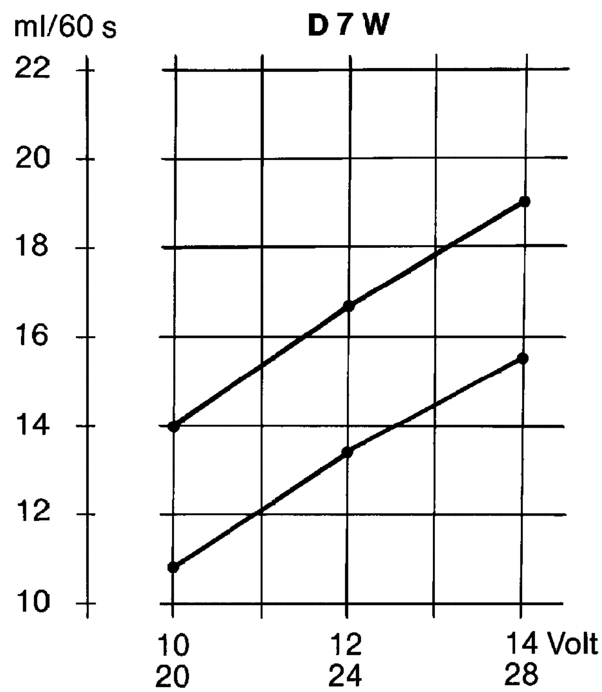
9. Switch the heater to the ON position, and allow the heater to run until fuel delivery stops (approximately 90 seconds after the heater is switched ON). Time the duration of the fuel delivery.

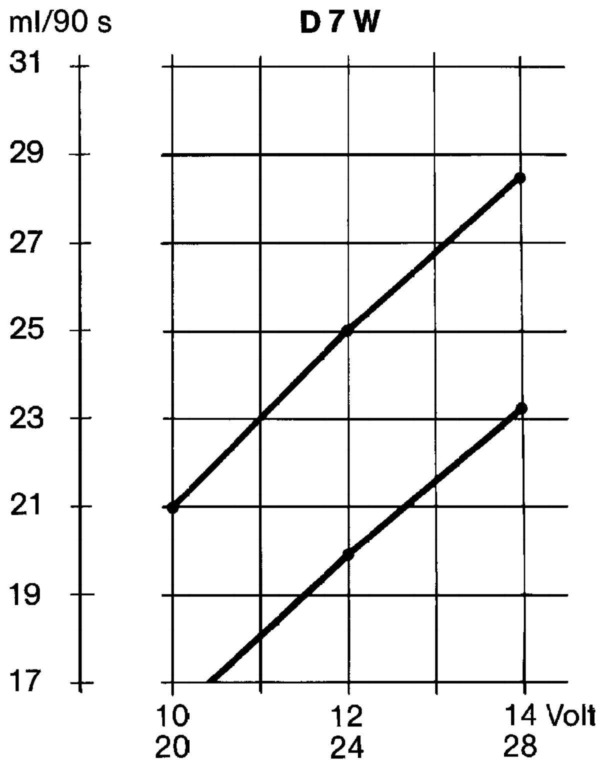
NOTE: Hold the measuring glass at the level of the fuel inlet port while the fuel is being delivered.

10. Read the voltage displayed on the multimeter while the fuel pump is operating.

11. Turn the heater OFF after the fuel pump has stopped.

12. Determine the quantity of liquid in the measuring glass.





13. Plot the voltage reading and the fuel measurement on the appropriate graph.

14. If the plotted coordinate falls between the two fuel consumption lines on the graph, the fuel delivery quantity is within specification.

15. If the plotted coordinate does not fall within the two fuel consumption lines on the graph, the fuel delivery quantity is not within specification. Check the fuel level in the tank and the fuel lines to the heater for an obstruction.

16. If the fuel delivery quantity is not within specification but the fuel tank contains sufficient fuel and the lines are not obstructed, the fuel pump should be replaced. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Machine Systems,* “Engine Coolant Heater.”

NOTE: Before changing the fuel pump, repeat this procedure to confirm that the fuel pump is not delivering sufficient flow.

TM5-2430-200-24

Disassembly & Assembly

Deployable Universal Combat Earthmover (DEUCE)

Machine Systems

PIN: 7RR00003-Up

Important Safety Information

Most accidents involving product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “WARNING” as shown below.

The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning, explaining the hazard, can be either written or pictorially presented.

Operations that may cause product damage are identified by NOTICE labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are therefore not all inclusive. If a tool, procedure, work method or operating technique not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and others. You should also ensure that the product will not be damaged or made unsafe by the operation, lubrication, maintenance or repair procedures you choose.

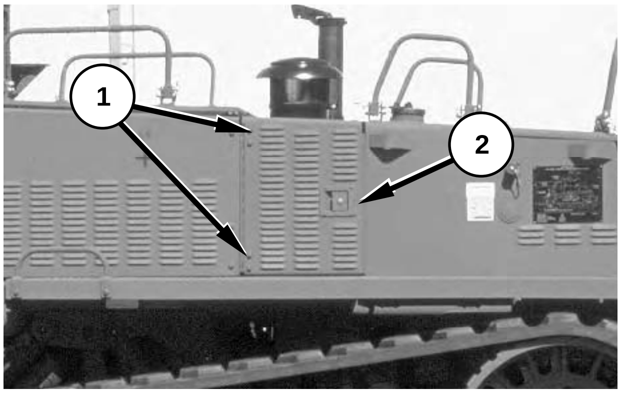
The information, specifications, and illustrations in this publication are on the basis of information available at the time it was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service given to the product. Obtain the complete and most current information before starting any job. Caterpillar dealers have the most current information available. For a list of the most current publication form numbers available, see the Service Manual Contents Microfiche, REG1139F.

Table of Contents

Air Cleaner Compartment Door

Remove and Install

NOTE: The group number related to this procedure is 144-7924.



1. Open air cleaner compartment door (2).

2. Remove four bolts (1) and washers, and remove door (2).

NOTE: To install the air cleaner compartment door, reverse the removal steps.

Air Conditioning Group

Remove and Install

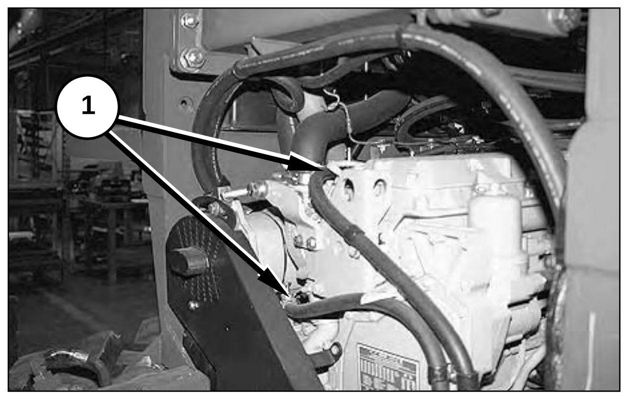
Tools Needed	A
138-7575 Link Bracket	2

a. Remove the seat assembly.

b. Remove the Single Channel Ground and Airborne Radio System (SINCGARS) bracket.

NOTE: Group numbers related to this procedure include 135-8787 and 145-0425.

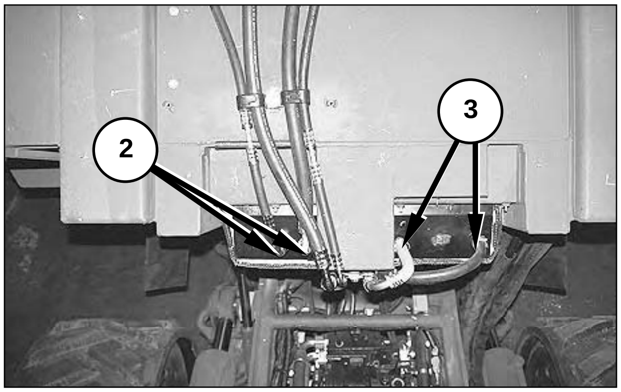
1. Tilt the cab. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Maintenance Features, Cab Tilt."



2. Turn coolant line valves (1) fully clockwise to close the valves.

3. Evacuate the refrigerant from the air conditioning system. Refer to *Specifications, Systems Operation, Testing and Adjusting, Machine Systems,* "Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Evacuating the System,"

NOTE: Upon reassembly, charge the system with the correct amount of refrigerant. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Machine Systems,* "Testing and Adjusting, Air Conditioning Testing and Adjusting Procedures, Charging the Air-Conditioning System,"

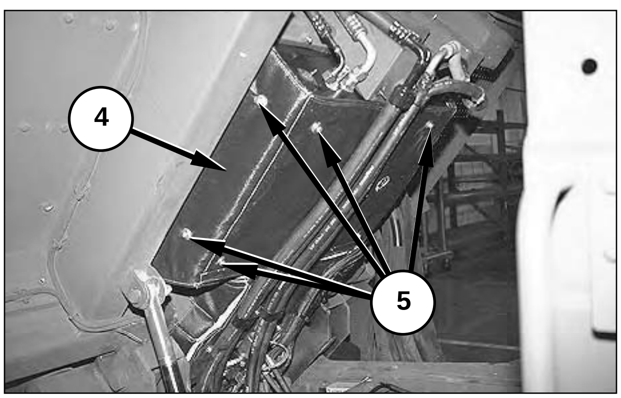


⚠ WARNING

Do not remove the coolant lines until the coolant has cooled enough so that a hand may rest comfortably on the lines being disconnected.

4. Disconnect two refrigerant lines (2) and two coolant lines (3). Mark the lines for correct location upon reassembly. Catch any coolant that leaks out of the hoses, and dispose of the coolant in accordance with local environmental regulations.

NOTE: Install a short section of heater hose between the ports for coolant lines (3) to keep coolant from spilling out of the air conditioning group when the coolant is removed.

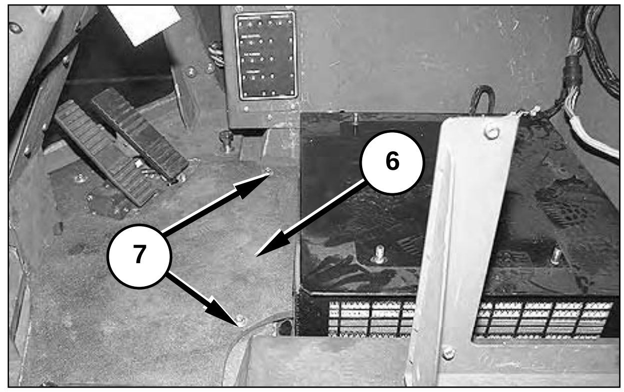


5. Remove eight caps (5) (only five visible), and insulation cover (4).

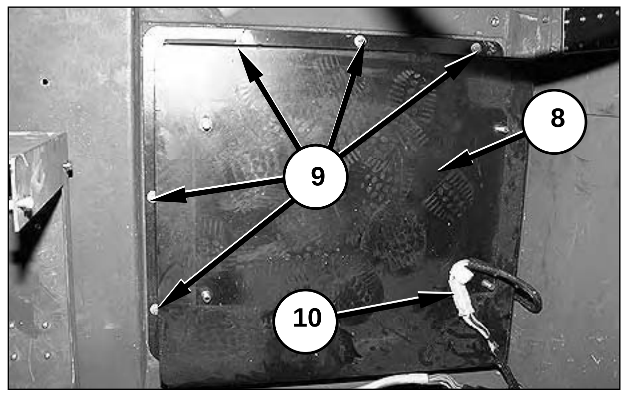
6. If necessary, grind off four insulation mounting spikes on the left and right sides of the air conditioning box to provide additional clearance.

NOTE: Replace any **6P-2216 Caps** (5) which are damaged during removal. Upon reassembly, reweld the insulation mounting spikes onto the air conditioning box using the appropriate equipment and materials.

7. Lower the cab.

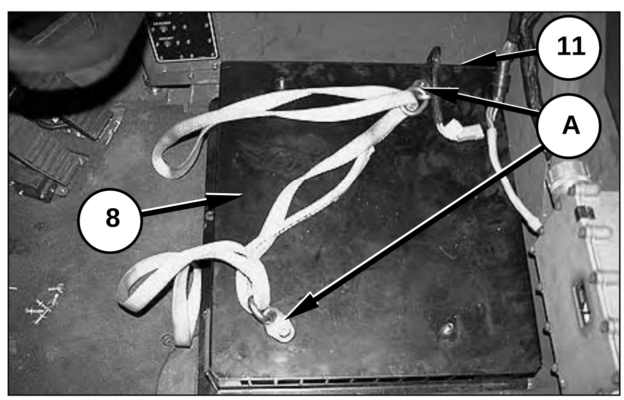


8. Remove two bolts (7) and washers, and roll floor mat (6) forward and out of the way of the front flange of the air conditioning unit.



9. Remove 12 bolts (9) (only five visible) and washers from around air conditioning unit (8).

10. Disconnect connector C157 (10).



11. Attach Tooling (A) and lifting straps to the four studs for the seat assembly, and use two people to lift air conditioning unit (8) up. The weight of the air conditioning unit is **25 kg (55 lb)**.

NOTE: Carefully lift the air conditioning unit up while watching the heater control cable on the right side of the unit. Lift the air conditioning unit just enough to clear the hole, and set the unit on the cab floor. If necessary, gently pull the heater control cable out of the right console. Upon reassembly, push heater control cable back into the right console.

12. Remove one bolt, spring washer, and lever (11), and disconnect the heater control lever from the shaft. Move the heater control cable out of the way so that it is not damaged when the air conditioning unit is removed.

NOTE: Lever (11) is not visible in the photograph. The lever is located on the side of the air conditioning unit.

NOTE: To install the air conditioning group, reverse the removal steps.

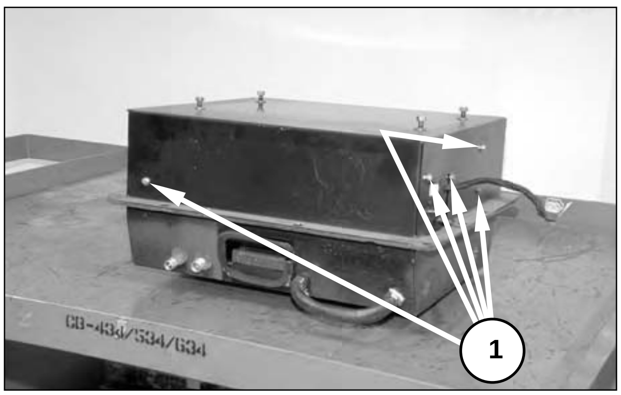
End By:

a. Install the seat assembly.

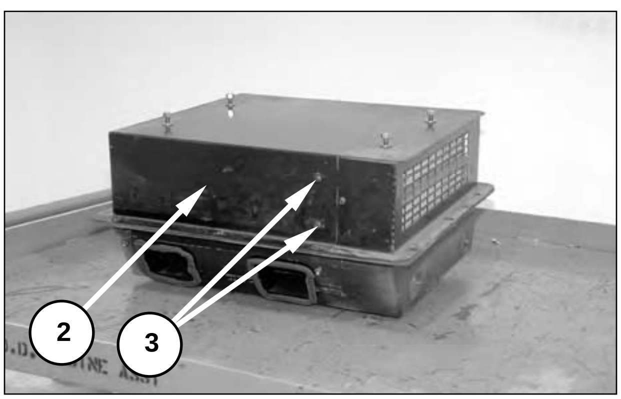
b. Install the SINCGARS bracket.

Disassemble and Assemble

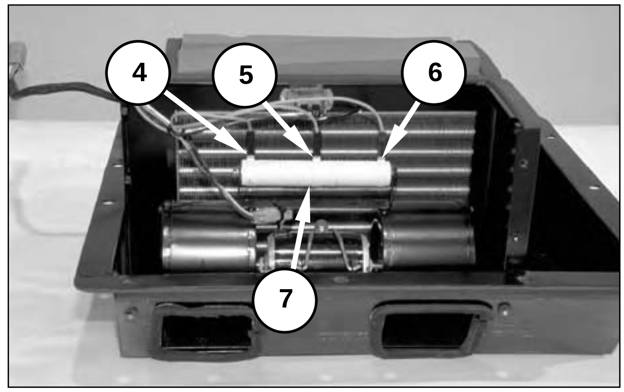
NOTE: The group number related to this procedure is 135-8787.



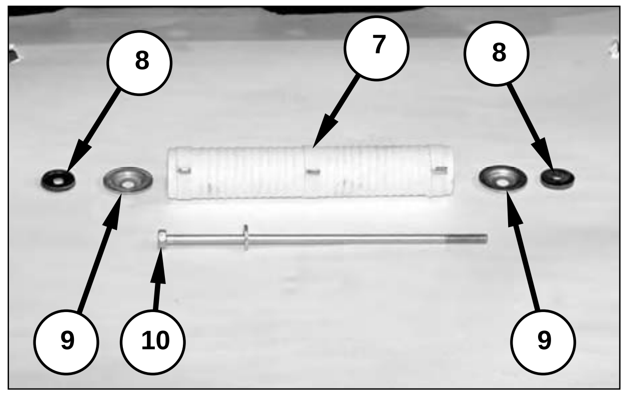
1. Remove five bolts (1) and washers.



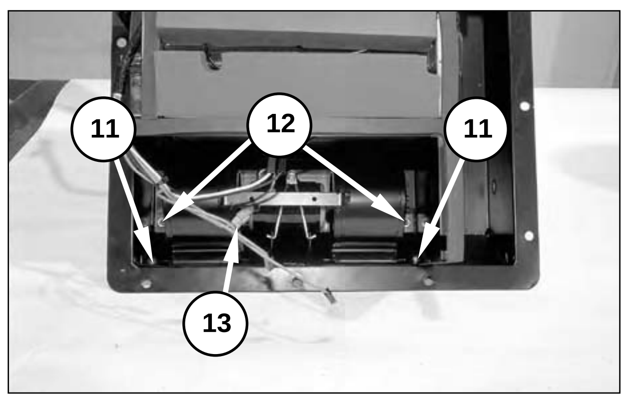
2. Remove two screws (3), and remove cover (2).



3. Disconnect 515-GY wire (4), 516-GN wire (5), and 517-BU wire (6) from resistor (7).



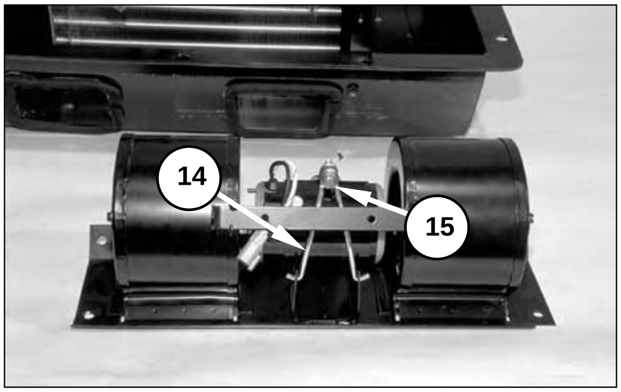
4. Remove bolt (10) and washer, and remove resistor (7) with metal washers (9) and rubber washers (8). During the assembly process, tighten bolt (10) so that resistor (7) is snug, but can still be turned by hand.



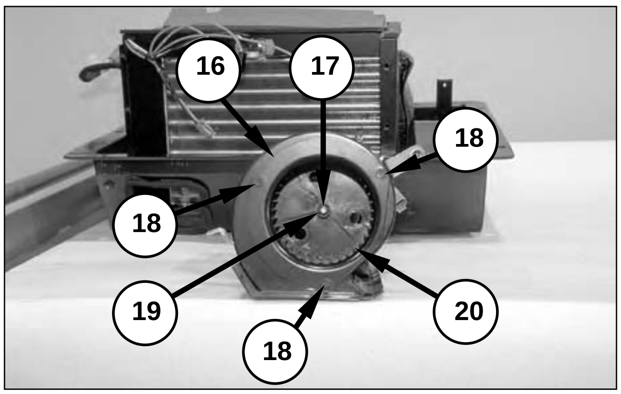
5. Disconnect blower motor connector (13).

NOTE: Blower motor connector (13) is a two-pin connector with a 200-BK wire at pin 1 and a 515-GY wire at pin 2.

6. Remove two bolts (11) with the washers, and two nuts (12) with the washers, and remove the motor bracket. Upon reassembly, tighten bolts (11) and nuts (12) to a torque of **12 ± 3 N•m (9 ± 2 lb ft).**



7. Remove bolt (15) with the nut and washers, and open motor clamp (14). During the assembly procedure, tighten the bolt to a torque of **4.5 ± 0.5 N•m (40 ± 4.5 lb in).**



8. Remove three screws (18) and plate (16).

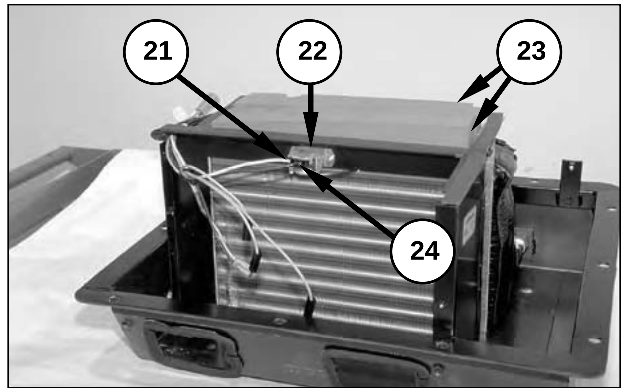
9. Remove clip (19) from both ends of shaft (17).

10. Remove blower wheel (20) from one end of shaft (17).

11. Remove the motor and the other blower wheel from the fan housing.

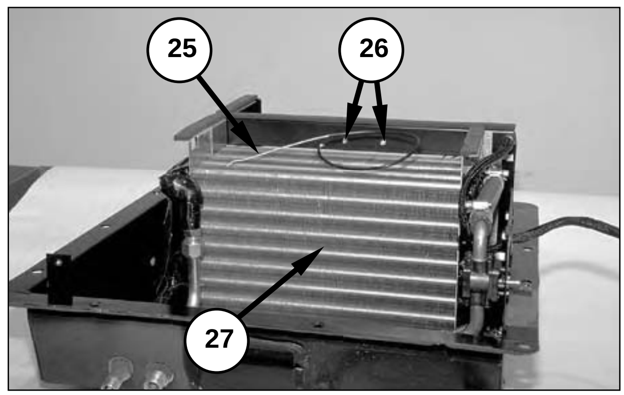
12. Remove the remaining blower wheel from shaft (17).

NOTE: During the assembly procedure, align the flat spot on shaft (17) with the flat spot on blower wheel (20). Center the motor between the two blower wheels.



13. Disconnect 522-WH-14 wire (21) and 200-BK-14 wire (24) from thermostat switch (22). Mark the wires for correct connection during reassembly.

14. Remove two insulation gaskets (23) from the top of the cores.

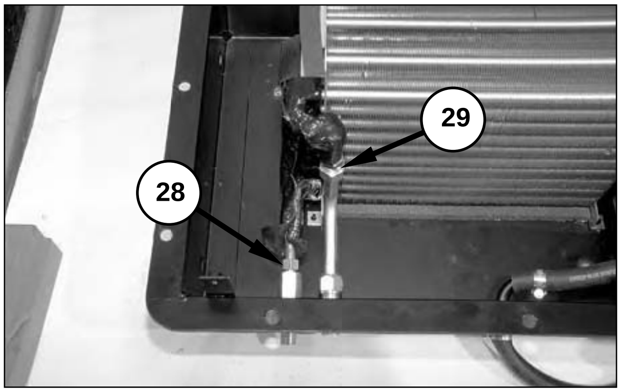


15. Remove capillary tube (25) from evaporator coil assembly (27). Upon reassembly, insert the capillary tube to a depth of **230 ± 10 mm (9 ± .4 in)** between the second and third rows of evaporator coil assembly (27).

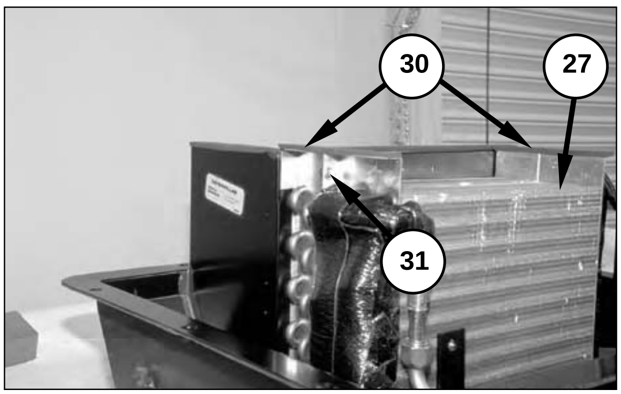
16. Remove two screws (26) with the lock washers, and remove thermostat switch (22). Upon reassembly, tighten the screws to a torque of **1.2 ± 0.2 N•m (10.7 ± 1.8 lb in)**.

NOTICE

Do not damage capillary tube (25) during disassembly or assembly.



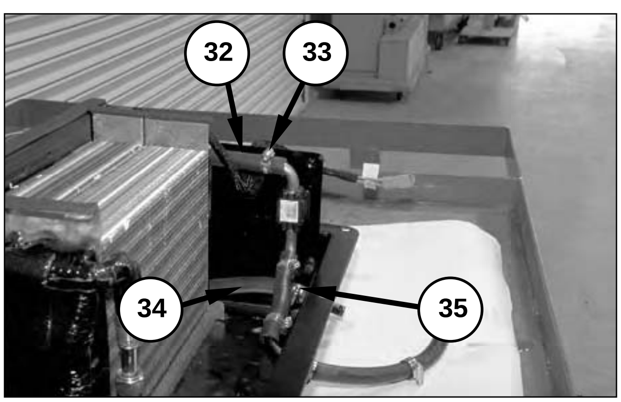
17. Disconnect tube (28) and tube (29). Upon reassembly, tighten the tubes to a torque of **12 ± 3 N•m (9 ± 2 lb ft)**.



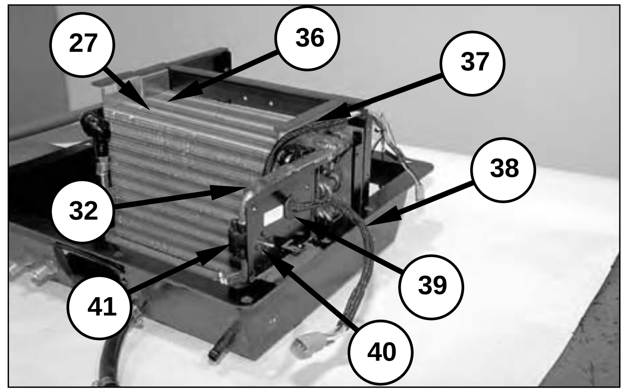
18. Remove bolt (31) and washer from the mounting brackets on both sides of evaporator coil assembly (27). Upon reassembly, tighten the bolts to a torque of **12 ± 3 N•m (9 ± 2 lb ft)**.

NOTE: Only one bolt (31) is shown. The other bolt is located in the mounting bracket on the opposite side of evaporator coil assembly (27), in the same relative position as bolt (31).

19. Remove seals (30) from the top of the mounting brackets on both sides of evaporator coil assembly (27).



20. Loosen hose clamp (33) on top hose (32), and loosen hose clamp (35) on bottom hose (34).



21. Remove four screws (40) on water valve assembly (41), and remove top hose (32). Upon reassembly, tighten the screws to a torque of **1.2 ± 0.2 N•m (10.7 ± 1.8 lb in)**.

22. Slide harness clip (37) out of the frame, and remove grommet (39) and harness (38).

23. Remove heater coil assembly (36), and remove bottom hose (34).

24. Remove evaporator coil assembly (27). Upon reassembly, align the pins on the bottom of the frame with the holes in the housing.

NOTE: To assemble the air conditioning group, reverse the disassembly steps.

Bulldozer Blade

Remove and Install

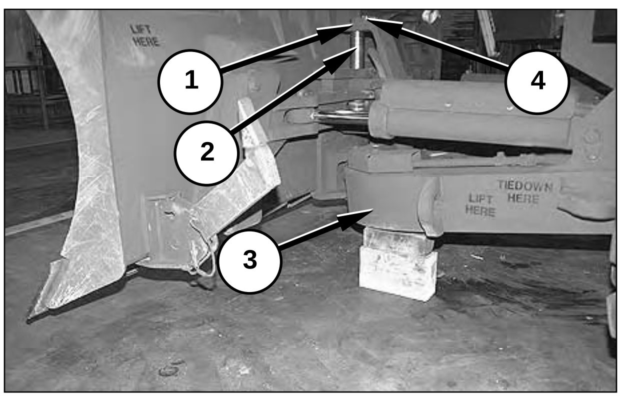
Start By:

a. Remove the tilt cylinder. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Hydraulic System,* “Tilt Cylinder.”

NOTE: Group numbers related to this procedure include 129-9252 and 133-4255.

⚠ WARNING

Make sure the machine is on level ground. Stop the engine, and move the blade control lever to make sure the weight of the bulldozer blade is on the ground. Move the control lever backward and forward to release the pressure in the hydraulic system. Slowly loosen the cap to release any pressure in the hydraulic tank. Let the hydraulic oil become cool before any lines are disconnected in the hydraulic system.



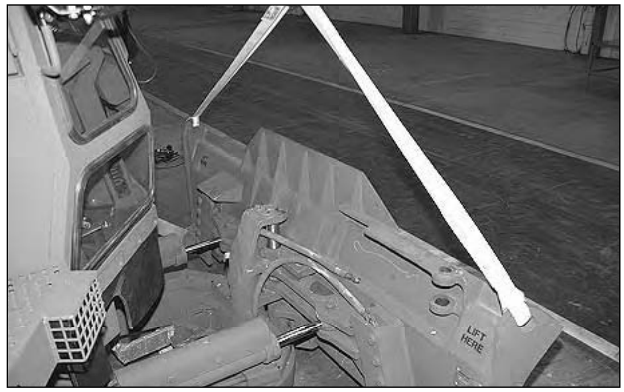
1. Reinstall pin (2) and retainer (1), which were removed with the tilt cylinder. Tighten bolts (4) to secure retainer (1).

NOTE: If necessary, pry on the singletree to align the holes and reinstall the pin.

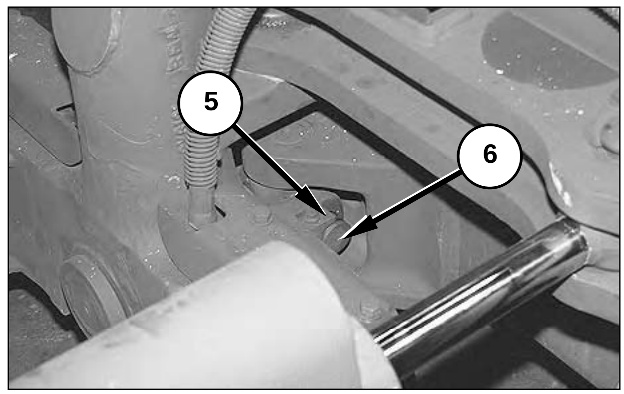
2. Start the machine, and use the blade lift circuit to raise the blade and install spacer blocks beneath C-frame (3) to hold the blade off the ground. Lower the blade. Stop the engine, and cycle the blade controls to release any pressure remaining in the system.

NOTICE

Do not operate the blade tilt circuit.

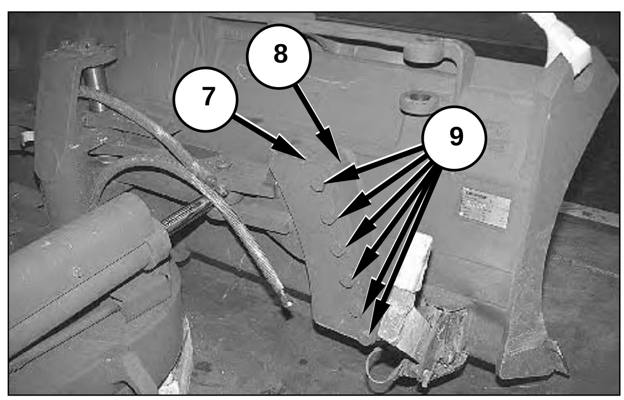


3. Install a hoist on the bulldozer blade. The weight of the blade is **748 kg (1650 lb).** Raise the hoist to support the weight of the blade.



4. Remove retainer bolt (5) and pin (6) from the bottom of the blade.

NOTE: Drive pin (6) from the right side of the machine.



5. Remove six bolts (9), two wear plates (7), and shims (8), from both sides of the blade. Mark the wear plates for correct placement during reassembly.

NOTE: Remove the top bolt of bolts (9) last to allow for controlled disassembly of wear plates (7) and shims (8).

6. Remove the blade from the machine. The weight of the blade is **748 kg (1650 lb).** Upon reassembly, add or subtract shims (8) to achieve a gap of **3 mm (0.12 in)** between the blade and the front wear plate (7).

NOTE: To install the bulldozer blade, reverse the removal steps.

End By:

a. Install the tilt cylinder.

Bulldozer C-Frame

Remove and Install

⚠ WARNING

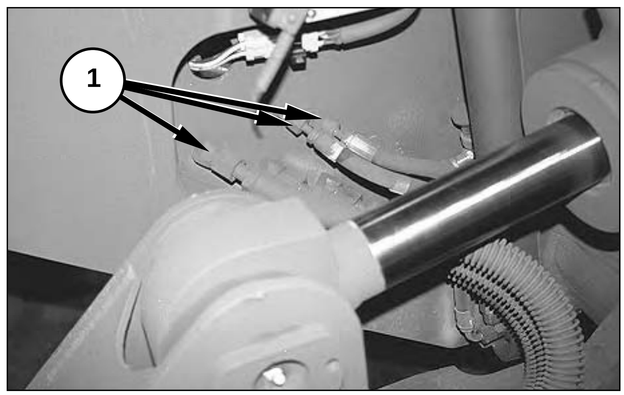
Make sure the machine is on level ground. Stop the engine, and move the blade control lever to make sure the weight of the bulldozer blade is on the ground. Move the control lever backward and forward to release the pressure in the hydraulic system. Slowly loosen the cap to release any pressure in the hydraulic tank. Let the hydraulic oil become cool before any lines are disconnected in the hydraulic system.

Start By:

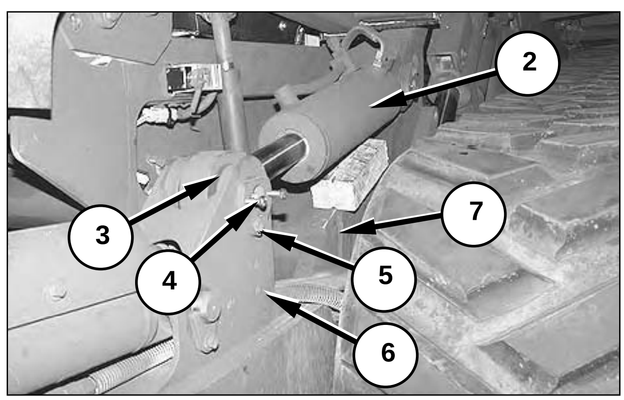
a. Remove the bulldozer blade.

b. Remove the singletree.

NOTE: Group numbers related to this procedure include 126-5857, 126-6557, and 133-4255.



1. Disconnect, cap and plug three lines (1) from each side of the machine. Mark each line for identification at reassembly.



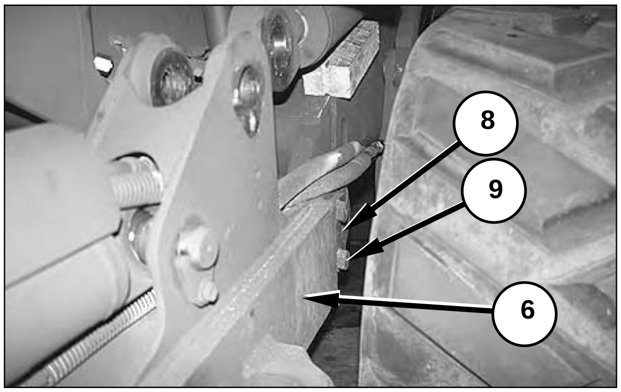
2. Install a suitable spacer between lift cylinder (2) and machine frame (7), on each side of the machine.

3. Remove bolt (5) with the washer and sleeve, and remove pin (4) with shims (3) from each side of C-frame (6). Note the position of all of the shims for use in reassembly.

NOTE: Puller holes are provided in pin (4) for **bolts (M10 X 30 mm)** to assist in removing the pin.

4. Start the engine and retract the lift cylinders.

5. Stop the engine and relieve the hydraulic pressure in the system. Refer to the warning at the beginning of this procedure.

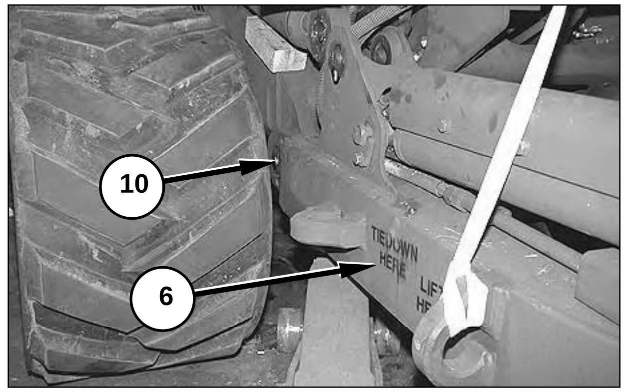


6. Remove bolts (9) and retainer (8) from both sides of C-frame (6).

7. Fasten a hoist to C-frame (6), and support the front of the C-frame with the hoist. The weight of the C-frame is **680 kg (1500 lb).**

NOTICE

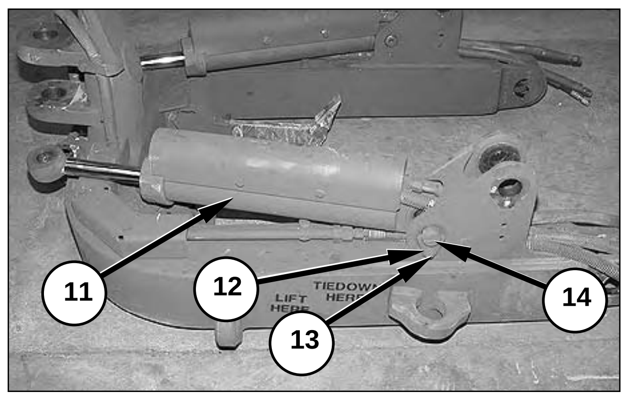
Do not break the cab window when fastening and operating the hoist to lift the C-frame.



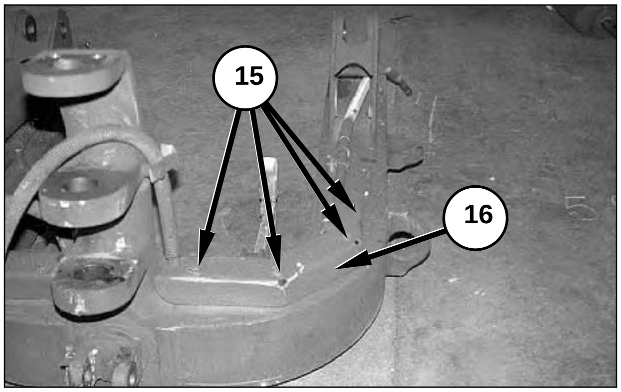
8. Install a jack beneath each side of the C-frame to support the pin end. Remove pin (10) and shims from each side of C-frame (6). Mark the shims for correct installation during reassembly.

9. Remove C-frame (6). The weight of the C-frame is **680 kg (1500 lb).**

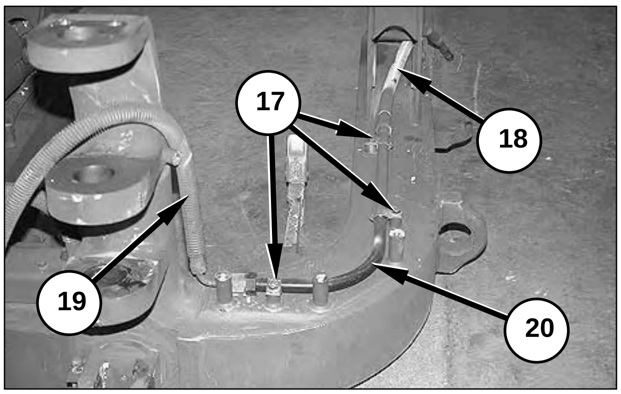
NOTE: If necessary, remove and replace the bearing which is located in the bore in the machine frame. To reinstall the bearing, cool the bearing to **-54°C (-130°F)**, and use a suitable press to push the bearing into the bore.



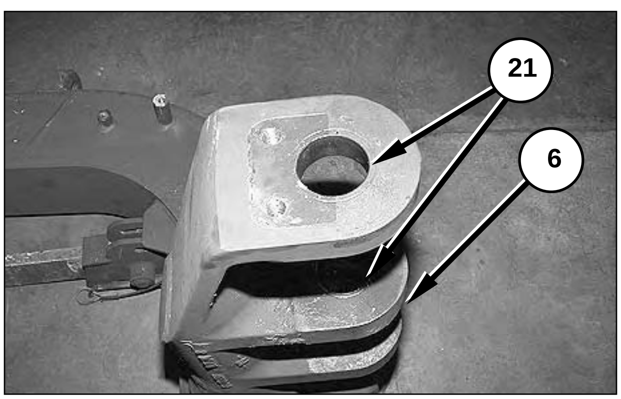
10. Remove bolt (13) with the washer, retainer (12), pin (14) and two spacers. Use a hoist to remove angle cylinder (11). The weight of the cylinder is **50 kg (110 lb)**. Repeat this step for both sides of the C-frame. Upon reassembly, apply **4C-4030 Compound (Loctite™ 242)** to bolt (13), and coat the pin bores with **7X-7699 Grease**.



11. Remove four bolts (15) and washers, and remove cover (16).



12. Remove three bolts (17) with the washers, and remove the brackets. Remove hoses (18) and (19), and tube (20).



13. If necessary, use a puller to remove and replace three bushings (21) in C-frame (6).

NOTE: To install the bulldozer C-frame, reverse the removal steps.

End By:

a. Install the singletree.

b. Install the bulldozer blade.

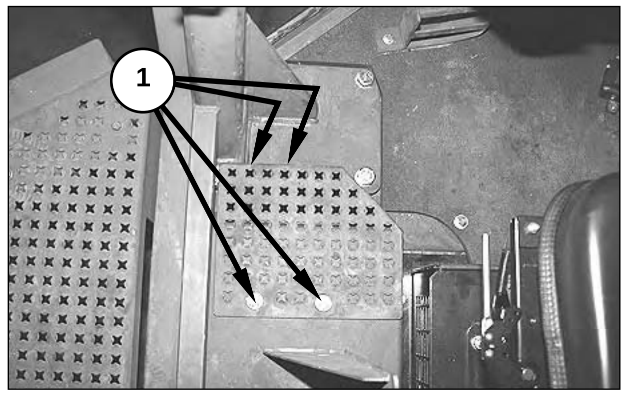
Cab Assembly

Remove and Install

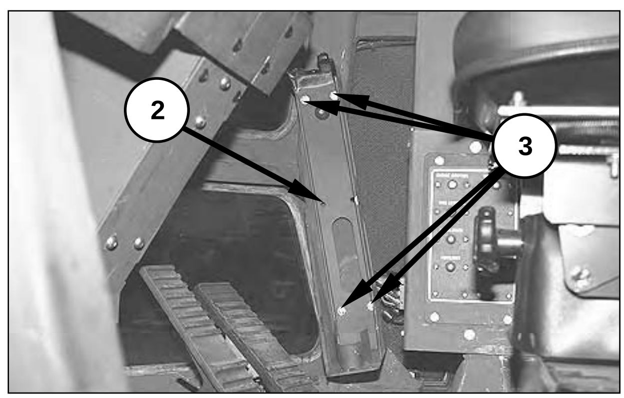
NOTE: Group numbers related to this procedure include 144-8532, 145-0425, and 152-7542.

NOTE: Park the machine on a level surface to remove the top half of the cab. If the machine is not level, there is an increased chance of a window breaking during the procedure.

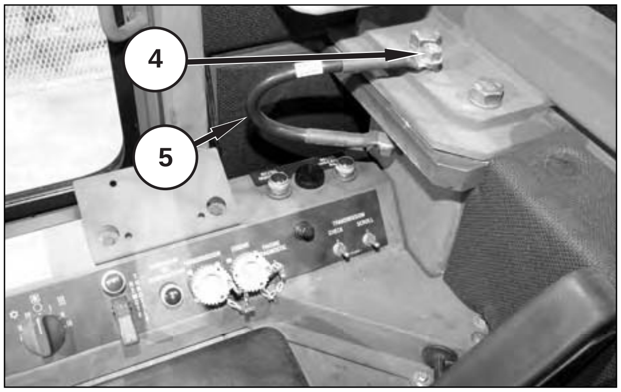
1. Turn the main disconnect switch to the OFF position. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Machine Features, Main Disconnect Switch."



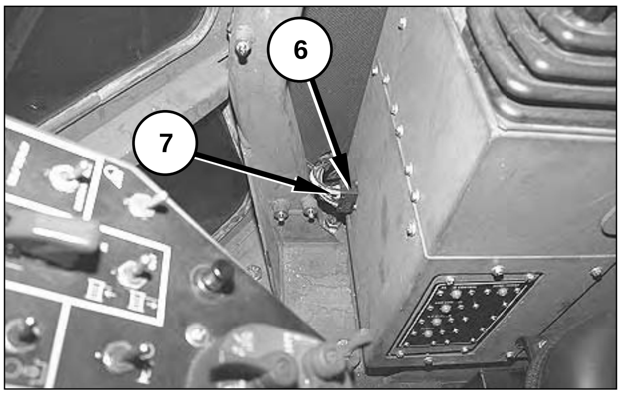
2. Remove four bolts (1) and the washers, and the tread plate.



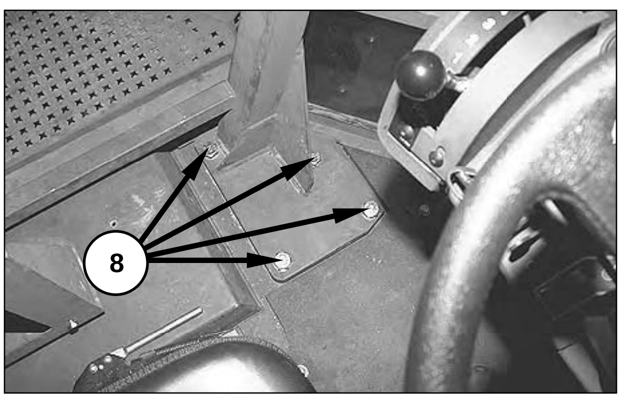
3. Remove four bolts (3) with the washers, and rifle bracket (2).



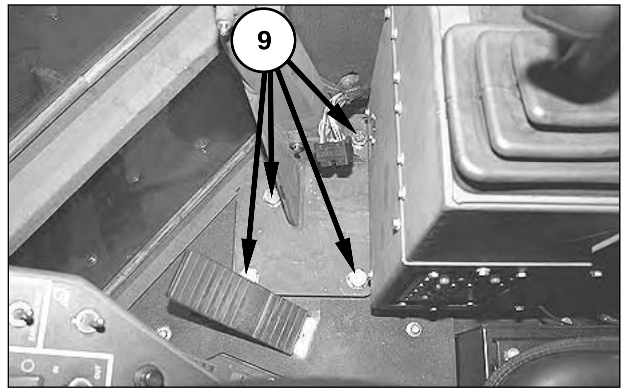
4. Remove one nut (4) with the washers, and disconnect ground cable (5) from the ground stud.



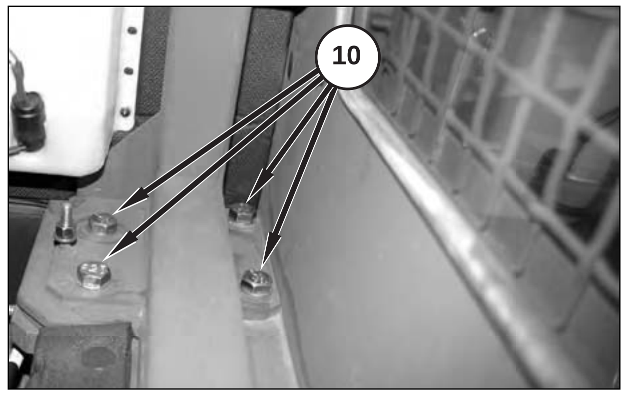
5. Loosen one screw (7), and disconnect connecter (6).



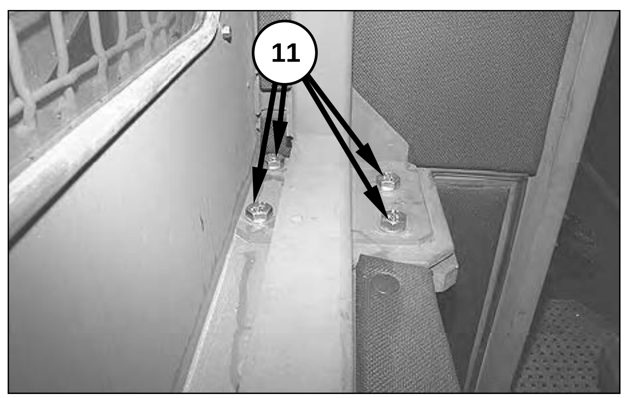
6. Remove four bolts (8) and washers in the left front corner of the cab.



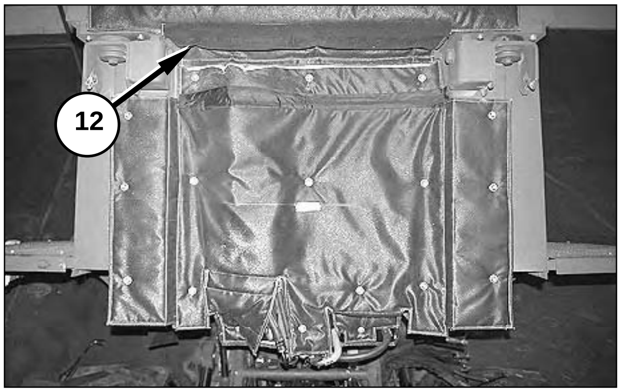
7. Remove four bolts (9) and washers in the right front corner of the cab.



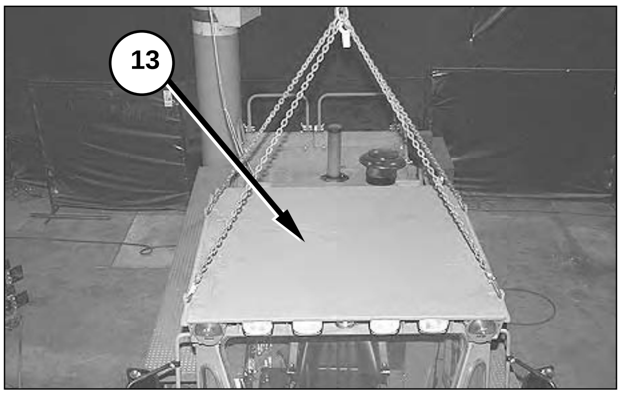
8. Remove four bolts (10) and washers from the right rear corner of the cab.



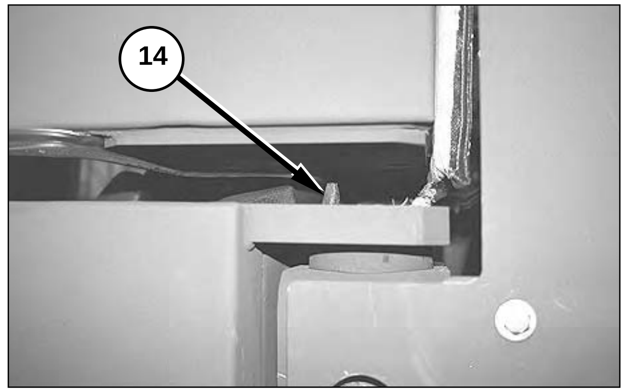
9. Remove four bolts (11) and washers from the left rear corner of the cab.

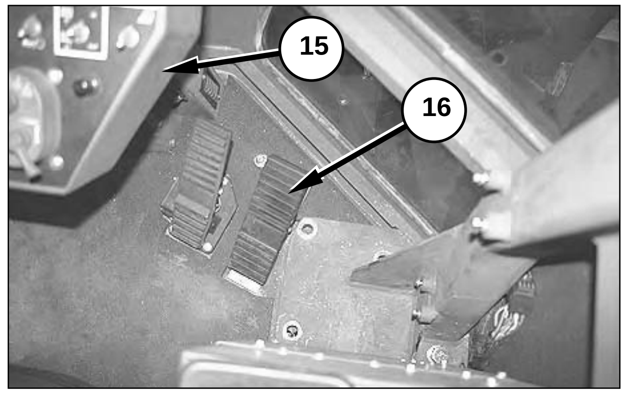


10. Detach the insulation cover on the back of the cab at seam (12).



11. Attach a hoist to cab (13). The weight of the upper cab is approximately **431 kg (950 lb).**



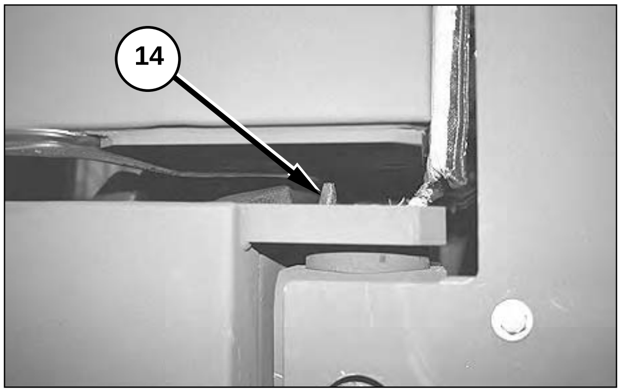


12. Lift the cab vertically for approximately **25 mm (1 in)** to allow the mounting pads in the upper cab to clear guide pins (14) at the rear of the cab platform. Once the cab has cleared the guide pins, slowly move the cab forward until the cab has cleared accelerator pedal (16), and then remove the cab.

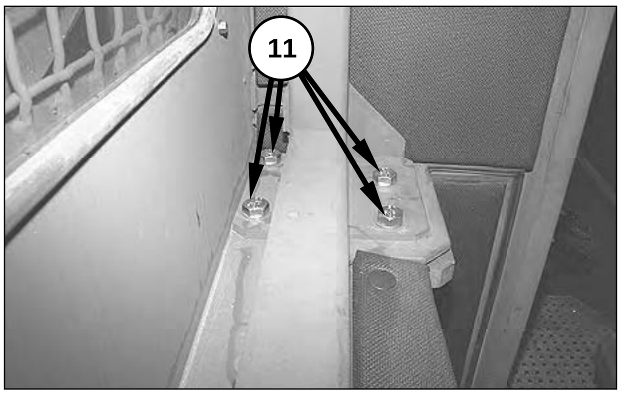
NOTE: Pay close attention when lifting the cab away from the platform. Make sure that the cab does not damage accelerator pedal (16), instrument console (15), or the back of the operator's seat.

NOTE: The following steps are for reinstalling the cab assembly.

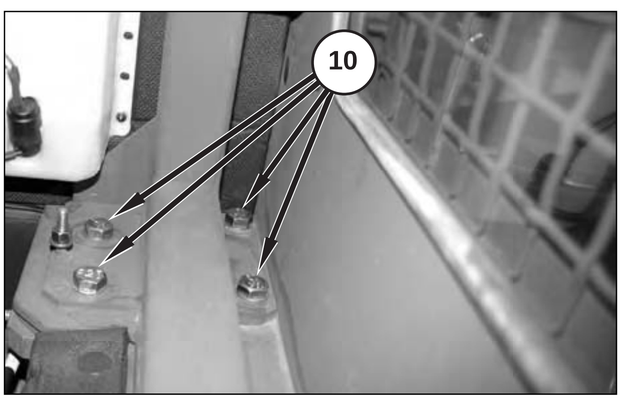
NOTE: Before the cab is replaced, the integrity of the seals between the cab and the platform should be checked. Replace the seals if necessary. Reseal any areas that may leak with **4C-9613 RTV Silicone-Clear**.



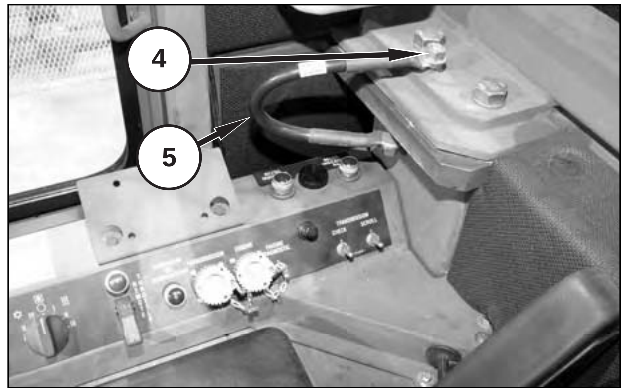
13. Lower cab (13) onto guide pins (14) at the rear of the cab platform.



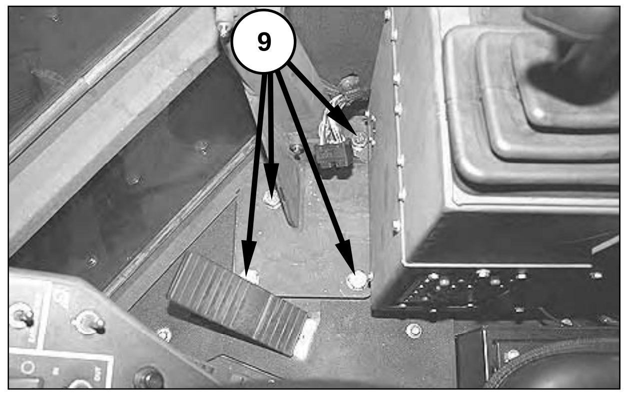
14. Install four bolts (11) and washers in the left rear corner of the cab. Tighten bolts to a torque of **460 ± 60 N•m (340 ± 45 lb ft).**



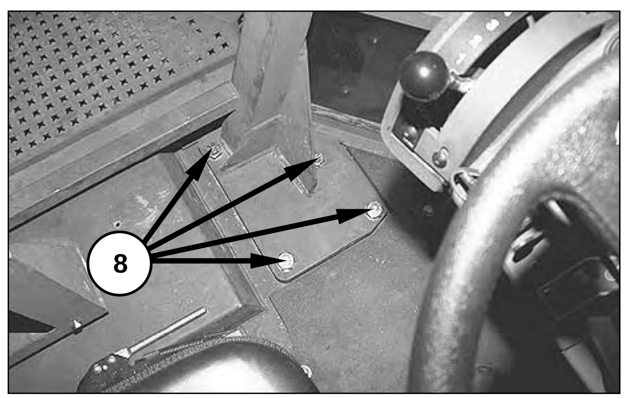
15. Install four bolts (10) and washers in the right rear corner of the cab. Tighten bolts to a torque of **460 ± 60 N•m (340 ± 45 lb ft).**



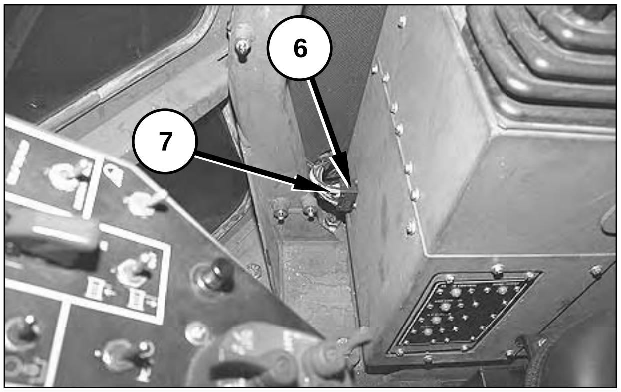
16. Connect ground cable (5) to the ground stud, and install nut (4) with the washers.



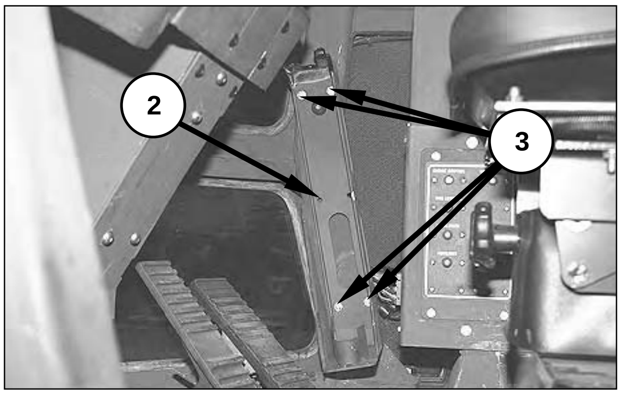
17. Install four bolts (9) and washers in the right front corner of the cab. Tighten bolts to a torque of **460 ± 60 N•m (340 ± 45 lb ft).**



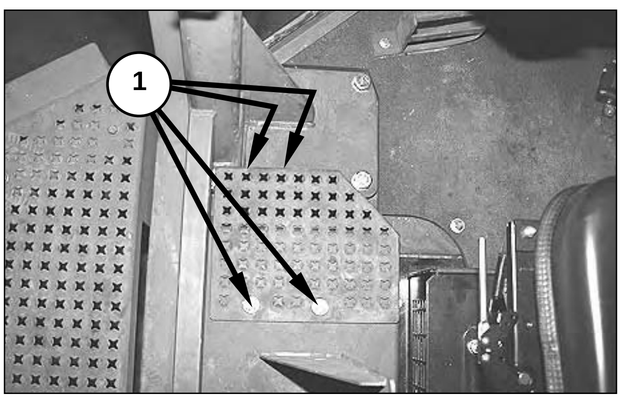
18. Install four bolts (8) and washers in the left front corner of the cab. Tighten bolts to a torque of **460 ± 60 N•m (340 ± 45 lb ft).**



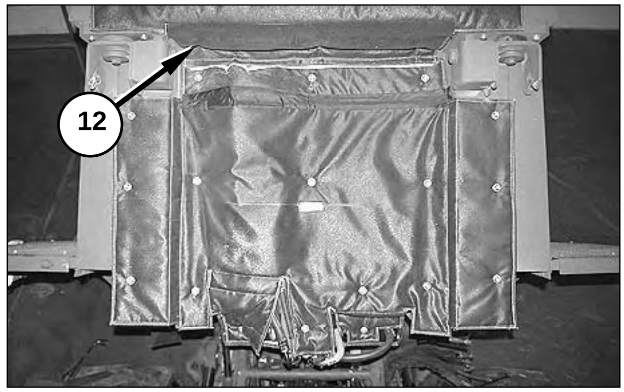
19. Connect connector C108 (6), and tighten screw (7) to a torque of **0.9 N•m (8 lb in).**



20. Install four bolts (3) and washers, and rifle bracket (2).



21. Install four bolts (1) with the washers, and the tread plate.



22. Attach the insulation cover at seam (12).

Cab Platform

Remove and Install

NOTE: Group numbers related to this procedure include 143-7782 and 145-0425.

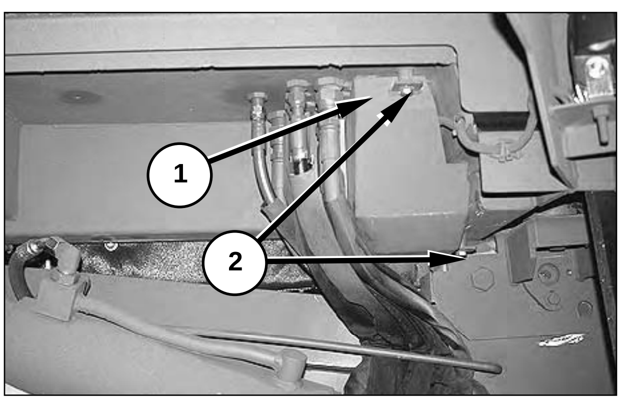
⚠ WARNING

Make sure the machine is on level ground. Stop the engine, and move the blade control lever to make sure the weight of the bulldozer blade is on the ground. Move the control lever backward and forward to release the pressure in the hydraulic system. Depress the brake pedal at least 120 times to release the pressure in the brake accumulator. Slowly loosen the cap to release any pressure in the hydraulic tank. Let the hydraulic oil become cool before any lines are disconnected in the hydraulic system.

1. Turn the main disconnect switch to the OFF position. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Machine Features, Main Disconnect Switch."

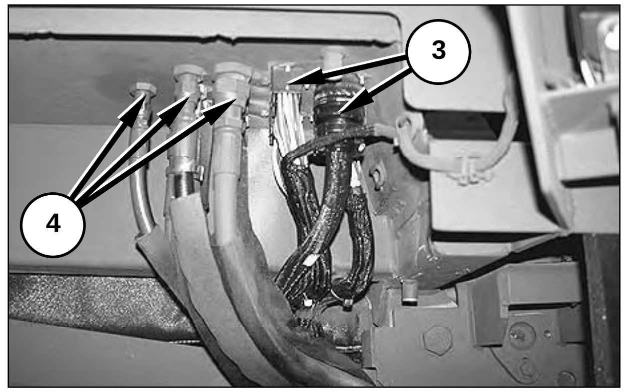
2. Drain the hydraulic tank. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Every 1000 Service Hours or One Year, Hydraulic System, Change Oil and Clean Suction Screens."

3. Recover the refrigerant from the air conditioning system. Refer to *Specifications Systems Operation Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Machine Systems,* "Recovering the Refrigerant."



4. Remove three bolts (2) with the washers, and remove cover (1) on the right side of the machine.

NOTE: Only two of three bolts (2) are visible.

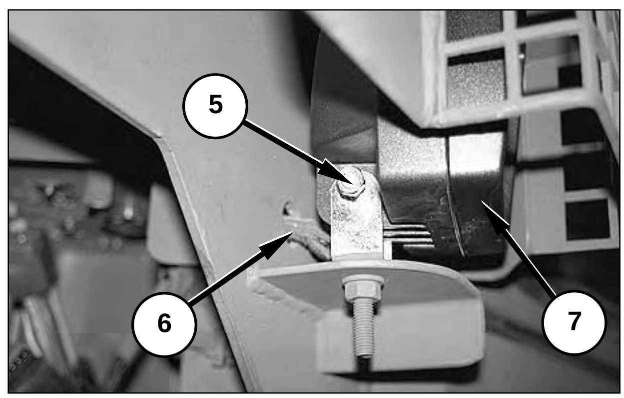


5. Disconnect four connectors (3) (only two visible in photo). Mark the three rectangular 40-pin connectors for the correct location upon reassembly.

NOTE: The rectangular connector numbers are: front left—C103, rear left—C105, and rear right—C104.

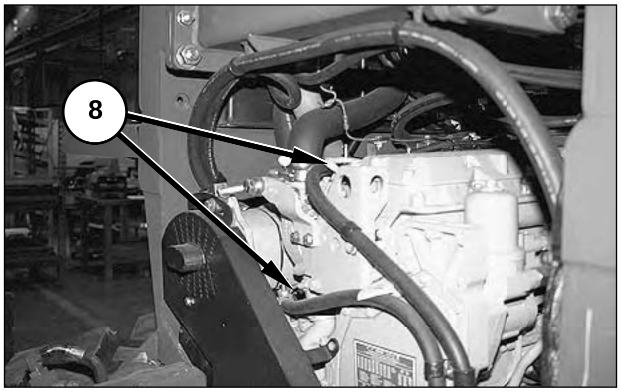
6. Disconnect, cap and plug nine hoses (4). Mark each hose for correct location upon reassembly.

NOTE: Make sure to cap and plug hoses (4) quickly to minimize oil spillage. Catch any spilled oil in a suitable container, and discard the oil according to local regulations.

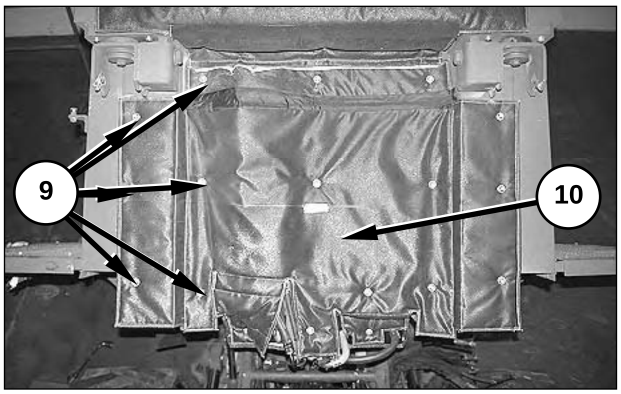


7. Remove bolt (5), and disconnect light assembly (7) from wiring harness (6) at the front of the machine on both sides. Pull the wiring harness out of the mounting box for the light assembly.

8. Tilt the cab. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Features, Cab Tilt."

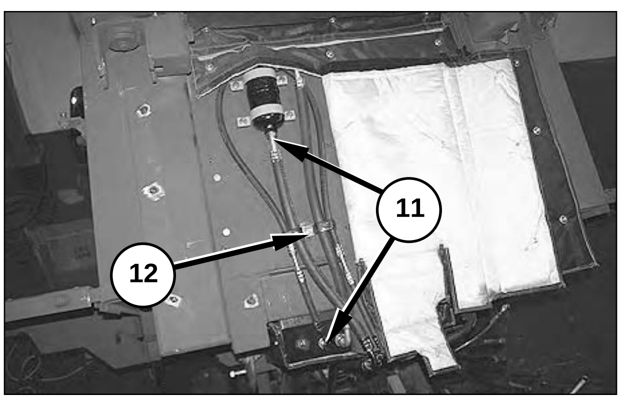


9. Close coolant valves (8) by turning the knobs fully clockwise.



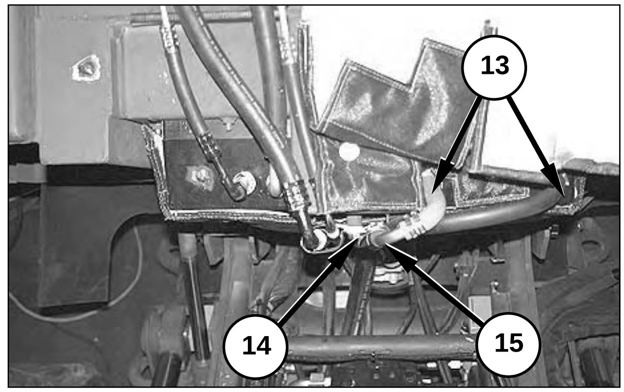
10. Remove six caps (9), and roll insulation (10) over.

NOTE: Replace any **6P-2216 Caps** (9) which are damaged in removal.



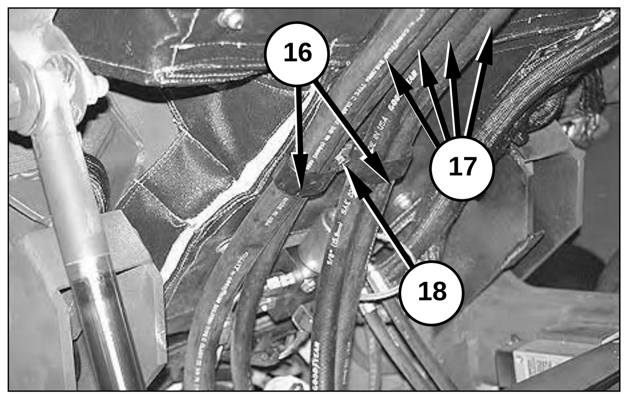
11. Remove bolt (12).

12. Disconnect, cap, and plug two lines (11).

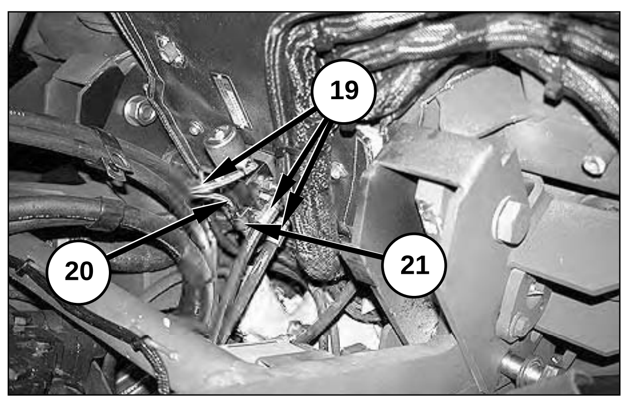


13. Disconnect two coolant lines (13). Catch any remaining coolant in a suitable container. Dispose of the coolant according to local regulations.

14. Remove bolt (14) with the washer, and remove clamp (15).



15. Remove bolt (18) with the washer, and remove two clamps (16). Move four lines (17) out of the way.

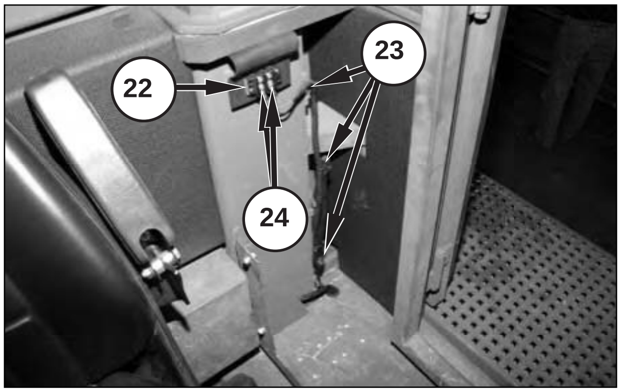


16. Disconnect, cap, and plug four lines (19) (only three shown in photo) from steering control solenoid valve (20). Mark the lines for correct location upon reassembly.

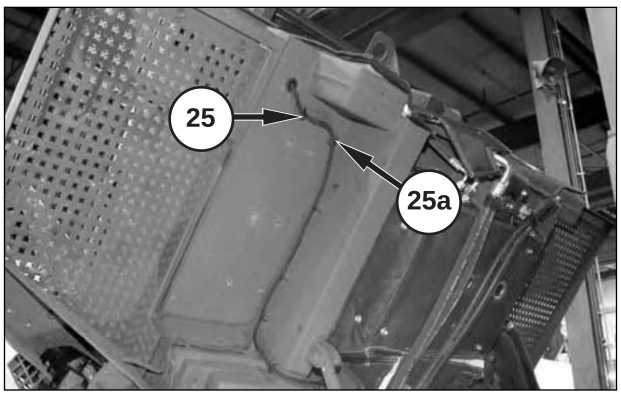
NOTE: Make sure to cap and plug lines (19) quickly to minimize oil spillage. Catch any spilled oil in a suitable container, and discard the oil according to local regulations.

17. Disconnect steering solenoid connector (21).

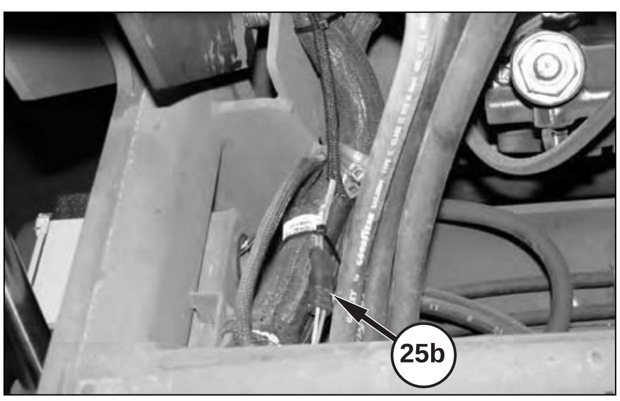
NOTE: Steering solenoid connector (21) is a two-pin connector with a F881-OR wire at pin 1 and a 200-BK wire at pin 2.



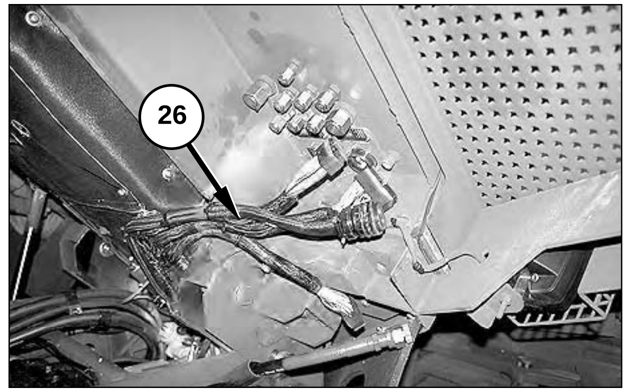
18. Cut tie wraps (23), and disconnect two terminals (24) from SINCGARS power strip (22).



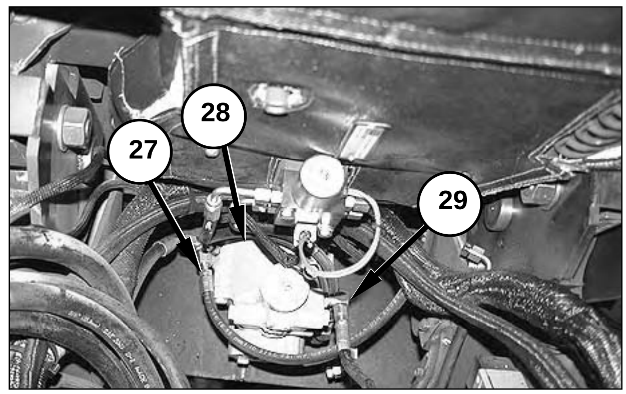
19. Cut the tie wraps on wires (25) and (25a). Separate the wires from the cab platform.



20. Unplug recoil alert connector (25b), located under cab platform.

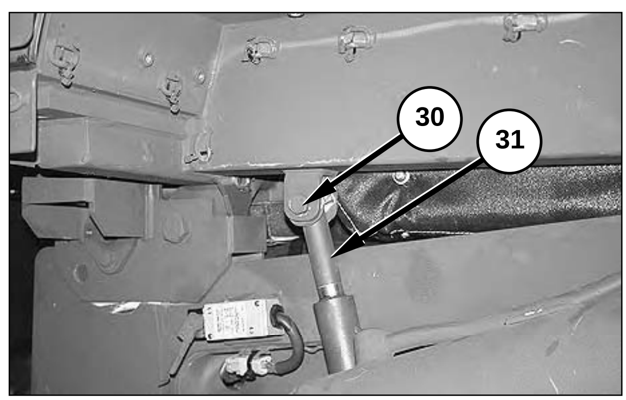


21. Cut the tie wraps on wire (26), and separate the wire from the cab platform.



21. Disconnect, cap, and plug lines (27) and (29) from steering control valve (28).

NOTE: Make sure to cap and plug the lines quickly to minimize oil spillage. Catch any spilled oil in a suitable container, and discard the oil according to local regulations.



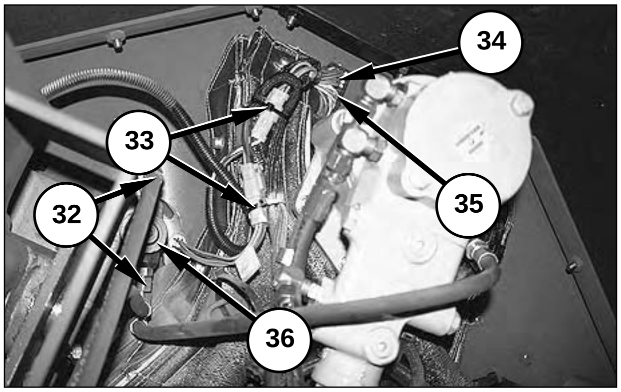
22. Lower the cab.

NOTICE

Make sure all hydraulic and electrical lines are clear of any pinch points when the cab is lowered. The cab comes down quickly at the end, so make sure the pinch points are clear before the cab is lowered.

NOTE: Do not install the rear cab retention bolts at this time.

23. Remove bolt (30) with the washers and spacers, and move lift cylinder (31) out of the way.



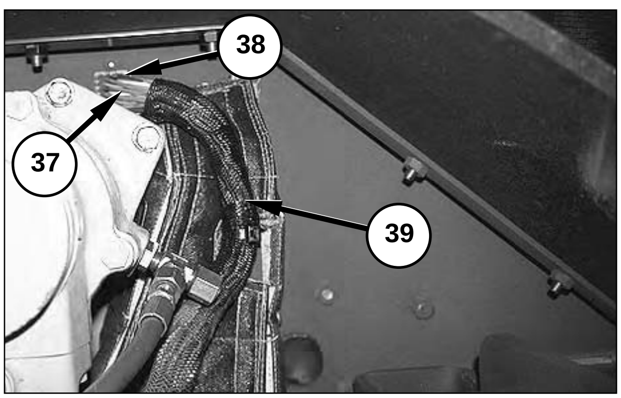
24. Disconnect, cap and plug two lines (32) on brake valve assembly (36). Mark the lines for correct connection upon reassembly.

NOTE: Make sure to cap and plug lines (32) quickly to minimize oil spillage. Catch any spilled oil in a suitable container, and discard the oil according to local regulations.

25. Disconnect connectors SW21 and C115 (33).

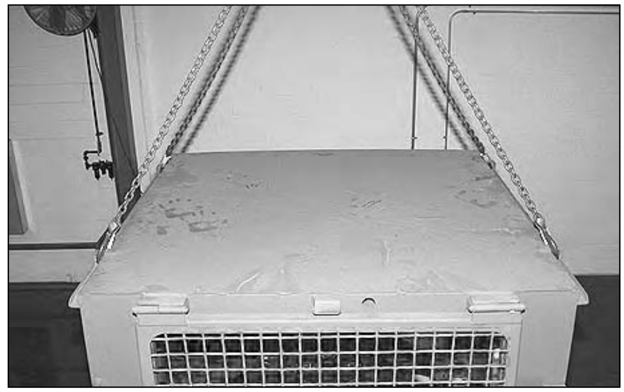
NOTE: Connector SW21 is a four-pin connector in the line to the service brake switches, and connector C115 is a three-pin connector in the line to the throttle position sensor.

26. Loosen bolt (35) and disconnect connector C101 (34).

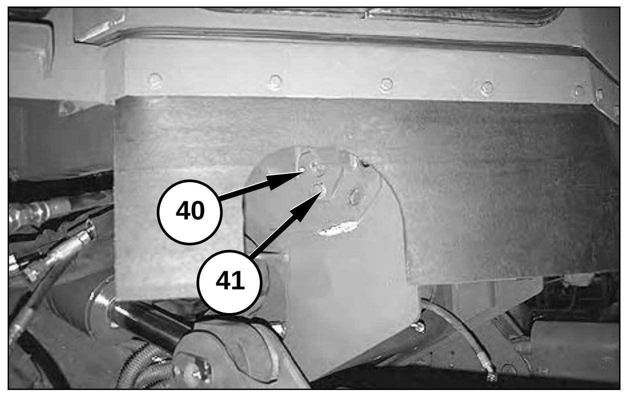


27. Loosen bolt (37) and disconnect connector C102 (38).

28. Pull harness (39) free of the brake line to ensure that the brake line is not damaged when the cab is lifted.



29. Support the cab assembly with a hoist. The weight of the cab assembly is approximately **680 kg (1500 lb).**



30. On each side of the platform, remove bolt (41) with the washer and spacer, and remove pin (40). Upon reassembly, apply **4C-4030 Compound (Loctite™ 242)** to the threads of bolt (41), and apply a thin coat of **5P-0960 Multipurpose Grease** to pin (40).

31. Remove the cab assembly with the platform.

NOTE: To reinstall the cab platform, reverse the removal steps.

Engine Coolant Heater (If Equipped)

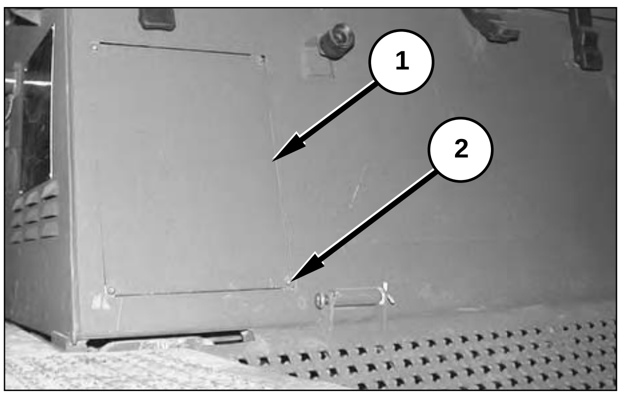
Remove and Install

Start By:

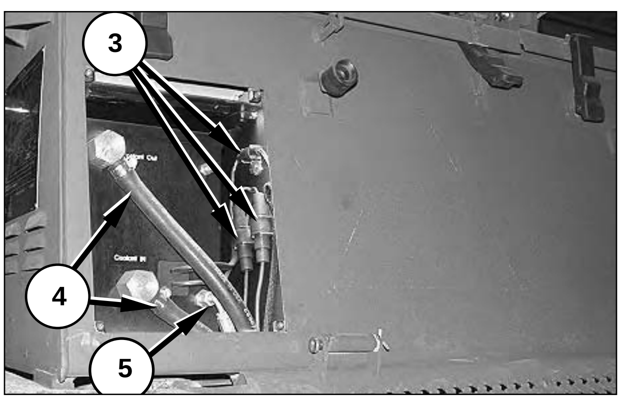
a. Remove the arctic battery box (if equipped). Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* "Arctic Battery Box."

NOTE: Group numbers related to this procedure include 1Q-4311 and 144-7867.

1. Turn the main disconnect switch to the OFF position. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Machine Features, Main Disconnect Switch."



2. Remove four screws (2) and cover (1).



3. Disconnect the C401, C411, and C421 connectors (3). Mark the connectors for correct location during reassembly.

NOTE: The C401 connector is a one-pin connector with the G799-RD-10 wire on the machine harness side of the connector and a 10-gauge red wire on the heater side of the connector. The C411 connector is a one-pin connector with the 200-BK-10 wire on the machine harness side of the connector and a 10-gauge black wire on the heater side of the connector. The C421 connector is a three-pin connector with 102-RD, 103-YL, and 104-BR wires on the machine harness side of the connector. Refer to *Schematic, Deployable Universal Combat Earthmover (DEUCE), Electrical Schematic.*

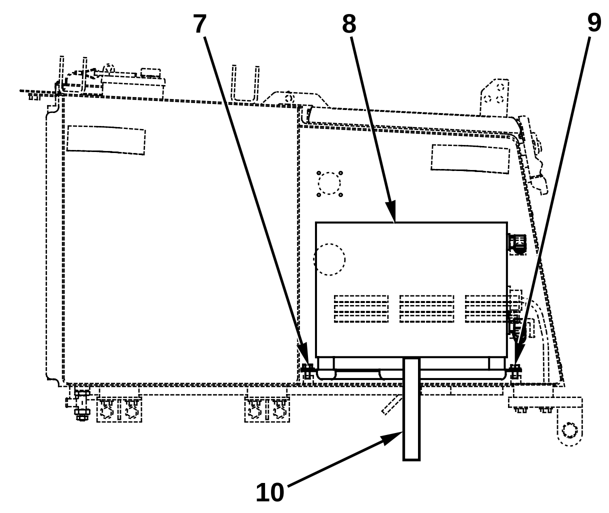
4. Disconnect, cap and then plug two coolant lines (4) and one fuel line (5). Mark the coolant lines for correct connection during reassembly.

NOTE: Some coolant may leak from lines (4) when they are disconnected. Catch the coolant in a suitable container, and dispose of the liquid according to local regulations. The two coolant lines are not the same length. The longer of the two lines is the "coolant out" line (top port on heater), and the shorter line is the "coolant in" line (bottom port on heater).

5. Disconnect, cap and then plug fuel line (5).

NOTE: Some fuel may leak from line (5) when it is disconnected. Catch the fuel in a suitable container, and dispose of the liquid according to local regulations.

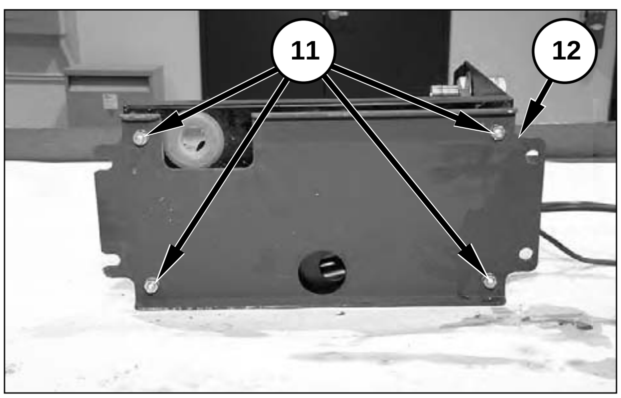
6. Remove plug (6).



7. Remove two bolts (9) and washers, and loosen but do not remove one bolt (7) with the washer.

8. Remove coolant heater unit (8). Push exhaust tube (10) through the hole in the bottom of the compartment, as the coolant heater unit is removed.

NOTE: Ensure that exhaust tube (10) is placed through the hole in the bottom of the compartment when the heater is installed.



9. Remove four nuts (11) with the washers, and remove plate (12).

NOTE: To install the coolant heater, reverse the removal steps.

End By:

a. Install the arctic battery box (if equipped).

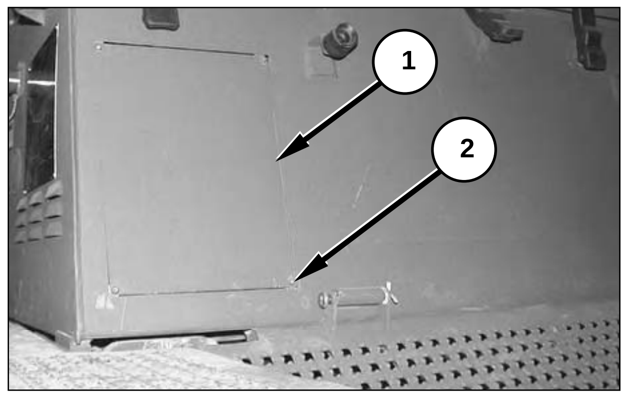
Initial Installation of Engine Coolant Heater

NOTE: All machines are configured to accept engine coolant heaters.

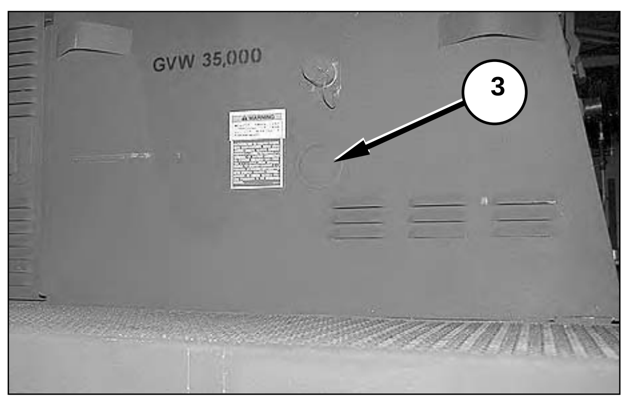
Start By:

a. Remove the arctic battery box (if equipped). Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* "Arctic Battery Box."

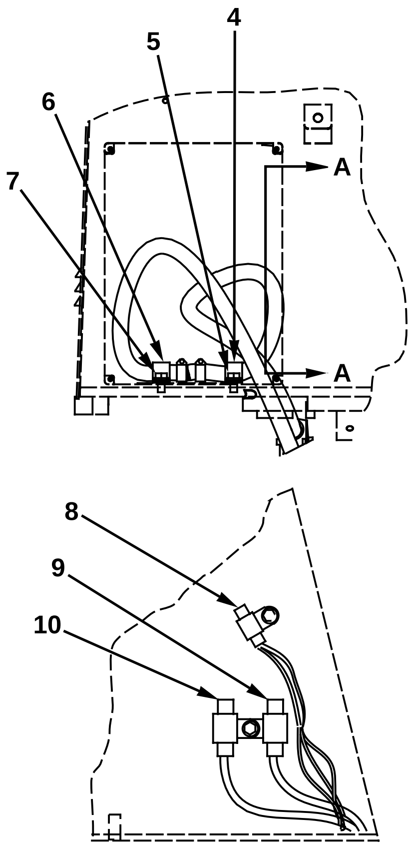
1. Turn the main disconnect switch to the OFF position. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Machine Features, Main Disconnect Switch."



2. Remove four screws (2) and cover (1).



3. Remove plug (3).



VIEW A-A

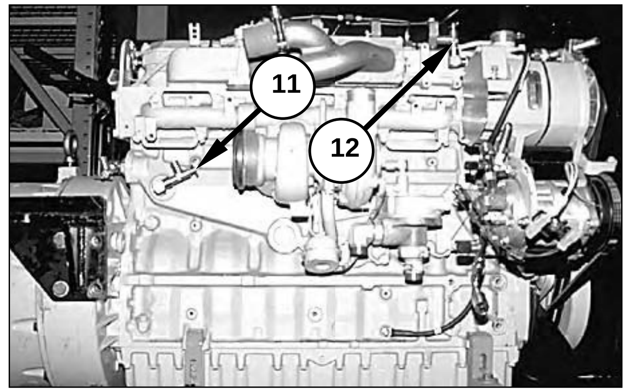
4. Remove bolt (5) and washer, and remove clip (4).

5. Remove bolt (7) and washer, and remove clip (6).

6. Inspect connectors C421 (8), C401 (9), and C411 (10) for corrosion or damage. Clean or replace the connectors, if necessary.

7. Perform the engine coolant heater installation procedure.

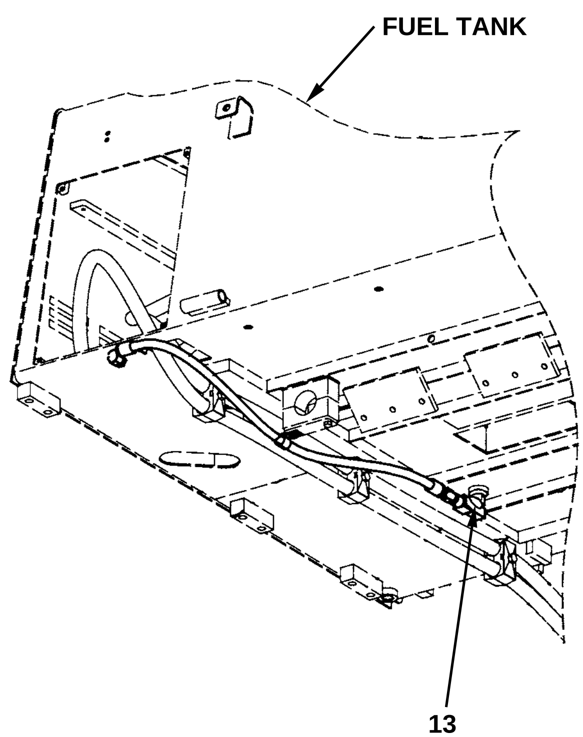
8. Raise the radiator. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* “Operation Section, Maintenance Features, Radiator Tilt.”



Engine Removed From Machine for Photographic Purposes.

9. Open coolant valves (11) and (12).

10. Lower the radiator.



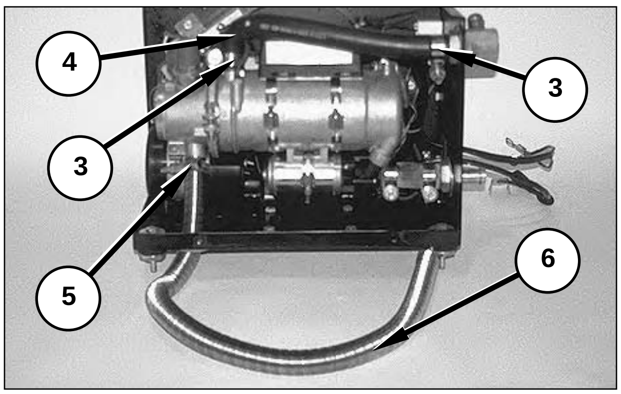
11. Open fuel valve (13) on the bottom left side of the fuel tank.

End By:

a. Install the arctic battery box (if equipped).

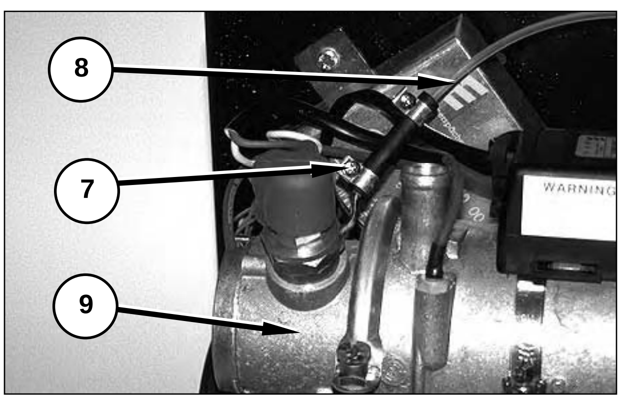
Disassemble and Assemble

1. Remove two bolts (1) with the washers, and remove top cover (2).

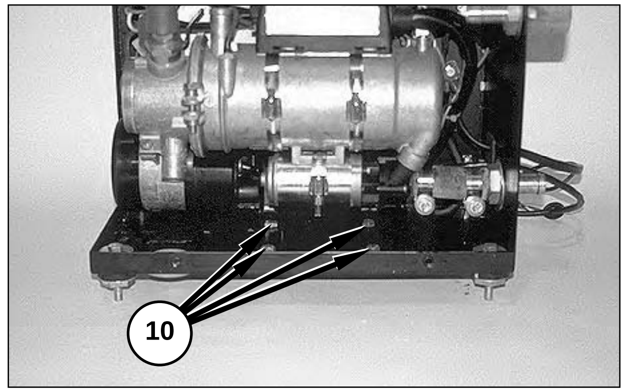


2. Loosen two clamps (3) and remove outlet hose (4).

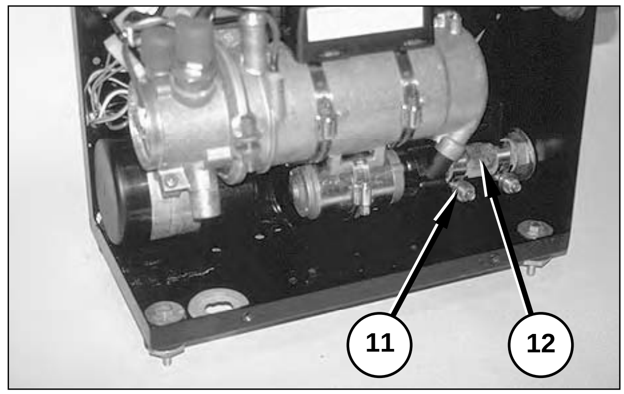
3. Loosen clamp (5) and remove exhaust pipe (6).



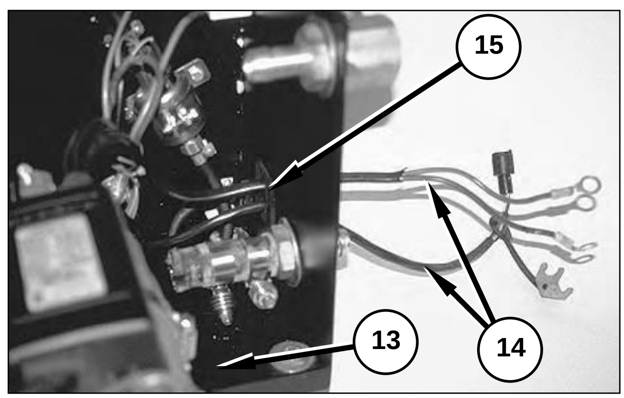
4. Loosen screw (7), and disconnect fuel line (8) from burner assembly (9).



5. Remove four bolts (10) with the nuts and washers.

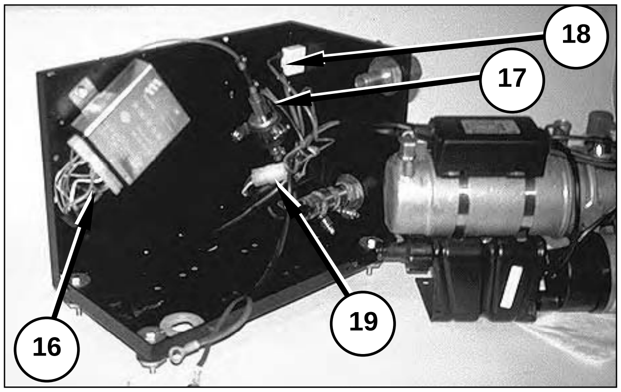


6. Loosen clamp (11) on inlet hose (12).



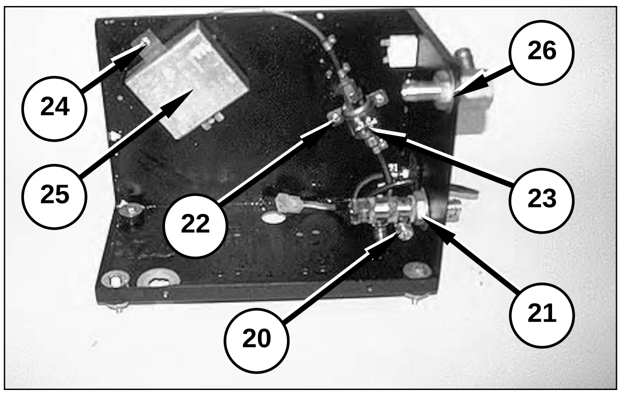
NOTE: Wires (14) are shown without the connectors. The connectors do not need to be removed to perform Step 7.

7. Slide the heater assembly away from bottom base (13). Remove grommet (15), and pull wires (14) through the hole, towards the inside of the unit.



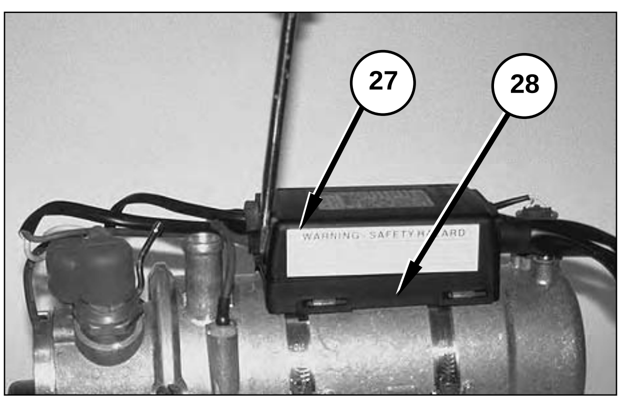
8. Mark and disconnect four control unit connectors (16) and two fuel pump connectors (17).

9. Mark and disconnect two circuit breaker connectors (18) and harness connector (19).

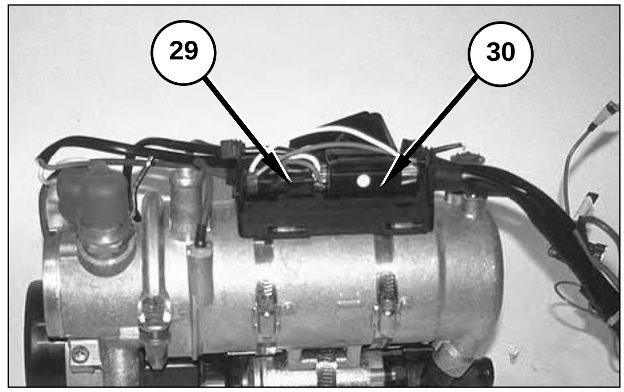


10. Loosen clamp (20) and remove the inlet hose. Remove the nut and lower bulkhead hose connector (21). Remove two bolts (22) with the nuts and washers, and fuel pump (23).

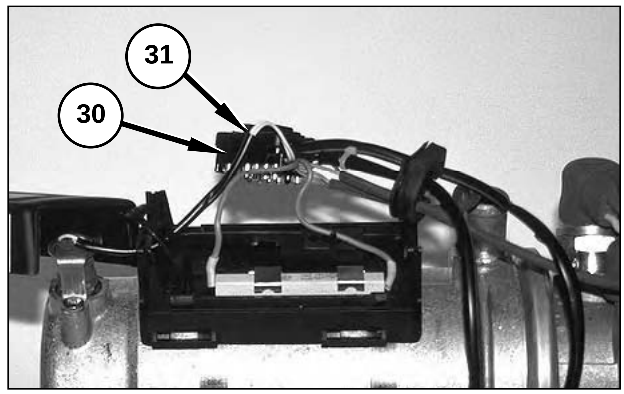
11. Remove two bolts (24) with the washers, and control unit (25). Remove nut and upper bulkhead hose connector (26).



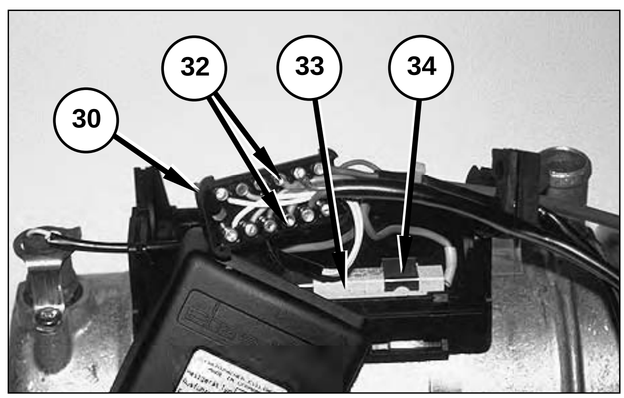
12. Use a screw driver to remove cover (27) from bracket (28). Upon reassembly, ensure that all grommets are properly positioned.



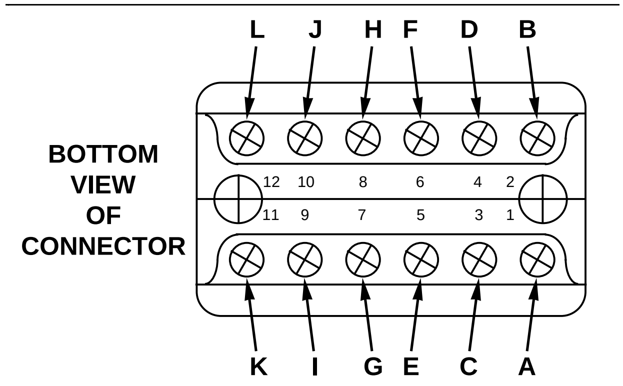
13. Remove and disconnect connectors (29) and (30).



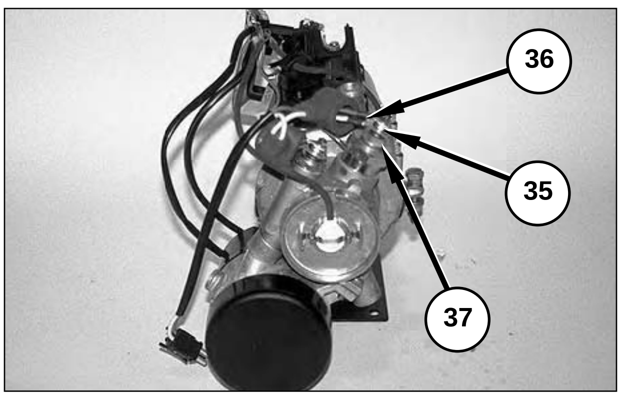
14. Remove back cover (31) on plug housing (30) to expose the pins.



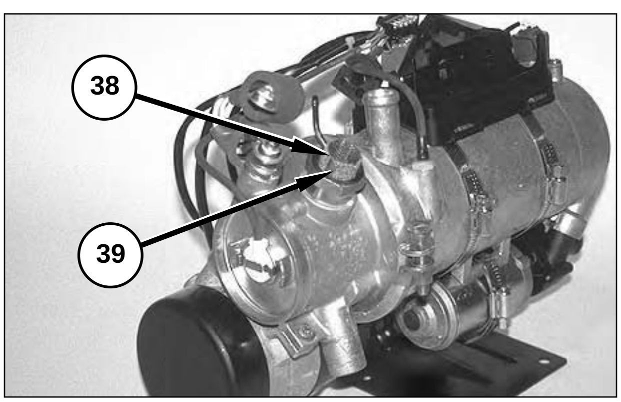
15. Remove pins 5 and 6 (32) for load resistor (33) from plug housing (30). Remove two clips (34) and remove the load resistor. Upon reassembly, refer to the diagram for correct pin locations.



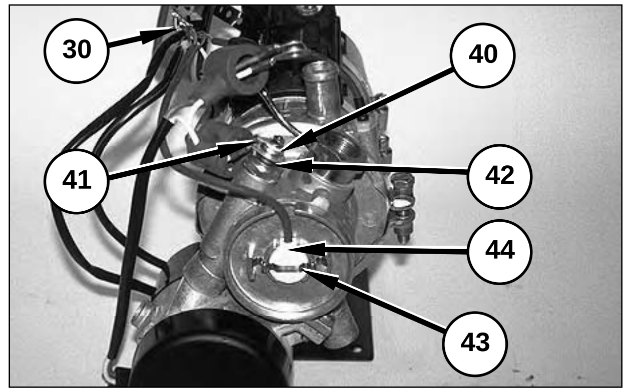
Pin Locations for Plug Housing (30).
(A) Water pump (black). (B) Water pump (brown). (C) Combustion air blower (brown). (D) Combustion air blower (violet). (E) Partial load resistor (red). (F) Partial load resistor (red). (G) Flame sensor (brown). (H) Temperature sensor (brown). (I) Flame sensor (gray). (J) Temperature sensor (gray). (K) Overheat switch (white). (L) Overheat switch (white).



16. Remove nut (35) with the washer, and disconnect glow plug connector (36). Turn glow plug (37) counterclockwise to remove with the ring seal. Upon reassembly, replace the ring seal if it is worn or damaged.

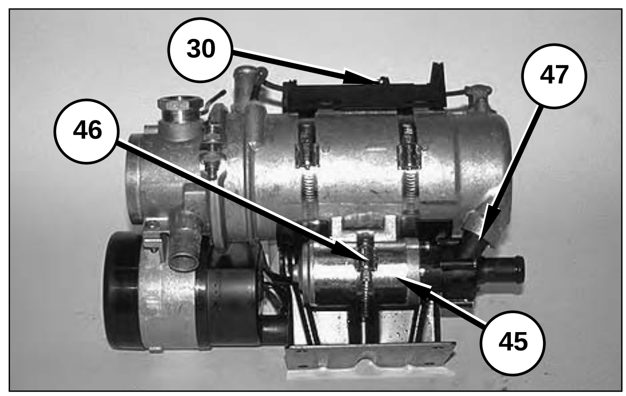


17. Remove glow plug screen (38). Note the correct orientation of slits (39) for reassembly.

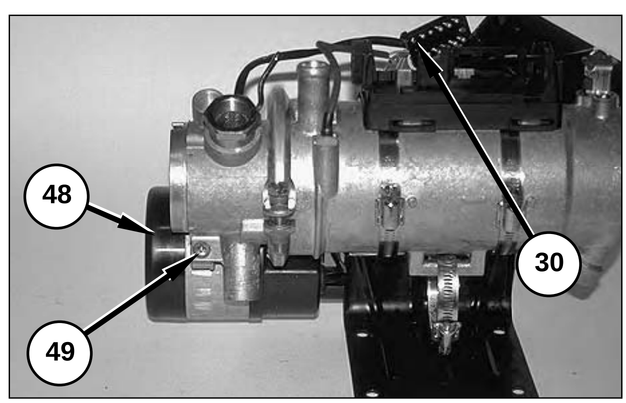


18. Remove nut (40) with the washers, and remove series resistor connector (41). To remove turn series resistor (42), turn it counterclockwise.

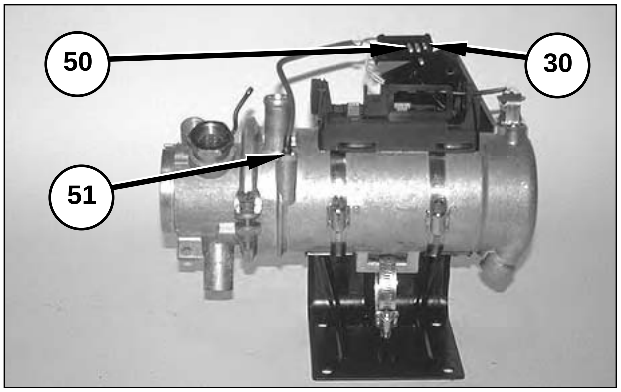
19. Remove pins 7 and 9 for flame sensor (44) from plug housing (30). Remove spring clip (43) and the flame sensor. Handle the flame sensor with care; it is very delicate. Upon reassembly, refer to the diagram for the correct pin locations.



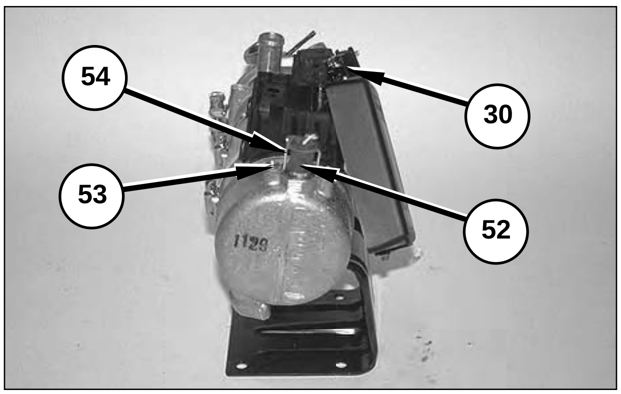
20. Remove pins 1 and 2 for water pump (45) from plug housing (30). Loosen clamp (46) and remove water pump (45) with O-ring (47). Upon reassembly, refer to the diagram for correct pin locations. Replace the O-ring if it is worn or damaged.



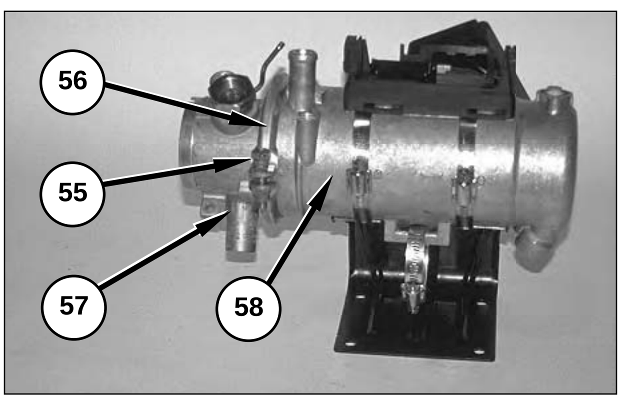
21. Remove pins 3 and 4 for blower motor (48) from plug housing (30). Remove screw (49) and blower motor with the O-ring. Upon reassembly, refer to the diagram for correct pin locations. Replace the O-ring if the O-ring is worn or damaged.



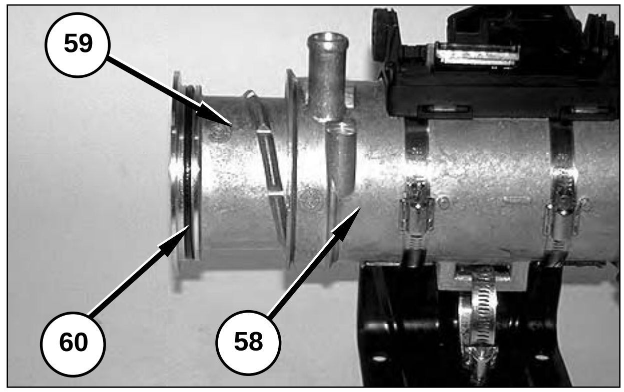
22. Remove pins 8 and 10 (50) for temperature sensor (51) from plug housing (30). Turn the temperature sensor counterclockwise to remove it with the O-ring. Upon reassembly, refer to the diagram for correct pin locations. Replace the O-ring if the O-ring is worn or damaged.



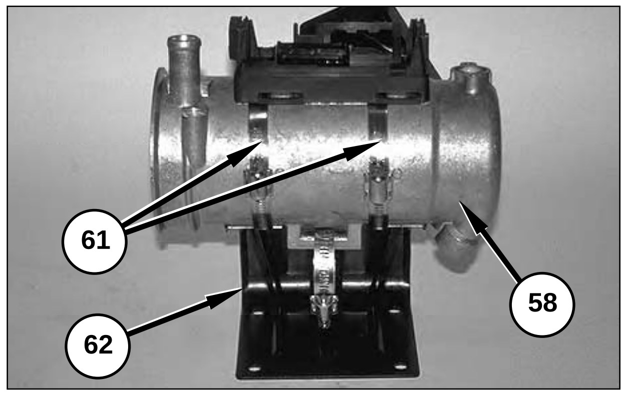
23. Remove pins 11 and 12 for overheat switch (52) from plug housing (30). Remove two screws (53), bracket (54), and the overheat switch with the O-ring. Upon reassembly, refer to the diagram for correct pin locations. Replace the O-ring if the O-ring is worn or damaged.



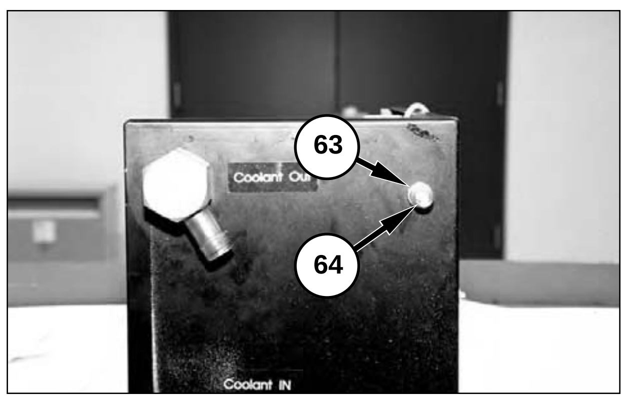
24. Remove bolt (55) and clamp (56). Scribe a mark on burner assembly (57) and jacket housing (58) for reassembly. Remove the burner assembly from the jacket housing.



25. Scribe a mark on heat exchanger (59) and jacket housing (58) for reassembly. Remove the heat exchanger with O-ring (60) from the jacket housing. Upon reassembly, replace the O-ring if the O-ring is worn or damaged.



26. Remove two clamps (61) to separate bracket (62) from jacket housing (58).



27. Remove plastic cover (64) and jam nut (63), and remove the circuit breaker.

NOTE: To reassemble the heater group, reverse the disassembly steps.

Fender Group, Left

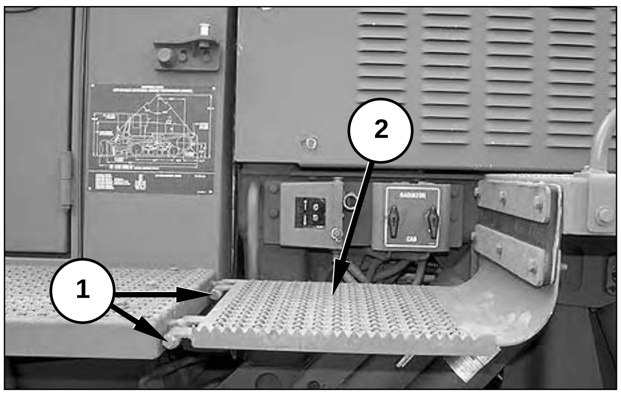
Remove and Install

Tools Needed	A
138-7575 Link Bracket	1

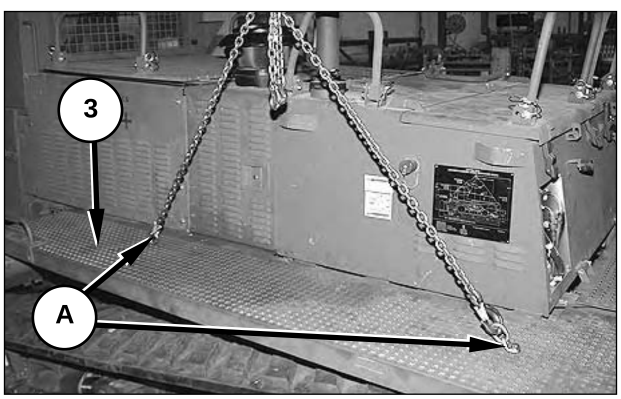
Start By:

a. Remove the arctic battery box (if equipped). Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* "Arctic Battery Box."

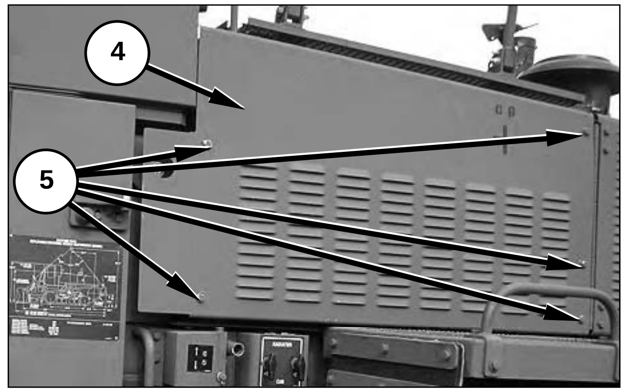
NOTE: The group number related to this procedure is 161-8626.



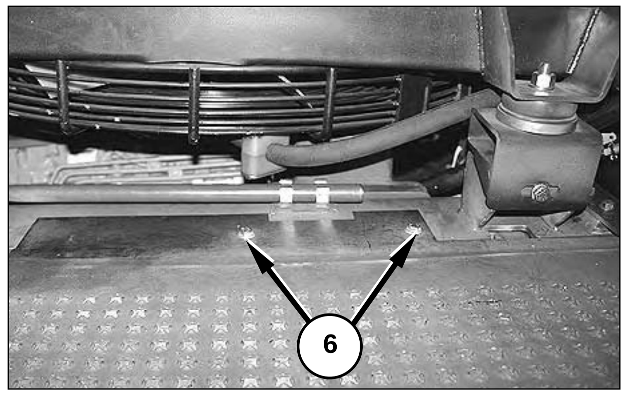
1. Remove two bolts (1) with the nuts and washers, and allow step (2) to hang down.



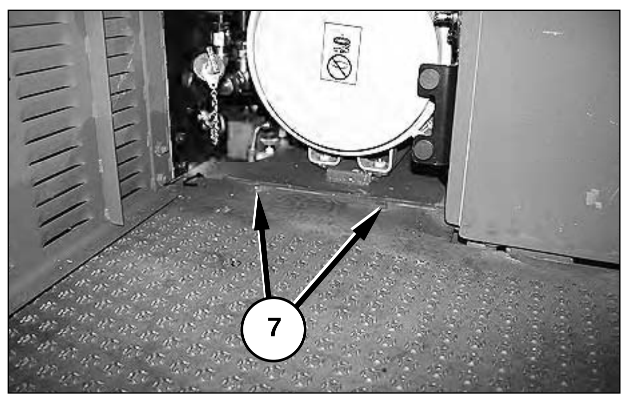
2. Install Tooling (A), and support left fender group (3) with a hoist. The weight of the fender is **105 kg (230 lb).**



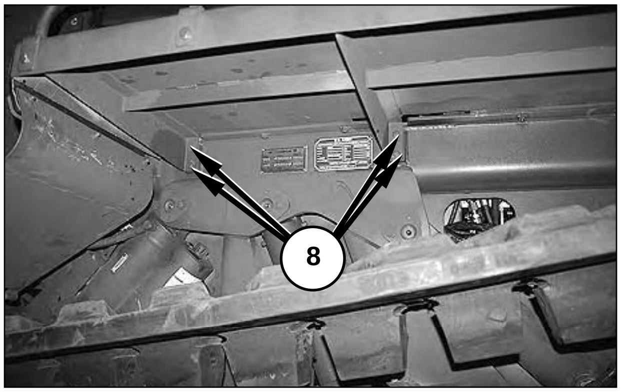
3. Remove five bolts (5) with the washers, and radiator cover (4).



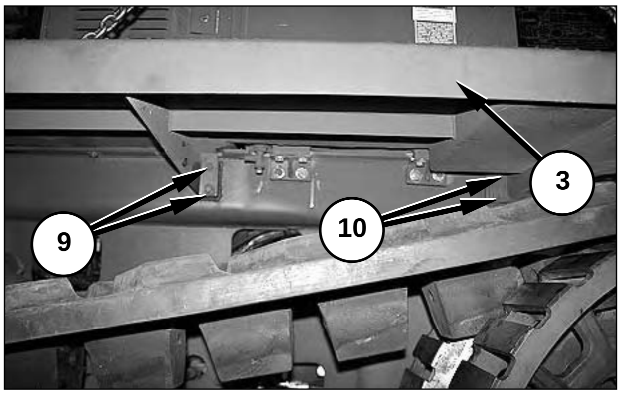
4. Remove two bolts (6) and washers.



5. Remove two bolts (7) and washers.



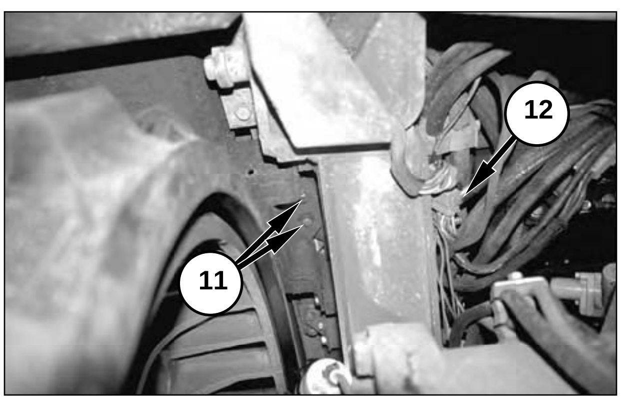
6. Remove four bolts (8) and washers.



7. Remove two bolts (9) with the washers.

8. Remove four bolts (10) with the washers.

NOTE: Two of four bolts (10) are not visible in the photograph.



9. Remove two bolts (11) and washers.

10. Disconnect light harness connector C415 (12), and cut wire ties as necessary. Upon reassembly, replace the wire ties which were removed.

11. Remove left fender group (3). The weight of the fender is **105 kg (230 lb).**

NOTE: To install the left fender group, reverse the removal steps.

End By:

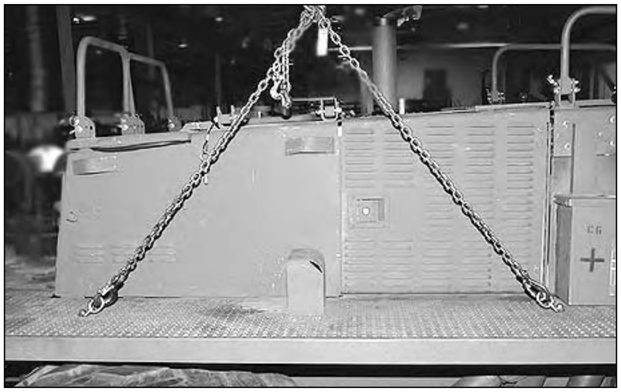
a. Install the arctic battery box (if equipped).

Fender Group, Right

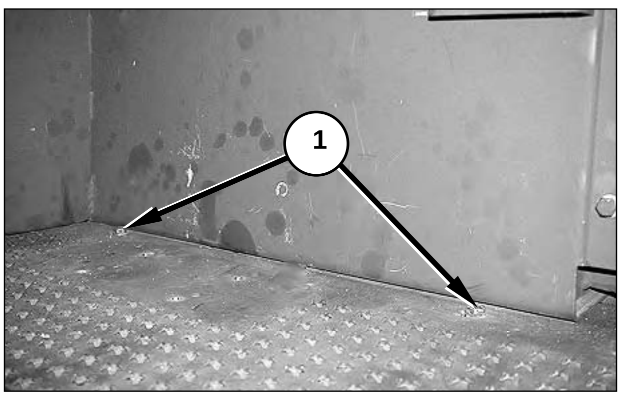
Remove and Install

Tools Needed	A
138-7575 Link Bracket	1

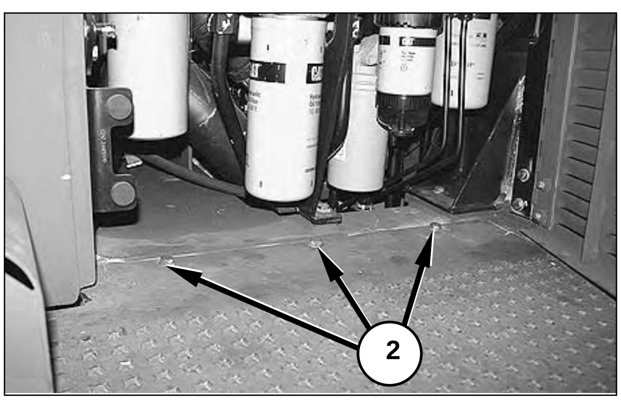
NOTE: The group number related to this procedure is 161-8626.



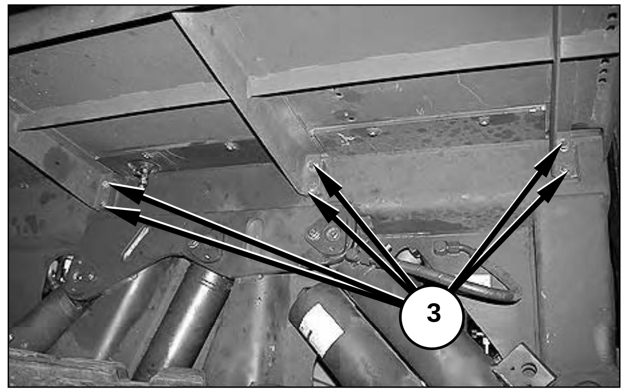
1. Install Tooling (A) and support the fender with a hoist. The weight of the fender group is **101 kg (223 lb).**



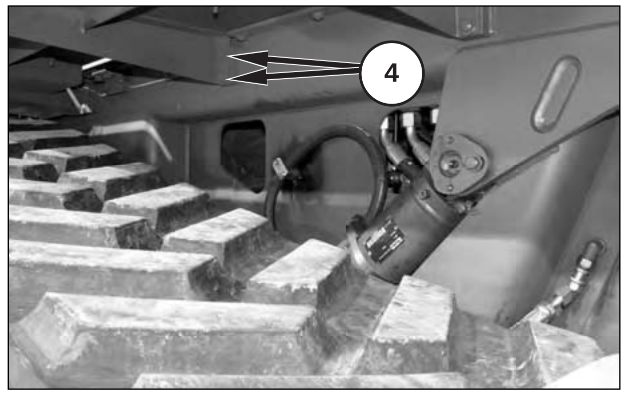
2. Remove two bolts (1) and washers.



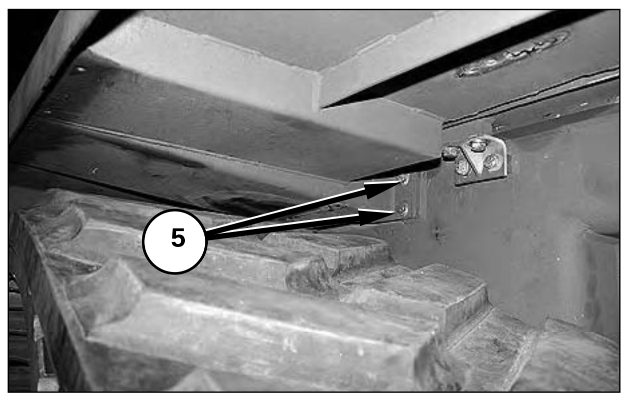
3. Remove three bolts (2) and washers.



4. Remove six bolts (3) and washers.

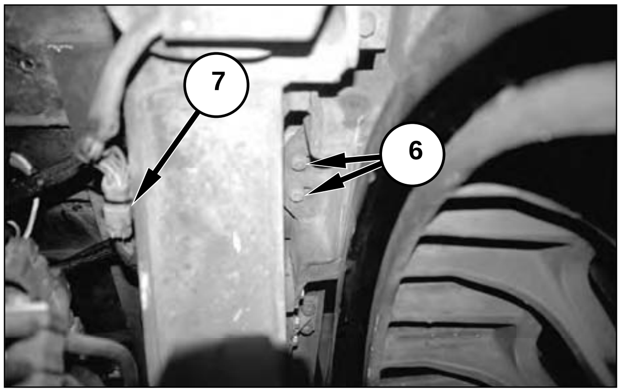


5. Remove two bolts (4) and washers.



6. Remove four bolts (5) and washers from the rear fender support.

NOTE: Two of four bolts (5) are not visible in the photograph.



7. Remove two bolts (6) and washers.

8. Disconnect light harness connector C405 (7), and cut wire ties as necessary. Upon reassembly, replace the wire ties which were removed.

9. Remove the right fender group. The weight of the fender group is **101 kg (223 lb).**

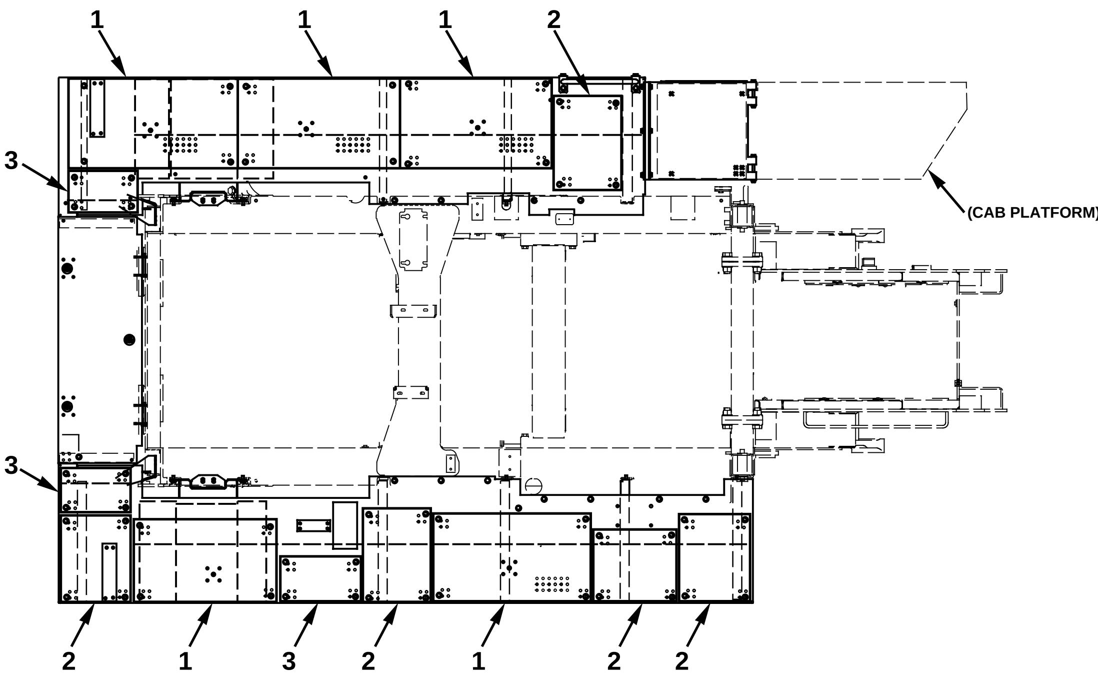
NOTE: To reinstall the left or right fender groups, reverse the removal steps.

Fender Group, Tread Plates

Remove and Install

NOTE: The group number related to this procedure is 161-8626.

NOTE: Some machines may be equipped with fenders which have integral tread plates. Fenders with integral tread plates are replaced by fenders with bolt-on tread plates.



1. Remove four bolts, nuts, and washers from each tread plate, and remove five tread plates (1), five tread plates (2), and three tread plates (3) from the fenders.

2. Remove the tape from under each tread plate. Upon reassembly, replace the tape.

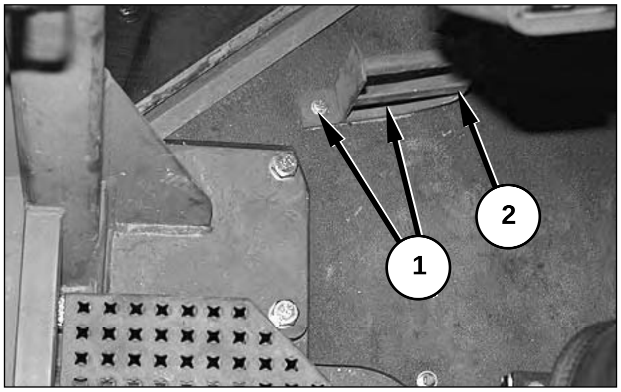
NOTE: Place the tape on the fender, perpendicular to the long side of the tread plate.

NOTE: To install the tread plates, reverse the removal steps.

Foot Rest

Remove and Install

NOTE: The group number related to this procedure is 125-8819.



1. Remove two bolts (1) with the washers, and foot rest (2).

NOTE: To install the foot rest, reverse the removal steps.

Fuel Tank

Remove and Install

Start By:

a. Remove the winch. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Hydraulic System* "Winch Bracket with Winch Assembly."

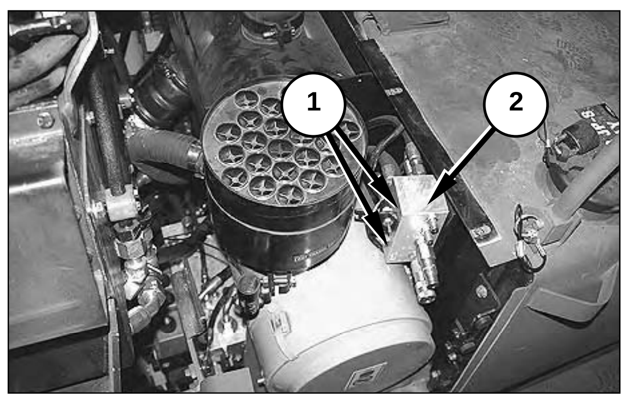
b. Remove the middle top cover.

c. Remove the arctic battery box (if equipped). Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* "Arctic Battery Box."

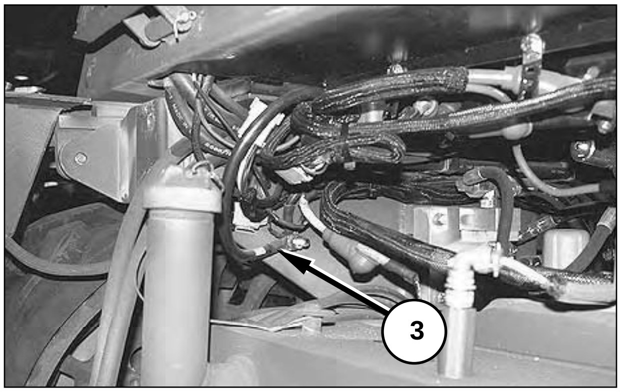
NOTE: The group number related to this procedure is 143-7323.

NOTE: Cut the wire ties as needed. Reinstall the wire ties during the installation procedure.

1. Turn the main disconnect switch to the OFF position. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Machine Features, Main Disconnect Switch."

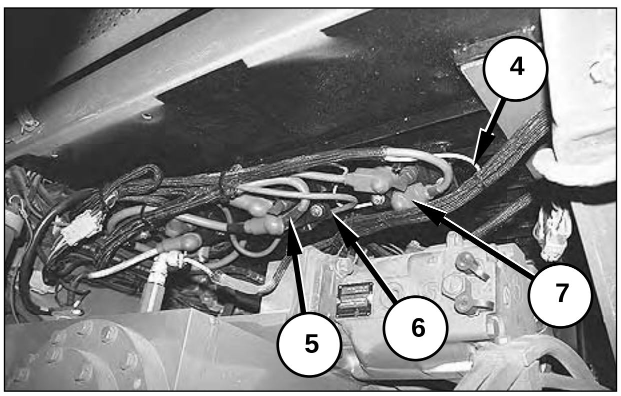


2. Remove two bolts (1) with the nuts and four washers. Remove and place remote tool manifold (2) out of the way of the fuel tank.



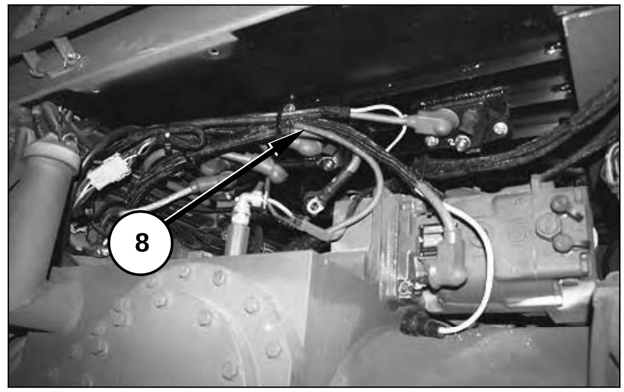
3. Disconnect two black ground wires from ground stud (3). Mark the wires for correct connection during reassembly.

NOTE: Several ground wires are connected to ground stud (3). The ground wire which is routed into the battery box and the ground wire for the engine coolant heater should be disconnected. The remaining ground wires can remain on the ground stud.



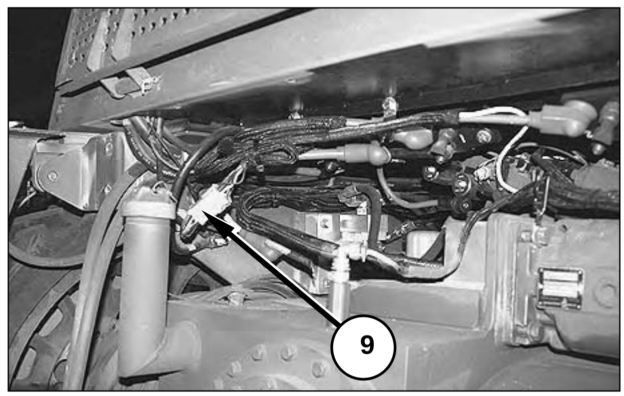
4. Remove the nut and washers, and disconnect one red wire (7) and one white wire (4). Mark the wires for correction connection during reassembly. Upon reassembly, tighten the nut to a torque of **70 ± 15 N•m (51.6 ± 11 lb ft).**

5. Remove the caps with the nuts and washers, and disconnect red wire (6). Unplug red wire (5). Mark the wires for correct connection during reassembly. Upon reassembly, tighten the nuts to a torque of **70 ± 15 N•m (51.6 ± 11 lb ft).**



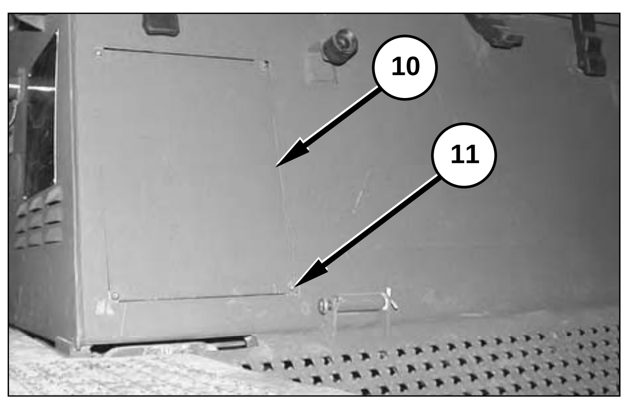
6. Remove the nut and washers, and disconnect orange wire (8). Mark the wire for correct connection during reassembly. Upon reassembly, tighten the nut to a torque of **70 ± 15 N•m (51.6 ± 11 lb ft).**

NOTE: Two orange wires are present. The one that is part of the machine harness should be disconnected.



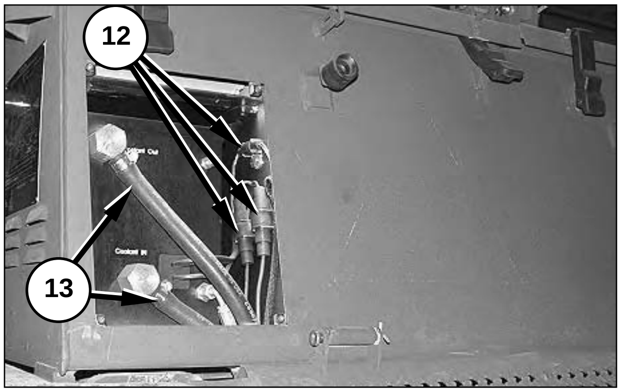
7. Disconnect harness connector C404 (9) for the rear circuit breaker panel.

NOTE: Two connectors are located on the left side of the machine: the left rear lighting group harness and the rear circuit breaker panel harness.



NOTE: Perform Steps 8 through 11 if the machine is equipped with an engine coolant heater.

8. Remove four screws (11) and cover (10).

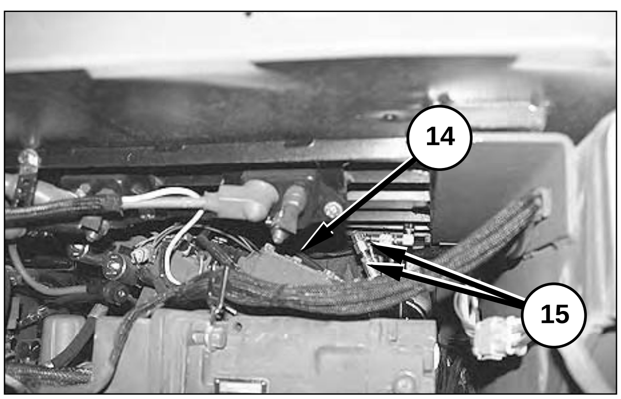


9. Disconnect three connectors C401, C411, and C421 connectors (12). Mark the connectors for correct location during reassembly.

NOTE: The C401 connector is a one-pin connector with the G799-RD-10 wire on the machine harness side of the connector and a 10-gauge red wire on the heater side of the connector. The C411 connector is a one-pin connector with the 200-BK-10 wire on the machine harness side of the connector and a 10-gauge black wire on the heater side of the connector. The C421 connector is a three-pin connector with 102-RD, 103-YL, and 104-BR wires on the machine harness side of the connector.

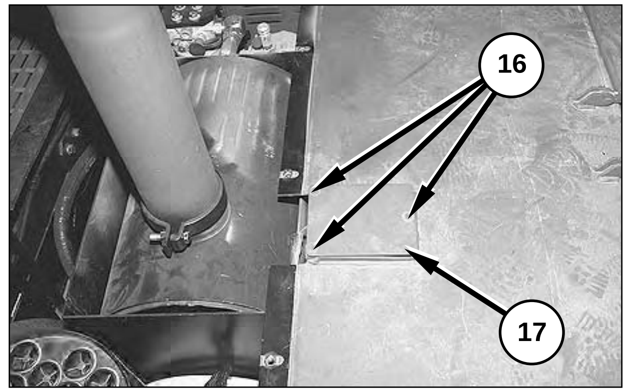
10. Disconnect, cap and plug two coolant lines (13). Mark the coolant lines for correct connection during reassembly. Catch any coolant that leaks out of the hoses, and dispose of the coolant in accordance with local environmental regulations.

11. Pull the wires and coolant lines (13) out and away from the fuel tank assembly.

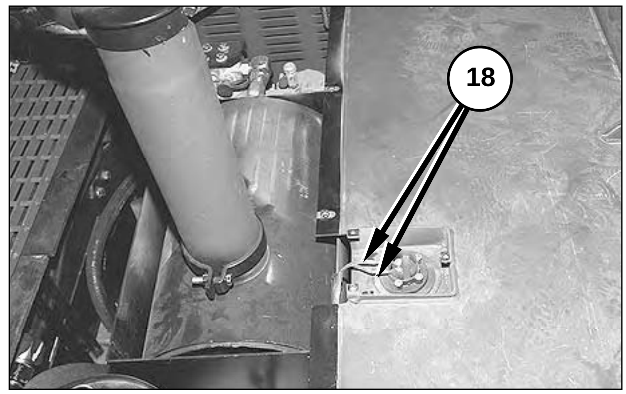


12. Disconnect, cap and plug fuel lines (14) and (15) under the fuel tank. There is a total of three fuel lines. Mark the fuel lines for correct connection during reassembly.

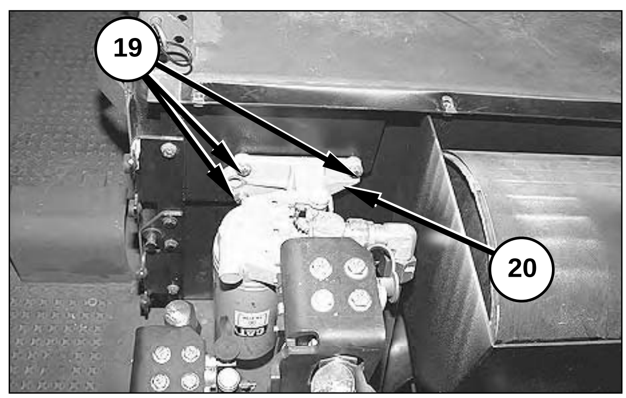
NOTE: The fuel valves can be closed to limit the amount of fuel which may leak during this step. Catch any fuel that leaks out of the hoses, and dispose of the fuel in accordance with local environmental regulations.



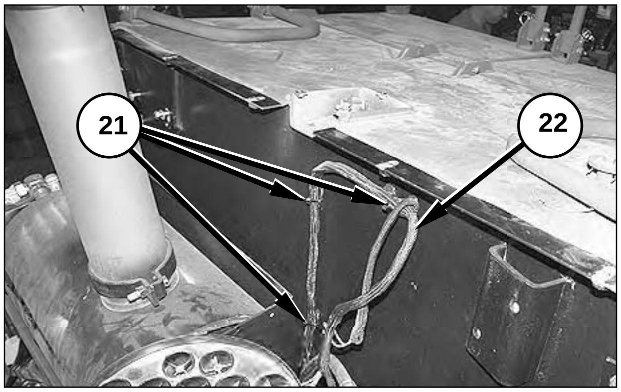
13. Remove three bolts (16) with the washers, and remove cover (17) from the top of the fuel sending unit.



14. Remove two nuts and washers, and disconnect two wires (18). Mark the wires for correct connection during reassembly.

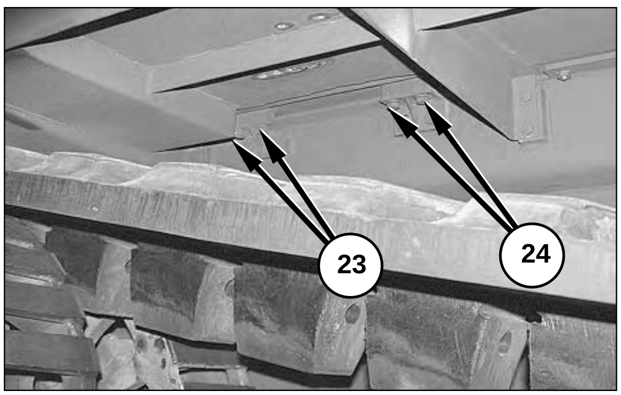


15. Remove three bolts (19) and washers, and remove power train oil filter bracket assembly (20).



16. Cut cable ties (21), and allow harness (22) to fall down away from the fuel tank.

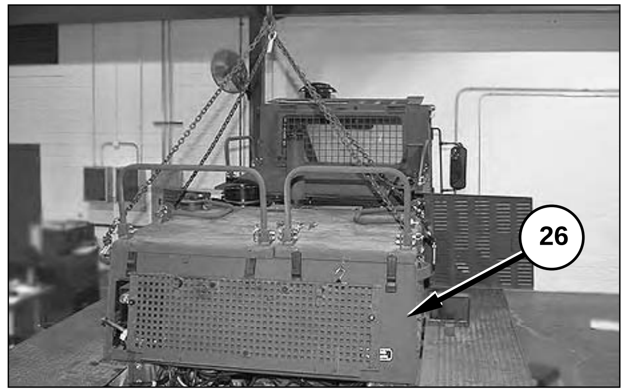
NOTE: If necessary, remove the muffler group to gain access to the cable ties.



17. Remove bolts (23) and (24) with the washers on both sides of the fuel tank. There is a total of eight bolts, four on each side of the fuel tank.

18. Remove four bolts (25) from the left and right rear corners of the fuel tank.

NOTE: Bolts (25) are not visible in the photograph. The bolts are threaded vertically into the bottom of the fuel tank.



WARNING

The fuel tank does not need to be drained before it is removed. However, if the tank is not empty, the fuel level must be determined and the weight of the fuel must be added to the weight of the tank to determine the total weight which must be lifted. The capacity of the fuel tank is 341 L (90 U.S. gal). The density of the fuel must be obtained from the fuel supplier. For the procedure to empty the fuel tank, refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Maintenance Intervals, Every 1000 Service Hours or When Required, Fuel Tank."

19. Fasten a hoist to fuel tank assembly (26). Remove the fuel tank assembly. The weight of the fuel tank, when empty, is **544 kg (1200 lb).**

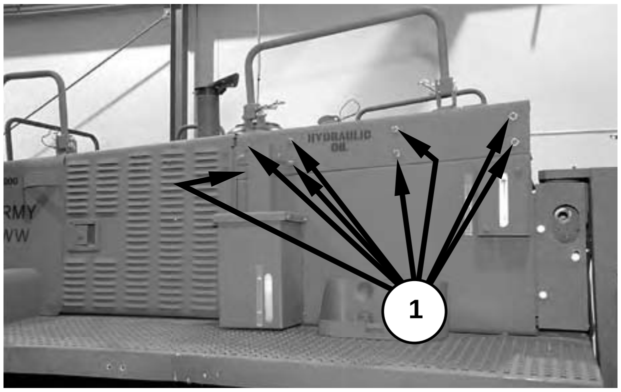
NOTE: Monitor the removal of fuel tank assembly (26) to ensure that all components which are attached to the fuel tank have been disconnected from the components which are attached to the machine.

NOTE: To install the fuel tank, reverse the removal steps.

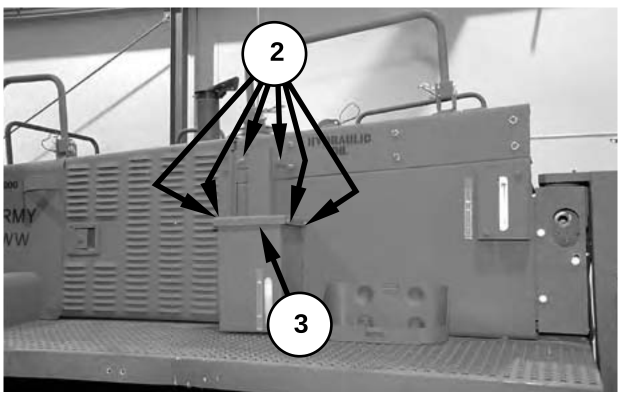
Hydraulic Tank Cover

Remove and Install

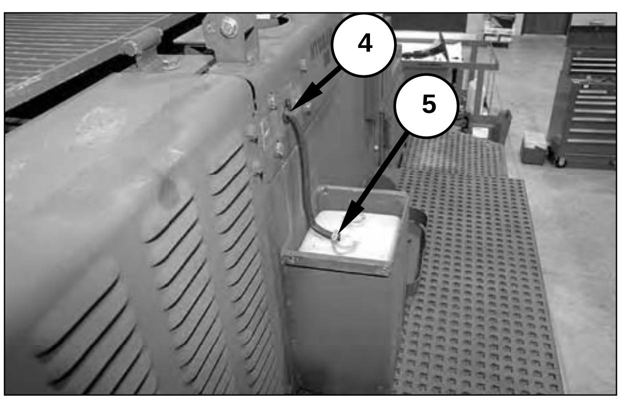
NOTE: The group number related to this procedure is 144-7924.



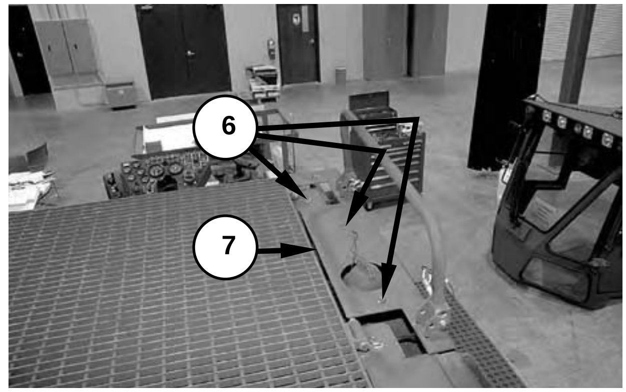
1. Remove eight bolts (1) and washers.



2. Remove six bolts (2) and washers, and remove radiator overflow bottle cover (3).



3. Loosen clamp (5), and remove the hose. Push the hose through hole (4).



4. Remove three bolts (6) and the washers, and remove cover (7).

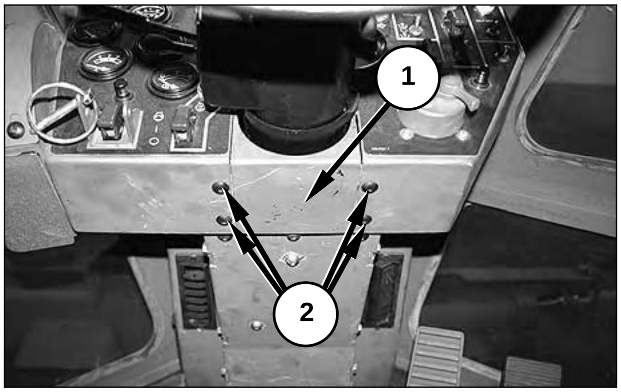
NOTE: To install the hydraulic tank cover, reverse the removal steps.

Instrument Panel

Remove and Install

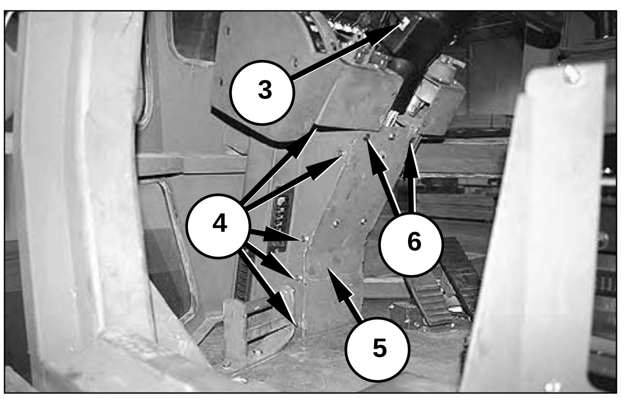
NOTE: The group number related to this procedure is 145-0075.

1. Turn the main disconnect switch to the OFF position. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Machine Features, Main Disconnect Switch."



2. Remove four screws (2)

NOTE: Cover (1) cannot be removed at this point. This cover will be removed in a later step.

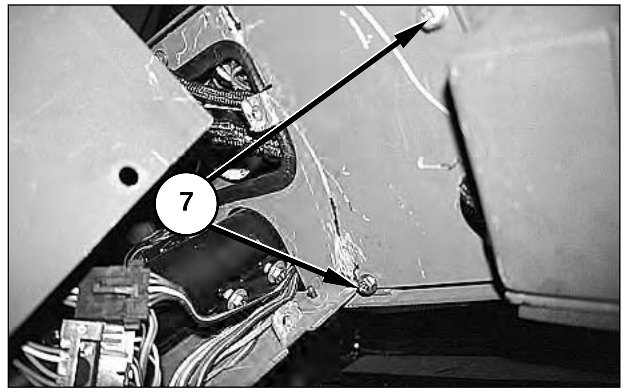


3. Remove five bolts (4) from both sides of cover (5). There is a total of 10 bolts (4); only four are shown.

NOTE: The second bolt from the top on the left side of the steering column has a larger washer and a cable.

4. Remove two bolts (6).

5. Allow cover (5), together with the steering column, to fold down towards the seat.



6. Remove five bolts (7) (only two visible in photo).

7. Remove cover (1).

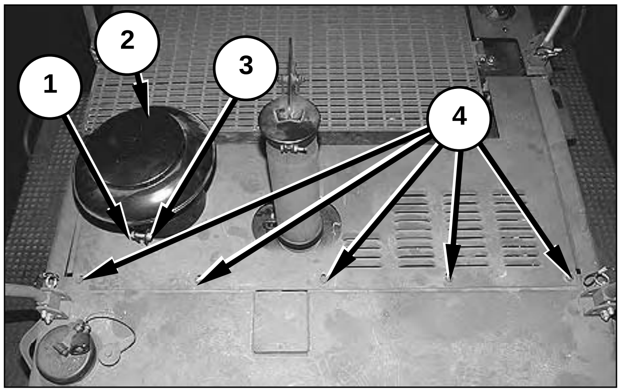
8. Rotate the bottom of the instrument panel up toward the front windshield to access the components mounted in the instrument panel, or disconnect the C101 and C102 harness connectors at the base of the steering column to remove the instrument panel with the instrument wiring group.

NOTE: To install the instrument panel, reverse the removal steps.

Middle Top Cover

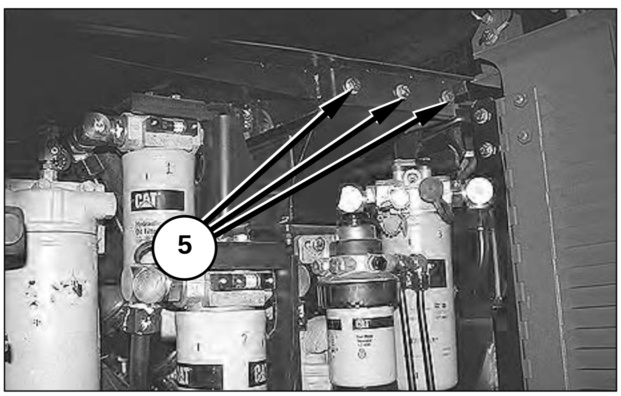
Remove and Install

NOTE: The group number related to this procedure is 144-7924.

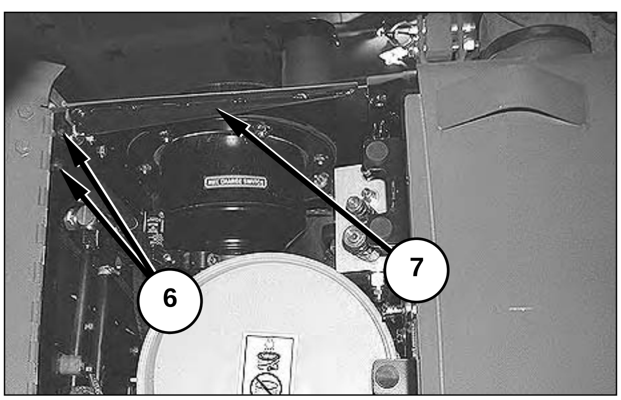


1. Remove nut (1), bolt (3) and the washer, and precleaner cover (2).

2. Remove five bolts (4) and washers.



3. Remove three bolts (5) and washers.



4. Remove two bolts (6) and the nuts and washers.

5. Remove top cover (7).

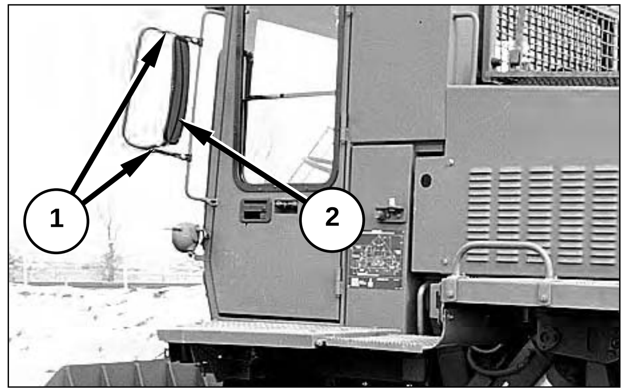
NOTE: To reinstall the middle top cover, reverse the removal steps.

Mirror, Left and Right

Remove and Install

NOTE: The group number related to this procedure is 126-5853.

NOTE: The removal procedure for the left side of the machine is shown. The right side is the same.



1. Remove two nuts (1) with the bolts and washers.

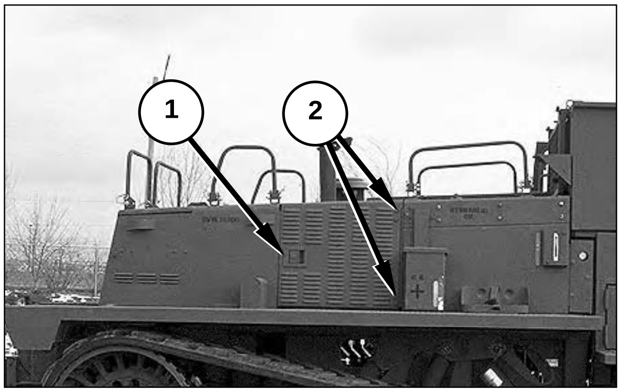
2. Remove mirror (2).

NOTE: To install the mirror, reverse the removal steps.

Oil Filter Compartment Door

Remove and Install

NOTE: The group number related to this procedure is 144-7924.



1. Remove four bolts (2) and washers.

2. Remove door (1).

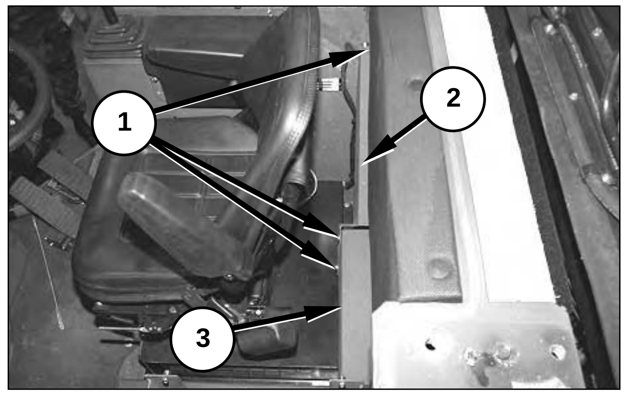
NOTE: To install the door, reverse the removal steps.

Operator's Console

Remove and Install

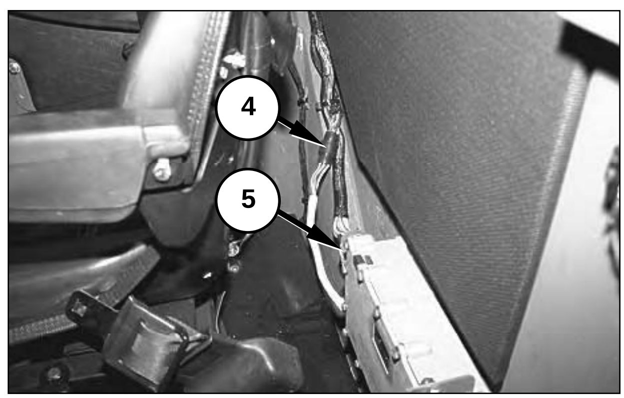
NOTE: Group numbers related to this procedure include 126-5842 and 145-0425.

1. Turn main disconnect switch to the OFF position. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Machine Features, Main Disconnect Switch."

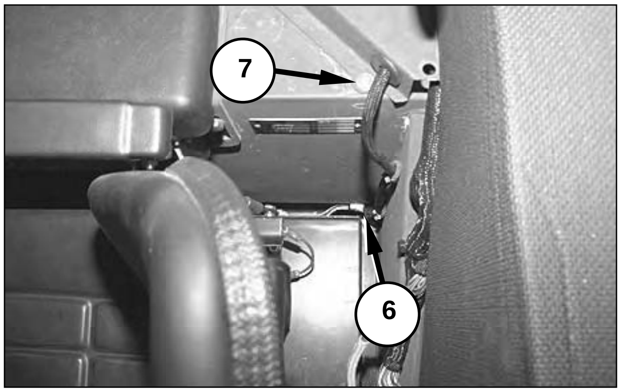


2. Remove four bolts (1) and washers and remove cover (2).

3. Remove one bolt and washer from each corner of cover (3), and remove the cover.

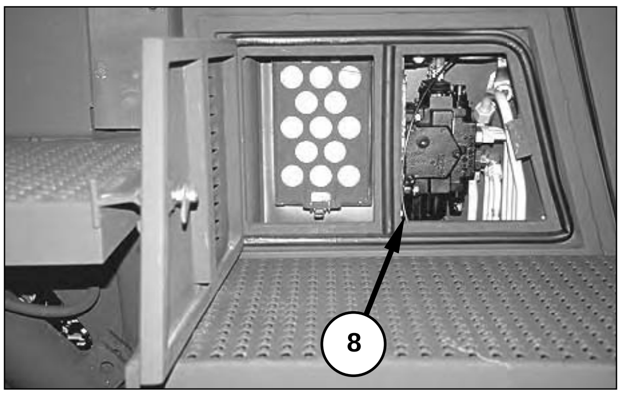


4. Disconnect electronic programmable transmission control (EPTC II) harness connectors C133 (4) and C123 (5).

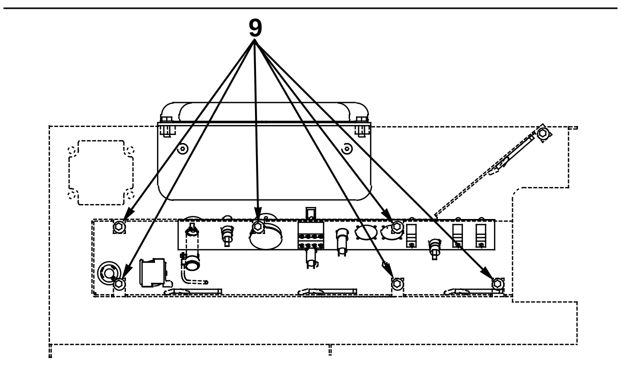


5. Disconnect air conditioning harness connector C157 (6).

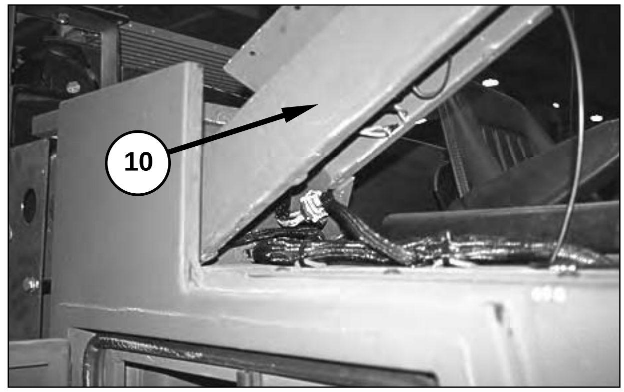
6. Remove bolt (7) and the washer.



7. Open the door to hydraulic valve compartment (8), on the right side of the machine.



8. Remove six bolts (9) and washers. The six bolts can be reached through hydraulic valve compartment (8).



Cab Removed for Photographic Purposes.

9. Lift operator console (10) to gain access to the components mounted to the console.

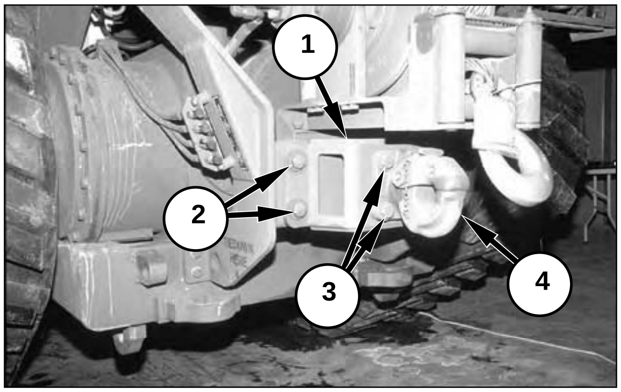
NOTE: To completely remove the operator's console, refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* "Console Wiring Group."

NOTE: To install the operator's console, reverse the removal procedure.

Pintle Hook

Remove and Install

NOTE: The group number related to this procedure is 145-0074.



1. Remove the nuts and washers from four bolts (3) (only two visible).

2. Use two people to support pintle hook (4), and remove four bolts (3) and the pintle hook. The weight of the pintle hook is **27 kg (60 lb).**

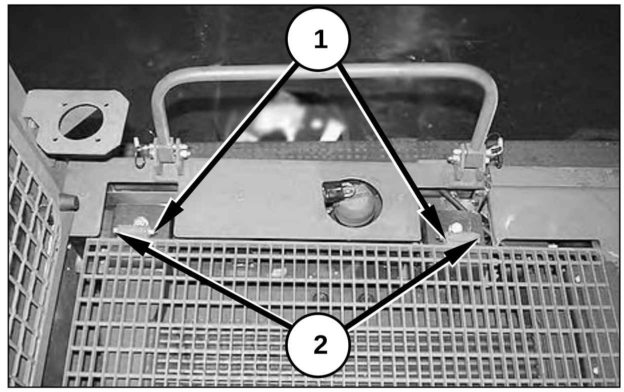
3. If necessary, remove eight bolts (2) (only two visible) with the nuts, washers, and two plates, and remove bracket (1). The weight of the bracket is **39 kg (86 lb).**

NOTE: To install the pintle hook, reverse the removal steps.

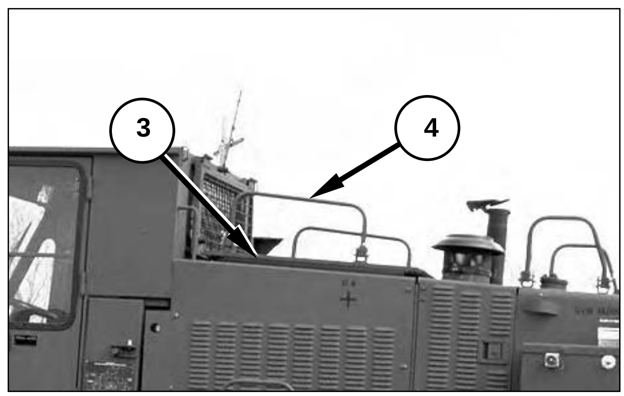
Radiator Grill

Remove and Install

NOTE: The group number related to this procedure is 146-0704.



1. Remove two nuts (1) and washers, and remove pivot pins (2). Upon reassembly and prior to installation, apply a light coat of grease to the pivot pins.



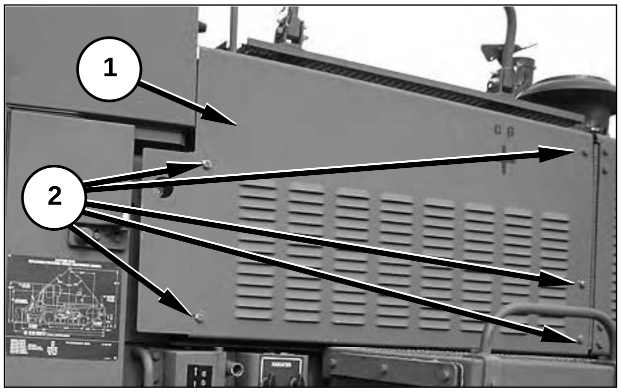
2. Pull up sharply on grab rail (4) to release radiator grill (3) from the rubber sockets. Remove the radiator grill.

NOTE: To install the radiator grill, reverse the removal steps.

Radiator Side Cover

Remove and Install

NOTE: The group number related to this procedure is 144-7924.



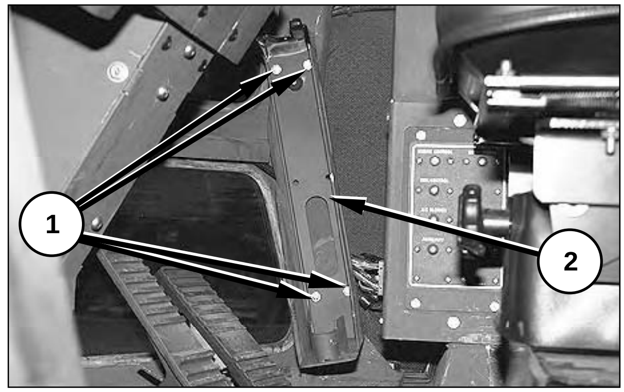
1. Remove five bolts (2) and washers, and remove radiator side cover (1).

NOTE: To install the radiator side cover, reverse the removal steps.

Rifle Bracket

Remove and Install

NOTE: The group number related to this procedure is 144-8532.



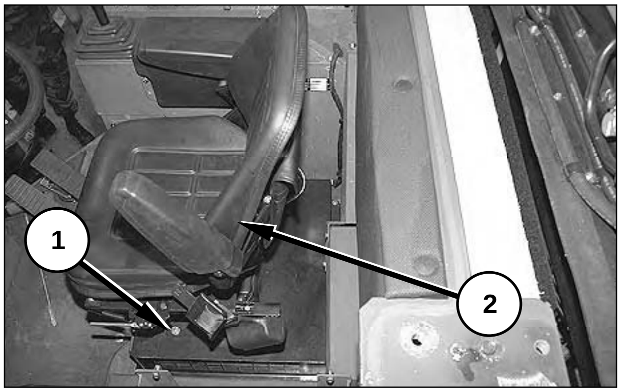
1. Remove four bolts (1) with washers and rifle bracket (2).

NOTE: Reverse the removal steps to install the rifle bracket.

Seat Assembly

Remove and Install

NOTE: Group numbers related to this procedure include 102-2423 and 159-1669.



1. Remove four nuts (1) (only one nut visible in photo) and washers.

2. Use two people to remove seat assembly (2). The weight of the seat assembly is **43 kg (95 lb).**

NOTE: To install the seat assembly, reverse the removal steps.

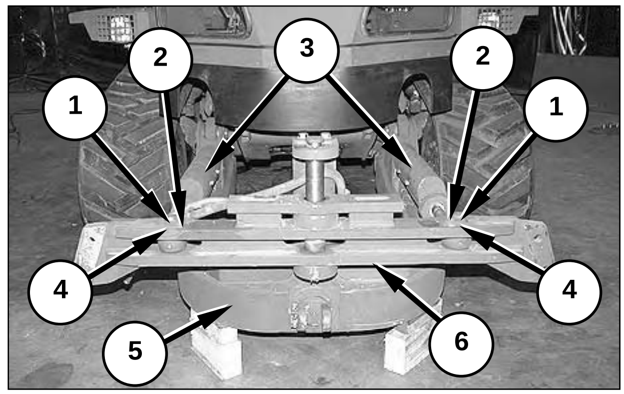
Singletree

Remove and Install

Start By:

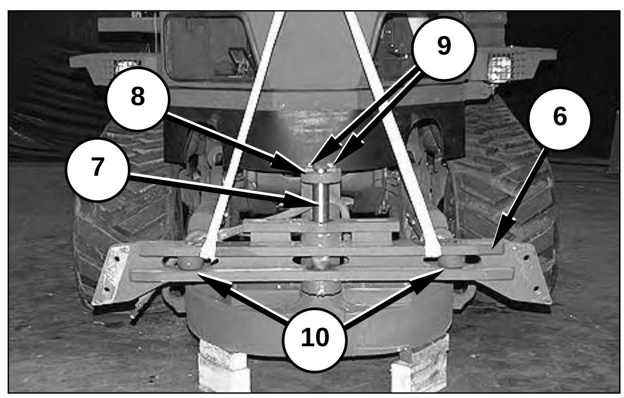
a. Remove the bulldozer blade.

NOTE: Group numbers related to this procedure include 8E2737 and 129-9252.



1. Remove bolt (2) and washers, retainer (4), and pin (1) from each angle cylinder (3).

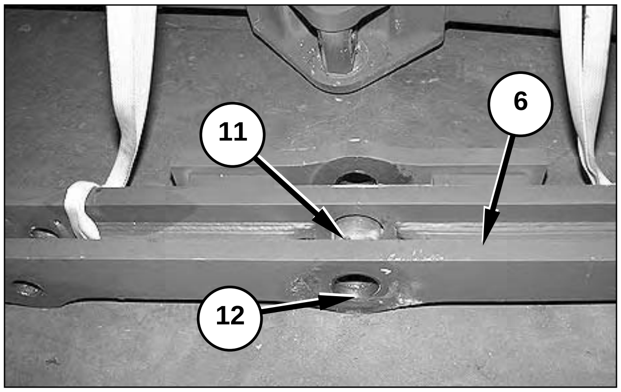
NOTE: Place blocks or other suitable spacers between each angle cylinder (3) and C-frame (5) to keep the cylinders from falling onto the C-frame when singletree (6) is removed.



2. Fasten a hoist to singletree (6) and support the singletree with the hoist. The weight of the singletree is **150 kg (325 lb).**

3. Remove two bolts (9), retainer (8) and pin (7).

4. Remove singletree (6). When the singletree is removed, washers (10) from above and below the angle cylinder rod eyes will also come out. Make a note of the position of the washers for reassembly (two washers on bottom and one on top).



5. If necessary, use a puller to replace bearing sleeves (12) and sleeves (11) in singletree (6).

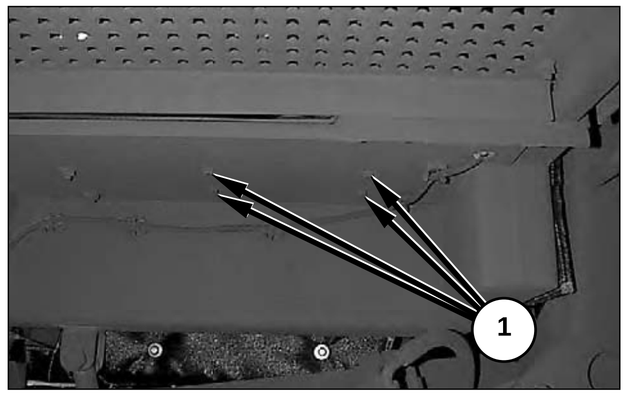
NOTE: To install the singletree, reverse the removal steps.

Single Channel Ground and Airborne Radio System (SINCGARS) Bracket

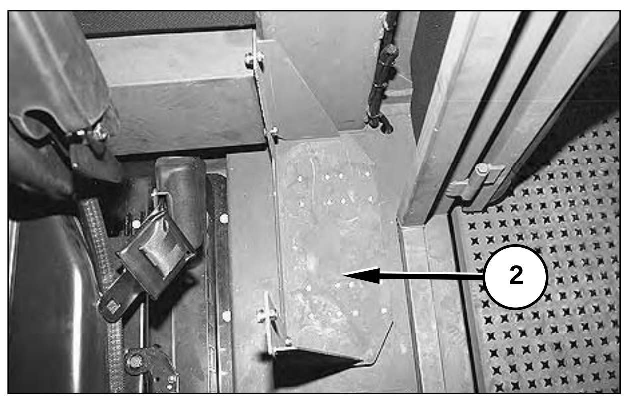
Remove and Install

NOTE: If the SINCGARS radio is installed in the radio bracket, remove the SINCGARS radio before removing the radio bracket.

NOTE: The group number related to this procedure is 144-5420.



1. Remove four bolts (1) and washers. Upon reassembly, tighten four bolts to a torque of **12 ± 3 N•m (106 ± 25 lb in).**



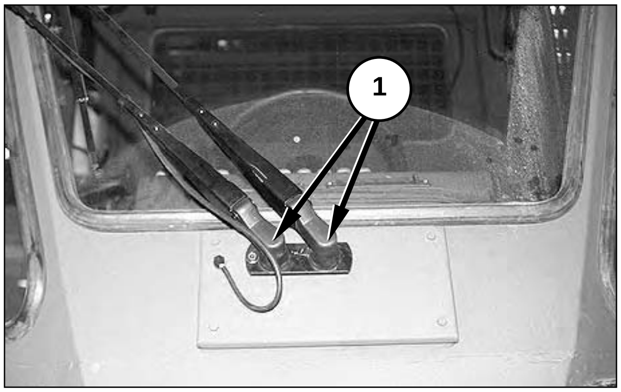
2. Remove SINCGARS radio bracket (2).

NOTE: To install the radio mounting group, reverse the removal steps.

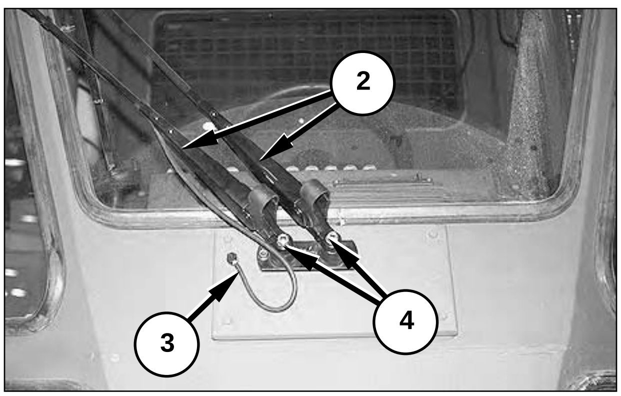
Washer and Wiper

Remove and Install

NOTE: The group number related to this procedure is 145-0425.



1. Lift covers (1).



2. Remove two nuts (4) and washers. Upon reassembly, tighten the nuts to a torque of **23 ± 1 N•m (203.5 ± 9 lb in).**

3. Disconnect line (3).

4. Remove wiper arm assemblies (2).

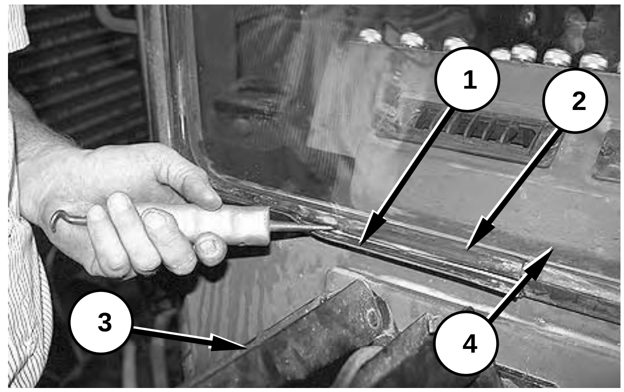
NOTE: To reinstall the washer and wiper, reverse the removal steps.

Window

Remove and Install

NOTE: The group number related to this procedure is 145-0425.

NOTE: The following procedure shows the removal of the front window pane. The other window panes in the cab can be removed in the same way.



1. Pull wiper arm assemblies (3) away from the window assembly, as shown.

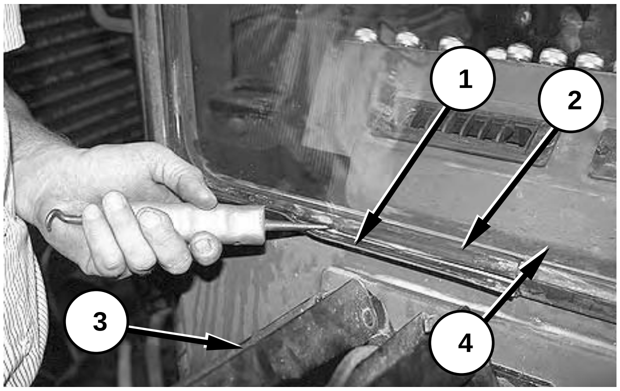
2. Use a suitable window removal tool to remove seal locking strip (1).

3. Use two people to remove window pane (4). The window pane weighs approximately **25 kg (55 lb)**. Have one person stand outside the cab and support the window pane during removal. Have the second person sit inside the cab and carefully press on the edges of the window pane. Push the window pane out of window seal (2), towards the outside of the cab.

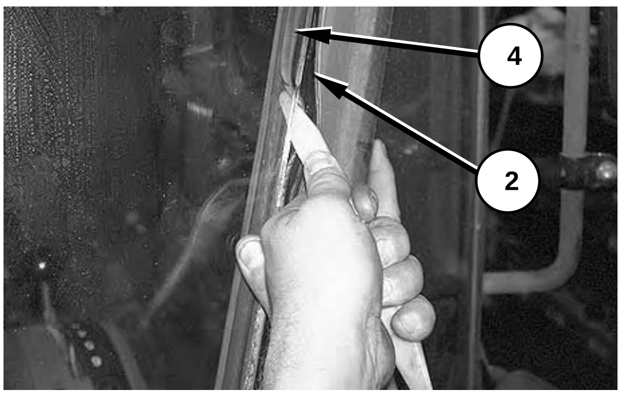
NOTICE

Do not press on the center of the window pane to push the window out of the window seal. Press carefully on the edge of the window pane, close to the window seal. The window pane may break if strong force is used in the center of the window.

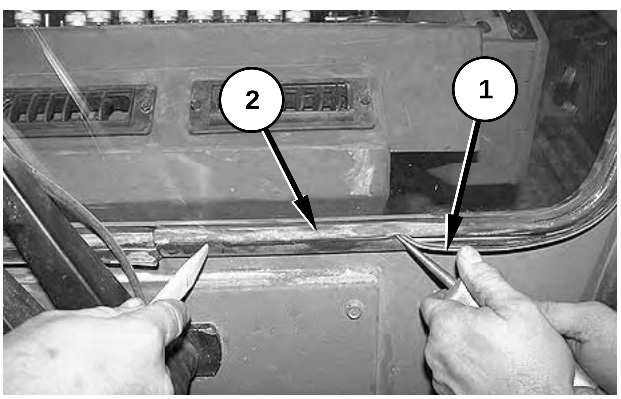
NOTE: The following steps are for installing a window.



4. Apply a rubber lubricant (such as **5P-3975 Rubber Lubricant**) to window seal (2), and seal locking strip (1).



5. Use a soft plastic or wood installation tool to insert window pane (4) into window seal (2).



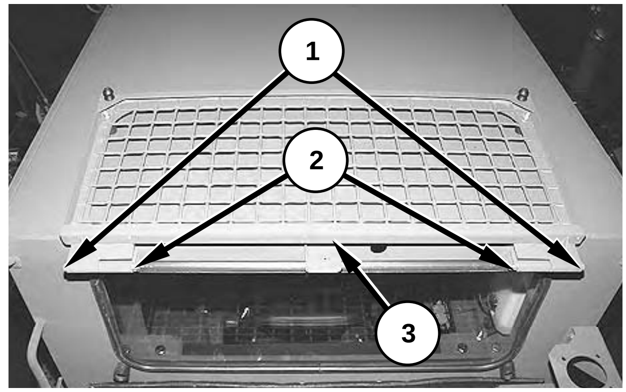
6. Install seal locking strip (1) into window seal (2).

NOTE: To ease installation of the seal locking strip, a second person may hold the locking strip in place.

Window Guard

Remove and Install

NOTE: The group number related to this procedure is 145-0425.



1. Raise guard (3), and rest the guard on the top of the cab.

2. Remove two nuts (2).

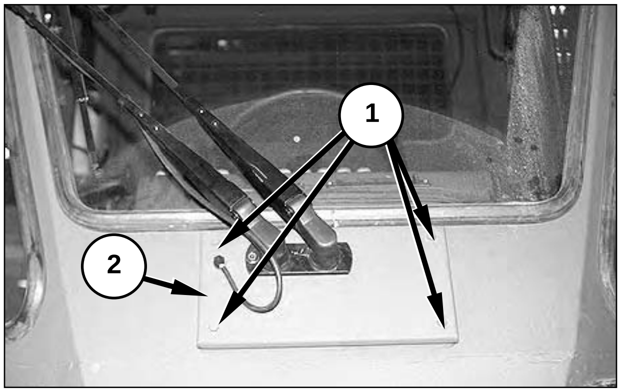
3. Remove two bolts (1) and guard (3).

NOTE: To install the window guard, reverse the removal steps.

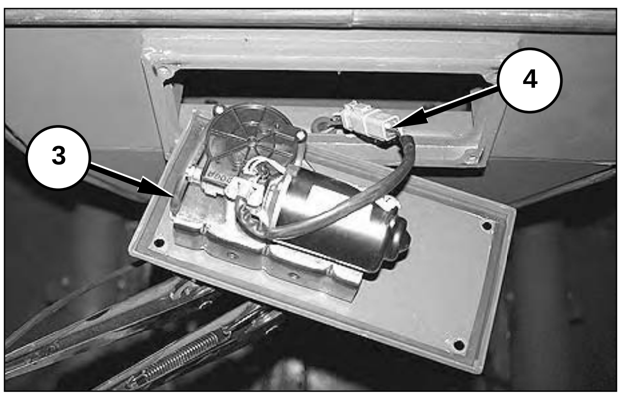
Windshield Wiper Motor Assembly

Remove and Install

NOTE: The group number related to this procedure is 145-0425.

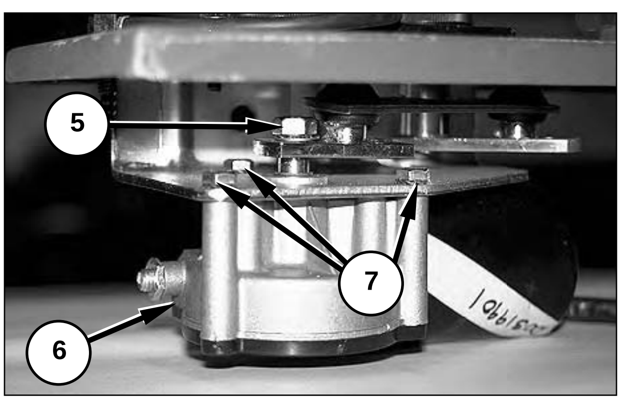


1. Remove four bolts (1), and slowly pull cover (2), with the wiper arm assemblies, away from the cab.



2. Disconnect fluid line (3).

3. Disconnect connector C118 (4).



4. Remove shaft nut (5) and washers.

5. Remove three bolts (7) and washers.

6. Remove windshield wiper motor assembly (6).

NOTE: To reinstall the windshield wiper motor assembly, reverse the removal steps.

TM5-2430-200-24

Systems Operation
Testing & Adjusting

Deployable Universal Combat Earthmover (DEUCE)

Electronic Programmable Transmission Control (EPTC II)

PIN: 7RR00003-Up

Important Safety Information

Most accidents involving product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “WARNING” as shown below.

The meaning of this safety alert symbol is as follows:

⚠ WARNING

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning, explaining the hazard, can be either written or pictorially presented.

Operations that may cause product damage are identified by NOTICE labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are therefore not all inclusive. If a tool, procedure, work method or operating technique not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and others. You should also ensure that the product will not be damaged or made unsafe by the operation, lubrication, maintenance or repair procedures you choose.

The information, specifications, and illustrations in this publication are on the basis of information available at the time it was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service given to the product. Obtain the complete and most current information before starting any job. Caterpillar dealers have the most current information available. For a list of the most current publication form numbers available, see the Service Manual Contents Microfiche, REG1139F.

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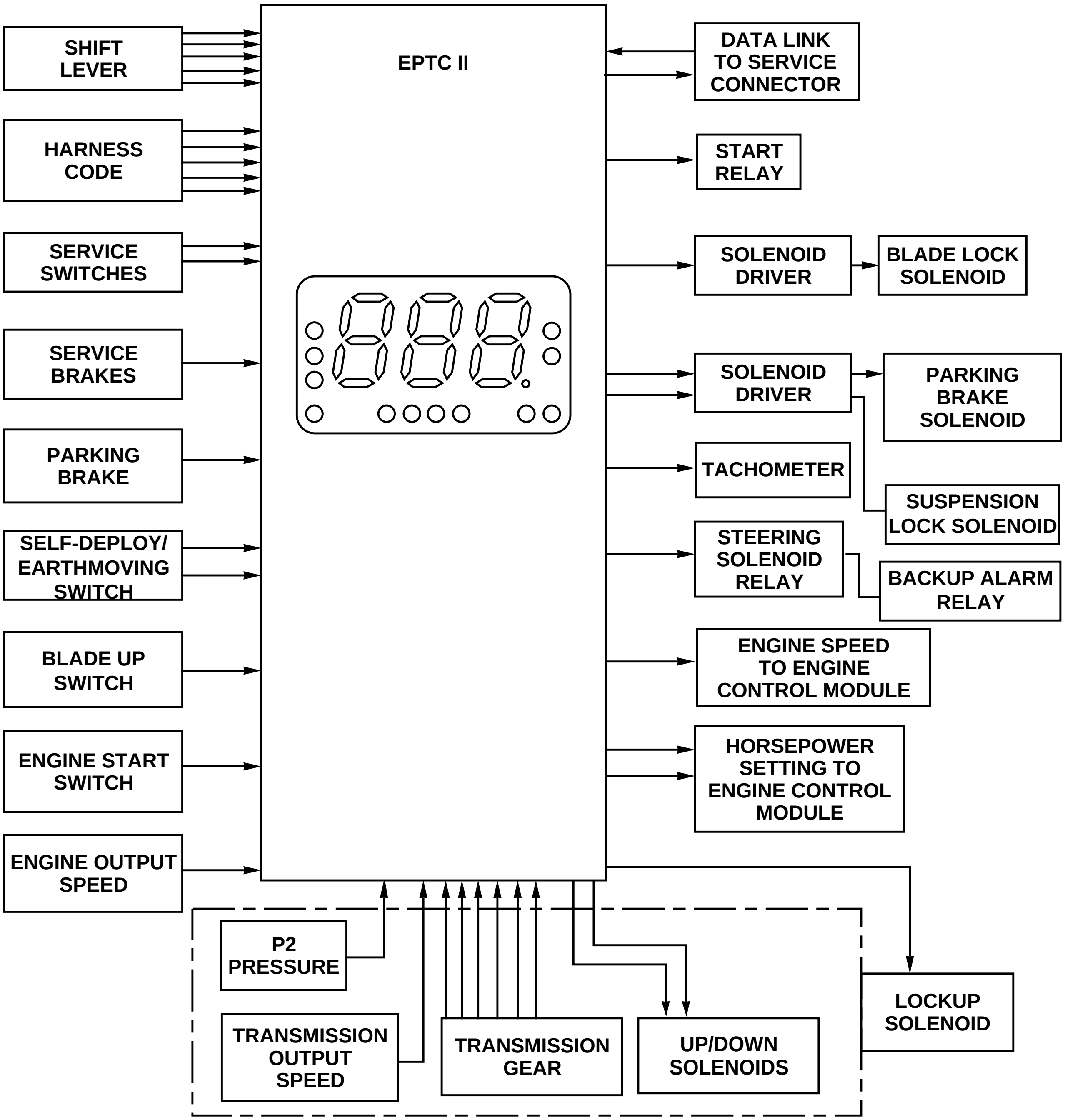
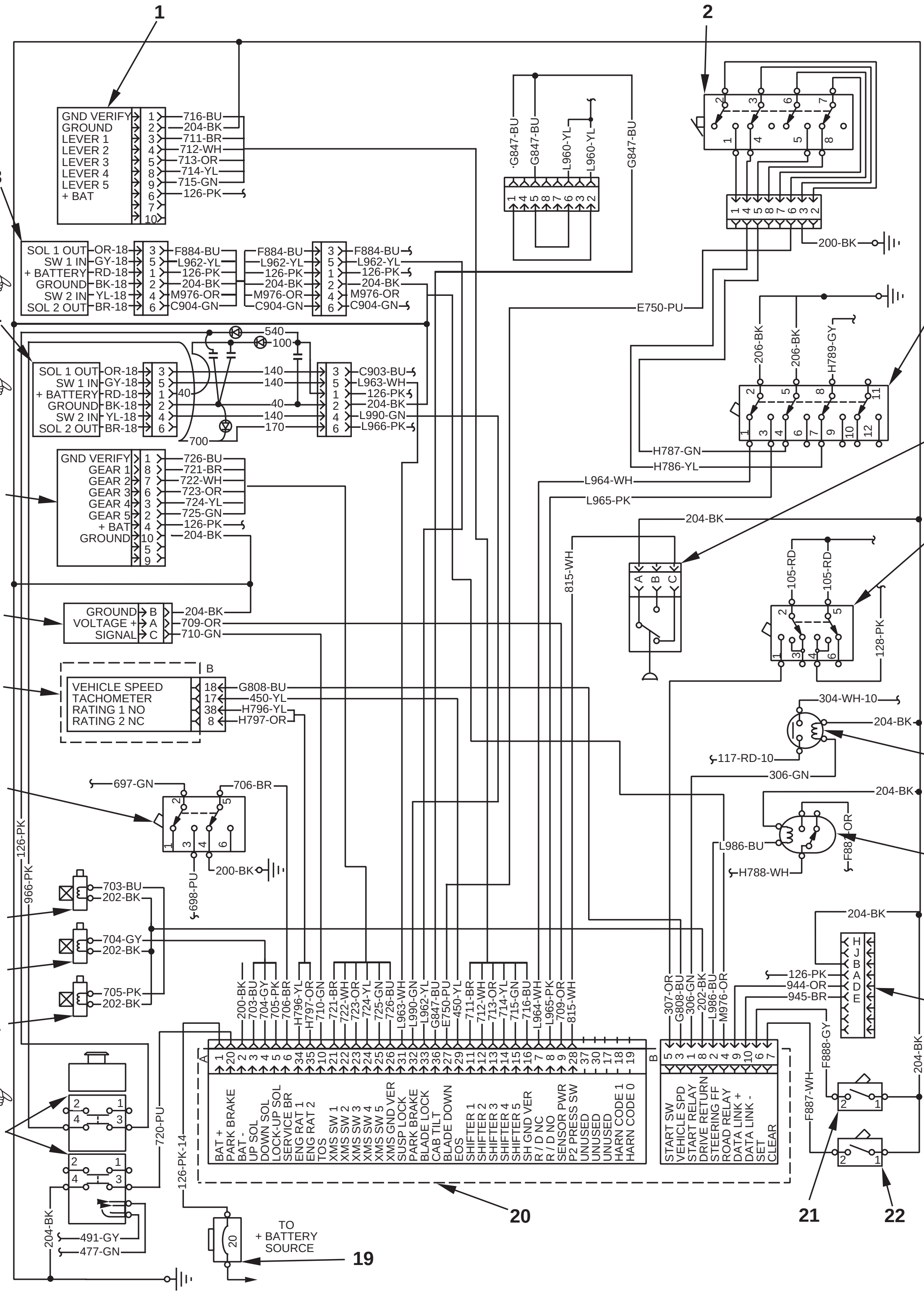
Introduction



EPTC II System Block Diagram for the DEUCE.

The Electronic Programmable Transmission Control (EPTC II) system electronically controls the transmission shifting and continuously monitors related machine conditions. The EPTC II also compares its internal memory information to the machine information that it receives. When conditions are appropriate, the EPTC II activates the upshift or downshift solenoid to shift the transmission.



EPTC II Simplified Electrical Schematic.
(1) Shift lever switch. (2) Blade position switch. (3) Number 1 solenoid driver. (4) Number 2 solenoid driver. (5) Transmission gear switch. (6) Transmission output speed sensor. (7) Engine ECM. (8) Service brake switch. (9) Upshift solenoid. (10) Downshift solenoid. (11) Lock solenoid. (12) Parking brake switch. (13) SELF-DEPLOY/EARTHMOVING switch. (14) P2 pressure switch. (15) Engine start switch. (16) Start relay. (17) Steering solenoid relay. (18) Transmission diagnostic plug. (19) EPTC II circuit breaker. (20) EPTC II. (21) Transmission diagnostic check switch. (22) Transmission diagnostic scroll switch.

This is a typical, electrically correct, schematic of the EPTC II system. All harness connectors are not shown, but all components are shown. For an accurate schematic, always refer to *Schematic, Deployable Universal Combat Earthmover (DEUCE), Electrical Schematic*.

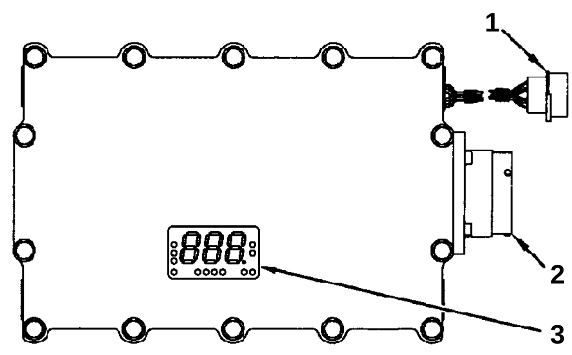
Component Description

The same EPTC II can be used on a variety of models. The EPTC II recognizes the machine on which it is installed and knows which components are present.

EPTC II

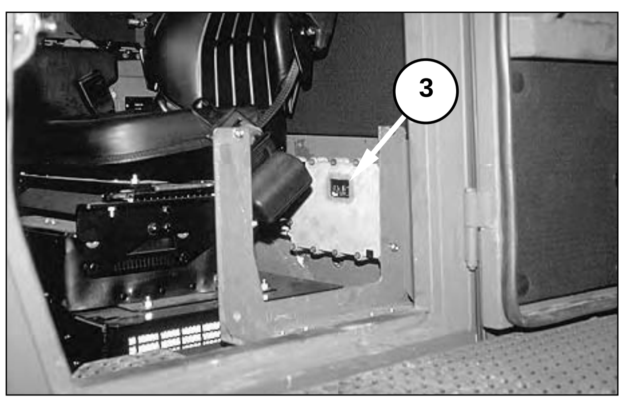
CONTACT DESCRIPTION		
EPTC II Connector "A" (37 Contacts)		
No.	Function	Type
1	Positive Battery	Power
2	Ground	Ground
3	Up Solenoid	Output
4	Down Solenoid	Output
5	Lockup Solenoid	Output
6	Service Brake	Switch Input
7	Operating Mode 1	Switch Input
8	Operating Mode 2	Switch Input
9	Sensor Supply (+10 Volt)	Output
10	Transmission Output Speed (TOS)	Sensor Input
11	Shift Lever 1	Switch Input
12	Shift Lever 2	Switch Input
13	Shift Lever 3	Switch Input
14	Shift Lever 4	Switch Input
15	Shift Lever 5	Switch Input
16	Shift Lever Ground Verify	Switch Input
17	Not Used	-
18	Harness Code 1	Switch Input
19	Harness Code 0	Switch Input
20	Parking Brake	Switch Input
21	Transmission Gear 1	Switch Input
22	Transmission Gear 2	Switch Input
23	Transmission Gear 3	Switch Input
24	Transmission Gear 4	Switch Input
25	Transmission Gear 5	Switch Input
26	Transmission Gear Ground Verify	Switch Input
27	Blade Up	Switch Input
28	Transmission P2 Pressure	Switch Input
29	Engine Output Speed	Input
30	Not Used	-
31	Suspension Lock Solenoid	Output
32	Parking Brake Solenoid	Output
33	Blade Lock Solenoid	Output
34	HP Rating 1	Output
35	HP Rating 2	Output
36	Remote Throttle	Input
37	Not Used	-

CONTACT DESCRIPTION		
EPTC II Connector "B" (10 Contacts)		
1	Start Relay	Output
2	Backup Alarm	Output
3	TOS Speedometer Output	Output
4	Roading Relay	Output
5	Engine Start Switch	Switch Input
6	Service Check	Switch Input
7	Service Scroll	Switch Input
8	Ground	Ground
9	CAT Data Link +	Input/Output
10	CAT Data Link –	Input/Output



EPTC II.
(1) Connector B. (2) Connector A. (3) Display.

Electronic circuits within the EPTC II make all the transmission system decisions. Software within the EPTC II tells the electronic circuits how to operate. Connectors join the harness wiring to the inputs and outputs of the EPTC II. Connector A (2) has 37 contacts, and connector B (1) has 10 contacts. Display (3) shows diagnostic information for troubleshooting the EPTC II system.



Machine Cab, SINCGARS Mount and EPTC II, Cover Removed. (3) Display.

The EPTC II is located in the cab behind the operator's seat. To access the EPTC II, remove the EPTC II cover. Display (3) is part of the EPTC II.

The EPTC II continuously monitors the machine conditions required for shifting the transmission. Components sense the machine conditions and send an electrical signal to the inputs of the EPTC II. The EPTC II compares the input information to memory information and then decides when to shift the transmission. After deciding to shift the transmission, an electrical signal is sent through the outputs of the EPTC II to the correct component (shift solenoid).

Functions other than transmission shifting are performed in the same manner. Decisions are based on input and memory information, and then the corresponding response is made through an output signal.

Input Signals

Numerous input signals inform the EPTC II of the status of the machine conditions. Two types of input exist: switch type and sensor type. Switches and harness wiring provide an open, ground, or positive battery signal to the switch type input of the EPTC II. Sensors provide a constantly changing signal to the sensor input terminals of the EPTC II.

Output Signals

The EPTC II responds to input signals by sending electrical impulses to various output devices. The output devices either create an action, provide information to other devices, or supply power to sensors.

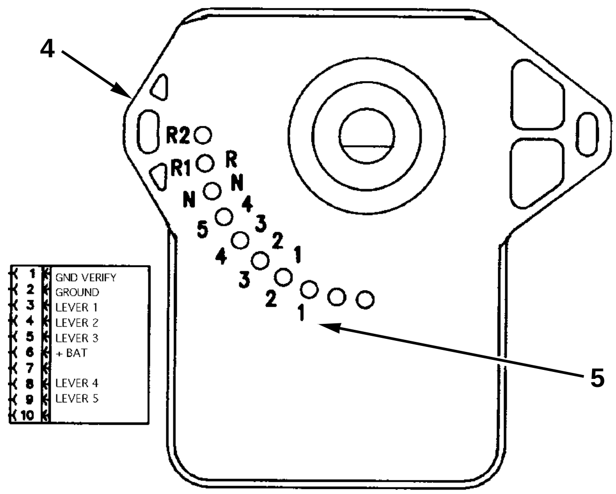
Input/Output

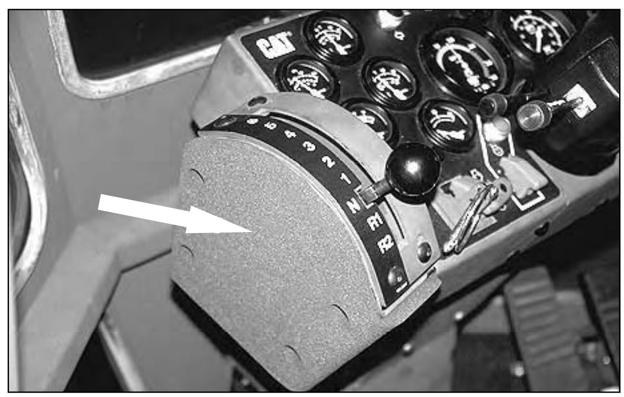
The transmission diagnostic plug is the connection point which the CAT Data Link uses to communicate with a service tool or other electronic control modules (if equipped). The data link is bidirectional, which allows the EPTC II to take in and send out information.

Switches

Switches provide an open, ground or positive battery signal to the switch-type input of the EPTC II.

Shift Lever Switch





Left Side of Instrument Panel, Switch Located Behind Cover (arrow).
(4) Shift lever switch. (5) DEUCE positions.

For a specific switch position, a closed circuit exists between each of the two listed contacts and ground (contact 2). All other lever circuits are open.

NOTE: Since shift lever switch (4) contains diodes, resistance measurements cannot be used to check the switch circuits. The diode function of a multimeter must be used to check the operation of the switch.

Shift lever switch (4) is an input of the EPTC II and connects to contacts 11, 12, 13, 14, 15, and 16 of connector A. The purpose of the switch is to tell the EPTC II which speed position the operator has selected with the shift lever. The shift lever switch is connected mechanically to the shift lever in the shift console. The switch has a connector with nine contacts.

Shift Lever Switch Logic[1]			
Switch Position	**Circuit Name**	**Grounded Switch Connector Contact No.**	**Grounded EPTC II Connector Contact No.**
Sixth	Lever 4 Lever 5	8 9	A-14 A-15
Fifth	Lever 3 Lever 5	5 9	A-13 A-15
Fourth	Lever 2 Lever 5	4 9	A-12 A-15
Third	Lever 1 Lever 5	3 9	A-11 A-15
Second	Lever 3 Lever 4	5 8	A-13 A-14
First	Lever 2 Lever 4	4 8	A-12 A-14
Neutral	Lever 1 Lever 4	3 8	A-11 A-14
Reverse 1	Lever 2 Lever 3	4 5	A-12 A-13
Reverse 2	Lever 1 Lever 3	3 5	A-11 A-13

[1]For each specific switch position, a closed circuit exists between each listed contact and ground.

NOTE: Since shift lever switch (4) contains diodes, resistance measurements cannot be used to check the switch circuits. The diode function of a multimeter must be used to check the operation of the switch.

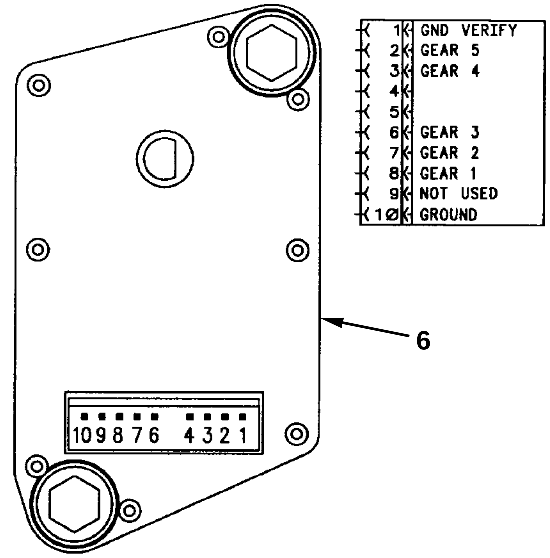
Five contacts (3, 4, 5, 8 and 9) of shift lever switch (4) provide the EPTC II with shift lever position information. For each position of the shift lever, the switch grounds (through internal diodes) two of the five contacts and opens the other three contacts. The EPTC II interprets the status (open or grounded) of the five contacts.

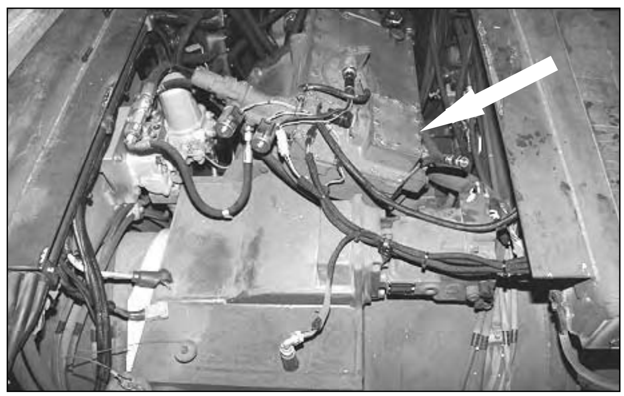
Contact 1 of shift lever switch (4) provides the EPTC II with a ground verify signal. The contact is normally connected to ground at all times; this tells the EPTC II that the shift lever switch is connected.

Contact 2 of shift lever switch (4) is connected to frame ground at all times. Contact 6 receives system voltage but is not used. Contact 10 is not connected. The position for contact 7 is blank; this serves as an index for the mating connector.

The EPTC II records a fault that occurs with the shift lever signals as a CID 702 fault. A fault is recorded if the combination of lever signals is invalid. Refer to "Detected Fault Troubleshooting" in the "Testing and Adjusting" section.

Transmission Gear Switch





Middle Section of Machine, Switch Located Behind Cover (arrow), Machine Partially Disassembled.
(6) Transmission gear switch.

Transmission Gear Switch Logic[1]			
Switch Position	Circuit Name	Grounded Switch Connector Contact No.	Grounded EPTC II Connector Contact No.
Neutral	Gear 4 Gear 5	3 2	A-24 A-25
Reverse 1	Gear 3 Gear 5	6 2	A-23 A-25
Reverse 2	Gear 2 Gear 5	7 2	A-22 A-25
First	Gear 1 Gear 5	8 2	A-21 A-25
Second	Gear 3 Gear 4	6 3	A-23 A-24
Third	Gear 2 Gear 4	7 3	A-22 A-24
Fourth	Gear 1 Gear 4	8 3	A-21 A-24
Fifth	Gear 2 Gear 3	7 6	A-22 A-23
Sixth	Gear 1 Gear 3	8 6	A-21 A-23

[1] For each specific switch position, a closed circuit exists between each listed contact and ground.

For a specific switch position, a low signal (less than 0.5 DCV) exists between each of the two listed contacts and ground. All other gear circuits are high (5.0 DCV). Switch connector contact 4 must be supplied with sensor supply voltage (10 DCV) or battery voltage.

Transmission gear switch (6) is an input of the EPTC II and connects to contacts 21, 22, 23, 24, 25, and 26 of connector A. The switch tells the EPTC II which transmission gear is currently engaged. The transmission gear switch is connected mechanically to the rotary actuator of the transmission. The switch has a connector with nine contacts.

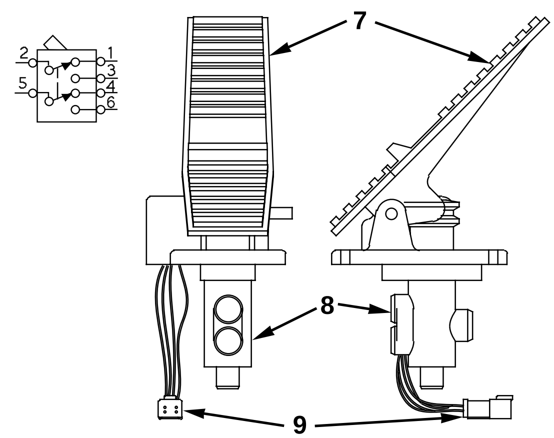
Five contacts (2, 3, 6, 7 and 8) of transmission gear switch (6) provide the EPTC II with the transmission gear information. For each position of the rotary actuator, the switch provides a low signal (less than 0.5 DCV) at two of the five contacts, and a high signal (5.0 DCV) at the other three contacts. The EPTC II interprets the status of the five contacts.

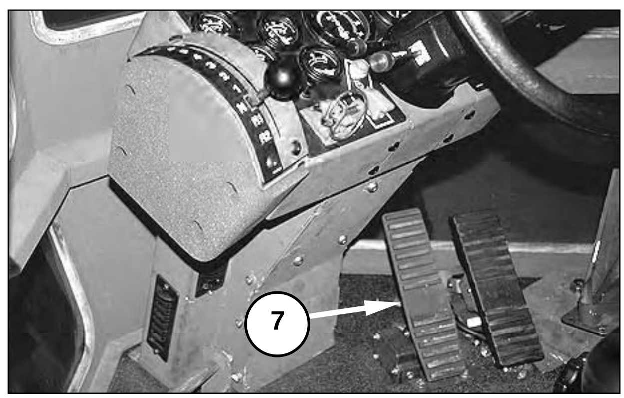
Contact 1 of transmission gear switch (6) provides the EPTC II with a ground verify signal. The contact is normally connected to ground at all times; this tells the EPTC II that the transmission gear switch is connected.

Contact 10 of transmission gear switch (6) is connected to frame ground at all times. Contact 4 connects to the 10-volt sensor supply, but is not used. Contact 9 is not connected. The position for contact 5 is blank; this serves as an index for the mating connector.

The EPTC II records a fault that occurs with the transmission gear signals as a CID 700 fault. A fault is recorded if the combination of gear signals is either invalid or not as expected. Refer to “Detected Fault Troubleshooting” in the “Testing and Adjusting” section.

Service Brake Pressure Switch



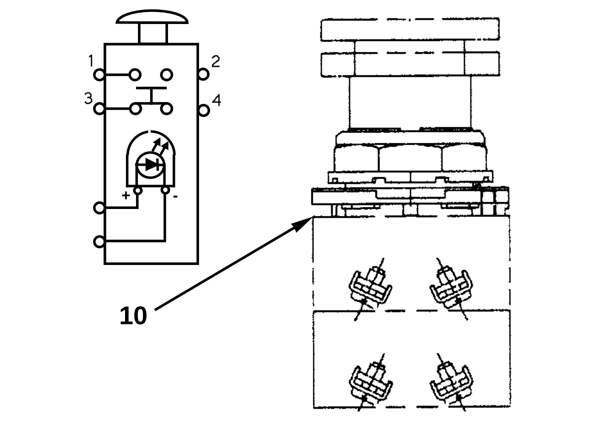


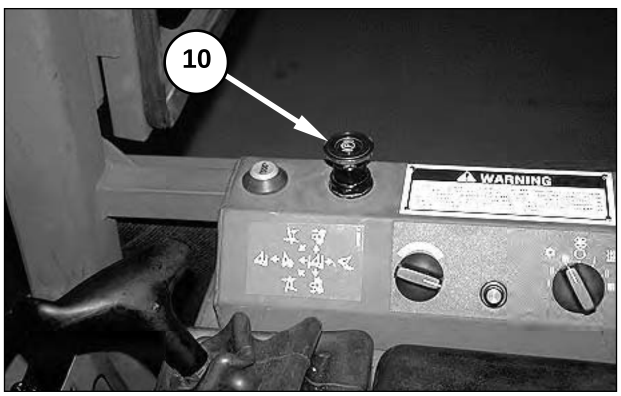
Cab.
(7) Service brake pedal. (8) Service brake control valve. (9) Service brake switch connector.

The service brake switch is mounted to service brake control valve (8), which is part of service brake pedal (7). The switch is a double-pole, double-throw switch. One pole is normally open and controls the brake lights. The other pole is normally closed and signals the EPTC II that the brakes are being applied. Service brake switch connector (9) is located under the cab.

The EPTC II records a fault that occurs with the service brake signal as a CID 704 fault. The fault is recorded if the machine is in operation and the service brake signal either remains open for seven hours or remains grounded for two hours. Refer to “Detected Fault Troubleshooting” in the “Testing and Adjusting” section.

Parking Brake Switch





Right Console.
(10) Parking brake switch.

Parking brake switch (10) is an input of the EPTC II and connects to contact 20 of connector A. The purpose of the switch is to tell the EPTC II that the operator wants to activate the parking brake. The operator activates the parking brake switch by pulling up on the parking brake knob. The EPTC II controls the parking brake through the number-2 solenoid driver.

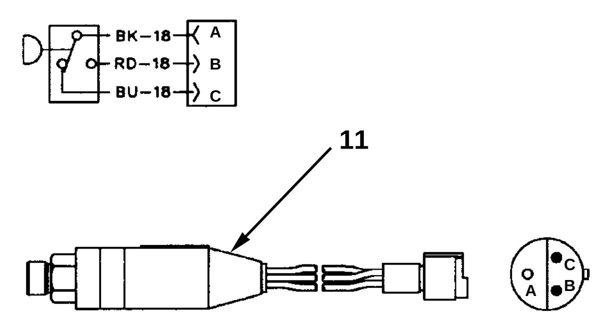
For more information, refer to “Additional Functions, Parking Brake Function” in this section. Also, the EPTC II initiates the parking brake function and cancels the turnaround shift function; refer to “Additional Functions, Turnaround Shift Function” in this section.

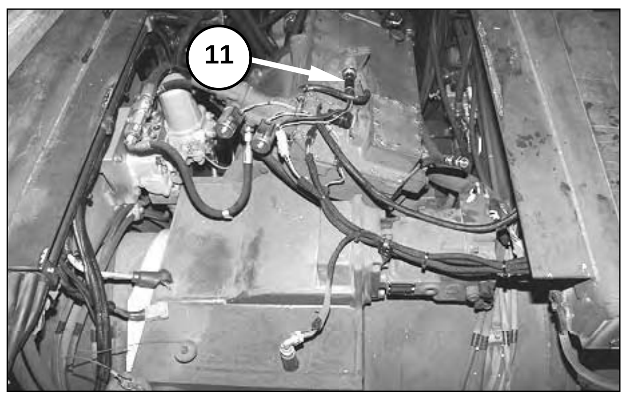
Parking brake switch (10) is located on the right console in the cab. During normal machine operation (parking brake knob IN), the parking brake switch is closed. The switch opens when the parking brake knob is pulled out by the operator.

Parking brake switch (10) has four contacts in the harness connector; contact 3 connects to the EPTC II, contact 4 connects to frame ground, and contacts 1 and 2 are not used.

The EPTC II records a fault that occurs with the parking brake signal as a CID 627 fault. The fault is recorded if the machine is in operation and the parking brake signal either remains grounded for seven hours or remains open for two hours. Refer to “Detected Fault Troubleshooting” in the “Testing and Adjusting” section.

Transmission P2 Pressure Switch





Middle Section of Machine, Machine Partially Disassembled.
(11) Transmission P2 pressure switch.

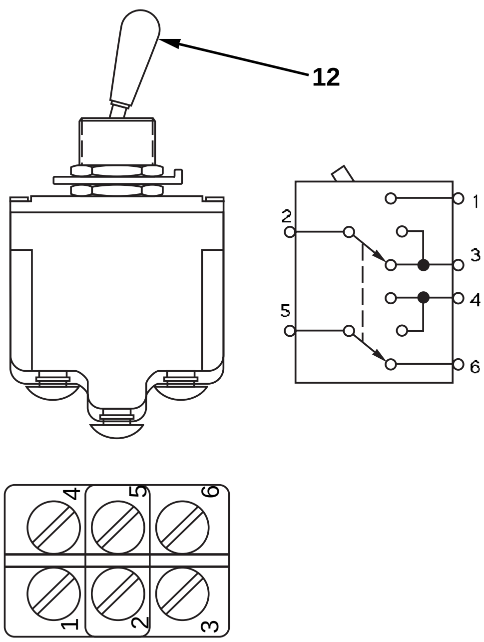
Transmission P2 pressure switch (11) is an input of the EPTC II and connects to contact 28 of connector A. The purpose of the pressure switch is to tell the EPTC II when P2 pressure is at a specific level. During shifting, the EPTC II waits until P2 pressure returns to the specified amount before activating the lockup clutch. For additional information, refer to “Additional Functions, Lockup Clutch Function” in this section.

Transmission P2 pressure switch (11) is located on the P1/P2 test cover, on top of the transmission. During normal machine operation (not in NEUTRAL or shifting), the switch is open (P2 pressure is greater than the activate trip point). When the machine is in NEUTRAL, or during a shift, the switch grounds the P2 pressure signal (P2 pressure is less than the deactivate trip point).

Transmission P2 pressure switch (11) has three contacts in the harness connector; contact 3 connects to the EPTC II, contact 1 connects to frame ground, and contact 2 is not used. Off the machine (on the bench), contacts 1 and 2 are normally open, and contacts 1 and 3 are normally closed.

The EPTC II records a fault that occurs with the P2 signal as a CID 602 fault. The fault is recorded if the status (open/grounded) of the P2 signal does not change during three consecutive shifts. Refer to "Detected Fault Troubleshooting" in the "Testing and Adjusting" section.

Engine Start Switch



Left Side of Instrument Panel, Switch Located Under Cover (arrow).
(12) Engine start switch.

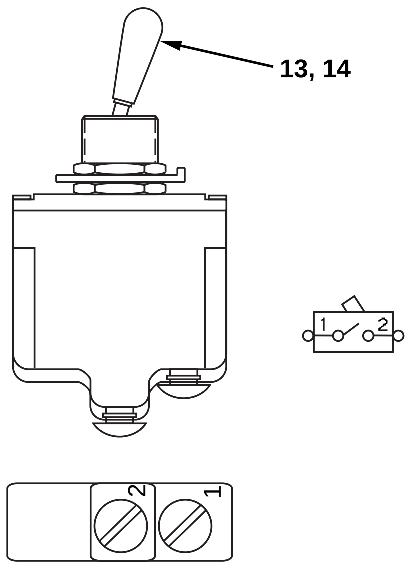
Engine start switch (12) is an input of the EPTC II and connects to contact 5 of connector B. The switch tells the EPTC II that the operator wants to start the engine (the engine start switch has been placed in the start position). The EPTC II then initiates the neutral start function; refer to "Additional Functions, Neutral Start Function" in this section. During normal machine operation, the start signal is open. When the engine start switch is held in the START position, the start signal closes to battery voltage.

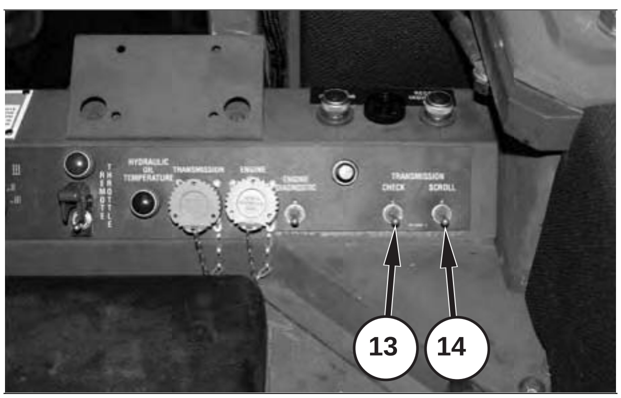
If engine start switch (12) is held in the START position while the engine is running (engine speed is greater than 300 rpm), the EPTC II initiates the lamp test function; refer to "Additional Functions, Lamp Test Function" in this section.

Engine start switch (12) has six terminals; terminal 1 connects to the EPTC II, terminal 2 and 5 connect to battery voltage, terminal 4 connects to the main relay, and terminals 3 and 6 are unused.

The EPTC II does not record faults that occur with the start signal.

Service Switches





Right Console.
(13) Transmission diagnostic check switch. (14) Transmission diagnostic scroll switch.

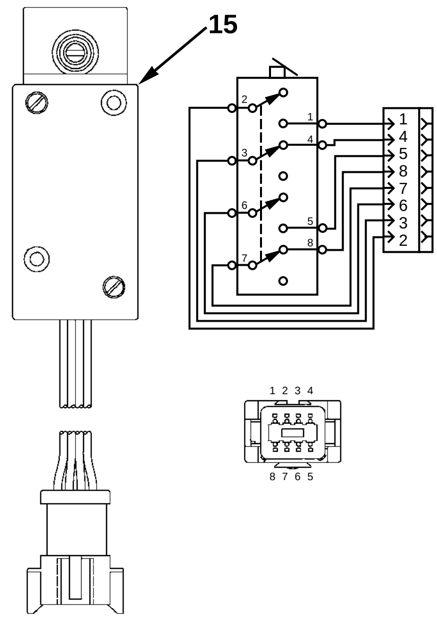
The transmission diagnostic switches are inputs of the EPTC II and connect to contacts 6 and 7 of connector B. The transmission diagnostic check and scroll switches (13 and 14) control the diagnostic and programming information that is shown on the EPTC II display; refer to “Introduction, Diagnostic Switch Operation, Display Modes” in the “Testing and Adjusting” section of this module.

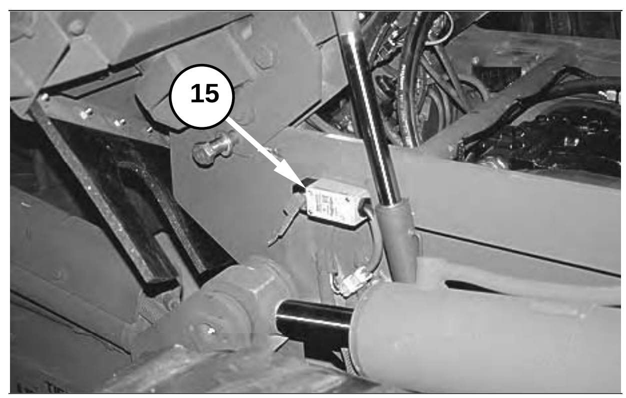
The switches are located on the control console to the right of the operator’s seat. The switches are momentary-type switches that service personnel activate by pressing and holding. During normal machine operation, the switches are open. When activated, the switches close to ground.

Each switch has two terminals; one terminal connects to the EPTC II, and the other terminal connects to frame ground. Off the machine (on the bench), the switches are normally open.

The EPTC II does not record faults that occur with the check or scroll signals.

Blade Down Limit Switch





Front of Machine, Cab Raised.
(15) Blade down limit switch.

Blade down limit switch (15) provides input to the EPTC II. The purpose of the blade down limit switch is to tell the EPTC II that the blade is not in the full up position for SELF-DEPLOY mode. The limit switch holds the EPTC II signal line at machine ground voltage when the switch is closed.

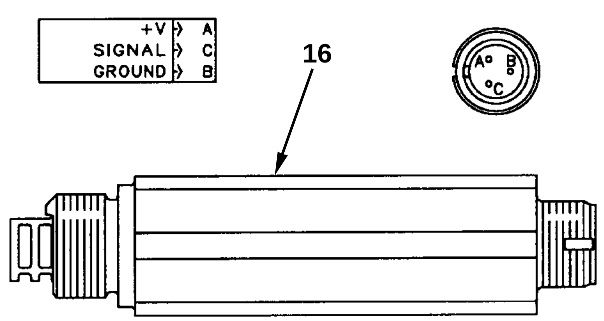
Blade down limit switch (15) is mounted beneath the cab on the left side of the machine. The contacts are closed when the blade is fully raised. Contact 4 in the limit switch connector is connected to the blade down warning indicator through the SELF-DEPLOY/EARTHMOVING switch. Contact 3 in the limit switch connector is connected to ground. Contact 5 in the blade down limit switch connector is connected to ground through the SELF-DEPLOY/EARTHMOVING switch. Contact 6 in the limit switch connector is connected to contact 27 of EPTC II connector A.

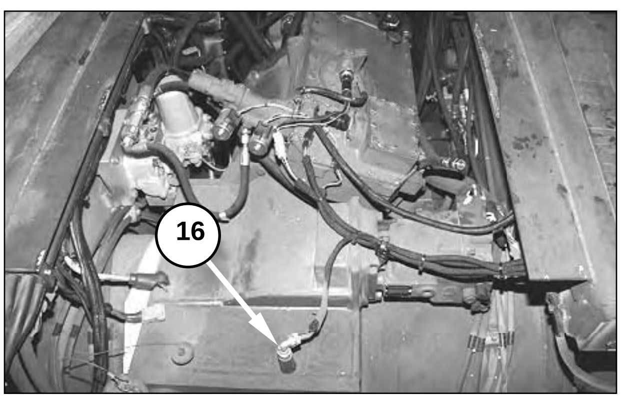
When the SELF-DEPLOY/EARTHMOVING switch is in the SELF-DEPLOY position and the blade is not in the full up position, blade down limit switch (15) turns on the blade down indicator and alarm. The limit switch also interrupts the ground signal to contact 27 of EPTC II connector A, which causes the EPTC II to keep the machine in EARTHMOVING mode (lower horsepower, lower speed). Refer to "Additional Functions, SELF-DEPLOY/EARTHMOVING Function" in this section.

The EPTC II does not record faults that occur with the blade down limit switch signal.

Sensors

Transmission Output Speed (TOS) Sensor





Middle Section of Machine, Machine Partially Disassembled.
(16) Transmission output speed sensor.

Sensors provide information (input) to the EPTC II about changing conditions, such as speed. The sensor signal changes in a proportional manner to reflect the changing condition. The EPTC II recognizes a frequency-type sensor signal. The frequency-type sensor produces a signal in which the frequency (Hz) varies as the conditions change.

Transmission output speed sensor (16) is an input of the EPTC II and connects to contact 10 of connector A. The purpose of the transmission output speed sensor is to tell the EPTC II the speed of the transmission output shaft. Information about the transmission output speed is the main parameter the EPTC II uses to decide when to shift the transmission. The sensor is located on the sensor gear housing, at the output end of the transmission.

Transmission output speed sensor (16) has a connector with three contacts. The sensor receives operating power (+10V) at sensor contact A from contact 9 of EPTC II connector A. Sensor contact B is connected to frame ground. The sensor sends the speed signal from sensor contact C to contact 10 of EPTC II connector A.

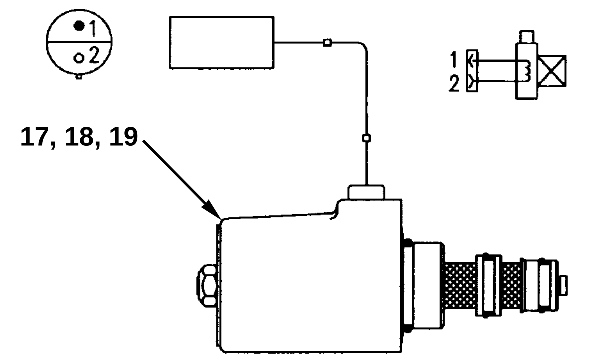
The speed signal from contact C of transmission output speed sensor (16) is a square wave with an amplitude of approximately 10 volts. The frequency (Hz) of the square wave is in direct proportion to the speed of the transmission output shaft.

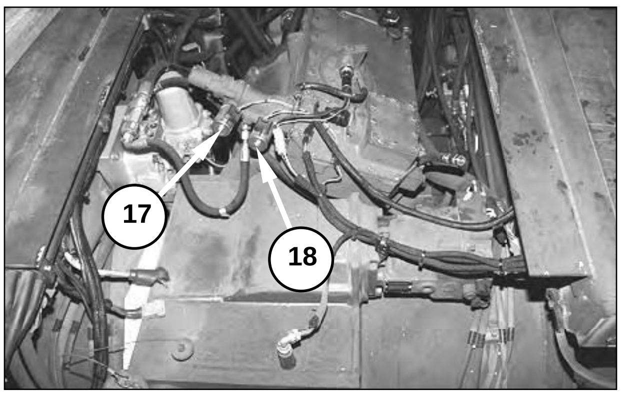
Transmission output speed is directly related to machine ground speed. Therefore, the speedometer and other electronic controls also use the transmission output speed signal (contact C).

The EPTC II records a fault that occurs with the transmission output speed signal as a CID 701 fault. The fault is recorded when the machine is in operation and the signal is incorrect. Refer to "Detected Fault Troubleshooting" in the "Testing and Adjusting" section.

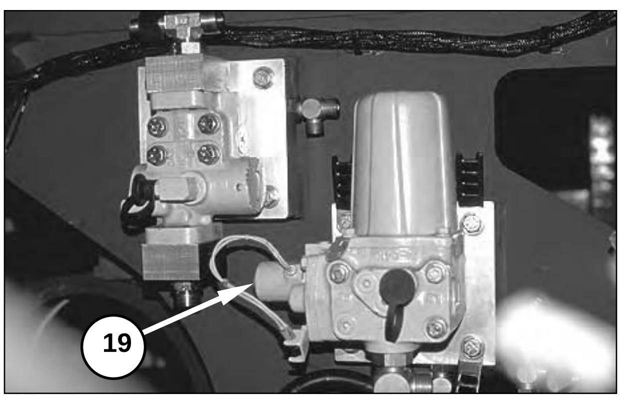
Solenoids

Upshift, Downshift, and Lockup Solenoids





Middle Section of Machine, Machine Partially Disassembled. (17) Upshift solenoid. (18) Downshift solenoid.



Left Side of Machine, Inside of Machine Frame, Machine Partially Disassembled.
(19) Lockup solenoid.

Upshift and downshift solenoids (17 and 18) are outputs of the EPTC II. The upshift solenoid is connected to contact 3 of connector A, and downshift solenoid is connected to contact 4 of connector A. The purpose of the upshift and downshift solenoids is to shift the transmission.

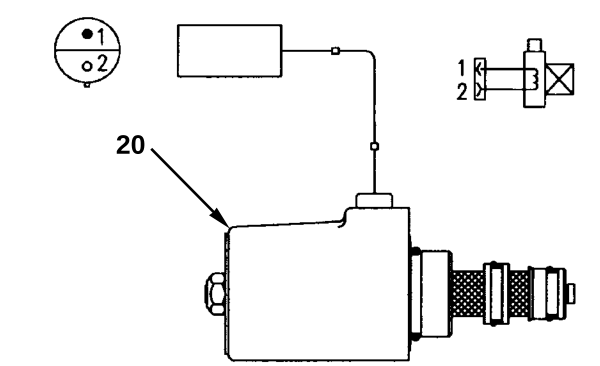
When the EPTC II decides to shift, the corresponding solenoid is activated with battery voltage until the shift occurs. The upshift and downshift solenoids turn the flow of oil that turns the rotary actuator within the transmission hydraulic control group on and off. Movement (turning) of the rotary actuator shifts the transmission. The upshift and downshift solenoids are located on the transmission hydraulic controls, at the top of the transmission.

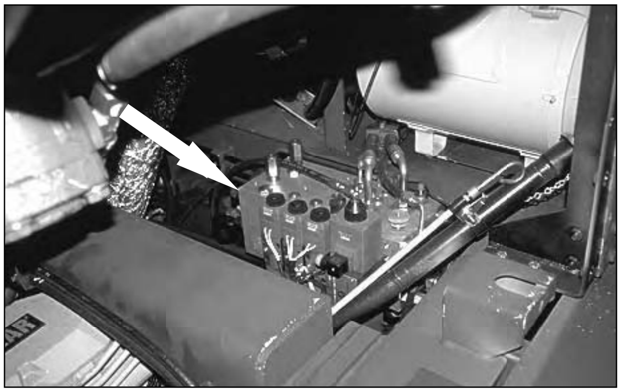
Lockup solenoid (19) is an output of the EPTC II and connects to contact 5 of connector A. The lockup solenoid electrically controls the direct drive function. The EPTC II activates the solenoid with battery voltage, and the solenoid is deactivated when battery voltage is not supplied. This turns the flow of oil to the lockup clutch valve on and off. Direct drive (lockup solenoid activated) is used in the upper transmission speeds. Torque converter drive (lockup solenoid deactivated) is used in the lower transmission speeds. The lockup solenoid is located on the lockup clutch valve at the torque converter.

The solenoids have a connector with two contacts. Contact 1 connects to the EPTC II and receives battery voltage to activate the solenoid. Contact 2 is connected to frame ground.

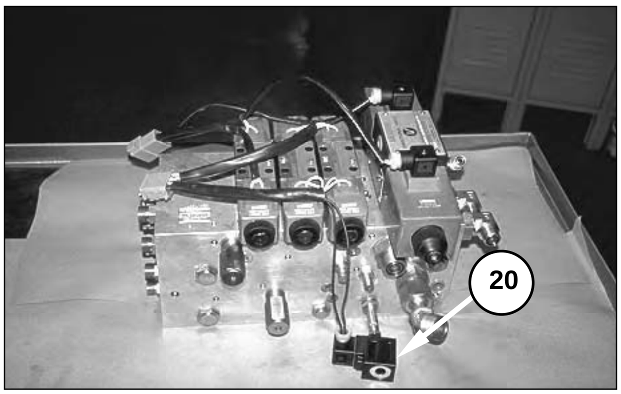
The EPTC II records faults that occur with the upshift, downshift, and lockup solenoids. A fault with the upshift solenoid signal is recorded as a CID 707 fault. A fault with the downshift solenoid signal is recorded as a CID 708 fault. A fault with the lockup solenoid signal is recorded as a CID 709 fault. Refer to “Detected Fault Troubleshooting” in the “Testing and Adjusting” section.

Parking Brake Solenoid





Location of Multifunction Control Valve (arrow).



Multifunction Control Valve Removed From Machine, Partially Disassembled.
(20) Parking brake solenoid.

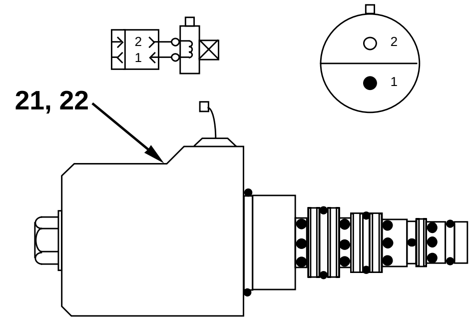
To release the parking brake, the operator pushes in the parking brake switch, which closes contacts 3 and 4 of the second contact block. Closing contacts 3 and 4 supplies battery voltage to parking brake solenoid (20). With the solenoid now energized, the parking brake is not applied. When the parking brake is not applied, the parking brake solenoid is on. The logic to activate the parking brake is the opposite of the logic to deactivate previously described.

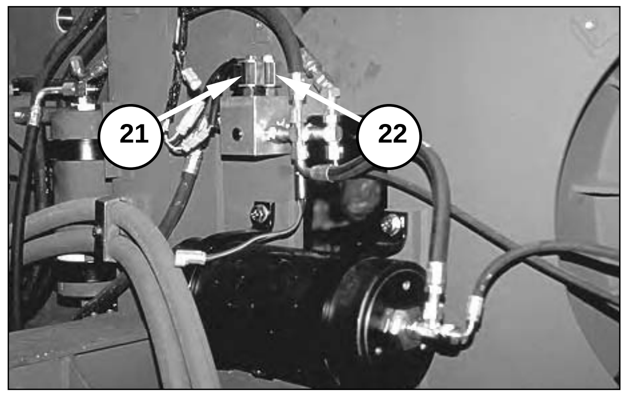
The parking brake solenoid is behind the cab, on the left side of the machine. The parking brake solenoid electrically controls the parking brake, which keeps the machine from moving after stopping. Refer to “Additional Functions, Parking Brake Function” in this module.

Parking brake solenoid (20) has a connector with two contacts. Contact 1 of the solenoid connector receives battery voltage from the second contact block, to activate the solenoid. Contact 2 of the solenoid connector is connected to the frame ground.

The EPTC II does not record faults that occur with the parking brake solenoid.

Suspension Lock Solenoid





Right Side of Machine, Inside Frame, Engine and Transmission Removed.
(21) Suspension lock solenoid. (22) Suspension lock solenoid.

NOTE: The machine is equipped with four suspension lock solenoids: two on each side. The right side is shown; the left side is symmetrical.

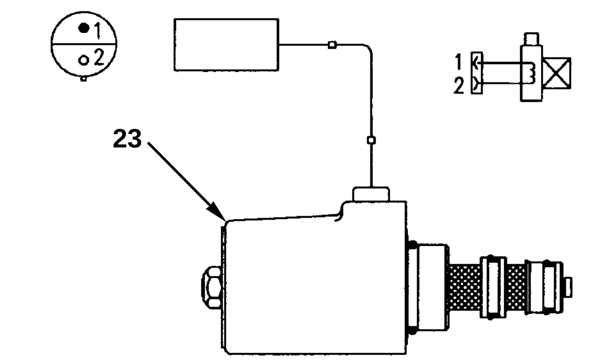
To activate the suspension lock, the EPTC II sends a ground signal to the suspension lock input of the solenoid driver. The solenoid driver then supplies battery voltage to the suspension relay which distributes power to all four suspension lock solenoids. With the solenoids now energized, the suspension is locked for EARTHMOVING mode.

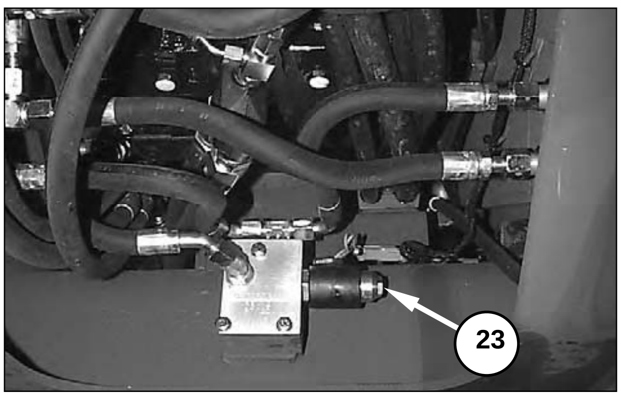
The suspension lock solenoids do not receive direct output signals from the EPTC II. Contact 31 of EPTC II connector A connects to the suspension lock input of the solenoid driver. The suspension lock solenoid electrically controls the locking of the suspension. The suspension locks help prevent movement of the machine while the parking brake is applied. Refer to “Additional Functions, Parking Brake Function” in this module. The suspension lock solenoids are located on the inside of the main frame on both sides of the machine, just ahead of the transmission.

Each solenoid has a connector with two contacts. Contact 1 of the solenoid connector receives battery voltage from the suspension relay to activate the solenoid. Contact 2 of the solenoid connector is connected to frame ground.

The EPTC II does not record faults that occur with the suspension lock solenoid.

Blade Lock Solenoid





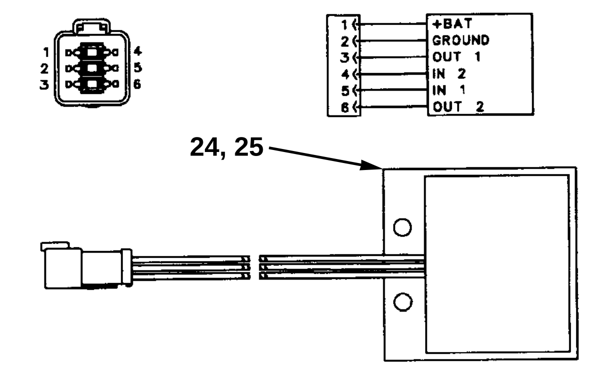
Under Front of Machine, Cover Removed.
(23) Blade lock solenoid.

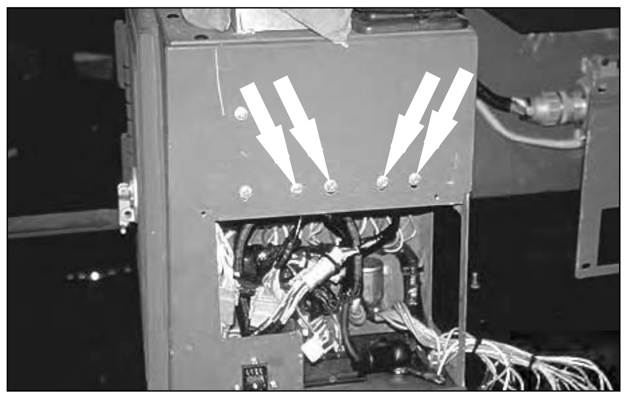
The EPTC II activates blade lock solenoid (23) when the SELF-DEPLOY/EARTHMOVING mode switch is placed into the SELF-DEPLOY position. To activate the blade lock solenoid, the EPTC II sends a ground signal to solenoid driver 1. The solenoid driver then supplies battery voltage to the blade lock solenoid. When the blade lock solenoid is activated, hydraulic oil flowing to the blade down circuit is blocked, preventing the blade from lowering.

Blade lock solenoid (23) is not a direct output of the EPTC II. Contact 33 of EPTC II connector A connects to the blade lock input of solenoid driver 1. Refer to "Additional Functions, SELF-DEPLOY/EARTHMOVING Function" in this module. The blade lock solenoid is located beneath the cab floor on a crossbeam.

Blade lock solenoid (23) has a connector with two contacts. Contact 1 of the solenoid connector receives battery voltage from contact 3 of the solenoid driver to activate the solenoid. Contact 2 of the solenoid connector is connected to frame ground.

Solenoid Driver





Front of Right Console, Partially Disassembled, Cover Removed, Mounting Bolts for Solenoid Drivers (arrows).
(24) Solenoid driver. (25) Solenoid driver.

Two solenoid drivers (24 and 25) are mounted in the cab, inside the right console. The solenoid drivers are an output of the EPTC II and connect to contacts 31, 32, and 33 of connector A, and contact 4 of connector B.

The solenoid drivers activate the parking brake solenoid, blade lock solenoid, and/or the suspension lock solenoid, and the SELF-DEPLOY/EARTHMOVING relay (to illuminate the SELF-DEPLOY lamp) when the EPTC II commands. When conditions are as specified, the EPTC II sends a ground signal to the appropriate solenoid driver. The solenoid responds by activating the corresponding solenoid with battery voltage. Refer to "Additional Functions, Parking Brake Function" in this section.

Solenoid drivers (24 and 25) have six contacts in the harness connector:

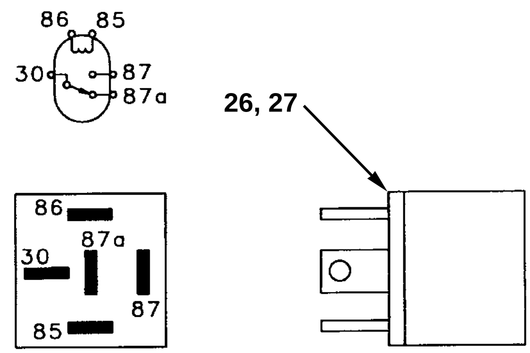
Driver 1
Contact 1 receives battery supply voltage.
Contact 2 connects to frame ground.
Contact 3 connects to the blade lock solenoid.
Contact 4 connects to EPTC II contact B-4 (roading relay).
Contact 5 connects to EPTC II contact 33 (blade lock solenoid).
Contact 6 connects to the SELF-DEPLOY/EARTHMOVING relay.

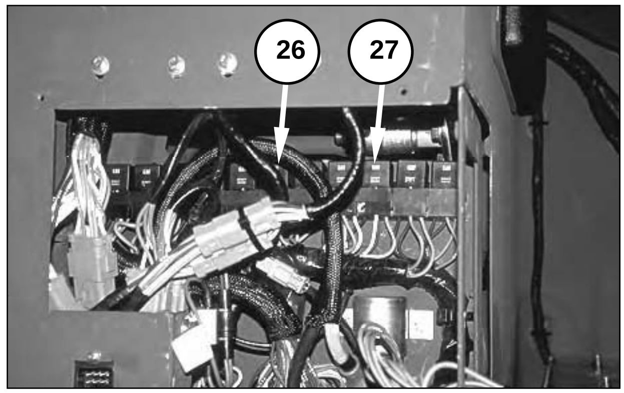
Driver 2
Contact 1 receives battery supply voltage.
Contact 2 connects to frame ground.
Contact 3 connects to the suspension relay.
Contact 4 open.
Contact 5 connects to EPTC II contact 31 (suspension lock solenoid).
Contact 6 open.

The EPTC II does not record faults within the self-deploy lamp signal, blade lock solenoid signal, the suspension lock solenoid signal, or the parking brake solenoid signal.

Relays

Steering Solenoid Relay and Backup Alarm Relay





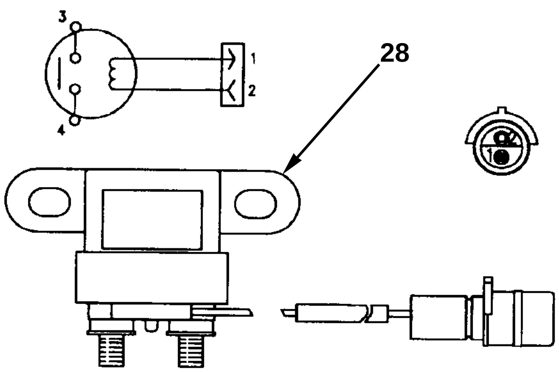
Front of Right Console, Partially Disassembled, Cover Removed.
(26) Steering solenoid relay. (27) Backup alarm relay.

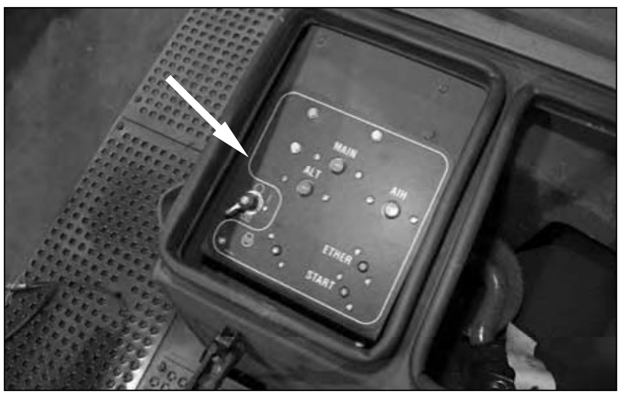
The steering solenoid relay is driven through contact 2 of EPTC II connector B. The steering solenoid relay controls the steering solenoid. The steering solenoid switches the steering direction when the transmission is in a reverse gear (C-turn logic). The backup alarm relay controls the backup alarm, which alerts personnel that the machine is backing up. Refer to “Additional Functions, Reverse Steering Function” and “Additional Functions, Backup Alarm Function” in this section.

When the transmission is in REVERSE, the control sends an activate signal to the backup alarm relay. When the backup alarm relay is activated, power from the machine electrical system is passed on to the backup alarm.

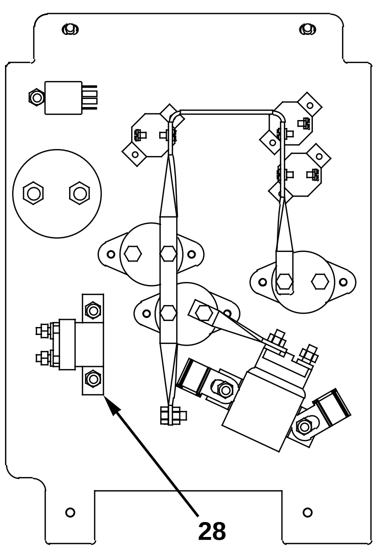
The EPTC II does not record faults that occur with the steering solenoid and backup alarm signals.

Start Relay





Rear of Machine, Rear Circuit Breaker Panel (arrow).



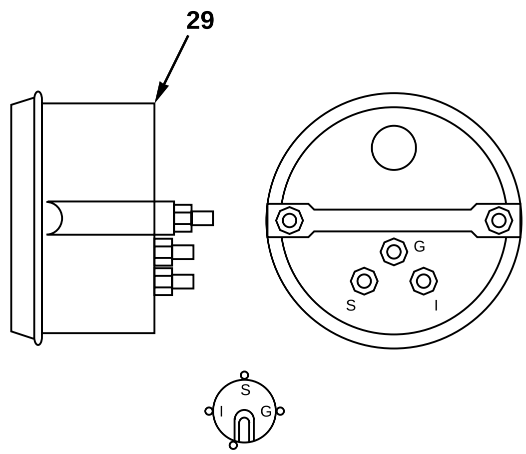
View of Rear Circuit Breaker Panel.
(28) Start relay.

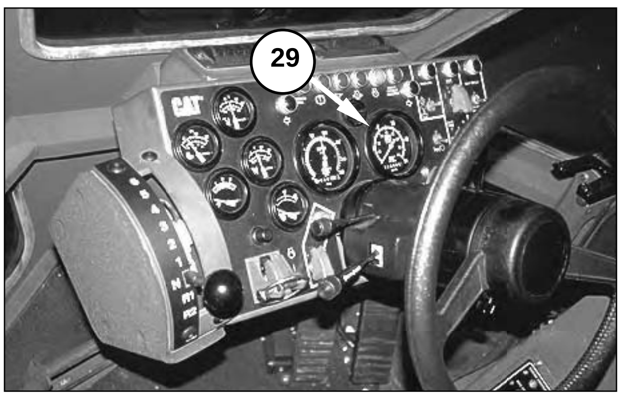
Start relay (28) is an output of the EPTC II and connects to contact 1 of connector B. The start relay turns the start solenoid, which controls the starting motor on and off. After the operator turns the engine start switch to the START position, and the control decides that all starting conditions are satisfied, the control then transfers power to the coil of the start relay. In order for the control to activate the start relay, the operator must also have NEUTRAL selected and the parking brake engaged. Refer to “Additional Functions, Neutral Start Function” in this section.

Start relay (28) has two terminals and a connector with two contacts. Relay connector contact 2 receives the actuate signal from contact 1 of EPTC II connector B. Relay connector contact 1 goes to frame ground. One relay terminal connects to a power source of the machine electrical system. The other relay terminal connects to the start solenoid.

The EPTC II does not record faults that occur with the start signal.

Speedometer





Instrument Panel.
(29) Speedometer.

The EPTC II computes vehicle speed using the transmission output speed signal. The EPTC II scales the transmission output speed signal and sends the scaled signal from terminal B-3 to the engine electronic control module (ECM). The ECM drives speedometer (29).

Speedometer (29) has three terminals. The G-terminal is connected to machine ground. The I-terminal is connected to battery positive (24V). The S-terminal is connected to terminal B-16 of the ECM.

The EPTC II does not record faults that occur with the speedometer signal.

Related

Harness Code

On all machines, the EPTC II must know on which model of machine the transmission control is installed. The EPTC II operates in a manner that corresponds to the open or grounded state of the harness code inputs: contacts 18, and 19 of connector A. These inputs receive information from permanent connections within the machine harness. The EPTC II interprets the status (open or grounded) of the two contacts, and therefore knows what machine it is installed on and how to operate.

The EPTC II also assigns a three-digit machine code to each valid harness code combination. The machine code is useful for determining whether the correct EPTC II is installed and for troubleshooting a harness code wiring problem. The three digits of the machine code are shown on the display during the self-test. Refer to the topics “Harness Code Check” and “Self-Test” in the “Testing and Adjusting” section.

The EPTC II does not record faults on an individual basis for each of the two harness code signals. However, the combination of the five harness code signals is diagnosed. The EPTC II records a fault that occurs with the harness code combination as a CID 650 fault. The fault is recorded if the harness code combination is unknown, or if the combination changes during machine operation. Refer to “Detected Fault Troubleshooting” in the “Testing and Adjusting” section.

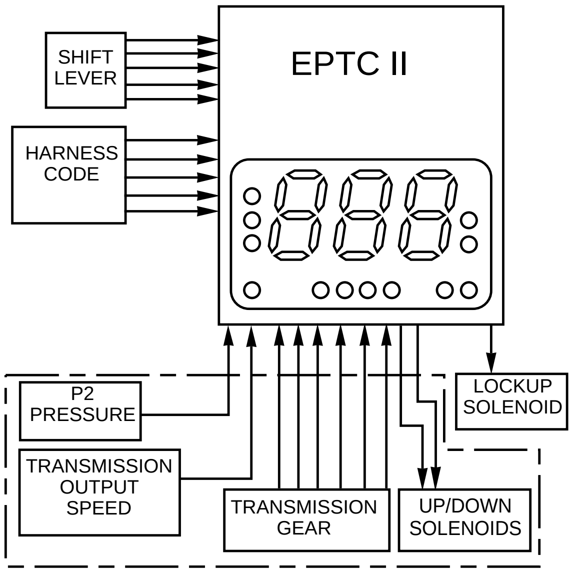
CAT Data Link

The CAT Data Link is an input and an output of the EPTC II at contacts 9 and 10 of connector B. The purpose of the data link is to communicate with a service tool. The data link is not a visible component; it consists of internal EPTC II circuits, the related harness wiring and the service tool connector. The service tool connector is the transmission diagnostic plug which is located on the console to the right of the operator’s seat. The data link is bidirectional, which allows the EPTC II to receive and distribute information. The EPTC II can send the following information to a service tool.

- Gear engagement counts.
- Lockup clutch engagement counts.
- Transmission overspeed counts.
- Machine overspeed counts.
- Engine overspeed counts.
- System overvoltage counts.

The EPTC II does not record faults that occur with the CAT Data Link signals.

Normal Operation



Normal Operation Diagram.

NOTE: For shift point information, refer to “Shift Point Specifications” in the “Testing and Adjusting” section of this module.

NOTE: Also refer to “Additional Functions” in this section.

The primary duty of the EPTC II is to electrically control the shifting of the transmission. The basic components and corresponding requirements for transmission shifting are:

- Harness Code—The shifting strategy is different on the various machine models. The EPTC II must know what model it is installed on, so that unit operates correctly. The status (open or grounded) of the five harness code inputs tells the EPTC II the model it is installed on. Permanent connections within the machine harness provide the harness code information.

- Shift Lever Switch—The EPTC II must know the speed position the operator has selected with the shift lever. Five shift lever input signals tell the EPTC II the selected speed position. The shift lever switch provides this information.

- Transmission Gear Switch—The EPTC II must know the transmission gear currently engaged. Five transmission gear input signals tell the EPTC II which transmission gear is engaged. The transmission gear switch provides this information.

- Transmission Output Speed (TOS) Sensor—The EPTC II must know the output speed of the transmission. One TOS sensor input tells the EPTC II the speed of the transmission output shaft. The TOS sensor provides this information.

- Upshift and Downshift Solenoids—The EPTC II must electrically shift the transmission. The EPTC II uses two separate outputs to upshift or downshift the transmission one gear at a time. The EPTC II activates the upshift or downshift solenoid to electrically shift the transmission.

When the operator selects a forward speed, the EPTC II automatically shifts up or down, as dictated by the transmission output speed. The automatic upshift and downshift points are stored in the EPTC II. A shift occurs when the transmission output speed matches the shift point value. When the transmission output speed increases to an upshift point, the EPTC II activates the upshift solenoid until the transmission gear switch changes to the correct position. The EPTC II automatically upshifts to the speed selected at the shift lever. When the transmission output speed decreases to a downshift point, the EPTC II activates the downshift solenoid until the transmission gear switch changes to the correct position. When operating conditions require, the EPTC II automatically downshifts to first speed.

NOTE: Transmission output speed (when in direct drive) is directly proportional to ground and engine speed.

When shifting from forward or reverse to NEUTRAL while the machine is moving faster than 8.3 kph (5 mph), the EPTC II will not shift the transmission to neutral until ground speed is less than 8.3 kph (5 mph). This discourages high speed coasting in neutral, which reduces transmission life. For more information, refer to “Additional Functions, Neutral Coast Function” in this section.

Reverse is not engaged until ground speed is less than 5 kph (3 mph). This helps protect the transmission from abusive directional shifts.

The EPTC II does not downshift when the operator selects a speed that is not appropriate for the current transmission output speed. Automatic upshifting and/or downshifting will continue. When the transmission output speed decreases to the downshift point of the selected gear, the transmission gear and the selected gear will be the same. The selected gear now becomes the new automatic shift top gear.

The EPTC II upshifts the transmission one gear above the shift lever selection if the transmission output speed reaches a critical value. This helps protect the engine from overspeeding. If the transmission is already in top gear, the lockup clutch is deactivated.

Additional Functions

The EPTC II performs additional functions that are machine dependent. The EPTC II provides the following functions in addition to normal operation.

SELF-DEPLOY/EARTHMOVING Function

The machine can operate in two distinct modes: EARTHMOVING and SELF-DEPLOY. EARTHMOVING mode is used for bulldozing. The SELF-DEPLOY mode is used for running the machine at high speed.

When the SELF-DEPLOY/EARTHMOVING mode switch is placed into the EARTHMOVING position, the EPTC II activates the suspension locking solenoid to lock the belt tension and rear idler suspension cylinders. The suspension is locked to provide a stable base for moving earth. The EPTC II also signals the engine to operate in low horsepower mode and limits the transmission to three speeds forward, manually shifted. The EPTC II deactivates the suspension lock solenoid when the machine is operated in a reverse gear, to allow for higher reverse speeds.

When the SELF-DEPLOY/EARTHMOVING mode switch is placed into the SELF-DEPLOY position, the EPTC II activates the blade lock solenoid to stop blade down operation. If the blade is not fully raised, the EPTC II turns on the blade down indicator and warning horn. The blade down indicator and warning horn will remain on until the blade is fully raised (the blade down limit switch is closed). If the blade is fully raised, the EPTC II turns on the SELF-DEPLOY indicator and signals the engine ECM to operate the engine in high horsepower mode. In SELF-DEPLOY mode, the EPTC II automatically shifts the transmission.

NOTE: When the shift lever is in SECOND gear, the EPTC II automatically shifts from FIRST to SECOND. If the position of the shift lever is higher than SECOND gear, the EPTC II shifts the transmission to the highest gear selected in the following sequence: FIRST-THIRD-FORTH-FIFTH-SIXTH.

Turnaround Shift Function

During normal shifting, the EPTC II does not allow a turnaround shift until approximately 2.3 seconds after a shift occurs. A turnaround shift is a shift which is opposite from the previous shift. For example, a downshift is prohibited for 2.3 seconds after an upshift, and an upshift is prohibited for 2.3 seconds after a downshift. The purpose of this turnaround time delay is to allow mechanical and hydraulic conditions to stabilize before another shift is made. The delay prevents hunting between gears.

However, the EPTC II overrides the turnaround time delay when the operator applies any brake. Downshifts now occur immediately as the decreasing transmission output speed dictates. This function is provided in case the operator is required to make a sudden stop while the turnaround time delay is in effect (2.3 seconds after an upshift).

Lockup Clutch Function

The lockup clutch function electrically controls direct drive. When the EPTC II activates the lockup solenoid, the lockup clutch within the torque converter mechanically connects the torque converter input shaft to the torque converter output shaft. The purpose of this function is to efficiently connect the power train to the engine. The EPTC II engages the lockup clutch (direct drive) most of the time during normal operation. However, during a shift the lockup solenoid is momentarily deactuated for smooth transmission shifting. In addition to a fixed deactuation time, the EPTC II uses the transmission P2 pressure to determine when the deactuation time period starts and stops. The machine is in torque converter drive when the lockup solenoid is deactivated. Reverse and neutral are torque converter drive only. First, second, and third gears are torque converter drive on the low end, and direct drive on the high end. Gears four through six are direct drive.

Parking Brake Function

The purpose of the parking brake function is to monitor the position of the parking brake switch and to help protect the parking brake from being damaged. When this function is enabled, the EPTC II allows normal operation. The parking brake solenoid is energized to DISENGAGE the parking brake.

When the operator pulls up on the park brake knob, contacts 3 and 4 of the parking brake switch open. The EPTC II reads an open circuit at contact A-20. This signal tells the EPTC II that the parking brake knob is in the ON position.

When the EPTC II reads an open circuit at contact A-20, the EPTC II allows the starter to engage (if the transmission input speed is 0), allows the remote throttle to operate if requested, and does not allow the transmission to go into gear if the transmission is in neutral.

When the operator pushes the parking brake knob down, contacts 3 and 4 of the parking brake switch close, and the EPTC II reads a closed circuit at contact A-20. This confirms that the parking brake knob is in the OFF position. The EPTC II sends a ground signal from contact A-32 to contact 4 of the solenoid driver. The solenoid driver transfers power from contact 6 to the parking brake solenoid and the coil of the parking brake relay. The parking brake solenoid and the coil in the parking brake relay energize, causing the parking brake to disengage and the parking brake lamp to go out.

NOTE: The EPTC II turns on the parking brake whenever the EPTC II is powered up, regardless of the position of the parking brake switch. If the parking brake switch is OFF when the EPTC II is powered up, the switch will have to be turned ON, and then OFF again to release the parking brakes.

Reverse Steering Function

The reverse steering function causes the machine to steer in the same direction in forward and reverse, for a given steering wheel rotation. When the EPTC II senses that the transmission shift control is in a reverse gear, the EPTC II causes the diverter (flip flop) valve to activate. When the diverter (flip flop) valve activates, the steering signal lines to the steering motor are reversed. This causes the machine to steer in the same direction in reverse as it does in forward (C-turn logic).

Neutral Coast Function

The neutral coast function restricts high speed coasting in neutral, which reduces transmission life. If the shift lever is moved from forward or reverse to NEUTRAL while the machine is moving faster than 8.3 kph (5 mph), the EPTC II will not shift the transmission to neutral until ground speed is less than 8.3 kph (5 mph). The neutral coast function is enabled all the time.

Neutral Start Function

The neutral start function starts the engine only when the shift lever is in NEUTRAL and the parking brake is ON. When this function is enabled, the EPTC II activates the start relay, which then cranks the starting motor.

This function is enabled when the shift lever is in NEUTRAL, the parking brake is ON and the engine start switch is in the START position. The shift lever switch tells the EPTC II that the shift lever is in NEUTRAL. The parking brake switch tells the EPTC II that the parking brake is ON. The engine start switch tells the EPTC II that the engine start switch is in START.

In addition to the neutral start function, the EPTC II also performs the start prevent function. This function is enabled when the electrical system voltage is greater than 36 volts. The EPTC II internally monitors electrical system voltage that is present at contact 1 of EPTC II connector A. This function protects the starting and charging system during an incorrect jump start. When this function is enabled, the EPTC II does not activate the start relay.

Auxiliary Engine Speed Control Function

The auxiliary engine speed control function operates the engine at a fixed speed when remote auxiliary hydraulic tools are in use. When the auxiliary engine speed control switch is activated, the EPTC II engages the parking brake and limits the transmission to NEUTRAL.

Backup Alarm Function

The backup alarm function alerts personnel that the machine is backing up. When this function is enabled, the EPTC II causes the backup alarm to sound. When the transmission is in REVERSE, the control activates the backup alarm relay, which then activates the backup alarm.

Lamp Test Function

The lamp test function ensures that the indicator lamps function. When the engine start switch is in the START position, current flows to terminal B-5 of the EPTC II and to the coil of the lamp test relay. Current in the lamp test relay coil energizes the coil and closes the relay.

When closed, the lamp test relay provides a ground path through the diode block for the blade down alarm and the tension fail, low brake pressure, blade down, engine oil pressure, hydraulic oil temperature, kneeling mode, winch, self-deploy mode, remote throttle, and park brake lamps. The lamps illuminate and the alarm sounds until the start switch is returned to the ON position.

NOTE: The blackout switch must be in either the SERVICE DRIVE or STOP LIGHT position for the kneeling mode lamp, winch lamp, and self-deploy mode lamp to function.

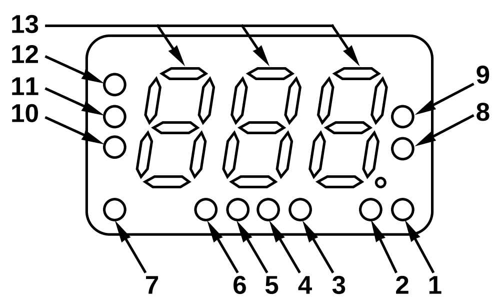
When the engine is running, terminal B-17 of the ECM sends an engine output speed signal to terminal A-29 of the EPTC II. If the engine speed is greater than 300 rpm when the start switch is moved from the ON position to the START position, the EPTC II will not complete a circuit from terminal B-1 to the start relay, and the starter will not engage. However, current from the start switch does energize the coil in the lamp test relay, which enables the lamp test to function.

Diagnostic Operation

To assist with troubleshooting, the EPTC II shows the following diagnostic information on the display:

- EPTC II system faults.
- The status (open, grounded or active) of most input and output signals.
- The transmission gear and shift lever positions currently used.
- The transmission output speed.

Display Modes



Display.
(1) Power indicator.
(2) Control indicator.
(3) Blade lock switch indicator.
(4) SELF-DEPLOY/EARTHMOVING switch indicator.
(5) Parking brake indicator.
(6) Service brake indicator.
(7) Remote throttle indicator.
(8) Service mode indicator.
(9) Fault present indicator.
(10) Transmission P2 indicator.
(11) Engine output speed indicator.
(12) Transmission output speed indicator.
(13) Readout.

NOTE: The dot at the right end of readout (13) is provided for orientation.

There are seven different modes of operation for the EPTC II display. Each mode shows or allows for programming of important information. Service personnel access this diagnostic information by entering the corresponding display modes. The seven display modes are:

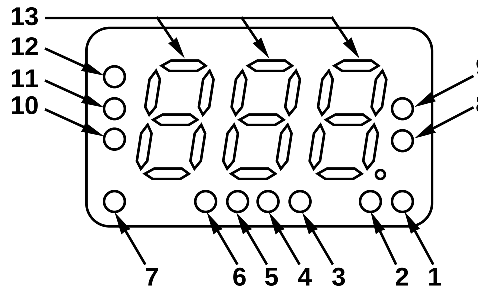
- Mode 0—Normal Mode
- Mode 1—Detected Fault Mode
- Mode 2—Shift Status Mode
- Mode 3—Other Status Mode
- Mode 4—Shift Monitor Mode
- Mode 5—Engine Output Speed Monitor Mode
- Mode 6—Transmission Output Speed Monitor Mode

The service switches, located within the operator compartment, provide access to the check and scroll inputs. When activated, the check switch grounds the check input (connector B, contact 6). When activated, the scroll switch grounds the scroll input (connector B, contact 7).

When the engine start switch is turned ON, the display shows the self-test information and then automatically enters normal mode (mode 0). To enter a different display mode, press and hold the check and scroll switches at the same time. This causes the mode numbers 0 through 8 to scroll on readout (13). When the switches are released, the display enters the mode which corresponds to the number that is presently shown. For example, releasing the switches when mode number "– 1 –" is shown on readout (13) causes the display to enter the detected fault mode (mode 1).

The display mode can be changed at any time. Pressing and holding the check and scroll switches at the same time initiates the scrolling of the mode numbers. Releasing the switches causes the display to enter the mode which is currently shown. Whenever the engine start switch is turned OFF and then back ON, while the check and scroll switches are released, the display enters the normal mode (mode 0).

Mode 0—Normal Mode



Display.
(1) Power indicator.
(2) Control indicator.
(3) Blade lock switch indicator.
(4) SELF-DEPLOY/EARTHMOVING switch indicator.
(5) Parking brake indicator.
(6) Service brake indicator.
(7) Remote throttle indicator.
(8) Service mode indicator.
(9) Fault present indicator.
(10) Transmission P2 indicator.
(11) Engine output speed indicator.
(12) Transmission output speed indicator.
(13) Readout.

NOTE: The dot at the right end of readout (13) is provided for orientation.

Normal mode (mode 0) is the display mode for normal machine operation. When in normal mode, power indicator (1) is ON, and service mode indicator (8) is OFF.

In addition to the normal duties of shifting the transmission, the EPTC II is constantly checking the inputs and outputs for correct operation. Whenever the EPTC II records information it is called an "event." Events are categorized into either "fault events" or "data events."

- A fault event is recorded when a certain component of the EPTC II system is not operating properly. Fault events are detected by the EPTC II when a signal at a connector contact is outside the valid range. Fault events (detected faults) are stored and shown on readout (13).

- A data event is recorded when the EPTC II decides the machine is operating in an abnormal or abusive manner. Based on a combination of signals at connector contacts, the EPTC II decides when the machine is operating abnormally.

In the normal mode, the display shows (with numbers and indicators) which components are faulty, and categorizes the faults.

Each detected fault consists of two identifiers (flashing numbers) and an indicator. The identifiers are shown on readout (13). The identifiers and indicator are:

- Component Identifier (CID)—The CID is a three-digit code that tells which component is faulty. The CID is shown on readout (13). For example, "627" means the circuit for the parking brake switch is faulty. For a list of CID codes, refer to "Detected Fault Troubleshooting" in the "Testing and Adjusting" section of this module.

- Failure Mode Identifier (FMI)—The FMI is a two-digit code that tells what type of failure has occurred. The two-digit code is preceded by the letter "F." The FMI is shown immediately after the CID on readout (13). For example, "F03" means the signal voltage is above normal. For a list of FMI codes, refer to "Detected Fault Troubleshooting" in the "Testing And Adjusting" section of this module.

- Fault present indicator (9)—When the fault present indicator is red (ON), the fault shown on readout (13) is currently present. When the indicator is OFF, no faults are currently detected.

One detected fault is described by a fault present indicator (9), a CID code, and an FMI code. For example, if the signal wire for the parking brake switch is shorted to battery voltage, then:

1. CID "627" is shown on readout (13).
2. FMI "F03" is shown on readout (13).
3. Fault present indicator (9) is ON.

When a fault is detected, the corresponding set of CID and FMI codes is shown in sequence on readout (13). If more than one fault is detected, readout (13) scrolls through the CID and FMI codes and displays the first detected fault, and then scrolls through the CID and FMI codes and displays the remaining detected faults. If no faults are detected, the readout shows "– – –."

Status Indicators

In addition to the detected fault information (CID and FMI codes and fault present indicator), the EPTC II continuously shows the status of certain conditions on status indicators (1) through (12). The following status indicators are active in all display modes:

(1) Power indicator (1) is green.

When power indicator (1) is ON, the EPTC II is receiving battery voltage; this is the normal operating condition.

When power indicator (1) is OFF, the EPTC II is not receiving battery voltage, and is therefore not able to function.

(2) Control indicator (2) is red.

When control indicator (2) is ON or FLASHING, the internal circuits of the EPTC II are faulty, and the EPTC II must be replaced.

When control indicator (2) is OFF, the internal circuits of the EPTC II are operating properly.

(3) Blade lock switch indicator (3) is amber.

When blade lock switch indicator (3) is ON, the circuit is open. This occurs whenever the blade down limit switch is open (the blade is down).

When blade lock switch indicator (3) is OFF, the circuit is grounded. This is occurs whenever the blade down limit switch is closed (the blade is up).

(4) SELF-DEPLOY/EARTHMOVING indicator (4) is amber.

When SELF-DEPLOY/EARTHMOVING indicator (4) is ON, the circuit is open. This occurs whenever the SELF-DEPLOY/EARTHMOVING switch is in the SELF-DEPLOY position.

When SELF-DEPLOY/EARTHMOVING indicator (4) is OFF, the circuit is closed. This occurs whenever the SELF-DEPLOY/EARTHMOVING switch is in the EARTHMOVING position.

(5) Parking brake indicator (5) is amber.

When parking brake indicator (5) is ON, the circuit is open. This occurs whenever the parking brake switch is activated (knob pulled out).

When parking brake indicator (5) is OFF, the circuit is grounded. This is the normal operating condition and occurs whenever the parking brake is NOT activated (knob pushed in).

(6) Service brake indicator (6) is amber.

When service brake indicator (6) is ON, the circuit is open. This occurs whenever the service brake is applied.

When service brake indicator (6) is OFF, the circuit is grounded. This is the normal operating condition and occurs whenever the service brake is not applied.

(7) Circuit ground ndicator (7) is amber.

When indicator (7) is ON, the circuit is grounded. This is the normal operating condition. When indicator (7) is OFF, the circuit is open. The parking brake is applied, and the transmission is in NEUTRAL when indicator (7) is OFF.

(8) Service mode indicator (8) is amber.

When service mode indicator (8) is ON, the display is not in the normal mode (mode 0) of operation. The display is in one of the other modes of operation (mode 1 through mode 6).

When service mode indicator (8) is OFF, the display is in the normal mode (mode 0) of operation. This is the normal operating condition.

(9) Fault present indicator (9) is red.

When fault present indicator (9) is ON, the detected fault being shown on readout (13) is currently present.

When fault present indicator (9) is OFF, no faults are currently detected.

(10) Transmission P2 indicator (10) is amber.

When transmission P2 indicator (10) is ON, the circuit is open. This is the normal operating condition and occurs whenever P2 pressure is normal.

When transmission P2 indicator (10) is OFF, the circuit is grounded. This occurs whenever P2 pressure is low, as momentarily during a shift, for example.

(11) Engine output speed indicator (11) is amber.

When engine output speed indicator (11) is ON, the EPTC II is receiving an engine speed signal. This is the normal operating condition and occurs whenever the engine is running.

When engine output speed indicator (11) is OFF, the EPTC II is not receiving an engine speed signal. This occurs whenever the engine is not running.

(12) Transmission output speed indicator (12) is amber.

When transmission output speed indicator (12) is ON, the EPTC II is receiving a transmission speed signal. This is the normal operating condition and occurs whenever the machine is moving.

When transmission output speed indicator (12) is OFF, the EPTC II is not receiving a transmission speed signal. This occurs whenever the machine is not moving.

The display enters normal mode when the engine start switch is turned from OFF to ON, with the check and scroll switches released. In normal mode, the only function of the service switches is to change the display mode. To change to a different display mode, press and hold both service switches at the same time. Release the service switches when the desired mode is shown on readout (13).

Mode 1—Detected Fault Mode

Detected fault mode (mode 1) is the display mode that allows for troubleshooting and clearing of each detected fault. For each detected fault, the display shows which component is faulty, the type of fault, the number of times the fault has occurred, and if the fault is currently present. The detected fault mode describes faults in the same as the normal mode (CID and FMI codes and the fault present indicator).

The number of occurrences of each fault is also shown in the detected fault mode. The occurrence identifier (OID) is a two-digit number that tells the number of times a fault has occurred. The two digits are preceded by the letter “C.” The OID code is shown immediately after the FMI code on readout (13). For example, “C12” means the fault has occurred twelve times.

The combination of CID, FMI, and OID codes and fault present indicator (9) describes one detected fault. For example, if the signal wire for the parking brake switch has been shorted to battery voltage twelve times, and the fault is currently present, then:

1. CID “627” is shown on readout (13).
2. FMI “F03” is shown on readout (13).
3. “C12” is shown on readout (13).
4. Fault present indicator (9) is ON.

Refer to “Detected Fault Troubleshooting” in the “Testing and Adjusting” section of this module for a description of each CID and FMI code.

The OID and fault present indicator (9) assist service personnel during the troubleshooting of intermittent faults. When the fault present indicator is ON, the fault shown is currently present. When the fault present indicator is OFF, the fault shown is not present at this time, but has occurred previously. This helps in the troubleshooting of intermittent faults. When the fault shown changes status from not present to present, the fault present indicator also changes respectively from OFF to ON.

While in detected fault mode, readout (13) shows only one detected fault at a time. Information about this fault will remain shown on the readout until the fault is cleared or the display is advanced to the next detected fault.

NOTE: The next detected fault will scroll onto readout (13) when the transmission diagnostic scroll switch is momentarily pressed.

After a fault is corrected, the fault must be cleared from the memory of the EPTC II. A corrected fault is cleared from memory when the transmission diagnostic check switch is momentarily pressed. After the check switch is released, the next stored fault (if present) scrolls onto the readout.

NOTE: It is only possible to clear a fault when the fault is not currently present (fault present indicator [9] is OFF). To change to a different display mode, press and hold both service switches at the same time.

After all faults have been shown, readout (13) shows “End,” and then the readout returns to the first detected fault. After all faults have been cleared, readout (13) shows “– – –.”

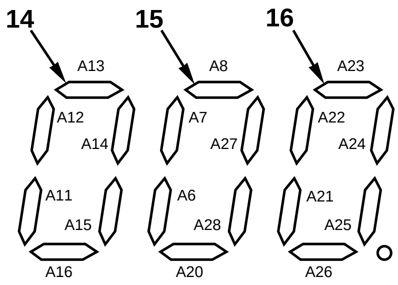
NOTE: The status indicators, as described in the “Normal Mode” section, also function in the detected fault mode.

Enter the detected fault mode by pressing and holding both of the service switches at the same time until mode number “– 1 –” is showing on readout (13). Service mode indicator (8) is ON while the display is in detected fault mode. Leave the detected fault mode by pressing and holding both of the service switches at the same time, or by moving the engine start switch to the OFF position.

Mode 2—Shift Status Mode

MODE 2—SHIFT STATUS MODE SEGMENT AND CIRCUIT STATUS			
Segment[1] and Contact[2]	**Circuit Name**	**Circuit Grounded**	**Circuit Open**
Left Digit (14)—Shift Lever Switch			
A-11	Lever 1	ON	OFF
A-12	Lever 2	ON	OFF
A-13	Lever 3	ON	OFF
A-14	Lever 4	ON	OFF
A-15	Lever 5	ON	OFF
A-16	Lever Ground Verify	ON	OFF
Center Digit (15)—Other Shift Signals			
A-6	Service Brake	OFF	ON
A-7	EARTHMOVING Mode	OFF	ON
A-8	SELF-DEPLOY Mode	ON	OFF
A-20	Parking Brake	OFF	ON
A-27	Blade Down	ON	OFF
A-28	Transmission P2	OFF	ON
Right Digit (16)—Transmission Gear Switch			
A-21	Gear 1	ON	OFF
A-22	Gear 2	ON	OFF
A-23	Gear 3	ON	OFF
A-24	Gear 4	ON	OFF
A-25	Gear 5	ON	OFF
A-26	Transmission Gear Ground Verify	ON	OFF

[1] Refer to the "Shift Status Mode Display" illustration (below) for the location of the listed segment.
[2] The listed contact corresponds to the EPTC II connector: "A-7" means contact 7 of connector A.
ON = segment on.
OFF = segment off.



Shift Status Mode Display.
(14) Left digit—shift lever switch. (15) Center digit—other shift signals. (16) Right digit—transmission gear switch.

NOTE: The dot at the end of the readout is provided for orientation.

Shift status mode (mode 2) is a troubleshooting aid used to determine the status of certain connector contacts (EPTC II input signals). Shift status mode shows the open or grounded status, active or inactive status, or valid or invalid status of the transmission shifting circuits.

The EPTC II does not detect and diagnose all faults. Therefore, this mode is useful for tracing circuits and determining the status of the connector contacts. Service personnel must refer to this module and *Schematic, Deployable Universal Combat Earthmover (DEUCE), Electrical Schematic* to properly use this mode.

Readout (13) displays three digits: left digit (14) is dedicated to the shift lever switch input signal; center digit (15) is dedicated to other shift input signals; and right digit (16) is dedicated to the transmission gear switch input signals.

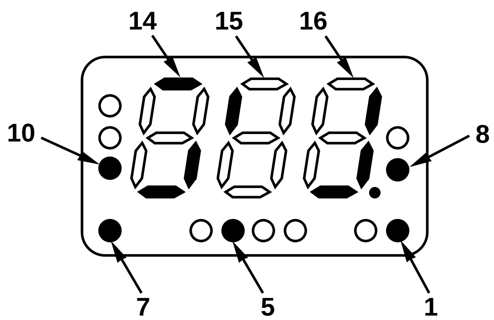
The segments of each digit are assigned to a contact of EPTC II connector A. For example, segment "A-7" corresponds to contact 7 of connector A. The ON or OFF state of a segment tells the status (open or grounded) of the corresponding connector contact.

NOTE: All the input may not be used. The segments that correspond to unused input remain OFF.

NOTE: The status indicators, as described in the "Normal Mode" section, also function in the shift status mode.

Enter the shift status mode by pressing and holding both of the service switches at the same time until mode number “– 2 –” is shown on readout (13). Service mode indicator (8) is ON while the display is in shift status mode. Leave the shift status mode by pressing and holding both of the service switches at the same time or by moving the engine start switch to the OFF position. In the shift status mode, the only function of the service switches is to change the display mode.

Example



Example.
(1) Power indicator.
(5) Parking brake indicator.
(7) Remote throttle indicator.
(8) Service mode indicator.
(10) Transmission P2 indicator.
(14) Left digit—shift lever switch.
(15) Center digit—other shift signals.
(16) Right digit—transmission gear switch.

NOTE: The dot at the end of the readout is provided for orientation.

The following example describes the display information shown in the above illustration. The machine conditions for this example are: engine running at low idle, engine start switch in the ON position, shift lever in NEUTRAL, parking brake activated, and the display in the shift status mode.

• Left Digit (14)—Shift Lever Switch:

These are the correct signals the EPTC II receives from the shift lever switch when in NEUTRAL.

Segment (A-16) is ON. Therefore, the EPTC II is receiving a ground signal at the lever ground verify input (connector A, contact 16).

Segments (A-12) and (A-15) are ON. Therefore, the EPTC II is receiving a ground signal at the lever three and lever five inputs (connector A, contacts 12 and 15).

All other segments of this digit are OFF.

• Center Digit (15)—Other Shift Signals:

These are the correct signals the EPTC II receives when the machine conditions are as previously stated.

Segment (A-7) is ON. Therefore, the EPTC II receives an open from SELF-DEPLOY/EARTHMOVING switch (connector A, contact 7).

• Right Digit (16)—Transmission Gear Switch:

These are the correct signals the EPTC II receives from the transmission gear switch in NEUTRAL.

Segment (A-26) is ON. Therefore, the EPTC II receives a ground signal at the transmission gear ground verify input (connector A, contact 26).

Segments (A-24) and (A-25) are ON. Therefore, the EPTC II receives a ground signal at the gear four and gear five input terminals (connector A, contacts 24 and 25).

All other segments of this digit are OFF.

• Status Indicators:

These are the correct signals the EPTC II receives when the machine conditions are as previously stated.

Power indicator (1) is ON. Therefore, the EPTC II is receiving battery voltage.

Parking brake indicator (5) is ON. Therefore, the parking brake is activated (input is open).

Circuit ground indicator (7) is ON. Therefore, the circuit is grounded.

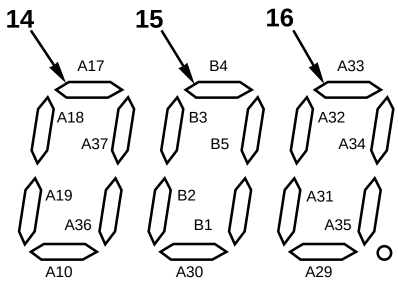
Service mode indicator (8) is ON. Therefore, the display is not in normal mode.

Transmission P2 indicator (10) is ON. Therefore, P2 pressure is normal.

Mode 3—Other Status Mode

MODE 3—OTHER STATUS MODE SEGMENT AND CIRCUIT STATUS			
Segment[1] and Contact[2]	Circuit Name	Circuit Grounded	Circuit Open
Left Digit (14)—Shift Lever Switch			
A-10	TOS	ON[3]	OFF[4]
A-17	Undefined	—	—
A-18	Harness Code 1	ON	OFF
A-19	Harness Code 0	ON	OFF
A-36	Circuit ground	ON	OFF
A-37	Undefined	ON	OFF
Center Digit (15)—B Connector			
B-1	Start Relay	OFF	ON[5]
B-2	Steering FF	OFF	ON[5]
B-3	Speedometer Output	ON	OFF
B-4	SELF-DEPLOY Mode Indicator Output	ON	OFF
B-5	Start Switch	ON[5]	OFF
A-30	Undefined	—	—
Right Digit (16)—Other Circuits			
A-29	EOS[6]	ON	OFF
A-31	Suspension Lock Solenoid	ON	OFF
A-32	Parking Brake Solenoid	ON	OFF
A-33	Blade Lock Solenoid	ON	OFF
A-34	Low Engine HP	ON	OFF
A-35	High Engine HP	ON	OFF

1 Refer to the “Other Status Mode Display” illustration (shown below) for the location of the listed segment.
2 The listed contact corresponds to a connector of the EPTC II.
3 When signal is valid (machine moving).
4 When there is no signal (machine stopped).
5 When battery voltage signal is present.
6 EOS = engine output speed
ON = segment on.
OFF = segment off.



Other Status Mode Display.
(14) Left digit—harness code. (15) Center digit—connector B. (16) Right digit—other circuits.

NOTE: The dot at the end of the readout is provided for orientation.

Other status mode (mode 3) is a troubleshooting aid used to determine the status of certain connector contacts (EPTC II inputs and outputs). Other status mode shows the open or grounded status, active or inactive status, or valid or invalid status of related transmission circuits.

The EPTC II does not detect and diagnose all faults. Therefore, this mode is useful for tracing circuits and determining the contact status. Service personnel must refer to this module and *Schematic, Deployable Universal Combat Earthmover (DEUCE), Electrical Schematic* to properly use this mode.

Readout (13) displays three digits: left digit (14) is mainly dedicated to harness code input; center digit (15) is mainly dedicated to the input and output of connector B; and right digit (16) has other circuits.

The segments of each digit are assigned to a contact of EPTC II connector A, or EPTC II connector B. The ON or OFF state of a segment tells the status of the corresponding connector contact.

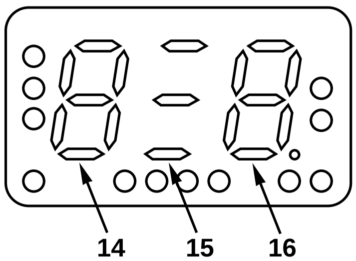
NOTE: All input and output is not used. The segments that correspond to unused input and unused output remain OFF.

NOTE: The status indicators, as described in the “Normal Mode” section, also function in the other status mode.

The operation of other status mode is similar to shift status mode.

Other status mode is entered when both of the service switches are pressed and held at the same time, until mode number "– 3 –" shows on readout (13). Service mode indicator (8) is ON while the display is in the other status mode. Leave the other status mode by pressing and holding both of the service switches at the same time or by moving the engine start switch to the OFF position. The only function of the service switches in the other status mode is to change the display mode.

Mode 4—Shift Monitor Mode



Shift Monitor Mode Display.
(14) Left digit—shift lever switch. (15) Center digit—up, lockup and down solenoids. (16) Right digit—transmission gear switch.

NOTE: The dot at the end of the readout is provided for orientation.

Shift monitor mode (mode 4) is a troubleshooting aid used to show the shifting functions: shift lever switch position, transmission gear switch position, upshift solenoid status, lockup solenoid status and downshift solenoid status. This mode is useful for troubleshooting power train system faults. In this mode, service personnel monitor critical EPTC II functions while the machine is operating.

Readout (13) displays three digits:

- Left digit (14) is dedicated to the shift lever switch. The symbol shown on the left digit corresponds to the position of the shift lever. For example, when the shift lever is in the fifth speed position, the left digit shows "5."

- Center digit (15) shows the status of the three solenoids: up, down and lockup. When an output is activated, a segment of the center digit is ON. The segments and corresponding solenoids are:

  Top segment is the upshift solenoid, which is ON during upshifts.

  Middle segment is the lockup solenoid, which is ON during direct drive.

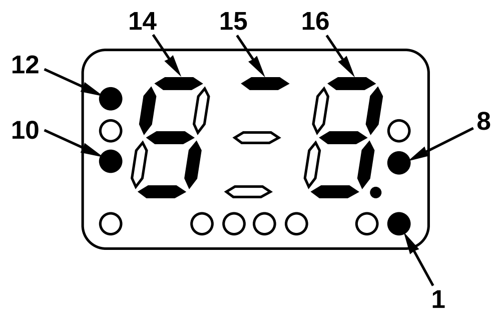
  Bottom segment is the downshift solenoid, which is ON during downshifts.

  Right digit (16) is dedicated to the transmission gear switch. The symbol shown on the right digit corresponds to the gear of the transmission that is engaged. For example, when the transmission is in fifth gear, the right digit shows "5."

NOTE: The status indicators, as described in the "Normal Mode" section, also function in the shift monitor mode.

Enter the shift monitor mode by pressing and holding both of the service switches at the same time until mode number "– 4 –" is shown on readout (13). Service mode indicator (8) is ON while the display is in shift monitor mode. Leave the shift monitor mode by pressing and holding both of the service switches at the same time, or by moving the engine start switch to the OFF position. The only function of the service switches in the shift monitor mode is to change the display mode.

Example



Example.
(1) Power indicator.
(8) Service mode indicator.
(10) Transmission P2 indicator.
(12) Transmission output speed indicator.
(14) Left digit—shift lever switch.
(15) Center digit—up, lockup, and down solenoids.
(16) Right digit—transmission gear switch.

NOTE: The dot at the end of the readout is provided for orientation.

This example describes the display information shown in the example above. The machine conditions for this example are: machine being driven, and the display in the shift monitor mode.

- Left digit (14) shows "5"; the shift lever is in the fifth speed position.

- Right digit (16) shows "3"; the transmission is in third gear.

- Center digit (15) has the top segment ON; the upshift solenoid is activated, and an upshift to fifth gear is in process.

• Status Indicators:

Power indicator (1) is ON. Therefore, the EPTC II is receiving battery voltage.

Service mode indicator (8) is ON. Therefore, the display is not in normal mode.

Transmission P2 indicator (10) is ON. Therefore, transmission P2 pressure is normal. The P2 indicator should briefly turn OFF during a shift.

Transmission output speed indicator (12) is ON. Therefore, the machine is moving (input is receiving a valid signal).

Mode 5—Engine Output Speed Monitor Mode

The engine output speed monitor mode (mode 5) is a troubleshooting aid used to show the output rpm of the engine. This mode is useful for troubleshooting EPTC II system faults. In this mode, service personnel monitor the engine output speed while the machine is in operation.

The engine rpm is shown on readout (13), which shows in tens of rpm. For example, 650 rpm is shown as “65,” and 1520 rpm is shown as “152” on the readout.

NOTE: The status indicators, as described in the “Normal Mode” section, also function in the engine output speed monitor mode.

Enter the engine output speed monitor mode by pressing and holding both of the service switches at the same time until mode number “– 5 –” is shown on readout (13). Service mode indicator (8) is ON while the display is in the engine output speed monitor mode. Leave the engine output speed monitor mode by pressing and holding both of the service switches at the same time, or by moving the engine start switch to the OFF position. The only function of the service switches in the engine output speed monitor mode is to change the display mode.

Mode 6—Transmission Output Speed Monitor Mode

The transmission output speed monitor mode (mode 6) is a troubleshooting aid used to show the rpm of the transmission output shaft. This mode is useful for troubleshooting EPTC II system faults. In this mode, service personnel monitor the transmission output speed while the machine is operating.

The rpm of the transmission output shaft is shown on readout (13). The readout shows in tens of rpm. For example, 650 rpm is shown as “65,” and 1520 rpm is shown as “152” on readout (13).

NOTE: The status indicators, as described in the “Normal Mode” section, also function in the transmission output speed monitor mode.

Testing and Adjusting

Introduction

When the troubleshooting procedure instructs to repair the harness, refer to *Schematic, Deployable Universal Combat Earthmover (DEUCE) Electrical Schematic* to trace the circuit. Perform continuity checks at connectors to locate harness failures. At component connectors, always check the ground circuit. Less than 5 ohms of resistance is required between the connector ground contacts and frame ground. Excessive ground resistance, greater than 5 ohms, can cause incorrect diagnosing of problems.

During troubleshooting, inspect all component and harness connections before any component is replaced. If these connections are not clean and tight, they can cause electrical problems, either permanent or intermittent. Make sure the connections are tight before other tests are made.

Failure of an electrical component can cause, or be caused by the failure of one or more other components. Always attempt to find and correct the cause of an electrical system failure before replacing a component.

Service Tools

Use the following service tools to make troubleshooting the electrical system easier.

6V-7070 Digital Multimeter or the equivalent
8T-3224 Needle Tip Group
7X-1710 Cable Probe Group
8T-8726 Adapter Cable
6V-3000 Repair Kit—Sure Seal
4C-3406 Connector Repair Kit—Deutsch

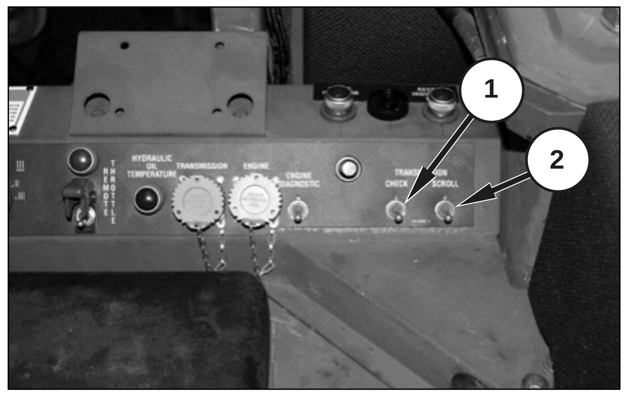
Use the 6V-7070 Digital Multimeter or the equivalent for making continuity (resistance) checks or voltage measurements. The 7X-1710 Cable Probe Group is used to make measurements at connectors without disconnecting them. The probes are pushed in the back of the connector alongside the wire. The 8T-8726 Adapter Cable is a three-pin breakout cable used to make measurements in sensor circuits.

NOTE: Continuity testers (such as 8T-0500), or voltage testers (such as 5P-7277) are not recommended for use on present-day Caterpillar electrical circuits, except for harness tests.

NOTE: Caterpillar dealers have access to special tools which perform most of the troubleshooting and programming functions on the EPTC II. If additional assistance is required in troubleshooting a problem, contact the nearest Caterpillar dealer.

Diagnostic Switch Operation

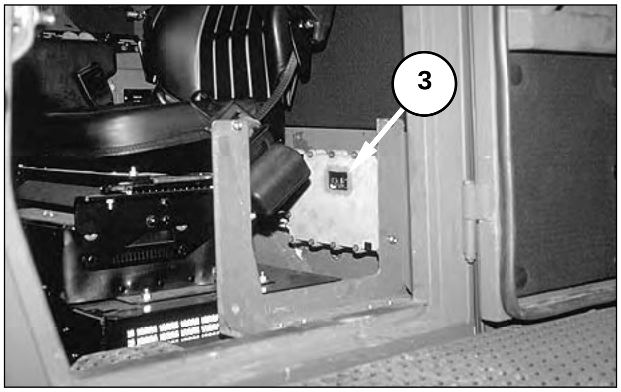
DIAGNOSTIC SWITCH OPERATION
In Any Mode: a. To change modes, press and hold both the check and scroll switches at the same time. b. When the desired mode number is shown, release both switches. c. To momentarily show the mode number that the display is in, press and hold both switches for one second, and then release the switches.
In Mode 1 (Detected Fault Mode): a. To advance to the next fault, momentarily press the scroll switch. b. To clear a fault, momentarily press the check switch.



Right Console.
(1) Transmission diagnostic check switch. (2) Transmission diagnostic scroll switch.

During troubleshooting, the service person must use the diagnostic operations of the EPTC II. The transmission diagnostic switches provide access to the different display modes of diagnostic operation.

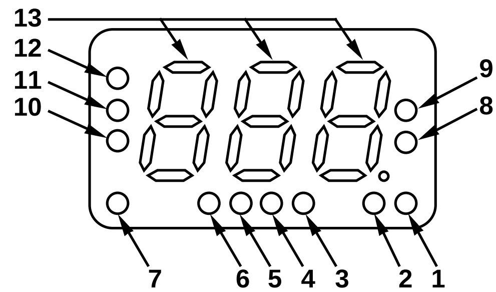
The switches are the momentary type that service personnel activate by pressing and holding. Depressing transmission diagnostic check switch (1) grounds the set input (contact B-6) of the EPTC II. Depressing transmission diagnostic scroll switch (2) grounds the clear input (contact B-7) of the EPTC II.



Cab, SINCGARS Mount and EPTC II, Cover Removed.
(3) Display.

The EPTC II is located in the cab behind the operator's seat. To access the EPTC II, remove the EPTC II cover. Display (3) is a part of the EPTC II.

Diagnostic Summary



Display.
(1) Power indicator.
(2) Control indicator.
(3) Blade lock switch indicator.
(4) SELF-DEPLOY/EARTHMOVING switch indicator.
(5) Parking brake indicator.
(6) Service brake indicator.
(7) Remote throttle indicator.
(8) Service mode indicator.
(9) Fault present indicator.
(10) Transmission P2 indicator.
(11) Engine output speed indicator.
(12) Transmission output speed indicator.
(13) Readout.

NOTE: The dot at the end of readout (13) is provided for orientation.

For a detailed explanation of diagnostic operation and display modes, refer to "Diagnostic Operation" in the "Systems Operation" section of this module.

The EPTC II display has seven modes of operation. The different display modes are identified by the mode number which is shown on readout (13). The modes of operation and the corresponding mode numbers are:

Mode 0—Normal Mode. This is the display mode for normal machine operation. The display shows all recorded faults on readout (13). Status indicators (1 through 12) show machine conditions.

Mode 1—Detected Fault Mode. This display mode allows for the troubleshooting and clearing of each detected fault. Status indicators (1 through 12) show machine conditions.

Mode 2—Shift Status Mode. This display mode shows the open or grounded status, active or inactive status, or valid or invalid status of the transmission shifting circuits on the segments of readout (13). Status indicators (1 through 12) show machine conditions.

Mode 3—Other Status Mode. This display mode shows the open or grounded status, active or inactive status, or valid or invalid status of related transmission circuits on the segments of readout (13). Status indicators (1 through 12) show machine conditions.

Mode 4—Shift Monitor Mode. This display mode shows information regarding critical shifting functions. Readout (13) shows: the shift lever position, shift solenoid status, and transmission gear. Status indicators (1 through 12) show machine conditions.

Mode 5—Engine Output Speed Monitor Mode. This display mode shows the rpm of the engine on readout (13). Status indicators (1 through 12) show machine conditions.

Mode 6—Transmission Output Speed Monitor Mode. This display mode shows the rpm of the transmission output shaft on readout (13). Status indicators (1 through 12) show machine conditions.

Changing Display Modes

The EPTC II enters normal mode when power is applied. The display mode can be changed at any time. Pressing and holding the check and scroll switches at the same time initiates the scrolling of the mode numbers on readout (13). Releasing the check and scroll switches causes the EPTC II to enter the mode currently shown on the readout.

Procedure

1. Turn the engine start switch ON. Wait approximately five seconds for the self test to finish.

2. Press and hold the check and scroll switches at the same time. This causes the mode numbers ("– 0 –" through "– 6 –") to scroll on readout (13).

3. When the desired mode number is shown on readout (13), release the check and scroll switches. The desired mode is now entered and active.

NOTE: To momentarily show the mode number that the display is currently in, press and hold both diagnostic switches for one second, and then release the switches.

NOTE: Whenever the engine start switch is moved from OFF to ON (and the diagnostic switches are not pressed), the display enters normal mode.

Detected Fault Troubleshooting

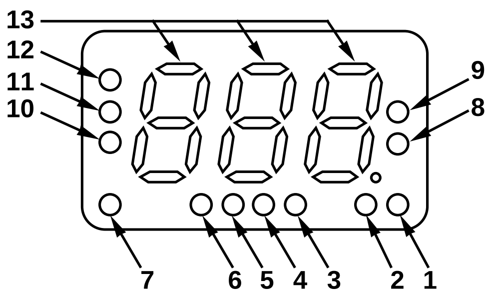
DETECTED FAULTS Refer to the chart below to interpret and troubleshoot CID and FMI codes displayed on the EPTC II readout.			
CID/FMI	**Fault Description**	**Result of Fault**	**Probable Causes**
CID 168—Electrical System Voltage (page 11-39)			
FMI F01	Below Normal Range	No shifts.	a. Faulty charging system component. b. Faulty harness wiring. c. Faulty EPTC II.
CID 269—Sensor Power Supply (page 11-39)			
FMI F00	Above Normal Range	No upshift past first gear.	a. Wire 709-OR shorted to battery voltage. b. Faulty EPTC II.
FMI F01	Below Normal Range	No upshift past first gear.	a. Wire 709-OR shorted to ground. b. Faulty transmission output speed sensor. c. Faulty EPTC II.
CID 589—SELF-DEPLOY/EARTHMOVING Switch (page 11-40)			
FMI F02	Signals Incorrect	a. Doesn't go into SELF-DEPLOY mode. b. Will not shift above THIRD gear. c. No automatic shifting.	a. Faulty harness wiring. b. Faulty SELF-DEPLOY/EARTHMOVING switch.
CID 602—Transmission P2 Pressure Switch (page 11-41)			
FMI F03	Signal Voltage Above Normal	a. P2 pressure indicator always on. b. Hesitation between shifts.	a. Wire 204-BK open. b. Wire 815-WH open. c. Faulty P2 pressure switch. d. Faulty EPTC II.
FMI F04	Signal Voltage Below Normal	a. P2 pressure indicator never on. b. Hesitation between shifts.	a. Faulty P2 pressure switch. b. Wire 815-WH shorted to ground. c. Faulty EPTC II.
CID 627—Parking Brake Switch (page 11-42)			
FMI F03	Signal Voltage Above Normal	a. Parking brake indicator always on. b. Transmission hunts or shifts frequently.	a. Wire 204-BK open. b. Faulty parking brake switch. c. Wire 720-PU open. d. Faulty EPTC II.
FMI F04	Signal Voltage Below Normal	a. Parking brake indicator never on.	a. Faulty parking brake switch. b. Wire 720-PU shorted to ground. c. Faulty parking brake relay. d. Faulty EPTC II.
CID 650—Harness Code (page 11-43)			
FMI F02	Signals Incorrect	Untimely shifts or no shifts.	a. Terminal A-18 or A-19 shorted to ground. b. Wrong EPTC II installed. c. Faulty EPTC II.

DETECTED FAULTS—CONTINUED Refer to the chart below to interpret and troubleshoot CID and FMI codes displayed on the EPTC II readout.			
CID 700—Transmission Gear Switch (page 11-44)			
FMI F02	Signals Incorrect	No shifts or transmission hunts.	a. Wires 721-BR, 722-WH, 723-OR, 724-YL, 725-GN or 726-BU open or shorted to ground. b. Wire 204-BK open. c. Faulty transmission gear switch. d. Faulty EPTC II.
FMI F07	Slow or Erratic Response	a. Shifts past selected gear. b. Transmission hunts. c. No shifts.	a. Leaking valve within solenoid. b. Broken detent spring on rotary selector spool. c. Faulty flex coupling.
CID 701—Transmission Output Speed Sensor (page 11-45)			
FMI F02	Signal Incorrect	a. No shifts above first gear. b. Lockup clutch drops out.	a. Wire 710-GN is open or shorted. b. Incorrectly installed transmission output speed sensor. c. Faulty transmission output speed sensor. d. Faulty EPTC II.
CID 702—Shift Lever Switch (page 11-46)			
FMI F02	Signal Incorrect	a. No shifts. b. Upshifts only to a certain gear.	a. Wires 711-BR, 712-WH, 713-OR, 714-YL, 715-GN or 716-BU open or shorted to ground. b. Wire 204-BK open. c. Faulty shift lever switch. d. Faulty EPTC II.
CID 704—Service Brake Switch (page 11-48)			
FMI F03	Signal Voltage Above Normal	a. Service brake indicator never on. b. No downshifts at higher engine rpm when service brake engaged.	a. Wire 200-BK open. b. Faulty service brake switch. c. Wire 706-BR open. d. Faulty EPTC II.
FMI F04	Signal Voltage Below Normal	a. Service brake indicator always on. b. Shifts more than usual or hunts. c. Downshifts at higher engine rpm.	a. Faulty service brake switch. b. Wire 706-BR shorted to ground. c. Faulty EPTC II.
CID 707—Upshift Solenoid (page 11-49)			
FMI F03	Circuit Voltage Above Normal	No shifts.	a. Wire 703-BU shorted to battery voltage. b. Faulty EPTC II.
FMI F05	Circuit Voltage Below Normal	No upshifts.	a. Wire 703-BU open. b. Faulty upshift solenoid. c. Faulty EPTC II.
FMI F06	Circuit Current Above Normal	No upshifts.	a. Wire 703-BU shorted to ground. b. Faulty upshift solenoid. c. Faulty EPTC II.

DETECTED FAULTS—CONTINUED Refer to the chart below to interpret and troubleshoot CID and FMI codes displayed on the EPTC II readout.			
CID 708—Downshift Solenoid (page 11-50)			
FMI F03	Circuit Voltage Above Normal	No shifts.	a. Wire 704-GY shorted to battery voltage. b. Faulty EPTC II.
FMI F05	Circuit Voltage Below Normal	No downshifts.	a. Wire 704-GY or 202-BK open. b. Faulty downshift solenoid. c. Faulty EPTC II.
FMI F06	Circuit Current Above Normal	No downshifts.	a. Wire 704-GY shorted to ground. b. Faulty downshift solenoid. c. Faulty EPTC II.
CID 709—Lockup Solenoid (page 11-52)			
FMI F03	Circuit Voltage Above Normal	Engine stops when machine stops.	a. Wire 705-PK shorted to battery voltage. b. Faulty EPTC II.
FMI F05	Circuit Voltage Below Normal	a. No shift to higher gears. b. Reduced power and increased fuel consumption.	a. Wire 705-PK or 202-BK open. b. Faulty lockup solenoid. c. Faulty EPTC II.
FMI F06	Circuit Current Above Normal	a. No shift to higher gears. b. Reduced power and increased fuel consumption.	a. Wire 705-PK shorted to ground. b. Faulty lockup solenoid. c. Faulty EPTC II.

When the EPTC II detects a fault while in normal mode (mode 0), the corresponding CID and FMI code of each detected fault is scrolled on the readout of the display, which notifies the service person. When no faults are detected, the readout shows "– – –." Detected fault mode (mode 1) allows service personnel to troubleshoot and clear the detected faults. For detailed information, refer to "Diagnostic Operation, Display Modes, Mode 1—Detected Fault Mode" in the "Systems Operation" section of this manual.

Initial Troubleshooting Procedure



Display.
(1) Power indicator.
(2) Control indicator.
(3) Blade lock switch indicator.
(4) SELF-DEPLOY/EARTHMOVING switch indicator.
(5) Parking brake indicator.
(6) Service brake indicator.
(7) Remote throttle indicator.
(8) Service mode indicator.
(9) Fault present indicator.
(10) Transmission P2 indicator.
(11) Engine output speed indicator.
(12) Transmission output speed indicator.
(13) Readout.

NOTE: The dot at the end of readout (13) is provided for orientation.

Use the following procedure to troubleshoot a detected fault.

1. Make sure the EPTC II has detected a fault. When the EPTC II detects a fault while in normal mode (mode 0), the corresponding CID and FMI codes of each detected fault scroll on readout (13) of the display. When no faults are detected, the readout shows "– – –."

2. Enter detected fault mode (mode 1). At the same time, press and hold both diagnostic switches (check and scroll) until "– 1 –" is shown on readout (13).

3. The CID, FMI and OID codes for the first fault are shown on readout (13). The fault shown on the readout is on hold at this time.

NOTE: When no faults are detected, readout (13) shows "– – –."

NOTE: To check other faults which have been logged by the system, press the check switch a single time. With each subsequent pressing of the check switch, the CID, FMI, and OID codes for the next logged fault are displayed on readout (13). After the last logged fault is shown, the readout displays "End." The list of detected faults is then repeated when the check switch is pressed again.

4. Place the desired fault on hold by releasing the diagnostic switches while the desired fault is shown.

5. Observe fault present indicator (9):

If fault present indicator (9) is ON, then the fault shown is currently present.

If fault present indicator (9) is OFF, then the fault shown is not present at this time, but has occurred sometime in the past (intermittent).

6. To troubleshoot the fault, go to the procedure with the same CID and FMI codes.

NOTE: A general method for locating intermittent faults is to wiggle the related wiring while a helper watches the status of fault present indicator (9).

7. After a detected fault is corrected or is no longer needed, the fault can be cleared when the check switch is briefly pressed while the fault is on hold. Readout (13) will clear and then advance to the next fault.

8. Repeat Steps 4 through 7 for the remaining faults. Return to normal mode when finished by simultaneously pressing and holding both diagnostic switches (check and scroll) until "– 0 –" is shown on readout (13).

9. The final step of the troubleshooting procedure may involve replacing the EPTC II. If EPTC II is replaced and the symptom disappears, then the original EPTC II should be reinstalled to verify that the symptom reappears. If the symptom reappears, the EPTC II is most likely faulty. If the symptom does not reappear, the EPTC II may or may not have been at fault. For example, a poor connection at the EPTC II connector may be the root cause.

Troubleshooting Procedures

Go to the procedure which corresponds to the CID and FMI codes shown on the readout of the display.

CID 168 Procedure: Electrical System Voltage

FMI F01

NOTE: Ensure that the fault (CID 168, FMI F01) is on hold and the fault present indicator is ON.

This fault is recorded when the EPTC II reads the electrical system voltage at contact A-1 as below normal range (less than 15 volts for one second).

The result of this fault condition is that the transmission does not shift because the voltage is too low to energize the shift solenoids.

Probable causes of this fault include:

- Faulty charging system component
- Faulty harness wiring
- Faulty EPTC II

1. Measure the voltage at the battery posts:

a. If the voltage is less than 15 DCV, the charging system is not correct. Check the charging system.

b. If the voltage is 15 DCV or greater, go to Step 2.

2. Check system voltage at the EPTC II:

a. Disconnect the machine harness from the EPTC II.

b. Turn the disconnect and engine start switches to the ON position.

c. Measure the voltage across contacts A-1 and A-2.

d. If the voltage is less than 15 DCV, the machine harness is faulty. Check the battery supply and ground circuits of the machine harness. Repair or replace the machine harness.

e. If the voltage is 15 DCV or greater, inspect EPTC II connector A for damage or corrosion. Connect the machine harness to the EPTC II. If the CID 168, FMI F01 fault remains present (fault present indicator is ON), replace the EPTC II.

CID 269 Procedure: Sensor Power Supply

FMI F00

NOTE: Ensure that the fault (CID 269 and FMI F00) is on hold and the fault present indicator is ON.

This fault is recorded when the EPTC II reads the voltage of the sensor power supply circuit (wire 709-OR) as above normal range.

The result of this fault condition is that the transmission does not upshift past first gear.

Probable causes of this fault include:

- Wire 709-OR shorted to battery voltage
- Faulty EPTC II

1. Check for a short to battery voltage:

a. Move the disconnect and the engine start switches to the OFF position.

b. Disconnect the machine harness from the EPTC II.

c. At the machine harness connector for the EPTC II, measure the resistance between contacts A-9 and A-1.

d. If the resistance is less than 5000 ohms, the machine harness is faulty. There is a short between the battery supply circuit and the sensor power supply circuit (wire 709-OR) in the machine harness. Repair or replace the machine harness.

e. If the resistance is greater than 5000 ohms, harness circuit resistance is correct. However, a faulty EPTC II is not the likely cause of this problem. Perform Step 1 again. If the cause is not found, replace the EPTC II.

FMI F01

NOTE: Ensure that the fault (CID 269 and FMI F01) is on hold and the fault present indicator is ON.

This fault is recorded when the EPTC II reads the voltage of the sensor power supply circuit (wire 709-OR) as below normal range.

The result of this fault condition is that the transmission does not upshift past first gear.

Probable causes of this fault include:

- Wire 709-OR shorted to ground
- Faulty transmission output speed sensor
- Faulty EPTC II

NOTE: Step 1 can create a CID 701 FMI F02 fault. When all harnesses are reconnected, this fault is shown as not present. Clear the CID 701 FMI F02 fault after this procedure is completed.

1. Check the transmission output speed sensor:

a. Observe the status of the fault present indicator. Disconnect the machine harness from the transmission output speed sensor at the transmission.

b. If the fault present indicator is OFF, the fault is no longer present. The sensor is faulty. Replace the transmission output speed sensor.

c. If the fault present indicator is ON, the fault remains present. The sensor is not causing the fault. Go to Step 2.

2. Check for a short to ground:

NOTE: Leave the transmission output speed sensor disconnected from the machine harness.

a. Turn the electrical disconnect switch to the OFF position.

b. Disconnect the machine harness from the EPTC II, and measure the resistance between contact A-9 (wire 709-OR) and frame ground.

c. If the resistance is less than 5000 ohms, the machine harness is faulty. There is a short between frame ground and wire 709-OR in the machine harness. Repair or replace the machine harness.

d. If the resistance is greater than 5000 ohms, harness circuit resistance is correct. However, a faulty EPTC II is not the likely cause of this problem. Perform this procedure again. If the cause is not found, replace the EPTC II.

CID 589 Procedure: SELF-DEPLOY/EARTHMOVING Switch

NOTE: In addition to this procedure the SELF-DEPLOY/EARTHMOVING circuit can be checked by monitoring the SELF-DEPLOY/EARTHMOVING indicator of the display. When the indicator is ON, the circuit is open, and the machine is in the SELF-DEPLOY mode. When the indicator is OFF, the circuit is grounded, and the machine is in the EARTHMOVING mode. The status of the SELF-DEPLOY/EARTHMOVING circuit is also shown in the shift status mode. Refer to “Diagnostic Operation, Display Modes, Mode 2—Shift Status Mode” in the “Systems Operation” section of this module.

FMI F02

This fault is recorded when the EPTC II reads the signals at terminals A-7 and A-8 as either both open or both closed.

Results of this fault condition are:

- Machine does not go into SELF DEPLOY mode
- Machine will not shift above THIRD gear
- Machine will not automatically shift

Probable causes of this fault include:

- Faulty harness wiring
- Faulty SELF-DEPLOY/EARTHMOVING switch

1. Check the switch ground circuit:

NOTE: Ensure that the fault (CID 589 and FMI F02) is on hold and the fault present indicator is ON.

a. Observe the status of the fault present indicator. At the EARTHMOVING/ SELF-DEPLOY switch, place a jumper from contact 2 (wire 206-BK) to frame ground.

b. If the fault present indicator is OFF, the fault is no longer present. The machine harness is faulty; wire 206-BK is open between the switch and frame ground. Repair or replace the machine harness.

c. If the fault present indicator is ON, the fault remains present. Go to Step 2.

2. Check the SELF-DEPLOY function of the switch:

a. With the engine start switch in the OFF position, move the electrical disconnect switch to the OFF position. Move the SELF-DEPLOY/EARTHMOVING switch to the SELF-DEPLOY position. Measure the resistance across contacts 1 and 2 of the switch. Move the switch to the EARTHMOVING position. Measure the resistance across contacts 1 and 2.

b. If the resistance across contacts 1 and 2 is greater than 5000 ohms in the SELF-DEPLOY position, and/or less than 5000 ohms while in the EARTHMOVING position, the switch is faulty. Replace the SELF-DEPLOY/EARTHMOVING switch.

c. If the resistance is less than 5000 ohms in the SELF-DEPLOY position, and greater than 5000 ohms while in the EARTHMOVING position, the fault remains present. Go to Step 3.

3. Check the EARTHMOVING function of the switch:

a. The electrical disconnect switch remains in the OFF position. Move the SELF-DEPLOY/EARTHMOVING switch to the EARTHMOVING position. Measure the resistance across contacts 2 and 3 of the switch. Move the switch to the SELF DEPLOY position. Measure the resistance across contacts 2 and 3.

b. If the resistance across contacts 2 and 3 is greater than 5000 ohms in the EARTHMOVING position, and/or less than 5000 ohms in the SELF-DEPLOY position, the switch is faulty. Replace the SELF-DEPLOY/EARTHMOVING switch.

c. If the resistance is less than 5000 ohms in the EARTHMOVING position, and greater than 5000 ohms in the SELF-DEPLOY position, the fault remains present. Go to Step 4.

4. Check for a short to ground in SELF-DEPLOY mode:

a. The electrical disconnect switch remains in the OFF position. Move the SELF-DEPLOY/EARTHMOVING switch to the EARTHMOVING position. Disconnect the machine harness from the EPTC II. At the machine harness connector for the EPTC II, measure the resistance between contact A-7 and frame ground.

b. If the resistance is less than 5000 ohms, the machine harness is faulty. Wire L964-WH has a short to ground between the switch and the EPTC II. Repair or replace the machine harness.

c. If the resistance is greater than 5000 ohms, harness circuit resistance is correct. Go to Step 5.

5. Check for open in EARTHMOVING mode:

a. The electrical disconnect switch remains in the OFF position. Move the SELF-DEPLOY/EARTHMOVING switch to the EARTHMOVING position. Disconnect the machine harness from the EPTC II. At the machine harness connector for the EPTC II, measure the resistance between contact A-8 and frame ground.

b. If the resistance is greater than 5000 ohms, the machine harness is faulty. Wire L965-PK is open between the switch and the EPTC II. Repair or replace the machine harness.

c. If the resistance is less than 5000 ohms, the harness circuit resistance is correct; it is unlikely that the EPTC II is faulty. Perform this procedure again. If the cause is not found, replace the EPTC II.

CID 602 Procedure: Transmission P2 Pressure Switch

NOTE: In addition to this procedure, the P2 pressure circuit can be checked when the P2 pressure indicator of the display is monitored. When the indicator is ON, the circuit is open, and P2 pressure is present. When the indicator is OFF, the circuit is grounded, and P2 pressure is NOT present. The status of the P2 pressure circuit is also shown in the shift status mode. Refer to “Diagnostic Operation, Display Modes, Mode 2—Shift Status Mode” in the “Systems Operation” section of this module.

FMI F03

NOTE: Ensure that the transmission functions properly. Ensure that the fault (CID 602 and FMI F03) is on hold, and the fault present indicator is ON.

This fault is recorded when the EPTC II reads the voltage of the transmission P2 pressure circuit (wire 815-WH) as above normal for three consecutive shifts.

Results of this fault condition are:
- P2 pressure indicator always ON
- Hesitation between shifts.

Probable causes of this fault include:
- Wire 204-BK open
- Wire 815-WH open
- Faulty P2 pressure switch
- Faulty EPTC II

1. Check the switch ground circuit:

a. Observe the status of the fault present indicator. At the P2 pressure switch, place a jumper from the ground terminal (wire 204-BK) to frame ground.

b. If the fault present indicator is OFF, the fault is no longer present. The machine harness is faulty; wire 204-BK is open between the switch and frame ground. Repair or replace the machine harness.

c. If the fault present indicator is ON, the fault remains present. Go to Step 2.

2. Check the switch:

a. Observe the status of the fault present indicator. At the P2 pressure switch, place a jumper across the two terminals.

b. If the fault present indicator is OFF, the fault is no longer present. The switch is faulty. Replace the P2 pressure switch.

c. If the fault present indicator is ON, the fault remains present. Go to Step 3.

3. Check for an open harness:

a. The jumper remains across the two switch terminals. Turn the electrical disconnect switch to the OFF position. Disconnect the machine harness from the EPTC II. At the machine harness connector for the EPTC II, measure the resistance between contact A-28 and frame ground.

b. If the resistance is greater than 5000 ohms, the machine harness is faulty. Wire 815-WH is open between the switch and the EPTC II. Repair or replace the machine harness.

c. If the resistance is less than 5000 ohms, the harness circuit resistance is correct. It is unlikely that the EPTC II is faulty. Perform this procedure again. If the cause is not found, replace the EPTC II.

FMI F04

NOTE: Ensure that the transmission functions properly. Ensure that the fault (CID 602 and FMI F04) is on hold, and the fault present indicator is ON.

This fault is recorded when the EPTC II reads the voltage of the P2 pressure circuit (wire 815-WH) as below normal for three consecutive shifts.

Results of this fault condition are:

- P2 pressure indicator NEVER ON
- Hesitation between shifts

Probable causes of this fault include:

- Faulty P2 pressure switch
- Wire 815-WH shorted to ground
- Faulty EPTC II

1. Check the switch:

a. Observe the status of the fault present indicator. At the P2 pressure switch, disconnect wire 815-WH from the switch terminal.

b. If the fault present indicator is OFF, the fault is no longer present. The switch is faulty. Replace the P2 pressure switch.

c. If the fault present indicator is ON, the fault remains present. Go to Step 2.

2. Check for a short to ground:

a. Wire 815-WH remains disconnected from the switch. Turn the electrical disconnect switch to the OFF position. Disconnect the machine harness from the EPTC II. At the machine harness connector for the EPTC II, measure the resistance between contact A-28 (wire 815-WH) and frame ground.

b. If the resistance is less than 5000 ohms, the machine harness is faulty. There is a short between frame ground and wire 815-WH in the machine harness. Repair or replace the machine harness.

c. If the resistance is greater than 5000 ohms, harness circuit resistance is correct. It is unlikely that the EPTC II is faulty. Perform this procedure again. If the cause is not found, replace the EPTC II.

CID 627 Procedure: Parking Brake Switch

NOTE: In addition to this procedure, the parking brake circuit can be checked by monitoring the parking brake indicator of the display. When the indicator is ON, the circuit is open, and the brakes are applied. When the indicator is OFF, the circuit is grounded, and the brakes are released. The status of the parking brake circuit is also shown in the shift status mode. Refer to "Diagnostic Operation, Display Modes, Mode 2—Shift Status Mode" in the "Systems Operation" section.

FMI F03

NOTE: Check that the parking brakes function properly. Ensure that the fault (CID 627 and FMI F03) is on hold, and the fault present indicator is ON.

This fault is recorded when the EPTC II reads the voltage of the parking brake circuit (wire 720-PU) as above normal for seven continuous hours of machine operation.

Results of this fault condition are:

- Parking brake indicator always ON
- Transmission hunts or shifts more than usual

Probable causes of this fault include:

- Wire 204-BK open
- Faulty parking brake switch
- Wire 720-PU open
- Faulty EPTC II

1. Check the switch ground circuit:

a. Observe the status of the fault present indicator. At the parking brake switch, place a jumper from the ground terminal (wire 204-BK) to frame ground.

b. If the fault present indicator is OFF, the fault is no longer present. The machine harness is faulty; wire 204-BK is open between the switch and frame ground. Repair or replace the machine harness.

c. If the fault present indicator is ON, the fault remains present. Go to Step 2.

2. Check the switch:

a. Ensure that the CID 627 FMI F03 fault is on hold and that the fault present indicator is ON. Observe the status of the fault present indicator. At the parking brake switch, place a jumper across the two terminals.

b. If the fault present indicator is OFF, the fault is no longer present. The switch is faulty. Replace the parking brake switch.

c. If the fault present indicator is ON, the fault remains present. Go to Step 3.

3. Check for an open harness:

a. The jumper remains across the two switch terminals. Turn the electrical disconnect switch to the OFF position. Disconnect the machine harness from the EPTC II. At the machine harness connector for the EPTC II, measure the resistance between contact A-20 and frame ground.

b. If the resistance is greater than 5000 ohms, the machine harness is faulty. Wire 720-PU is open between the switch and the EPTC II. Repair or replace the machine harness.

c. If the resistance is less than 5000 ohms, harness circuit resistance is correct. It is unlikely that the EPTC II is faulty. Perform this procedure again. If the cause is not found, replace the EPTC II.

FMI F04

NOTE: Ensure that the fault (CID 627, FMI F04) is on hold, and the fault present indicator is ON.

This fault is recorded when the EPTC II reads the voltage of the parking brake circuit (wire 720-PU) as below normal for two continuous hours of machine operation.

Results of this fault condition are:

- Parking brake indicator never ON

Probable causes of this fault include:

- Faulty parking brake switch
- Wire 720-PU shorted to ground
- Faulty EPTC II

1. Check the switch:

a. Observe the status of the fault present indicator. At the parking brake switch, disconnect wire 720-PU from the switch terminal.

b. If the fault present indicator is OFF, the fault is no longer present. The switch is faulty. Replace the parking brake switch.

c. If the fault present indicator is ON, the fault remains present. Go to Step 2.

2. Check for short to ground:

a. Wire 720-PU remains disconnected from the switch. Turn the electrical disconnect switch to the OFF position. Disconnect the machine harness from the EPTC II. At the machine harness connector for the EPTC II, measure the resistance between contact A-20 (wire 720-PU) and frame ground.

b. If the resistance is less than 5000 ohms, the machine harness is faulty. There is a short between frame ground and wire 720-PU in the machine harness. Repair or replace the machine harness.

c. If the resistance is greater than 5000 ohms, harness circuit resistance is correct. It is unlikely that the EPTC II is faulty. Perform this procedure again. If the cause is not found, replace the EPTC II.

CID 650 Procedure: Harness Code

FMI F02

NOTE: Ensure that the fault (CID 650, FMI F02) is on hold. Ensure that the fault present indicator is ON.

This fault is recorded when the EPTC II reads a change in the signal of the harness code circuits (connector A, pins 18 and 19) during machine operation or when the signals are not valid (incorrect).

The result of this fault condition is that the transmission does not shift, or shifts at the wrong time.

Probable causes of this fault include:

- Wrong harness code wire open or shorted
- Wrong EPTC II is installed
- Faulty EPTC II

To troubleshoot this fault “wring out” the harness code circuits in the machine harness. Refer to “Harness Code Check” in this section.

CID 700 Procedure: Transmission Gear Switch

FMI F02

NOTE: In addition to this procedure, the position of the transmission gear switch is shown in the shift monitor mode; refer to “Diagnostic Operation, Display Modes, Mode 4—Shift Monitor Mode” in the “Systems Operation” section of this module.

NOTE: Ensure that the fault (CID 700, FMI F02) is on hold. Ensure that the fault present indicator is ON.

This fault is recorded when the EPTC II reads the signals of the transmission gear switch (wires 721-BR, 722-WH, 723-OR, 724-YL, 725-GN and 726-BU) as not valid (incorrect).

The result of this fault condition is that the transmission does not shift or hunts.

Probable causes of this fault include:

- Wire 204-BK open
- Faulty transmission gear switch
- Faulty EPTC II
- Wires 126-PK, 721-BR, 722-WH, 723-OR, 724-YL, 725-GN or 726-BU open or shorted to ground

NOTE: This procedure uses the shift status mode to check the circuits of the transmission gear switch in the machine harness. For more information, refer to “Diagnostic Operation, Display Modes, Mode 2—Shift Status Mode” in the “Systems Operation” section of this module. The help of an additional service person may be beneficial when this procedure is performed.

1. Check the power supply:

a. The switch must be receiving 10 volts or battery voltage at connector contact 4 (wire 126-PK). At the transmission, remove the cover to expose the transmission gear switch. Remove the two bolts that fasten the switch to the transmission control housing. Disconnect the machine harness from the transmission gear switch. Place the engine start switch in the ON position. At the machine harness connector for the transmission switch, measure the voltage from contact 4 to frame ground.

b. If the voltage is approximately 10 DCV or greater, the voltage is correct. Go to Step 2.

c. If the voltage is less than 10 DCV, the harness is open or shorted. Check wire 126-PK in the machine harness for an open or a short circuit. Repair or replace the machine harness.

2. Check the harness:

a. The transmission gear switch remains disconnected from the machine harness as in Step 1. Put the display in mode 2 (shift status mode). Observe the right digit of the display. Under these conditions, all segments of the right digit must be OFF.

b. If all segments are OFF, the transmission gear circuits in the machine harness are correct (open). Go to Step 4.

c. If all segments are not OFF, there is a defect. The segments which are ON correspond to transmission gear circuits in the machine harness that are shorted to ground. Go to Step 3.

3. Check for a short to ground:

a. The transmission gear switch remains disconnected from the machine harness. Turn the electrical disconnect switch to the OFF position. Disconnect the machine harness from the EPTC II. Determine the contacts of the machine harness connector that correspond to the segments which were ON in Step 2; refer to “Diagnostic Operation, Display Modes, Mode 2—Shift Status Mode” in the “Systems Operation” section of this module. At the machine harness connector for the EPTC II, measure the resistance between the suspected contact and frame ground.

b. If the resistance is less than 5000 ohms, the machine harness is faulty. In the machine harness, the wire that corresponds to the suspected contact is shorted to ground between the transmission gear switch and the EPTC II. Repair or replace the machine harness.

c. If the resistance is greater than 5000 ohms, harness circuit resistance is correct. It is unlikely that the EPTC II is faulty. Perform this procedure again. If the cause is not found, replace the EPTC II.

4. Check for an open harness:

a. The transmission gear switch remains disconnected from the machine harness. The display remains in mode 2. Observe the right digit of the display. At the machine harness connector for the transmission gear switch, briefly touch each of contacts 1, 2, 3, 6, 7 and 8 to frame ground. When each contact is touching frame ground, the corresponding segment of the right digit must be ON.

b. If each segment is ON when touched to ground, the transmission gear circuits operate properly. Go to Step 6.

c. If any one segment is not ON when touched to ground, there is a defect. The segments which are OFF correspond to open transmission gear circuits in the machine harness. Go to Step 5.

5. Check for an open harness:

a. The transmission gear switch remains disconnected from the machine harness. Turn the electrical disconnect switch to the OFF position. Disconnect the machine harness from the EPTC II. Determine the contacts of the machine harness connector which correspond to the segments that were OFF in Step 4; refer to "Diagnostic Operation, Display Modes, Mode 2—Shift Status Mode" in the "Systems Operation" section of this module. Check the continuity of the suspected transmission gear circuits in the machine harness. Measure the resistance from the machine harness connector for the EPTC II to the machine harness connector for the transmission gear switch.

b. If the resistance is greater than 5.0 ohms, the machine harness is faulty. In the machine harness, the suspected wire is open between the transmission gear switch and the EPTC II. Repair or replace the machine harness.

c. If the resistance is 5.0 ohms or less, the harness circuits are correct. It is unlikely that the EPTC II is faulty. Perform this procedure again. If the cause is not found, replace the EPTC II.

6. Check the harness ground circuit:

a. The transmission gear switch remains disconnected from the machine harness. Turn the electrical disconnect switch to the OFF position. At the machine harness connector for the transmission switch, measure the resistance between contact 10 (wire 204-BK) and frame ground.

b. If the resistance is greater than 5.0 ohms, the machine harness is faulty. Wire 204-BK is open between the transmission gear switch and frame ground. Repair or replace the machine harness.

c. If the resistance is 5.0 ohms or less, harness circuit resistance is correct. The switch is faulty. Replace the transmission gear switch. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Transmission Control Valve."

FMI F07

NOTE: Ensure that the fault (CID 700, FMI F07) is on hold. Ensure that the fault present indicator is ON.

This fault is recorded when the EPTC II activates a shift solenoid but the transmission does not shift. The EPTC II activates the shift solenoid based on the signals received from the transmission gear switch (wires 721-BR, 722-WH, 723-OR, 724-YL, 725-GN and 726-BU).

Results of this fault condition are:

- Transmission shifts past selected gear
- Transmission hunts
- Transmission does not shift

Probable causes of this fault are mechanical or hydraulic:

- Leaking valve within shift solenoid
- Broken detent spring on rotary selector spool
- Faulty flex coupling on transmission gear switch

Refer to "Testing and Adjusting, Troubleshooting" in *Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Transmission and Torque Converter* to investigate the cause.

CID 701 Procedure: Transmission Output Speed Sensor

NOTE: In addition to this procedure, the circuit for the transmission output speed sensor can be checked when the transmission output speed indicator of the display is monitored. When the indicator is ON, the speed signal is valid, and the machine should be moving. When the indicator is OFF, the EPTC II is not receiving a speed signal, and machine should be stopped. Also, in the transmission output speed monitor mode, the signal from the transmission output speed sensor is converted to rpm and shown on the display; refer to "Diagnostic Operation, Display Modes, Mode 7—Transmission Output Speed Monitor Mode" in the "Systems Operation" section of this module.

NOTE: If a sensor power supply fault is present (CID 269), correct it prior to troubleshooting this fault (CID 701, FMI F02). The machine must be operating in second gear or higher in order for the EPTC II to show this fault as present (fault present indicator ON). Ensure that the CID 701 FMI F02 fault is on hold.

FMI F02

This fault is recorded when the EPTC II reads the transmission output speed sensor signal (wire 710-GN) as not valid (incorrect).

Results of this fault condition are:

- Transmission does not shift above first gear
- Lockup clutch drops out

Probable causes of this fault include:

- Machine harness is open or shorted
- Faulty transmission output speed sensor
- Faulty EPTC II
- Transmission output speed sensor incorrectly installed

1. Replace the transmission output speed sensor:

a. Replace the sensor, and then clear the CID 701 FMI F02 from the EPTC II. Operate the machine in second gear or higher for a brief period of time. Stop the machine. Check to see if the CID 701 FMI F02 fault has recurred.

b. If a CID 701 FMI F02 fault has not been recorded, the fault is no longer present. The replaced sensor was faulty.

c. If a CID 701 FMI F02 fault has been recorded, the fault remains present. The replaced sensor was not the cause of the defect. Wire 710-GN is shorted, open, or the EPTC II is faulty. Go to Step 2.

d. If the fault present indicator is OFF, the fault is no longer present. The replaced sensor was faulty.

e. If the fault present indicator is ON, the fault remains present. The replaced sensor was not the cause of the defect. Wire 710-GN is shorted, open, or the EPTC II is faulty. Go to Step 2.

2. Check for a short to ground:

a. Turn the disconnect and engine start switches to the OFF position. Disconnect the machine harness from the EPTC II and the transmission output speed sensor. At the machine harness connector for the sensor, measure the resistance between contact C (wire 710-GN) and frame ground.

b. If the resistance is less than 5000 ohms, the machine harness is faulty. Wire 710-GN is shorted or has leakage in the machine harness between the sensor and the EPTC II. Repair or replace the machine harness.

c. If the resistance is greater than 5000 ohms, harness circuit resistance in wire 710-GN is correct. Wire 710-GN is shorted to battery voltage, open or the EPTC II is faulty. Go to Step 3.

3. Check for a shorted harness:

a. The transmission output speed sensor remains disconnected from the machine harness. Connect the machine harness to the EPTC II. Turn the disconnect and engine start switches to the ON position. At the machine harness connector for the sensor, measure the DC voltage between contact C (wire 710-GN) and contact B (wire 204-BK).

b. If DC voltage is present, the machine harness is faulty. In the machine harness, wire 710-GN is shorted to a battery source between the sensor and the EPTC II. Repair or replace the machine harness.

c. If DC voltage is not present, the voltage is correct. Wire 710-GN is open, or the EPTC II is faulty. Go to Step 4.

4. Check for an open harness:

a. The transmission output speed sensor remains disconnected from the machine harness. Turn the electrical disconnect switch to the OFF position. Disconnect the machine harness from the EPTC II. At the machine harness connector for the sensor, place a jumper from contact B to contact C. At the machine harness connector for the EPTC II, measure the resistance between contact A-10 and frame ground.

b. If the resistance is greater than 5.0 ohms, the machine harness is faulty. Wire 710-GN is open between the sensor and the EPTC II. Repair or replace the machine harness.

c. If the resistance is 5.0 ohms or less, the harness circuit resistance is correct. It is unlikely that the EPTC II is faulty. Perform this procedure again. If the cause is not found, replace the EPTC II.

CID 702 Procedure: Shift Lever Switch

FMI F02

NOTE: In addition to this procedure the position of the shift lever switch is shown in the shift monitor mode; refer to “Diagnostic Operation, Display Modes, Mode 4—Shift Monitor Mode” in the “Systems Operation” section of this module.

NOTE: Ensure that the fault (CID 702, FMI F02) is on hold. Ensure that the fault present indicator is ON.

This fault is recorded when the EPTC II reads the signals of the shift lever switch (wires 711-BR, 712-WH, 713-OR, 714-YL, 715-GN and 716-BU) as not valid (incorrect).

Results of this fault condition are:

- Transmission does not shift
- Transmission upshifts only to a certain gear

Probable causes of this fault include:

- Wire 204-BK is open
- Faulty shift lever switch
- Faulty EPTC II
- Wires 711-BR, 712-WH, 713-OR, 714-YL, 715-GN, or 716-BU open or shorted to ground

NOTE: This procedure uses the shift status mode to check the circuits of the shift lever switch in the machine harness. For more information, refer to “Diagnostic Operation, Display Modes, Mode 2—Shift Status Mode” in the “Systems Operation” section of this module. It is beneficial for an additional service person to help perform this procedure.

1. Check the harness:

a. At the shift console, remove the necessary covers or the shift lever to expose the shift lever switch. Disconnect the machine harness from the shift lever switch. Put the display in the shift status mode (mode 2). Observe the left digit of the display. Under these conditions, all segments of the left digit must be OFF.

b. If all segments are OFF, the shift lever circuits in the machine harness are correct (open). Go to Step 3.

c. If all segments are not OFF, there is a defect. The segments that are ON correspond to shift lever circuits in the machine harness which are shorted to ground. Go to Step 2.

2. Check for a short to ground:

a. The shift lever switch remains disconnected from the machine harness. Turn the electrical disconnect switch to the OFF position. Disconnect the machine harness from the EPTC II. Determine the contacts of the machine harness connector that correspond to the segments which were ON in Step 1; refer to “Diagnostic Operation, Display Modes, Mode 2—Shift Status Mode” in the “Systems Operation” section of this module. At the machine harness connector for the EPTC II, measure the resistance between the suspected contact and frame ground.

b. If the resistance is less than 5000 ohms, the machine harness is faulty. In the machine harness, the wire that corresponds to the suspected contact is shorted to ground between the shift lever switch and the EPTC II. Repair or replace the machine harness.

c. If the resistance is greater than 5000 ohms, harness circuit resistance is correct. It is unlikely that the EPTC II is faulty. Perform this procedure again. If the cause is not found, replace the EPTC II.

3. Check for an open harness:

a. The shift lever switch remains disconnected from the machine harness. The display remains in mode 2. Observe the left digit of the display. At the machine harness connector for the shift lever switch, briefly touch each of the contacts 1, 3, 4, 5, 8 and 9 to frame ground. When each contact is touching frame ground, the corresponding segment of the left digit must be ON.

b. If each segment is ON when touched to ground, the shift lever circuits operate properly. Go to Step 5.

c. If any one segment is not ON when touched to ground, there is a defect. The segments that are OFF correspond to open shift lever circuits in the machine harness. Go to Step 4.

4. Check for an open harness:

a. The shift lever switch remains disconnected from the machine harness. Turn the electrical disconnect switch to the OFF position. Disconnect the machine harness from the EPTC II. Determine the contacts of the machine harness connector that correspond to the segments that were OFF in Step 3; refer to “Diagnostic Operation, Display Modes, Mode 2—Shift Status Mode” in the “Systems Operation” section of this module. Check the continuity of the suspected shift lever circuits in the machine harness. Measure from the machine harness connector for the EPTC II to the machine harness connector for the shift lever switch.

b. If the resistance is greater than 5.0 ohms, the machine harness is faulty. In the machine harness, the suspected wire is open between the shift lever switch and the EPTC II. Repair or replace the machine harness.

c. If the resistance is 5.0 ohms or less, the harness circuits are correct. It is unlikely that the EPTC II is faulty. Perform this procedure again. If the cause is not found, replace the EPTC II.

5. Check the harness ground circuit:

a. The shift lever switch remains disconnected from the machine harness. Turn the electrical disconnect switch to the OFF position. At the machine harness connector for the shift lever switch, measure the resistance between contact 2 (wire 204-BK) and frame ground.

b. If the resistance is greater than 5.0 ohms, the machine harness is faulty. Wire 204-BK is open between the shift lever switch and frame ground. Repair or replace the machine harness.

c. If the resistance is 5.0 ohms or less, the harness circuit resistance is correct. The switch is faulty. Replace the shift lever switch. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Electrical System,* “Transmission Control Switch

CID 704 Procedure: Service Brake Switch

FMI F03

NOTE: In addition to this procedure, the service brake circuit can be checked when the service brake indicator of the display is monitored. When the indicator is ON, the circuit is grounded, and the service brakes should be applied. When the indicator OFF, the circuit is open, and the service brakes should be released. The status of the service brake circuit is also shown in the shift status mode; refer to “Diagnostic Operation, Display Modes, Mode 2—Shift Status Mode” in the “Systems Operation” section of this module.

NOTE: Check that the service brakes are functioning properly. Ensure that the fault (CID 704 and FMI F03) is on hold, and the fault present indicator is ON.

This fault is recorded when the EPTC II reads the voltage of the service brake circuit (wire 706-BR) as above normal for seven continuous hours of machine operation.

Results of this fault condition are:

- Service brake indicator never ON
- Downshift points do not occur at higher than normal rpm when the service brake is applied

Probable causes of this fault include:

- Wire 200-BK open
- Faulty service brake pressure switch
- Wire 706-BR open
- Faulty EPTC II

1. Check the switch ground circuit:

a. Observe the status of the fault present indicator. At the service brake pressure switch, place a jumper from the ground terminal (wire 200-BK) to frame ground.

b. If the fault present indicator is OFF, the fault is no longer present. The machine harness is faulty; wire 200-BK is open between the switch and frame ground. Repair or replace the machine harness.

c. If the fault present indicator is ON, the fault remains present. Go to Step 2.

2. Check the switch:

a. Ensure that the CID 704 FMI F03 fault is on hold and that the fault present indicator is ON. Observe the status of the fault present indicator. At the service brake switch, place a jumper across the two terminals.

b. If the fault present indicator is OFF, the fault is no longer present. The switch is faulty. Replace the service brake pressure switch.

c. If the fault present indicator is ON, the fault remains present. Go to Step 3.

3. Check for an open harness:

a. The jumper remains across the two switch terminals. Turn the disconnect switch to the OFF position. Disconnect the machine harness from the EPTC II. At the machine harness connector for the EPTC II, measure the resistance between contact A-27 and frame ground.

b. If the resistance is greater than 5.0 ohms, the machine harness is faulty. Wire 706-BR is open between the switch and the EPTC II. Repair or replace the machine harness.

c. If the resistance is 5.0 ohms or less, the harness circuit resistance is correct. It is unlikely that EPTC is faulty. Perform this procedure again. If the cause is not found, replace the EPTC II.

FMI F04

NOTE: Ensure that the fault (CID 704 and FMI F04) is on hold. Ensure that the fault present indicator is ON.

This fault is recorded when the EPTC II reads the voltage of the service brake circuit (wire 706-BR) as below normal for two continuous hours of machine operation.

Results of this fault condition are:

- Service brake indicator always ON
- Transmission shifts more than usual or hunts
- Downshift points occur at a higher engine rpm

Probable causes of this fault include:

- Faulty service brake switch
- Wire 706-BR shorted to ground between the service brake pressure switch and EPTC II
- Faulty EPTC II

1. Check the switch:

a. Observe the status of the fault present indicator. At the service brake switch, disconnect wire 706-BR from the switch terminal.

b. If the fault present indicator is OFF, the fault is no longer present. The switch is faulty. Replace the service brake switch.

c. If the fault present indicator is ON, the fault remains present. Go to Step 2.

2. Check for a short to ground:

a. Wire 706-BR remains disconnected from the switch. Turn the disconnect switch to the OFF position. Disconnect the machine harness from the EPTC II. At the machine harness connector for the EPTC II, measure the resistance between contact A-6 (wire 706-BR) and frame ground.

b. If the resistance is less than 5000 ohms, the machine harness is faulty. There is a short between frame ground and wire 706-BR in the machine harness. Repair or replace the machine harness.

c. If the resistance is greater than 5000 ohms, the harness circuit resistance is correct. It is unlikely that the EPTC II is faulty. Perform this procedure again. If the cause is not found, replace the EPTC II.

CID 707 Procedure: Upshift Solenoid

FMI F03

NOTE: In addition to this procedure, the status of the upshift solenoid circuit is shown in the shift monitor mode; refer to “Diagnostic Operation, Display Modes, Mode 4—Shift Monitor Mode” in the “Systems Operation” section of this module.

NOTE: Ensure that the fault (CID 707 and FMI F03) is on hold, and the fault present indicator is ON.

This fault is recorded when the EPTC II reads the voltage of the upshift solenoid circuit (wire 703-BU) as above normal (short to battery supply).

The result of this fault condition is that the transmission does not shift because the upshift solenoid is ON all the time.

Probable causes of this fault include:

- Wire 703-BU shorted to battery voltage
- Faulty EPTC II

1. Check for shorted harness:

a. Turn the electrical disconnect switch to the OFF position. Disconnect machine harness connectors A and B from the EPTC II. Disconnect the machine harness from the upshift solenoid. At machine harness connectors A and B for the EPTC II, measure the resistance between contact A-3 (wire 703-BU) and all other contacts of the connectors. If a short exists, it is most likely that the short is to the battery supply circuit (contact A-1) or another output circuit.

b. If the resistance is less than 5000 ohms, the machine harness is faulty. Wire 703-BU is shorted within the machine harness between the upshift solenoid and the EPTC II. Repair or replace the machine harness.

c. If the resistance is greater than 5000 ohms, the harness circuit resistance is correct. It is unlikely that the EPTC II is faulty. Perform this procedure again. If the cause is not found, replace the EPTC II.

FMI F05

NOTE: Ensure that the fault (CID 707 and FMI F04) is on hold, and the fault present indicator is ON.

This fault is recorded when the EPTC II reads the current of the upshift solenoid circuit (wire 703-BU) as below normal (open circuit).

The result of this fault condition is that the transmission does not upshift because the upshift solenoid is never ON.

Probable causes of this fault include:

- Wire 703-BU or wire 202-BK is open
- Faulty upshift solenoid
- Faulty EPTC II

NOTE: This procedure can create a CID 707 FMI F06 fault. When all harnesses are reconnected, this fault is shown as not present. Clear the CID 707 FMI F06 fault after this procedure is completed.

1. Check the solenoid:

a. Disconnect the machine harness from the upshift solenoid. Observe the status of the fault present indicator. At the machine harness connector for the upshift solenoid, place a jumper from contact 1 (wire 703-BU) to contact 2 (wire 202-BK).

b. If the fault present indicator is OFF, the fault is no longer present. The upshift solenoid is faulty. Check the upshift solenoid and replace if necessary.

c. If the fault present indicator is ON, the fault remains present. The machine harness or the EPTC II is faulty. Go to Step 2.

2. Check the ground circuit:

a. Remove the jumper which was installed in Step 1. Observe the status of the fault present indicator. At the machine harness connector for the upshift solenoid, place a jumper from contact 1 (wire 703-BU) to frame ground.

b. If the fault present indicator is OFF, the fault is no longer present. Wire 202-BK is open in the machine harness between the upshift solenoid and frame ground. Repair or replace the machine harness.

c. If the fault present indicator is ON, the fault remains present. Wire 703-BU or the EPTC II is faulty. Go to Step 3.

3. Check for an open harness:

a. Turn the electrical disconnect switch to the OFF position. The jumper of Step 2 remains. Disconnect the machine harness from the EPTC II. At machine harness connector A for the EPTC II, measure the resistance between contact A-3 (wire 703-BU) and frame ground.

b. If the resistance is greater than 5.0 ohms, the machine harness is faulty. Wire 703-BU is open within the machine harness between the upshift solenoid and the EPTC II. Repair or replace the machine harness.

c. If the resistance is 5.0 ohms or less, harness circuit resistance is correct. It is unlikely that the EPTC II is faulty. Perform this procedure again. If the cause is not found, replace the EPTC II.

FMI F06

NOTE: Ensure that the fault (CID 707 and FMI F06) is on hold. Ensure that the fault present indicator is ON.

This fault is recorded when the EPTC II reads the current of the upshift solenoid circuit (wire 703-BU) as above normal (short to ground).

The result of this fault condition is that the transmission does not upshift because the upshift solenoid is never ON.

Probable causes of this fault include:

- Wire 703-BU shorted to ground
- Faulty upshift solenoid
- Faulty EPTC II

NOTE: This procedure can create a CID 707 FMI F05 fault. When all harnesses are reconnected, this fault is shown as not present. Clear the CID 707 FMI F05 fault after this procedure is completed.

1. Check the solenoid:

a. Disconnect the machine harness from the upshift solenoid. Observe the status of the fault present indicator.

b. If the fault present indicator is OFF, the fault is no longer present. The upshift solenoid is faulty. Check the upshift solenoid and replace if necessary.

c. If the fault present indicator is ON, the fault remains present. The machine harness or the EPTC II is faulty. Go to Step 2.

2. Check for a short to ground:

a. Turn the electrical disconnect switch to the OFF position. Disconnect the machine harness from the EPTC II. At machine harness connector A for the EPTC II, measure the resistance between contact A-3 (wire 703-BU) and frame ground.

b. If the resistance is less than 5000 ohms, the machine harness is faulty. Wire 703-BU is shorted to ground within the machine harness between the upshift solenoid and the EPTC II. Repair or replace the machine harness.

c. If the resistance is greater than 5000 ohms, harness circuit resistance is correct. It is unlikely that the EPTC II is faulty. Perform this procedure again. If the cause is not found, replace the EPTC II.

CID 708 Procedure: Downshift Solenoid

FMI F03

NOTE: In addition to this procedure, the status of the downshift solenoid circuit is shown in the shift monitor mode; refer to “Diagnostic Operation, Display Modes, Mode 4—Shift Monitor Mode” in the “Systems Operation” section of this module.

NOTE: Ensure that the fault (CID 708 and FMI F03) is on hold. Ensure that the fault present indicator is ON.

This fault is recorded when the EPTC II reads the voltage of the downshift solenoid circuit (wire 704-GY) as above normal (short to battery voltage).

The result of this fault condition is that the transmission does not shift because the downshift solenoid is ON all the time.

Probable causes of this fault include:

- Wire 704-GY shorted to battery voltage
- Faulty EPTC II

1. Check for a shorted harness:

a. Turn the electrical disconnect switch to the OFF position. Disconnect machine harness connectors A and B from the EPTC II. Disconnect the machine harness from the downshift solenoid. At machine harness connectors A and B for the EPTC II, measure the resistance between contact A-4 (wire 704-GY) and all other contacts of the connectors. If a short exists, it is most likely that the short is to the battery supply circuit (contact A-1) or another output circuit.

b. If the resistance is less than 5000 ohms, the machine harness is faulty. Wire 704-GY is shorted within the machine harness between the downshift solenoid and the EPTC II. Repair or replace the machine harness.

c. If the resistance is greater than 5000 ohms, harness circuit resistance is correct. It is unlikely that the EPTC II is faulty. Perform this procedure again. If the cause is not found, replace the EPTC II.

FMI F05

NOTE: Ensure that the fault (CID 708 and FMI F05) is on hold. Ensure that the fault present indicator is ON.

This fault is recorded when the EPTC II reads the current of the downshift solenoid circuit (wire 704-GY) as below normal (open circuit).

The result of this fault condition is that the transmission does not downshift because the downshift solenoid is never ON.

Probable causes of this fault include:

- Wire 704-GY or wire 202-BK open
- Faulty downshift solenoid
- Faulty EPTC II

NOTE: This procedure can create a CID 708 FMI F06 fault. When all harnesses are reconnected, this fault is shown as not present. Clear the CID 708 FMI F06 fault after this procedure is completed.

1. Check the solenoid:

a. Disconnect the machine harness from the downshift solenoid. Observe the status of the fault present indicator. At the machine harness connector for the downshift solenoid, place a jumper from contact 1 (wire 704-GY) to contact 2 (wire 202-BK).

b. If the fault present indicator is OFF, the fault is no longer present. The downshift solenoid is faulty. Check the downshift solenoid and replace if necessary.

c. If the fault present indicator is ON, the fault remains present. The machine harness or the EPTC II is faulty. Go to Step 2.

2. Check the ground circuit:

a. Remove the jumper which was installed in Step 1. Observe the status of the fault present indicator. At the machine harness connector for the downshift solenoid, place a jumper from contact 1 (wire 704-GY) to frame ground.

b. If the fault present indicator is OFF, the fault is no longer present. Wire 202-BK is open in the machine harness between the downshift solenoid and frame ground. Repair or replace the machine harness.

c. If the fault present indicator is ON, the fault remains present. Wire 704-GY or the EPTC II is faulty. Go to Step 3.

3. Check for an open harness:

a. Turn the electrical disconnect switch to the OFF position. The jumper of Step 2 remains. Disconnect the machine harness from the EPTC II. At machine harness connector A for the EPTC II, measure the resistance between contact A-4 (wire 704-GY) and frame ground.

b. If the resistance is greater than 5.0 ohms, the machine harness is faulty. Wire 704-GY is open within the machine harness between the downshift solenoid and the EPTC II. Repair or replace the machine harness.

c. If the resistance is 5.0 ohms or less, the harness circuit resistance is correct. It is unlikely that the EPTC II is faulty. Perform this procedure again. If the cause is not found, replace the EPTC II.

FMI F06

NOTE: Ensure that the fault (CID 708 and FMI F06) is on hold, and the fault present indicator is ON.

This fault is recorded when the EPTC II reads the current of the downshift solenoid circuit (wire 704-GY) as above normal (short to ground).

The result of this fault condition is that the transmission does not downshift because the downshift solenoid is never ON.

Probable causes of this fault include:

- Wire 704-GY shorted
- Faulty downshift solenoid
- Faulty EPTC II

NOTE: This procedure can create a CID 708 FMI F05 fault. When all harnesses are reconnected, this fault is shown as not present. Clear the CID 708 FMI F05 fault after this procedure is completed.

1. Check the solenoid:

a. Disconnect the machine harness from the downshift solenoid. Observe the status of the fault present indicator.

b. If the fault present indicator is OFF, the fault is no longer present. The downshift solenoid is faulty. Check the downshift solenoid and replace if necessary.

c. If the fault present indicator is ON, the fault remains present. The machine harness or the EPTC II is faulty. Go to Step 2.

2. Check for a short to ground:

a. Turn the electrical disconnect switch to the OFF position. Disconnect the machine harness from the EPTC II. At machine harness connector A for the EPTC II, measure the resistance between contact A-4 (wire 704-GY) and frame ground.

b. If the resistance is less than 5000 ohms, the machine harness is faulty. Wire 704-GY is shorted to ground within the machine harness between the downshift solenoid and the EPTC II. Repair or replace the machine harness.

c. If the resistance is greater than 5000 ohms, harness circuit resistance is correct. It is unlikely that the EPTC II is faulty. Perform this procedure again. If the cause is not found, replace the EPTC II.

CID 709 Procedure: Lockup Solenoid

FMI F03

NOTE: In addition to this procedure the status of the lockup solenoid circuit is shown in the shift monitor mode; refer to “Diagnostic Operation, Display Modes, Mode 4—Shift Monitor Mode” in the “Systems Operation” section of this module.

NOTE: Ensure that the fault (CID 709 and FMI F03) is on hold. Ensure that the fault present indicator is ON.

This fault is recorded when the EPTC II reads the voltage of the lockup solenoid circuit (wire 705-PK) as above normal (short to battery voltage).

The result of this fault condition is that the engine stops when the machine is brought to a stop because the lockup solenoid is ON all the time.

Probable causes of this fault include:

- Wire 705-PK shorted to battery voltage
- Faulty EPTC II

1. Check for a shorted harness:

a. Turn the electrical disconnect switch to the OFF position. Disconnect machine harness connectors A and B from the EPTC II. Disconnect the machine harness from the lockup solenoid. At machine harness connectors A and B for the EPTC II, measure the resistance between contact A-5 (wire 705-PK) and all other contacts of the connectors. If a short exists, it is most likely that the short is to the battery supply circuit (contact A-1) or another output circuit.

b. If the resistance is less than 5000 ohms, the machine harness is faulty. Wire 705-PK is shorted within the machine harness between the lockup solenoid and the EPTC II. Repair or replace the machine harness.

c. If the resistance is greater than 5000 ohms, the harness circuit resistance is correct. It is unlikely that the EPTC II is faulty. Perform this procedure again. If the cause is not found, replace the EPTC II.

FMI F05

NOTE: Ensure that the fault (CID 709 and FMI F05) is on hold, and the fault present indicator is ON.

This fault is recorded when the EPTC II reads the current of the lockup solenoid circuit (wire 705-PK) as below normal (open circuit).

Results of this fault condition are:

- Transmission does not shift to highest gears
- Reduced power and increased fuel consumption

Probable causes of this fault include:

- Wire 705-PK or wire 202-BK open
- Faulty lockup solenoid
- Faulty EPTC II

NOTE: This procedure can create a CID 709 FMI F06 fault. When all harnesses are reconnected, this fault is shown as not present. Clear the CID 709 FMI F06 fault after this procedure is completed.

1. Check the solenoid:

a. Disconnect the machine harness from the lockup solenoid. Observe the status of the fault present indicator. At the machine harness connector for the lockup solenoid, place a jumper from contact 1 (wire 705-PK) to contact 2 (wire 202-BK).

b. If the fault present indicator is OFF, the fault is no longer present. The lockup solenoid is faulty. Check the lockup solenoid and replace if necessary.

c. If the fault present indicator is ON, the fault remains present. The machine harness or the EPTC II is faulty. Go to Step 2.

2. Check the ground circuit:

a. Remove the jumper which was installed in Step 1. Observe the status of the fault present indicator. At the machine harness connector for the lockup solenoid, place a jumper from contact 1 (wire 705-PK) to frame ground.

b. If the fault present indicator is OFF, the fault is no longer present. Wire 202-BK is open in the machine harness between the lockup solenoid and frame ground. Repair or replace the machine harness.

c. If the fault present indicator is ON, the fault remains present. Wire 705-PK or the EPTC II is faulty. Go to Step 3.

3. Check for an open harness:

a. Turn the electrical disconnect switch to the OFF position. The jumper of Step 2 remains. Disconnect the machine harness from the EPTC II. At machine harness connector "A" for the EPTC II, measure the resistance between contact A-5 (wire 705-PK) and frame ground.

b. If the resistance is greater than 5.0 ohms, the machine harness is faulty. Wire 705-PK is open within the machine harness between the lockup solenoid and the EPTC II. Repair or replace the machine harness.

c. If the resistance is 5.0 ohms or less, the harness circuit resistance is correct. It is unlikely that the EPTC II is faulty. Perform this procedure again. If the cause is not found, replace the EPTC II.

FMI F06

NOTE: Ensure that the fault (CID 709 and FMI F06) is on hold. Ensure that the fault present indicator is ON.

This fault is recorded when the EPTC II reads the current of the lockup solenoid circuit (wire 705-PK) as above normal (short to ground).

Results of this fault condition are:

- Transmission does not shift to highest gears
- Reduced power and increased fuel consumption

Probable causes of this fault include:

- Wire 705-PK shorted to ground
- Faulty lockup solenoid
- Faulty EPTC II

NOTE: This procedure can create a CID 709 FMI F05 fault. When all harnesses are reconnected, this fault is shown as not present. Clear the CID 709 FMI F05 fault after this procedure is completed.

1. Check the solenoid:

a. Disconnect the machine harness from the lockup solenoid. Observe the status of the fault present indicator.

b. If the fault present indicator is OFF, the fault is no longer present. The lockup solenoid is faulty. Check the lockup solenoid and replace if necessary.

c. If the fault present indicator is ON, the fault remains present. The machine harness or the EPTC II is faulty. Go to Step 2.

2. Check for a short to ground:

a. Turn the electrical disconnect switch to the OFF position. Disconnect the machine harness from the EPTC II. At machine harness connector A for the EPTC II, measure the resistance between contact A-5 (wire 705-PK) and frame ground.

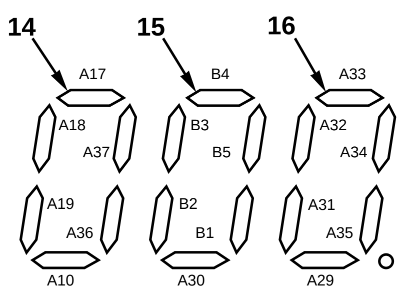
b. If the resistance is less than 5000 ohms, the machine harness is faulty. Wire 705-PK is shorted to ground within the machine harness between the lockup solenoid and the EPTC II. Repair or replace the machine harness.

c. If the resistance is greater than 5000 ohms, the harness circuit resistance is correct. It is unlikely that the EPTC II is faulty. Perform this procedure again. If the cause is not found, replace the EPTC II.

Harness Code Check

DEUCE HARNESS CODE TROUBLESHOOTING[1]			
Wire Identification	**NC**	**NC**	**Machine Code[3]**
Display Segment[2] and EPTC II Connector Contact	**A18**	**A19**	
Contact Status	**O**	**O**	**"352"**

1 While in the Other Status Mode.
2 Refer to the "Other Status Mode Display" illustration (shown below) for the location of the segment displays.
3 The machine code is shown on the display during the self-test.
NC = No connection.
X = The display segment is ON, and the EPTC II connector contact is grounded.
O = The display segment is OFF, and the EPTC II connector contact is open.
NOTE: The EPTC II has more than one part number. The EPTC II part number for the DEUCE is different than the part number for other applications.



Other Status Mode Display.
(14) Left digit—harness code. (15) Center digit—connector B. (16) Right digit—other circuits.

NOTE: The dot at the end of the readout is provided for orientation.

This check is necessary if the wrong machine code is shown during the self-test or a harness code fault (CID 650 FMI F02) is detected. The probable causes for a harness code problem are:

- Wrong harness code input
- Contact A-18 or A-19 is open or shorted
- Wrong EPTC II installed
- Faulty EPTC II

"Harness code" and "machine code" are terms which describe the particular machine on which the EPTC II is installed The harness code describes the status (open or ground) of the two harness code input signals (connector contacts A-18 and A-19). The machine code is the number that the EPTC II assigns to a particular harness code for a particular machine. The machine code is shown during the self-test. Each sales model has a specific harness code and a specific machine code.

NOTE: The EPTC II has more than one part number. The EPTC II part number for the DEUCE is different than the part number for other machines.

This procedure uses the Other Status Mode to check the harness code circuits in the machine harness. For more information, refer to "Diagnostic Operation, Display Modes, Mode 3—Other Status Mode" in the "Systems Operation" section in this module.

1. Check the harness code:

a. Put the display in mode 3 (other status mode). Observe the display segments of the left digit. Check to see that the sales model and the display segment status are in agreement according to the DEUCE Harness Code Troubleshooting chart.

b. If the sales model and display segments agree, the harness code circuits in the machine harness are correct. Go to Step 2.

c. If the sales model and display segments do not agree, there is a defect. The wrong harness code circuits in the machine harness are open or grounded. Use the "DEUCE Harness Code Troubleshooting" chart, and *Schematic, Deployable Universal Combat Earthmover (DEUCE), Electrical Schematic* to troubleshoot the machine harness. Repair or replace the machine harness.

2. Check the machine code:

a. Perform a self-test (move the engine start switch OFF and then ON). Make a note of the machine code shown during the self-test. Check to see that the sales model and the machine code are in agreement according to the "DEUCE Harness Code Troubleshooting" chart.

b. If the sales model and machine code agree, the harness code circuits and the EPTC II are correct. Check the machine harness for dirty connectors, bent contacts and frayed wires.

c. If the sales model and machine code do not agree, there is a defect. The wrong EPTC II is installed, or the EPTC II is faulty. Check the part number to make sure the correct EPTC II is installed. If necessary, replace the EPTC II.

Shift Lever Switch

Shift Lever Switch Check

1. Turn the disconnect and engine start switches to the ON position. Do not start the engine.

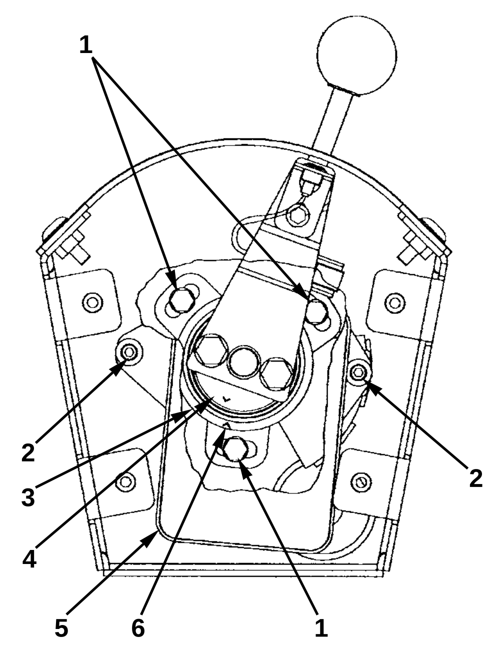
2. Put the display of the EPTC II in the shift monitor mode; refer to “Diagnostic Operation, Display Modes, Mode 4—Shift Monitor Mode” in the “Systems Operation” section, in this module.

3. Place the shift lever in each speed position while observing the left digit of the display. Observe whether the left digit matches each speed position of the shift lever.

a. If the left digit matches the shift lever position, the shift lever switch is operating correctly.

b. If the left digit does not match the shift lever position, the shift lever switch is not operating correctly. Align the shift lever switch; refer to “Shift Lever Switch Alignment” in this section.

Shift Lever Switch Alignment



Shift Lever.
(1) Housing mounting bolts. (2) Switch mounting bolts.
(3) Housing. (4) Shaft. (5) Switch. (6) Timing marks.

The shift lever switch must be aligned correctly for proper operation of the EPTC II system. Two adjustments are necessary: first, align the shift lever, and then align the shift lever switch.

1. Turn the electrical disconnect switch to the OFF position. Remove the shift console cover to expose the shift lever mechanism.

2. Place the shift lever in the FIRST-SPEED position. Observe whether the aligning marks on the housing and shaft meet “point to point.”

a. If the marks do not align, move the shift lever to the speed position which causes the alignment marks to meet. Then loosen housing mounting bolts (1). Move the shift lever so that it aligns with the FIRST-SPEED markings on the shift console. Tighten the housing mounting bolts. Go to Step 3.

b. If the marks are in alignment, go to Step 3.

3. Turn the electrical disconnect and engine start switches to the ON position. Do not start the engine. Put the display of the EPTC II in the shift monitor mode; refer to “Diagnostic Operation, Display Modes, Mode 4—Shift Monitor Mode” in the “Systems Operation” section of this module.

4. Place the shift lever in the FIRST speed position. Loosen switch mounting bolts (2). Observe whether the left digit of the display shows “1.” If “1” is not shown, slowly rotate the switch so that “1” is shown.

5. Rotate the shift lever switch until “1” appears on the left digit of the display. Make note of where the “1” first appears. Continue to rotate the shift lever switch until the “1” disappears. Return the shift lever switch to half way between where the “1” appears and disappears. Tighten switch mounting bolts (2) without moving the position of the switch.

6. Place the shift lever in each speed position while observing the left digit of the display. Observe whether the left digit matches each speed position of the shift lever.

a. If the left digit matches shift lever position, the shift lever switch is aligned correctly.

b. If the left digit does not match the shift lever position, the shift lever switch is not aligned correctly. Repeat Steps 4, 5 and 6. If a fault is present, the EPTC II should have detected a CID 702 FMI F02 fault. Refer to “Detected Fault Troubleshooting, Troubleshooting Procedures, CID 702—Shift Lever Switch” in this section.

Transmission Gear Switch

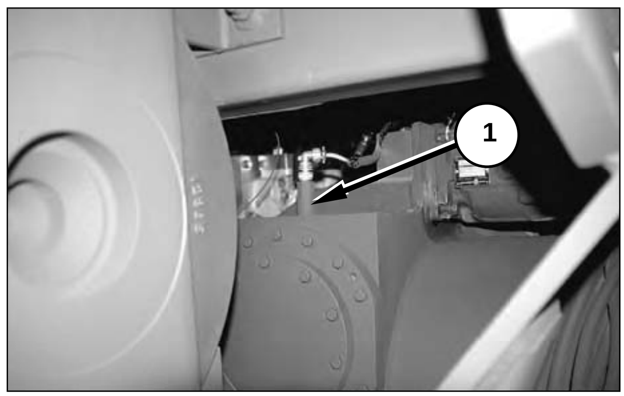
Transmission Gear Switch Check

Tools Needed		
8T-5200	Signal Generator Group	1

NOTE: This procedure requires that the machine be operated. Refer to *Operator’s Manual, Deployable Universal Combat Earthmover (DEUCE)* for information about machine operation.

1. Park the machine on a hard, level surface, move the start and disconnect switches to OFF, and block the belts.

2. Remove the drive axles and adapters from both sides of the machine. After the axles have been removed, replace the covers. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* “Operation Section, Towing Information, Preparation for Towing a Disabled Machine.”



Transmission Speed Sensor.
(1) Transmission speed sensor.

3. Cut the lock wire, disconnect transmission speed sensor (1), and connect the 8T-5200 Signal Generator Group to the connector side of the harness.

4. Turn the disconnect and engine start switches to the ON position. Do not start the engine.

5. Put the display of the EPTC II in the shift monitor mode; refer to “Diagnostic Operation, Display Modes, Mode 4—Shift Monitor Mode” in the “Systems Operation” section. In mode 4, the right digit of the readout shows the value of the signals being received from the transmission gear switch.

n = neutral
r = reverse
1 = first
2 = second
3 = third
4 = fourth
5 = fifth
6 = sixth

6. Start and run the engine at low idle with the shift lever in NEUTRAL.

7. Place the machine in SELF-DEPLOY.

8. Move the shift lever to SECOND REVERSE, and use the signal generator to slowly increase the transmission input signal to the EPTC II. The right digit of the display should show an “r.”

9. Use the signal generator to return the transmission input signal to zero, and then place the shift lever in SECOND FORWARD.

10. Use the signal generator to slowly increase the transmission input signal to the EPTC II. At first, the right digit of the display should show a “1.” When the signal from the signal generator reaches the shift point, the EPTC II will shift the transmission to SECOND and a “2” should appear in the display.

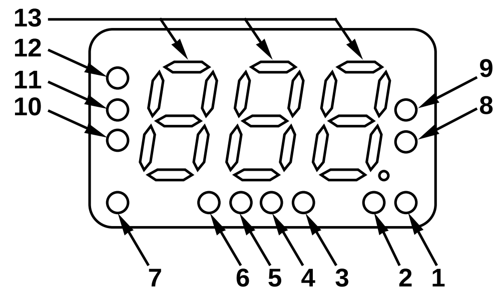
11. Move the shift lever to SIXTH. Use the signal generator to slowly increase the transmission input signal to the EPTC II. As the transmission shifts from SECOND to SIXTH, the right digit of the display should show the gear currently engaged.

12. After the test is complete, slowly return the output signal from the signal generator to zero, move the start and electrical disconnect switches to OFF, disconnect the signal generator, and reconnect the transmission speed sensor.

NOTE: When the transmission speed sensor is reconnected, install lock wire. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Transmission and Torque Converter* “Testing and Adjusting, Transmission Hydraulic System, Installation of Lock Wire on Transmission Gear Switch and Transmission Speed Sensor Connectors.”

13. If the right digit matched the gear during the test, the transmission gear switch is operating correctly. If the right digit did not match the gear, there is a defect. The EPTC II should have detected a fault (CID 700 FMI F02 or F07). Refer to “Detected Fault Troubleshooting, Troubleshooting Procedures, CID 700 Procedure: Transmission Gear Switch” in this section.

Self-Test



Display.
(1) Power indicator.
(2) Control indicator.
(3) Blade lock switch indicator.
(4) SELF-DEPLOY/EARTHMOVING switch indicator.
(5) Parking brake indicator.
(6) Service brake indicator.
(7) Remote throttle indicator.
(8) Service mode indicator.
(9) Fault present indicator.
(10) Transmission P2 indicator.
(11) Engine output speed indicator.
(12) Transmission output speed indicator.
(13) Readout.

NOTE: The dot at the end of readout (13) is provided for orientation.

The self-test verifies that the EPTC II is operating correctly. The EPTC II performs an automatic self-test each time the engine start switch is turned from the OFF to the ON position.

The internal circuits and the display are automatically checked. Service personnel must observe the display to determine whether the EPTC II is operating properly. A self-test takes approximately five seconds.

During the self-test:

- Control indicator (2) flashes once at the beginning of the self-test. This is the only time that the control indicator should illuminate. If it is ON at any other time (self-test or normal operation), the EPTC II is faulty.

- Indicators (1) through (12) are all ON at the beginning of the self-test. When readout (13) shows “– 0 –,” the indicators begin normal operation and show the status of the corresponding conditions.

- Readout (13) shows the following in sequence:

a. “XXX”—a three-digit number that the factory uses to identify the internal circuits.

b. “ XX”—a two-digit number that the factory uses to further identify the internal circuits.

c. “888”—this tests all segments of readout (13).

d. “– 0 –”—this is the mode number for display mode 0 (normal display mode).

e. “027”—this is the module identifier number for the EPTC II. The module identifier number identifies the EPTC II to other electronic controls on the CAT Data Link.

f. “352”—a three-digit machine code. The machine code is a three-digit representation of the harness code. The correct machine code is 352.

The self-test is now finished, and the display is in normal mode (mode 0). If there are no faults, readout (13) shows “– – –.” If a fault has occurred, the readout shows the corresponding CID and FMI codes. Refer to “Diagnostic Operation” in the “Systems Operation” section in this module.

If the EPTC II operates as described, the EPTC II is operating properly. If the EPTC II does not operate as described, the wrong EPTC II is installed, there is a harness code problem, or the EPTC II is faulty.

NOTE: The EPTC II has more than one part number. The EPTC II part number for DEUCE is different than the part number for other applications.

Shift Point Specifications

The normal shift points for the DEUCE are listed in the following table. To help protect the power train, certain shifting restrictions exist. The major shifting restrictions are described in the following paragraphs.

The engine overspeed protection allows the transmission to upshift one gear if engine speed increases to approximately 2900 rpm. If in top gear, the lockup clutch will be disengaged, placing the machine in torque converter drive.

The engine underspeed protection forces the transmission to downshift one gear if engine speed decreases to approximately 750 rpm.

The transmission protection does not allow the transmission to shift in the opposite direction for 2.3 seconds after a shift. For example, after an upshift, a downshift is not allowed until 2.3 seconds have passed. This is called the “antihunt” feature and eliminates shifting due to minor ground speed fluctuations near a shift point. The 2.3 second restriction allows conditions to stabilize before an opposite shift. If any brake is applied, the antihunt feature is canceled and transmission downshifts occur as conditions demand.

When NEUTRAL is selected at the shift lever while the transmission is in a forward gear, the neutral coast protection allows the transmission to shift into NEUTRAL only when ground speed is 5 mph or less. If the machine is coasting with the transmission in NEUTRAL, the transmission will not shift into a forward gear. The transmission will only shift to REVERSE when ground speed is less than 3 mph.

DEUCE NORMAL SHIFT POINTS[1]			
Shift	Transmission Shift TOS[2] (rpm)	Lockup Clutch Engage TOS[2] (rpm)	Lockup Clutch Disengage TOS[2] (rpm)
Upshifts:			
1C - 1L	–	131.1	120.0
1L - 2C	183.5	–	–
2C - 2L	–	216.5	198.2
2L - 3C	290.0	–	–
3C - 3L	–	303.2	271.6
3L - 4L	516.0	–	–
4L - 5L	859.0	–	–
5L - 6L	1485.0	–	–
Downshifts:			
6L - 5L	1366.2	–	–
5L - 4L	790.3	–	–
4L - 3L	475.2	–	–
3L - 3C	–	303.2	271.6
3C - 2L	266.8	–	–
2L - 2C	–	216.5	198.2
2C - 1L	168.8	–	–
1L - 1C	–	131.1	120.0

[1] All rpm values are for reference only. Mode 6 of EPTC II shows the transmission output speed rpm. The rpm values shown can vary slightly.
[2] TOS = Transmission Output Speed.

NOTE: The rpm of the transmission output shaft is shown on readout on the face of the EPTC II. The readout shows in tens of rpm. For example, 650 rpm is shown as “65,” and 1520 rpm is shown as “152” on the readout.

Glossary EPTC II Terms

CID (Component Identifier)

The CID is a three-digit code that tells which component is faulty. The CID is shown on the EPTC II display in normal or detected fault mode.

Clear

"Clear" refers to erasing diagnostic information from the memory of the EPTC II.

Connector Contact

A connector contact is the component of a harness connector that actually makes the electrical connection. Connector contacts are either pins or sockets.

Data Event

A data event is an occurrence of abnormal or abusive machine operation. Based on a combination of signals at the EPTC II connector, the EPTC II decides when the machine is operating abnormally. Data events are recorded by the EPTC II and are viewed with a service tool.

Detected Fault

A detected fault is a fault that has been found by the EPTC II. The fault is recorded, and diagnostic information is available in detected fault mode (mode 2).

Diagnostic

Diagnostic refers to the showing, monitoring and/or recording of information other than normal. Diagnostic information is available in each display mode.

Display

The display is the readout and indicators that are visible through the cover of the EPTC II.

Event

Whenever the EPTC II records information, it is called an "event." The EPTC II categorizes the events into either a fault event or a data event.

Fault or Fault Event

A fault is a failure of a component of the EPTC II system. Faults are detected by the EPTC II when a signal at the EPTC II connector (for example, open or shorted harness, faulty switch, or faulty sensor) is outside a valid range. The CID and FMI codes for detected faults (fault events) are shown on the EPTC II display in normal or detected fault mode.

FMI (Failure Mode Identifier)

The FMI is a two-digit code that tells what type of failure has occurred. The two-digit code is preceded by the letter "F." The FMI is shown on the EPTC II display in normal or detected fault mode.

Harness Code

"Harness code" refers to the grounded or open condition of the five harness code inputs (contacts 17, 18, 19, 36 and 37 of connector A). The harness code tells the EPTC II the characteristics of the machine on which it is installed.

Hold or On Hold

"Hold" or "on hold" refers to holding (or locking) on the display the codes for a fault, in the detected fault mode (mode 1). A fault must be on hold for troubleshooting or clearing.

Hunting

A hunting condition is an unwanted rapid upshift and downshift. Hunting is caused by changes in ground speed while the machine is operating at or near a shift point.

Indicator

An indicator is a light emitting diode (LED) within the display, which operates in an ON, FLASHING or OFF manner. There are twelve indicators that show the status of significant conditions of the EPTC II system.

Jumper

A jumper is a piece of wire used to make an electrical connection during troubleshooting.

Module Identifier

The module identifier is a three-digit code that identifies the EPTC II to other electronic controls on the CAT Data Link. The module identifier for the EPTC II is “027.” The module identifier is only shown within the display during the self-test.

Machine Code

The machine code is a three-digit number that the EPTC II has assigned to a particular harness code for a particular machine. The machine code is shown within the display during the self-test. Each sales model has a specific harness code and a specific machine code.

Positive (+) Battery

Positive (+) battery refers to any of the harness wiring which is part of the circuit that connects to the positive battery post.

Pulse Width Modulated

A pulse width modulated signal is a signal in which the duty cycle (time on verses time off) varies according to the machine conditions that are monitored. The frequency of this signal is constant.

Scroll

Scrolling is the process of showing all faults, one fault at a time. The codes for a fault are shown briefly, and then the display automatically advances to the next fault. After all faults are shown, the faults are repeated.

Signal

Signal refers to the condition of the EPTC II input. There are four types of signals:

A ground signal has continuity with frame ground.

An open signal is not connected to frame ground; the voltage level is approximately 5 DCV.

A battery voltage signal is at the same voltage level as the voltage of the battery, between 25 and 30 DCV.

A constantly changing signal comes from a sensor to a EPTC II input. The transmission output speed sensor provides a frequency signal that is constantly changing.

Signal Wire

The signal wire is the harness wire which connects the sensor or switch to the EPTC II.

Switch Input

A switch input is any input of the EPTC II which is expecting a grounded, open or battery supply signal.

System Voltage

System voltage is the actual voltage that exists between the positive battery post and frame ground.

Wring Out

This refers to checking the continuity of a harness.

TM5-2430-200-24

Specifications
Systems Operation
Testing & Adjusting

Deployable Universal Combat Earthmover (DEUCE)

Electrical System

PIN: 7RR00003-Up

Important Safety Information

Most accidents involving product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product until you have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “WARNING,” as shown below.

The meaning of this safety alert symbol is as follows:

WARNING

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning, explaining the hazard, can be either written or pictorially presented.

Operations that may cause product damage are identified by NOTICE labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are therefore not all inclusive. If a tool, procedure, work method or operating technique not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and others. You should also ensure that the product will not be damaged or made unsafe by the operation, lubrication, maintenance or repair procedures you choose.

The information, specifications, and illustrations in this publication are based on information available at the time it was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service given to the product. Obtain the complete and most current information before starting any job. Caterpillar dealers have the most current information available. For a list of the most current publication form numbers available, see the Service Manual Contents Microfiche, REG1139F.

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Specifications

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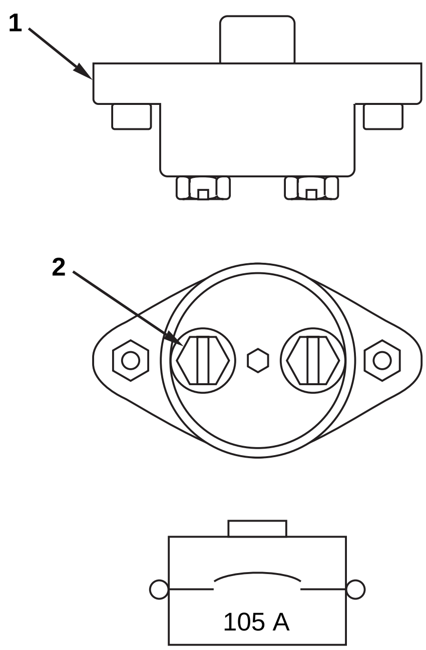
NOTE: Dielectric grease should not be used in electrical connectors on Caterpillar machines regardless of the connector family. The use of dielectric grease in connector assemblies can result in moisture and dirt contamination. Moisture and dirt contamination can lead to shorts and/or intermittant connections.

NOTE: Dielectric grease shall be restricted to use on bolted connections such as ring terminals, cable assemblies, battery posts and spark plug connections. On bolted connections, Caterpillar part number **151-1340 Dielectric Tune-Up Grease** should be used.

Specifications

Circuit Breakers

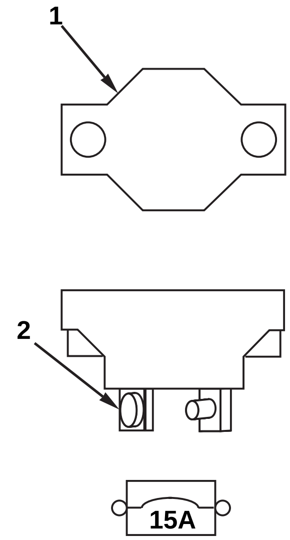
Alternator and Main Power



(1) Nominal current rating ....105 A

(2) Tighten contact screws to a torque of ....4.6 ± 0.4 N•m (41 ± 3.5 lb in)

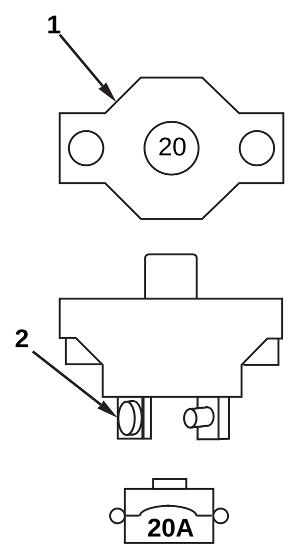
Left and Right Work Light



(1) Nominal current rating ....15 A

(2) Tighten contact screws to a torque of ....1.7 ± 0.2 N•m (15 ± 1.8 lb in)

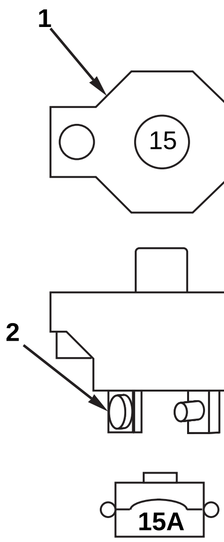
ECM (Engine) and EPTC II (Transmission)



(1) Nominal current rating ....20 A

(2) Tighten contact screws to a torque of ....1.7 ± 0.2 N•m (15 ± 1.8 lb in)

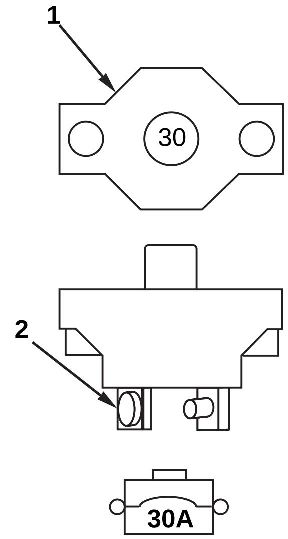
Air Conditioning Blower Motor, Auxiliary, Horn/Dome, Start-Aid (Ether)



(1) Nominal current rating ....15 A

(2) Tighten contact screws to a torque of ....1.7 ± 0.2 N•m (15 ± 1.8 lb in)

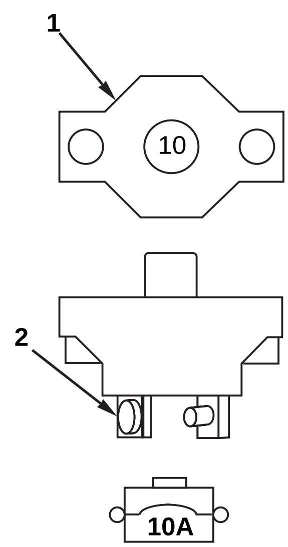
Engine Coolant Heater



(1) Nominal current rating ....30 A

(2) Tighten contact screws to a torque of ....1.7 ± 0.2 N•m (15 ± 1.8 lb in)

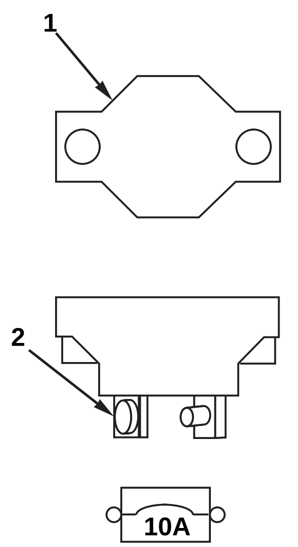
Start Switch



(1) Nominal current rating ....10 A

(2) Tighten contact screws to a torque of ....1.7 ± 0.2 N•m (15 ± 1.8 lb in)

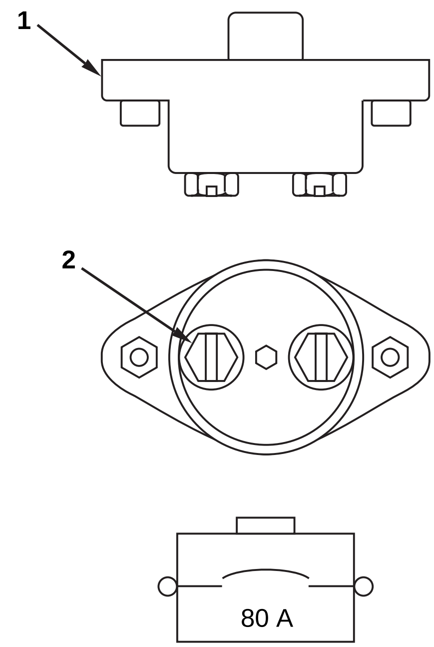
Turn/Flasher, Warning Lights, Washer/Wiper



(1) Nominal current rating ....10 A

(2) Tighten contact screws to a torque of ....1.7 ± 0.2 N•m (15 ± 1.8 lb in)

Intake Air Heater

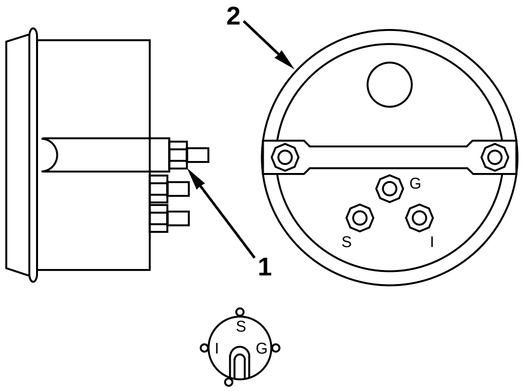


(1) Nominal current rating ....80 A

(2) Tighten contact screws to a torque of ....4.6 ± 0.4 N•m (40.7 ± 3.5 lb in)

Gauges

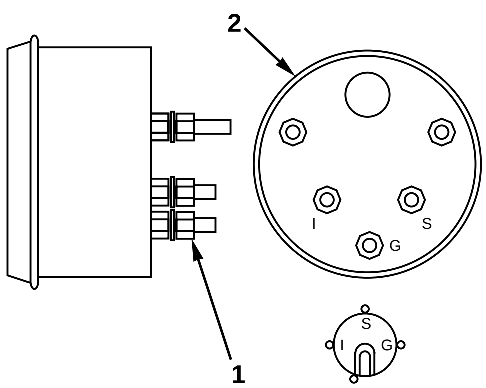
Tachometer



(1) Tighten nut to a torque of..............0.62 ± 0.10 N•m
....(5.5 ± .9 lb in)

(2) Signal frequency ...113 pulses per engine revolution

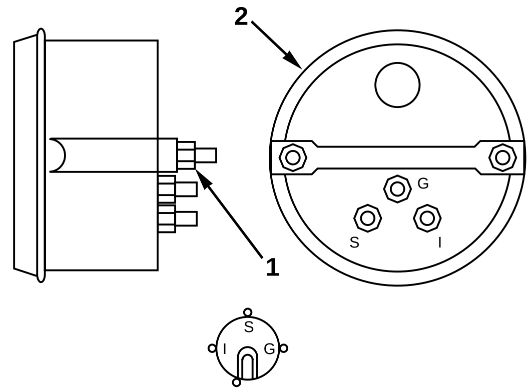
Transmission Oil Temperature



(1) Tighten nut to a torque of..............0.85 ± 0.12 N•m
....(7.5 ± 1.1 lb in)

(2) Resistance at 54.4°C (130°F)..................................
....................................12 950 + 12 100 /- 5215 Ω
Resistance at 110°C (230°F).......1325 + 35 /- 50 Ω
Resistance at 160°C (320°F).........290 + 52 /- 60 Ω

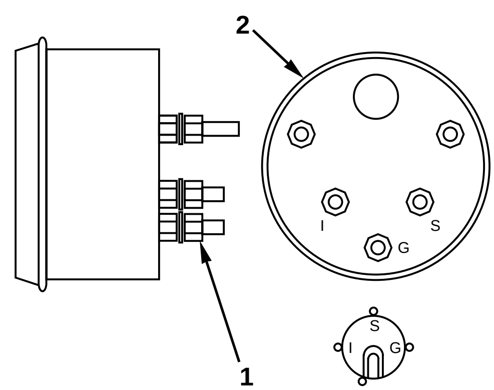
Speedometer



(1) Tighten nut to a torque of..............0.62 ± 0.10 N•m
....(5.5 ± .9 lb in)

(2) Signal frequency at 1.7 km/hr (1 mph).........16.7 Hz
Signal frequency at 80 km/hr (50 mph)....829.75 Hz

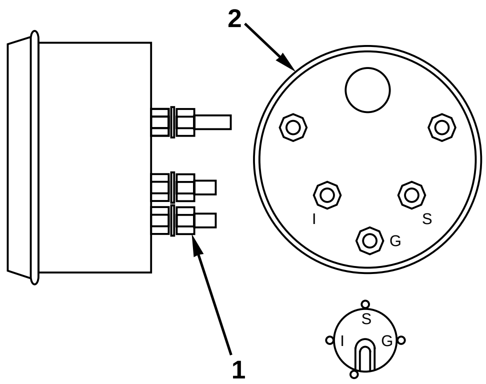
Engine Coolant Temperature



(1) Tighten nut to a torque of..............0.85 ± 0.12 N•m
....(7.5 ± 1.1 lb in)

(2) Resistance at 50°C (122°F).....................................
....8000 + 6400 /- 2800 Ω
Resistance at 80°C (176°F)................2150 ± 200 Ω
Resistance at 110°C (230°F)..................660 ± 30 Ω

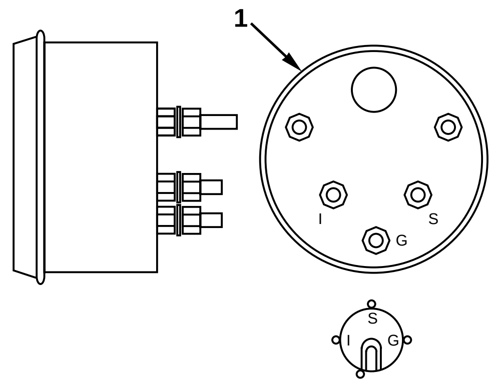
Engine Oil Pressure



(1) Tighten nut to a torque of..............0.85 ± 0.12 N•m
....(7.5 ± 1.1 lb in)

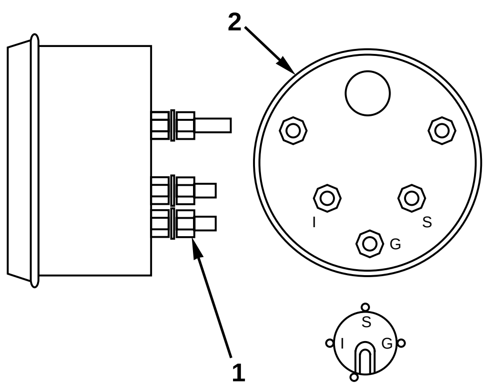
(2) Resistance at 0 kPa (0 psi).................................0 Ω
Resistance at 100 kPa (14.5 psi) .....16.25 ± 1.25 Ω
Resistance at 550 kPa (79.7 psi)..........88.0 ± 5.0 Ω

Fuel Level



(1) Resistance at empty position.................227 ± 13 Ω
Resistance at half-full position..................103 ± 5 Ω
Resistance at full position ....33.5 ± 6.5 Ω

Voltmeter

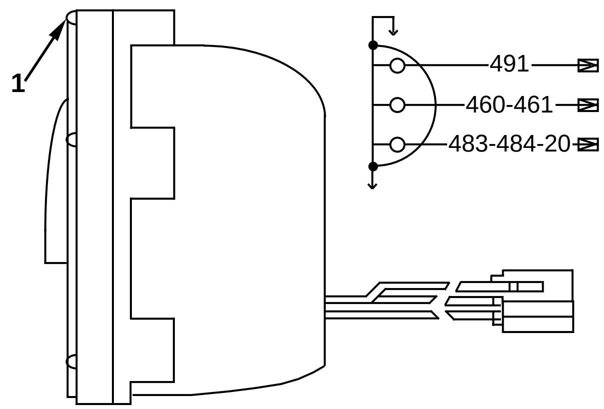


(1) Tighten nut to a torque of..............0.85 ± 0.12 N•m
....(7.5 ± 1.1 lb in)

(2) Voltage at end of first red zone.............21.0 ± 1.0 V
Voltage at end of second red zone.......30.0 ± 0.3 V

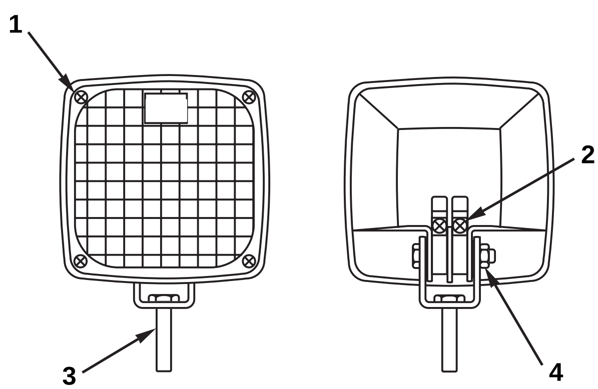
Lamps

Blackout Tail Lamp



(1) Tighten five screws to a torque of ....2.55 ± 0.25 N•m (22.5 ± 2.5 lb in)

Work Lamp



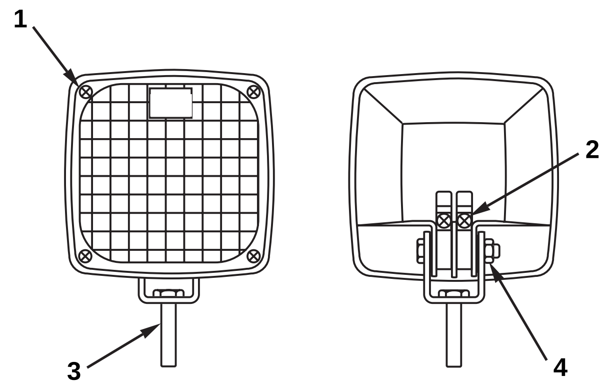
(1) Tighten screw to a torque of ....1.1 ± 0.15 N•m ....(0.8 ± 0.1 lb ft)

(2) Tighten screw to a torque of ....1.7 ± 0.25 N•m ....(1.3 ± 0.2 lb ft)

(3) Tighten bolt to a torque of.....................25 ± 7 N•m ....(18.4 ± 5.2 lb ft)

(4) Tighten nut to a torque of......................12 ± 4 N•m ....(8.8 ± 3.0 lb ft)

Head Lamp



(1) Tighten screw to a torque of ....1.1 ± 0.15 N•m ....(0.8 ± 0.1 lb ft)

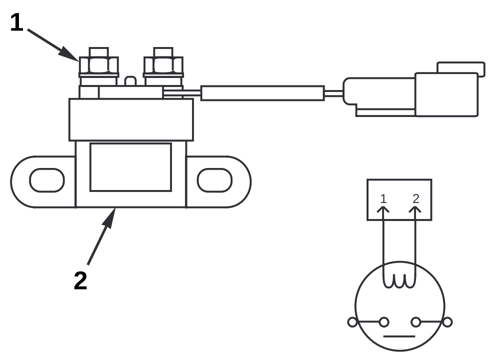
(2) Tighten screw to a torque of ....1.7 ± 0.25 N•m ....(1.3 ± 0.2 lb ft)

(3) Tighten bolt to a torque of.....................25 ± 7 N•m ....(18.4 ± 5.2 lb ft)

(4) Tighten nut to a torque of......................12 ± 4 N•m ....(8.8 ± 3.0 lb ft)

Relays

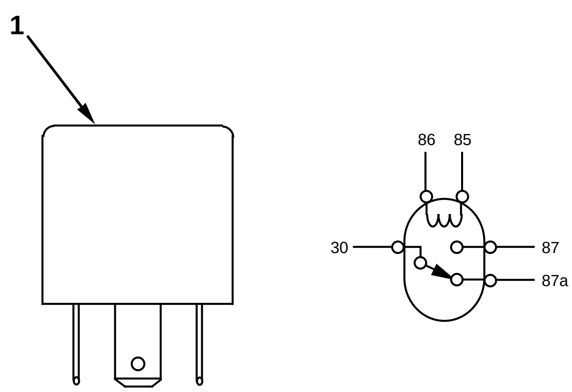
Intake Air Heater



(1) Tighten nut to a torque of..................6.0 ± 0.5 N•m
....(35 ± 4 lb in)

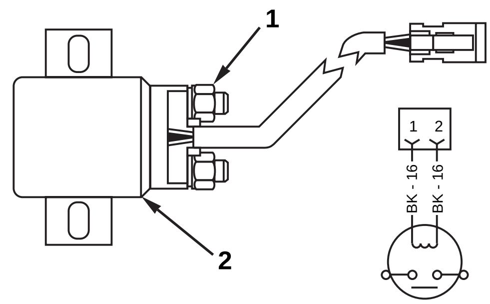
(2) Pull-in voltage ....16 V max
Hold-in voltage...8 V max
Coil resistance ....27.5 ± 3 Ω

Backup, Blackout Switch, Diagnostic, Horn, Lamp Test, Park Brake, Roading, Start-Aid, Steering, Suspension, Wiper



(1) Pull-in voltage ....14.4 V max
Hold-in voltage...7 V max
Coil resistance ....360 Ω

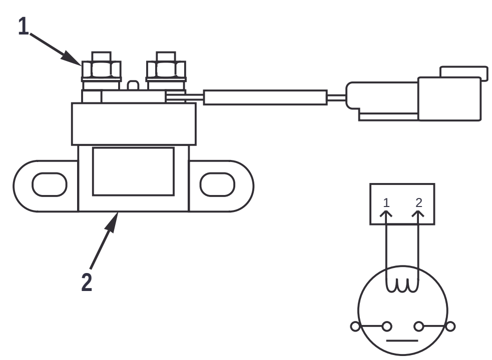
Blackout, Main



(1) Tighten nut to a torque of..................5.0 ± 0.5 N•m
....(44 ± 4 lb in)

(2) Pull-in voltage ....12.9 V max
Hold-in voltage..6.9 V max
Coil resistance ....53 ± 5 Ω

Start

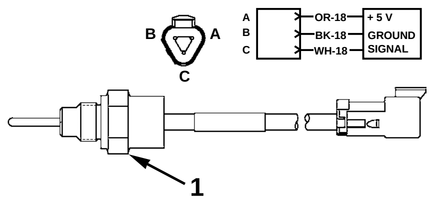


(1) Tighten nut to a torque of..................4.0 ± 0.5 N•m
....(35.4 ± 4 lb in)

(2) Pull-in voltage ....16 V max
Hold-in voltage...8 V max
Coil resistance ....27.5 ± 3 Ω

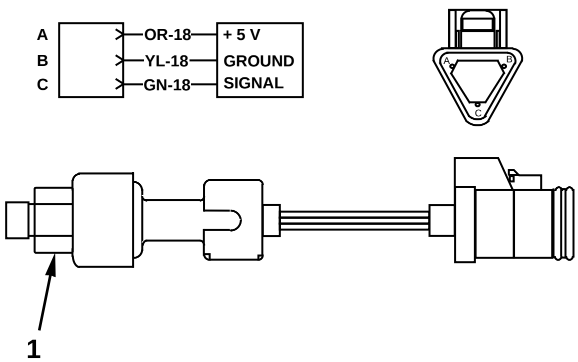
Sensors

Engine Oil Temperature



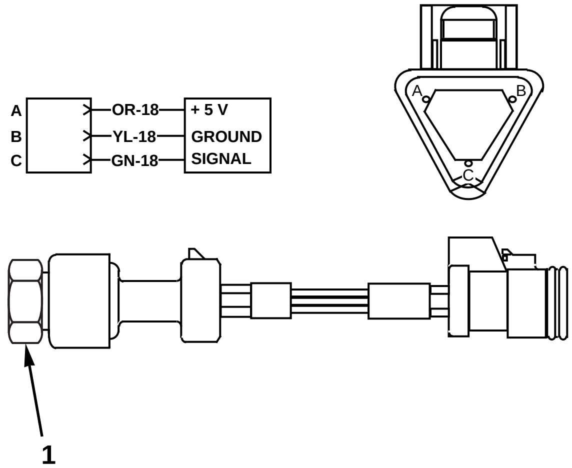
(1) Install sensor to a torque of...................20 ± 3 N•m
....(15.8 ± 2.3 lb ft)

Injection Actuation Pressure



(1) Install sensor to a torque of...................10 ± 2 N•m
....(7.4 ± 1.5 lb ft)

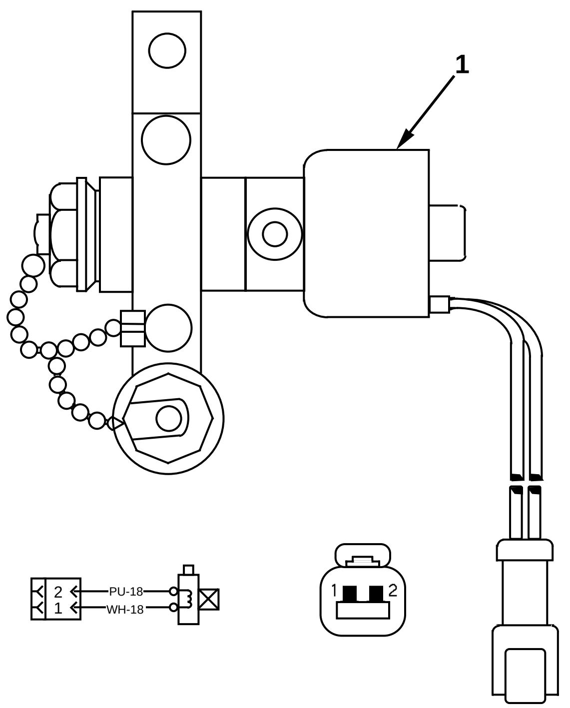
Boost Pressure



(1) Install sensor to a torque of...................10 ± 2 N•m
....(7.4 ± 1.5 lb ft)

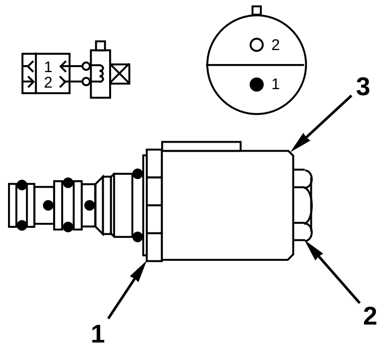
Solenoids

Start-Aid



(1) Pull-in voltage..16 V
Drop-out voltage...10 V
Coil resistance ....6 Ω

Transmission Lock

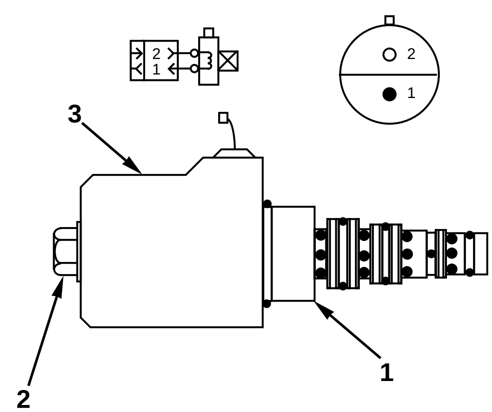


(1) Tighten nut to torque of.....50 ± 5 N•m (37 ± 4 lb ft)

(2) Tighten nut to torque of.....................5.0 ± 0.5 N•m ....(45 ± 4 lb in)

(3) Coil resistance ....33.8 ± 1.0 Ω

Self-Deploy/Earthmoving Suspension

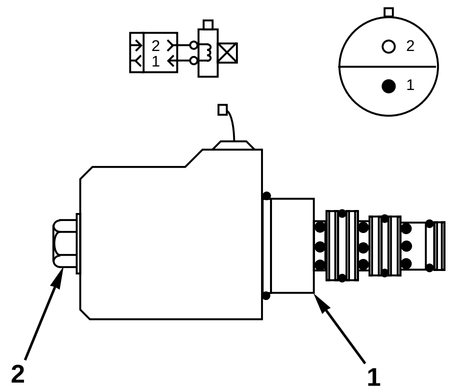


(1) Tighten nut to torque of...115 ± 7 N•m (85 ± 5 lb ft)

(2) Tighten nut to torque of ....4.1 ± 0.5 N•m (3 ± 0.4 lb ft)

(3) Coil resistance ....33.6 Ω

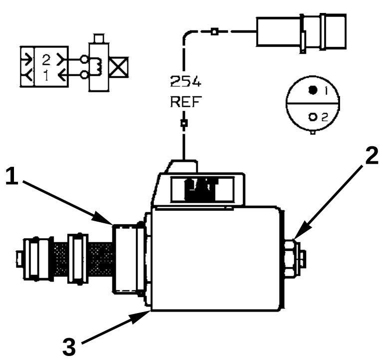
Steering



(1) Tighten nut to torque of...115 ± 7 N•m (85 ± 5 lb ft)

(2) Tighten nut to torque of ....
.................................2.85 ± 0.15 N•m (24 ± 1 lb in)

Transmission Up/Down

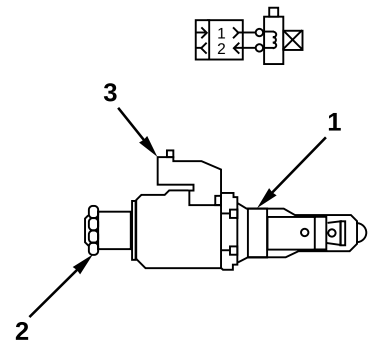


(1) Tighten nut to torque of ....
..................................80 ± 5 N•m (59.2 ± 3.7 lb ft)

(2) Tighten nut to torque of ....
.................................9.0 ± 0.5 N•m (6.7 ± 0.4 lb ft)

(3) Coil resistance ....32.6 ± 1.6 Ω

Injection Actuation

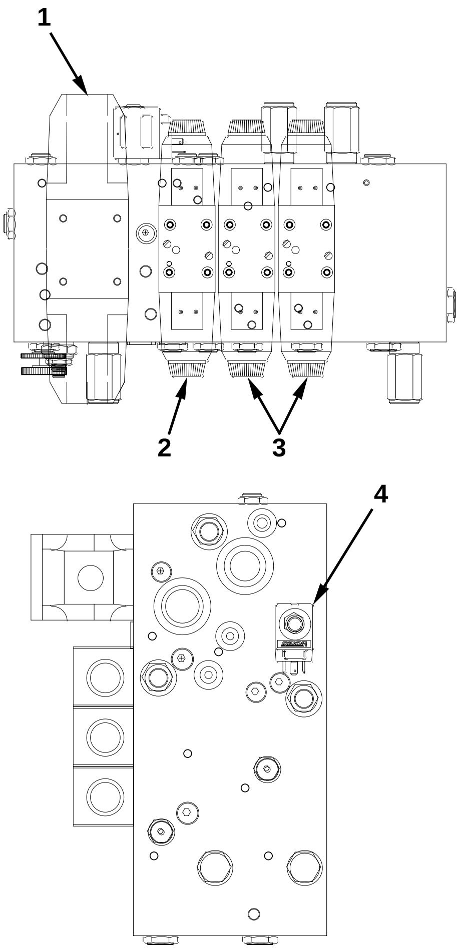


(1) Tighten nut to torque of.........................50 ± 5 N•m
....(37 ± 3.5 lb ft)

(2) Tighten nut to torque of ....
.............................5.5 ± 1.5 N•m (48.5 ± 13.5 lb in)

(3) Coil resistance ....10.1 Ω

Winch, Undercarriage Charge, Kneeling, Park Brake



(1) Install winch solenoid to a torque of ....13 N•m
....(115 lb in)
Coil resistance ....13.5 Ω

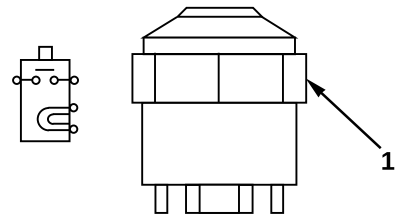
(2) Install undercarriage charge solenoid to a torque of.............................6 ± 1 N•m (53 ± 9 lb in)
Coil resistance ....19.7 Ω

(3) Install kneeling solenoids to a torque of ....
....6 ± 1 N•m (53 ± 9 lb in)
Coil resistance ....19.7 Ω

(4) Install park brake solenoid cartridge to a torque of ....50.5 ± 3.5 N•m (37.5 ± 2.5 lb ft)
Tighten coil nuts to a torque of..........6.5 ± 1.5 N•m
....(5 ± 1 lb ft)
Coil resistance ....32 Ω

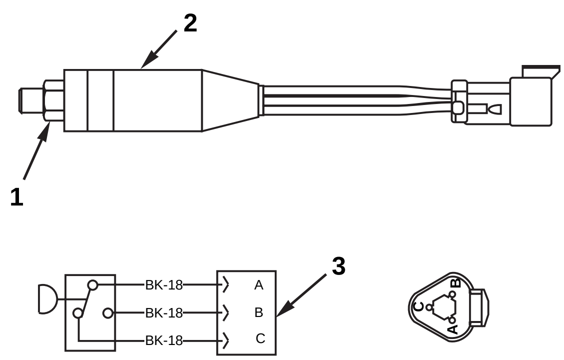
Switches

Engine Heater



(1) Install switch to a torque of ....2.5 ± 0.5 N•m
....(22 ± 4.5 lb in)

Engine Oil Pressure



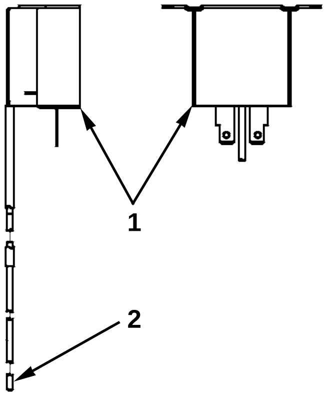
(1) Install switch to a torque of ....30 ± 3 N•m
....(265.5 ± 26.5 lb in)

(2) Actuation pressure ....85 kPa (12.3 psi)
Deactuation pressure.........35 ±21 kPa (5.1 ± 3 psi)

(3) Contact position A–B normally open below deactuation temperature.

Contact position A–C normally closed below deactuation temperature.

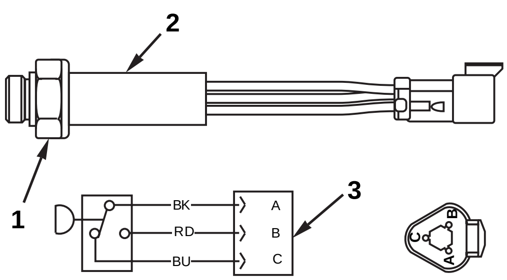
Air-Conditioning Thermostat



(1) Cut-in temperature..........2.2 ± 0.8°C (36.0 ± 1.4°F)
Cut-out temperature ....1.1 ± 0.8°C (34.0 ± 1.4°F)

(2) Distance to insert capillary tube..........230 ± 10 mm
....(9 ± 0.4 in)

P2 Pressure



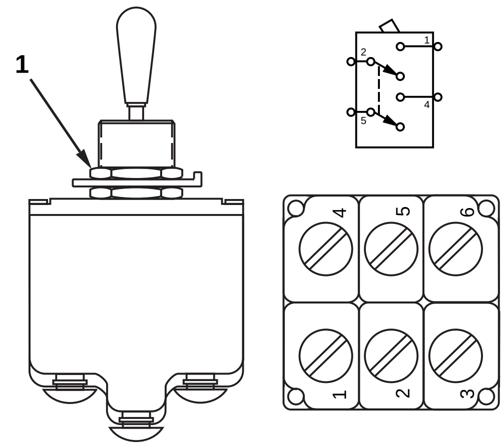
(1) Install switch to a torque of ....82 ± 8 N•m
....(60.5 ± 6 lb ft)

(2) Actuation pressure..............1400 kPa (200 psi) max
Deactuation pressure...
..................................1100 ±75 kPa (160 ± 11 psi)

(3) Contact position A–B normally open below deactuation pressure.

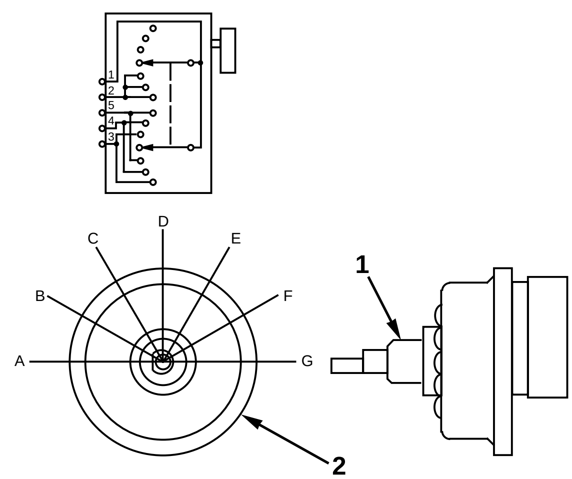
Contact position A–C normally closed below deactuation pressure.

Horn On/Off, Winch Enable



(1) Tighten nut to a torque of ....2.2 ± 0.1 N•m
....(19.5 ± .9 lb in)

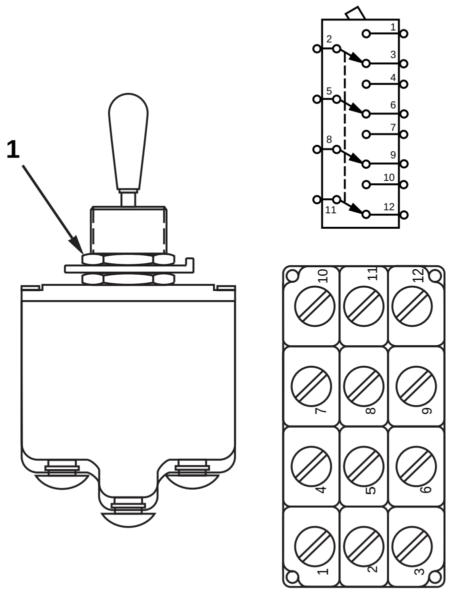
Air-Conditioning Blower



(1) Tighten nut to a torque of ....5.2 ± 0.2 N•m
....(46 ± 2 lb in)

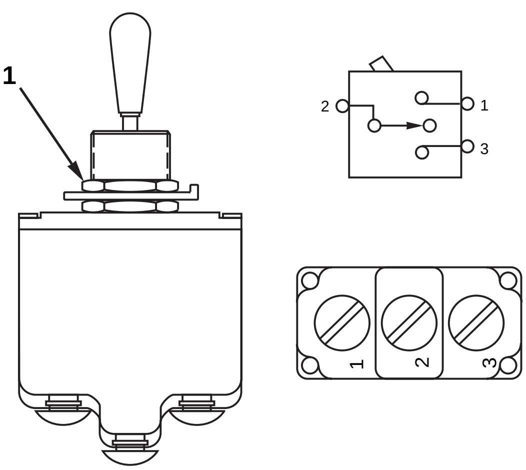
(2) Contacts closed at position A........................1, 2, 3
Contacts closed at position B........................1, 2, 4
Contacts closed at position C........................1, 2, 5
Contacts closed at position D..............OFF position
Contacts closed at position E............................1, 3
Contacts closed at position F 1, 4
Contacts closed at position G............................1, 5

Self-Deploy/Earthmoving, Remote Throttle Control



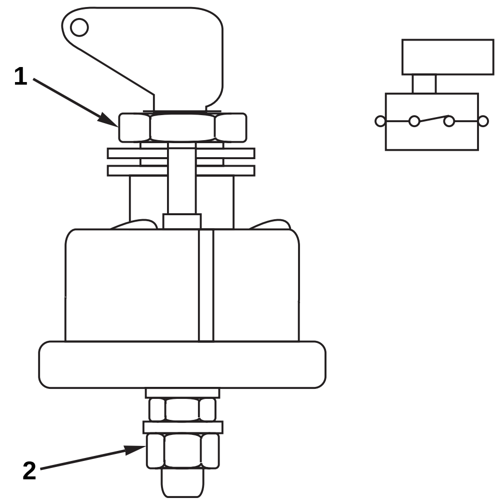
(1) Tighten nut to a torque of ....2.2 ± 0.1 N•m ....(19.5 ± 0.9 lb in)

Winch, Kneeling



(1) Tighten nut to a torque of ....2.2 ± 0.1 N•m ....(19.5 ± 0.9 lb in)

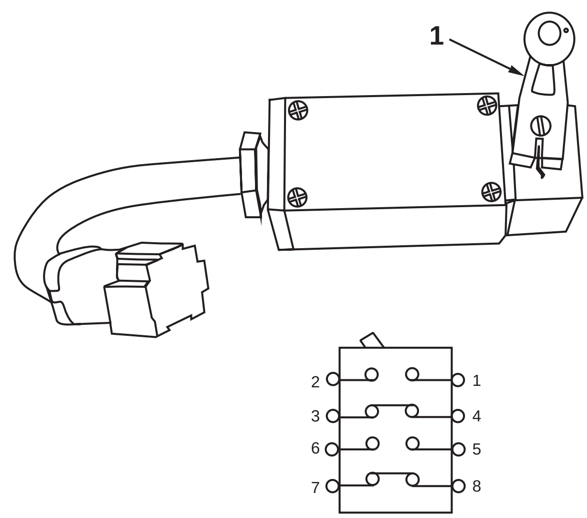
Electrical Disconnect



(1) Tighten nut to a torque of......................23 ± 4 N•m ....(203.5 ± 35.5 lb in)

(2) Tighten nut to a torque of........................8 ± 2 N•m ....(71 ± 17.7 lb in)

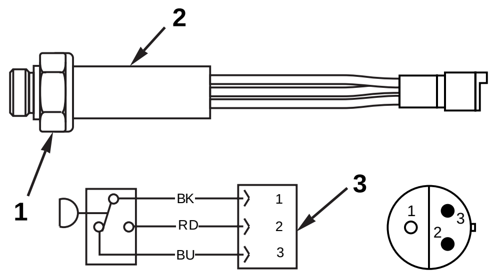
Recoil Alarm Switch



(1) Actuator arm (1), is positioned approximately 5 degrees off vertical when the recoil alarm switch is in the acuated position.

(2) Contact position normally open.

Track Tension Pressure, Brake Pressure



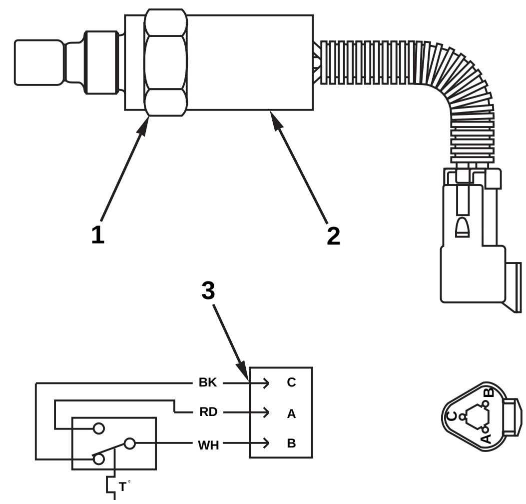
(1) Install switch to a torque of ....35 ± 3 N•m ....(26 ± 2 lb ft)

(2) Actuation pressure ....9500 kPa (1375 psi) max
Deactuation pressure...
...............................8300 ±350 kPa (1245 ± 50 psi)

(3) Contact position 1-2 normally open below deactuation pressure.

Contact position 1-3 normally closed below deactuation pressure.

Hydraulic Oil Temperature



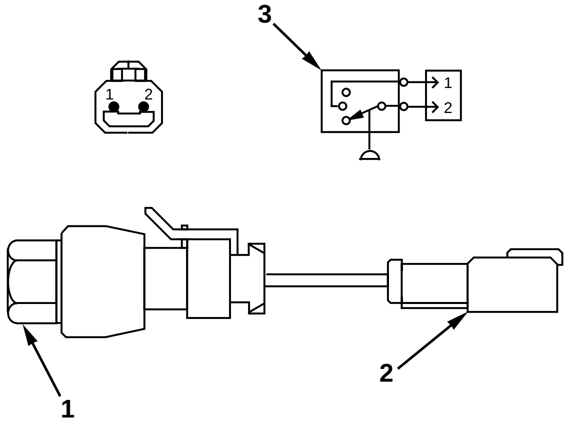
(1) Install sensor to a torque of...................75 ± 7 N•m ....(55 ± 5 lb ft)

(2) Actuation temperature............................92 ± 1.5°C
....(197.6 ± 2.7°F)
Deactuation temperature......85°C (185°F) minimum

(3) Contact position A–B normally open below actuation temperature.

Contact position B–C normally closed below actuation temperature.

Air-Conditioning Pressure



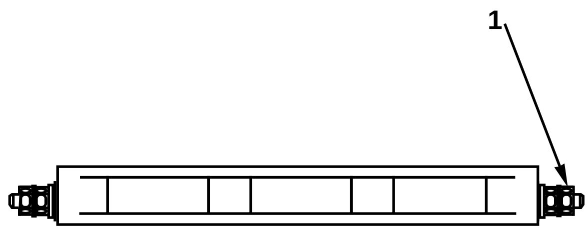
(1) Install switch to a torque of ....8.0 ± 1.5 N•m ....(79 ± 13.3 lb ft)

(2) Low setting actuation pressure...................275 kPa ....(39.9 psi) Max
Low setting deactuation pressure............................ ....170 ± 55 kPa (24.6 ± 7.8 psi)
High setting actuation pressure......2800 ± 140 kPa ....(405 ± 20.3 psi)
High setting deactuation pressure ....1750 ± 200 kPa (254 ± 30 psi)

(3) Contact positions:
Normally open below low setting deactuation pressure.
Normally closed between low setting actuation pressure and high setting deactuation pressure.
Normally open above high setting actuation pressure.

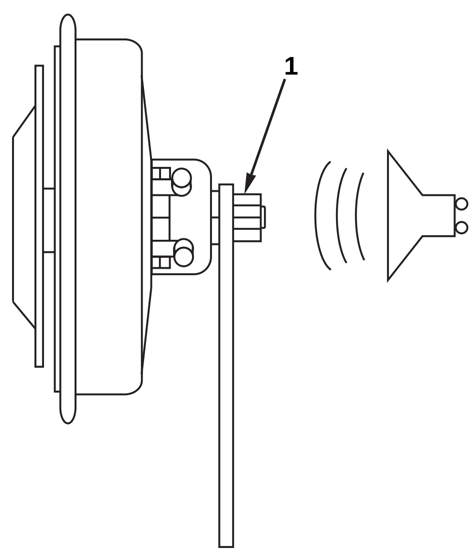
Other Components

Intake Air Heater



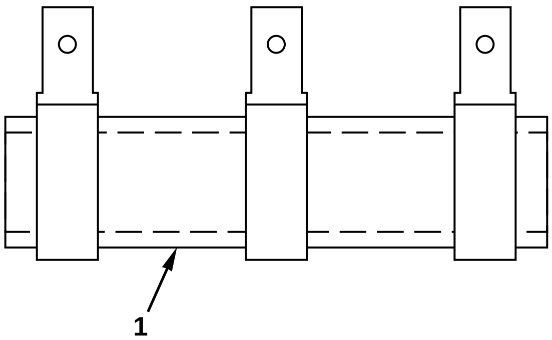
(1) Tighten nut to torque of ....7.8 ±1.0 N•m ....(69 ± 8.9 lb in)

Horn



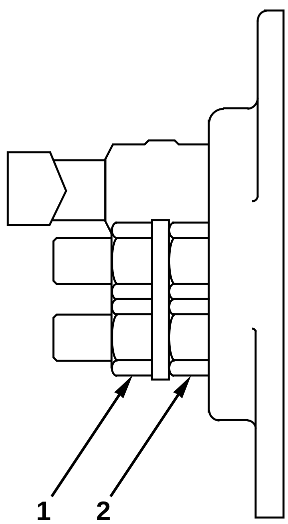
(1) Tighten nut to torque of ....13.6 ± 0.7 N•m ....(120 ± 6 lb in)

Air-Conditioning Resistor



(1) Overall resistance ....2 ± 0.1 Ω
Resistance each side of tap....................1 ± 0.05 Ω

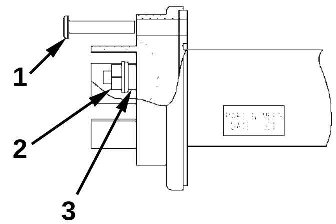
Power Buss Bar



(1) Tighten nut to a torque of....................70 ± 15 N•m
....(51.6 ± 11 lb ft)

(2) Tighten nut to a torque of....................70 ± 15 N•m
....(51.6 ± 11 lb ft)

Fuel Level Sender

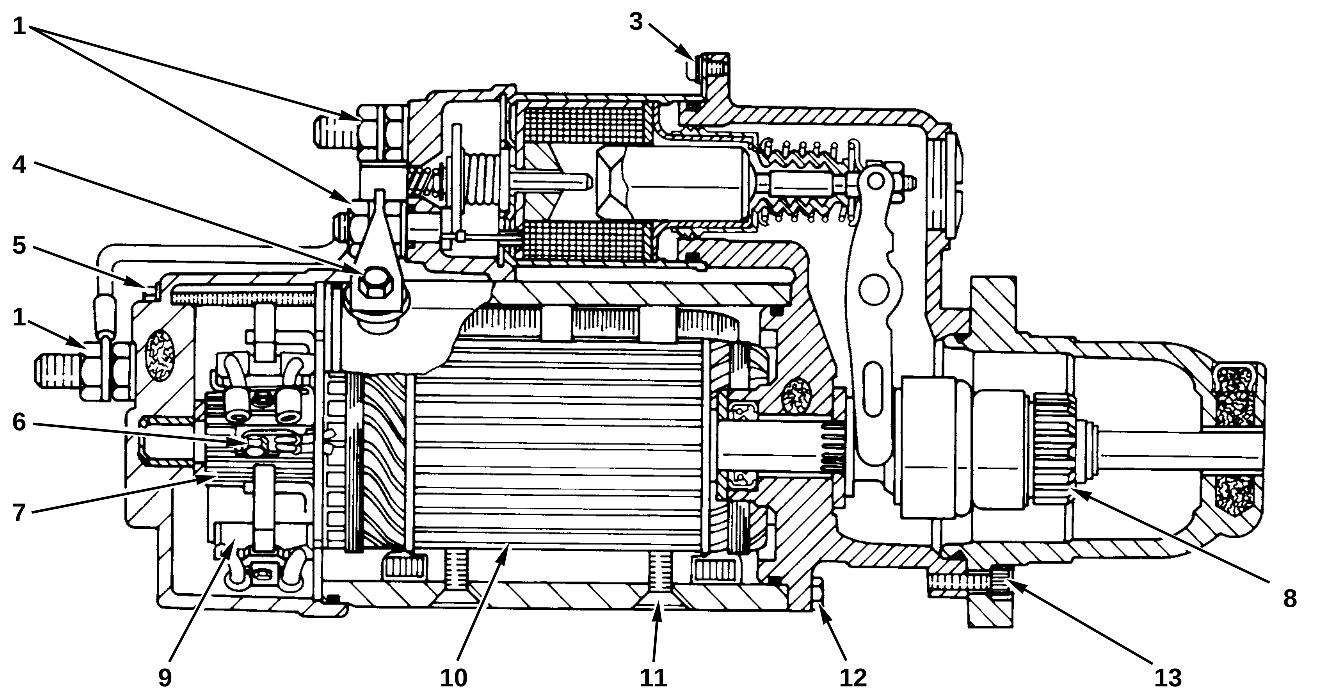


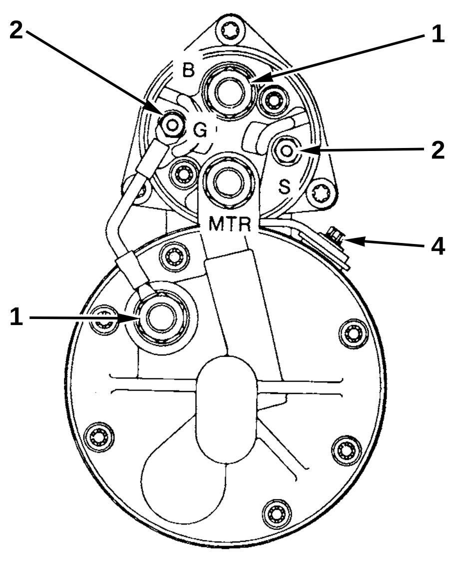
(1) Install switch to a torque of.......................2.93 N•m
....(26 ± 2 lb in)

(2) Resistance at full................................250 ± 12.5 Ω
Resistance at empty...............................33 ± 1.7 Ω

(3) Do not loosen.

Starter





Solenoid

Pull-in winding resistance at 20°C (68°F) ....0.43 to 0.49 Ω

Hold-in winding resistance at 20°C (68°F) ....1.37 to 1.77 Ω

Pull-in winding current at 20°C (68°F) ....56.5 ± 4.5 A at 20 V

Hold-in winding current at 20°C (68°F) ....14.6 A at 20 V

Starting Motor No-Load Test

Voltage...23.0 V

Maximum current.......................................67.5 ± 7.5 A

Minimum speed.................................7643 ± 1683 rpm

Starting Motor Load Test (at 27°C [80°F])

Voltage...18.0 V

Maximum current..750 A

Minimum speed ....1200 rpm

Torque

(1) Tighten nut to a torque of................30.5 ± 3.5 N•m ....(22.5 ± 2.5 lb ft)

(2) Tighten nut to a torque of..............2.25 ± 0.25 N•m ....(20 ± 2 lb in)

(3) Tighten bolt to a torque of...............17.8 ± 3.7 N•m ....(158 ± 33 lb in)

(4) Tighten bolt to a torque of.........................8 ±3 N•m ....(71 ± 26.5 lb in)

(5) Tighten bolts to a torque of ....5.7 ± 1.1 N•m
....(50 ± 10 lb in)

(6) Tighten screw to a torque of ....2.9 ± 1.0 N•m
....(26 ± 9 lb in)

(7) Commutator:
New diameter...............................54.0 mm (2.12 in)
Minimum diameter ....51.9 mm (2.04 in)
Minimum mica depth ....0.64 mm (0.025 in)
Maximum total indicator runout..0.13 mm (0.005 in)

(8) Pinion clearance ....9.1 ± 0.8 mm (0.36 ±0.03 in)

(9) Brush:
New length...................................23.0 mm (0.91 in)
Minimum length...............................10 mm (0.39 in)

(10) Laminated core maximum total indicator runout ......
....0.13 mm (0.005 in)

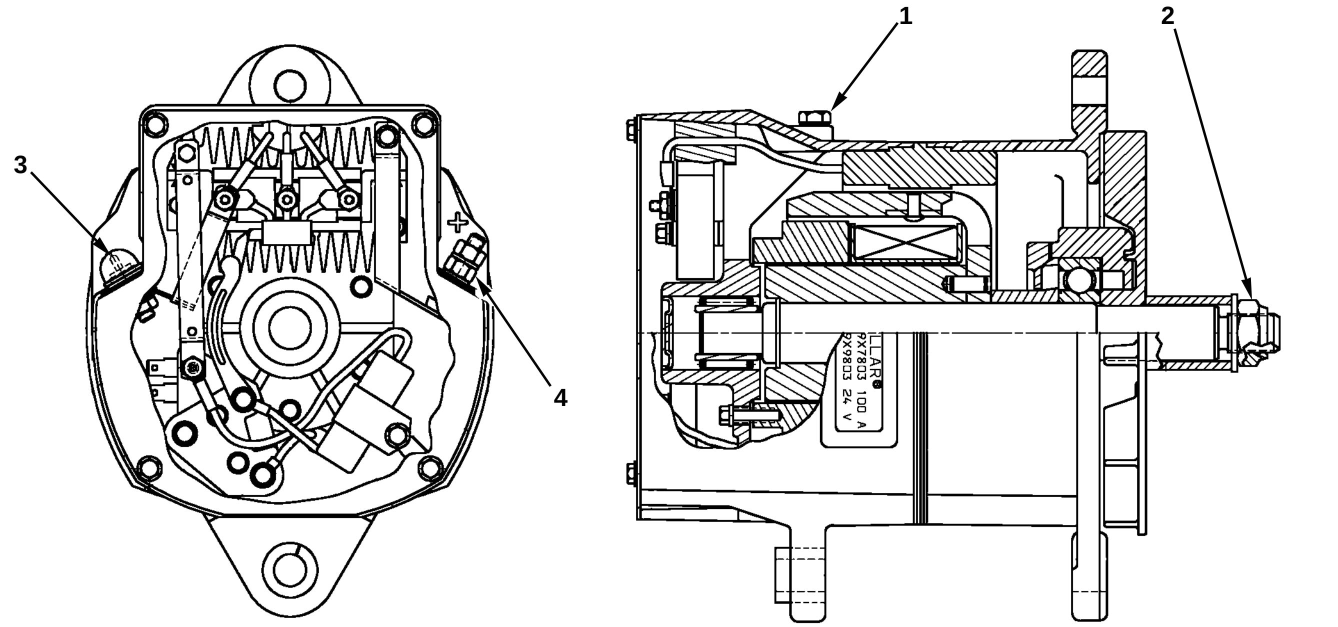
(11) Tighten screws to a torque of ....20.3 ± 2.3 N•m
....(180 ± 20 lb in)

NOTE: Apply 9S-3263 Thread Lock to the threads before installation.

(12) Tighten bolts to a torque of ....18.9 ± 2.6 N•m
....(167 ± 23 lb in)

(13) Tighten bolts to a torque of ....23.7 ± 6.1 N•m
....(210 ± 54 lb in)

Alternator



General

Voltage rating ....24 V

Polarity ....negative ground

Rotation...either direction

Maximum turn-on speed.................................2000 rpm

Output voltage ....27.5 ± 1.0 V

Minimum full-load current at 5000 rpm ....94 A

Minimum full-load current at 2000 rpm......................9 A

Regulator

Voltage setting ....no adjustment

Permissible voltage range ....26.5 to 28.5 V

Torque

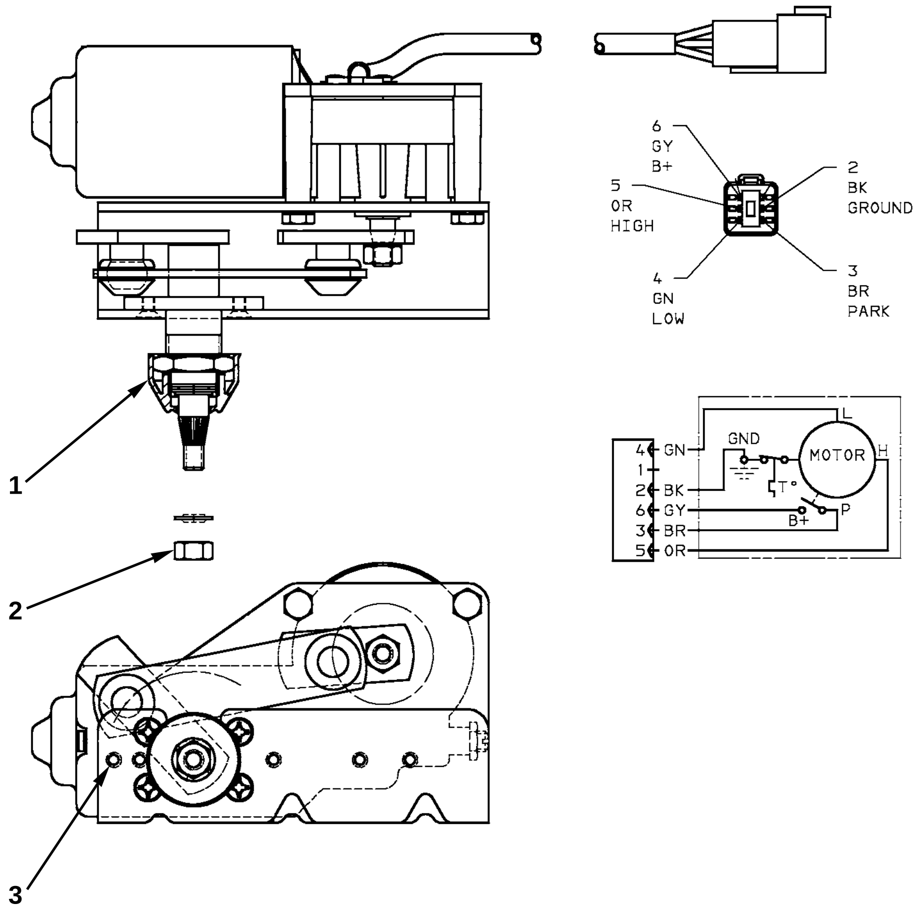
(1) Tighten bolt to a torque of.................6.2 ± 0.6 N•m ....(55 ± 5.5 lb in)

(2) Tighten nut to a torque of....................102 ± 7 N•m ....(75 ± 5 lb ft)

(3) B-terminal is AC tap from stator.

(4) Tighten nut on B+ Terminal to a torque of ....7.1 ± 0.8 N•m ....(63 ± 7 lb in)

Wiper Motor Assembly



(1) Tighten nut to a torque of......................19 ± 1 N•m
....(168 ± 9 lb in)

(2) Tighten wiper nut to a torque of ....23 ± 1 N•m
....(203.5 ± 9 lb in)

NOTE: After a minimum of 30 minutes (maximum of four hours) of use, torque the wiper nut to 23 ± 1 N•m (203.5 ± 9 lb in).

(3) Tighten mounting hardware to a torque of...............
....6 ± 1 N•m (53 ± 9 lb in)

Systems Operation

Introduction

The 24-volt electrical system can be divided into several different circuits.

The power distribution circuit distributes power to all the electrical components on the machine.

The start, charge, and stop circuit starts and stops the engine. The start-aid function, which is part of this circuit, controls the engine heaters and the ether delivery.

The lamp test circuit checks the indicator lamps when the start switch is held in the START position.

The operating pressure and temperature circuit monitors temperature and pressure in various machine and engine systems.

The winch control circuit controls operation of the winch.

The self-deploy/earthmoving circuit controls the machine's mode of operation.

The kneeling circuit allows the front of the machine to be raised and lowered for air transport.

The remote throttle circuit operates the engine at a constant rpm to allow use of remote hydraulic tools.

The lighting circuit controls the machine lights as well as the operation of some machine condition monitoring indicators.

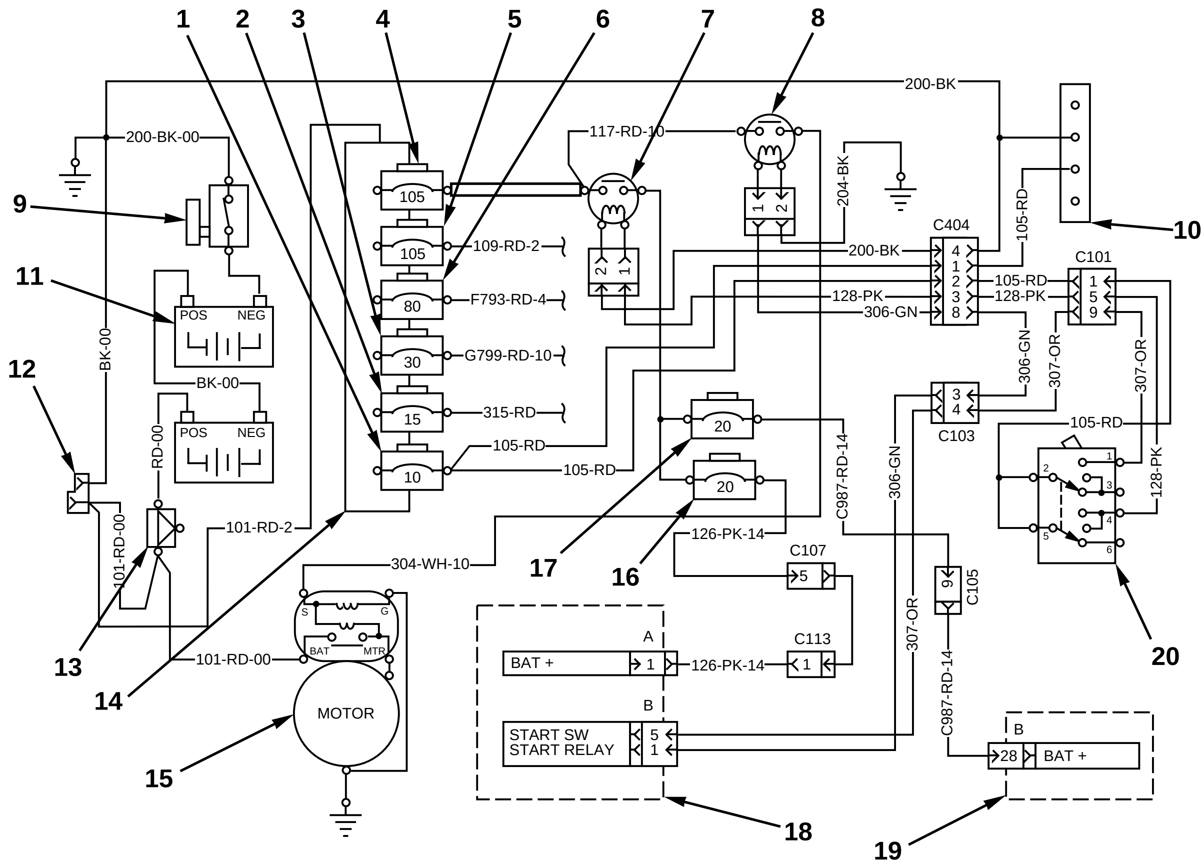
The gauges and auxiliary circuit controls operation of the gauges, machine horns, and track tension charge system.

The blower, air conditioning, and washer and wiper circuit controls the operation of the air conditioning and the windshield washer and wiper.

The transmission control circuit electronically controls the transmission and continuously monitors machine conditions.

The electronic control module (ECM) circuit controls the 3126 hydraulic electronic unit injector (HEUI) engine by monitoring inputs from engine and machine components.

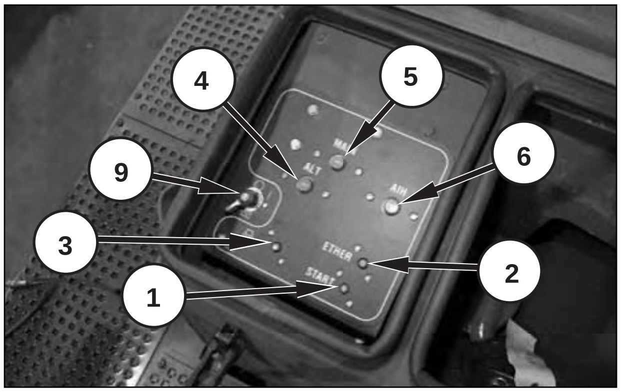
Power Distribution Circuit



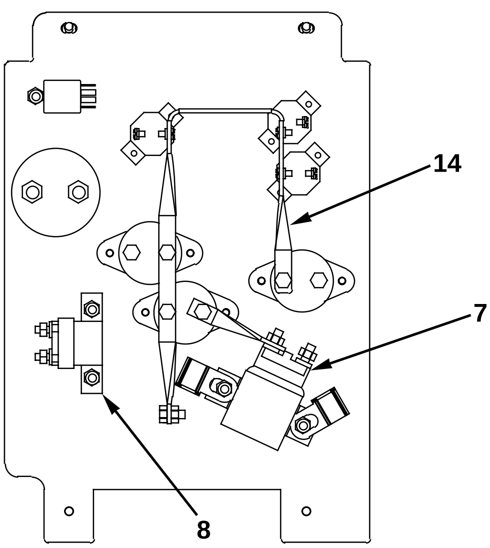
Power Distribution Circuit, Major Components.
(1) Start switch circuit breaker. (2) Start-aid circuit breaker. (3) Engine coolant heater circuit breaker. (4) Main power circuit breaker. (5) Alternator circuit breaker. (6) Intake air heater circuit breaker. (7) Main power relay. (8) Start relay. (9) Main disconnect switch. (10) SINCGARS power strip. (11) Batteries. (12) Auxiliary start receptacle. (13) Power buss bar. (14) Power buss bar. (15) Starter. (16) EPTC II circuit breaker. (17) ECM circuit breaker. (18) EPTC II. (19) ECM. (20) Start switch.

The power distribution circuit supplies 24-volt DC power, which operates all the electrical components on the machine. The main components of the circuit are: start switch circuit breaker (1), start-aid circuit breaker (2), engine coolant heater circuit breaker (3), main power circuit breaker (4), alternator circuit breaker (5), intake air heater circuit breaker (6), main power relay (7), start relay (8), main disconnect switch (9), single channel ground airborne radio system (SINCGARS) power strip (10), batteries (11), auxiliary start receptacle (12), power buss bar (13), power buss bar (14), starter (15), electronic programmable transmission control (EPTC II) circuit breaker (16), electronic control module (ECM) circuit breaker (17), EPTC II (18), ECM (19), start switch (20).

Component Location



Circuit Breaker Panel, Rear of Machine, Far Left Compartment.
(1) Start switch circuit breaker. (2) Start-aid circuit breaker. (3) Engine coolant heater circuit breaker. (4) Alternator circuit breaker. (5) Main power circuit breaker. (6) Intake air heater circuit breaker. (9) Main disconnect switch.

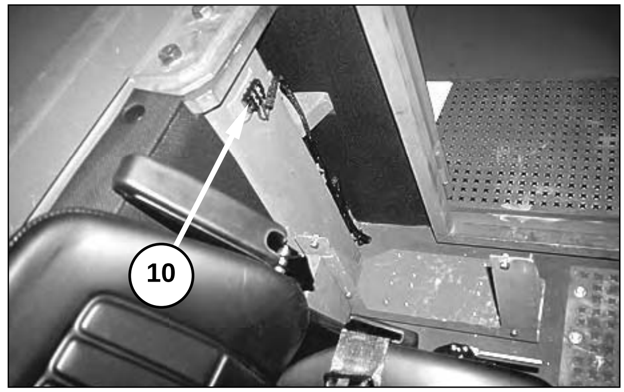


View of Rear Circuit Breaker Panel.
(7) Main power relay. (8) Start relay. (14) Power buss bar.

Main disconnect switch (9) and various circuit breakers are inside the left compartment on the top deck at the rear of the machine. The amp ratings of the circuit breakers are as follows:

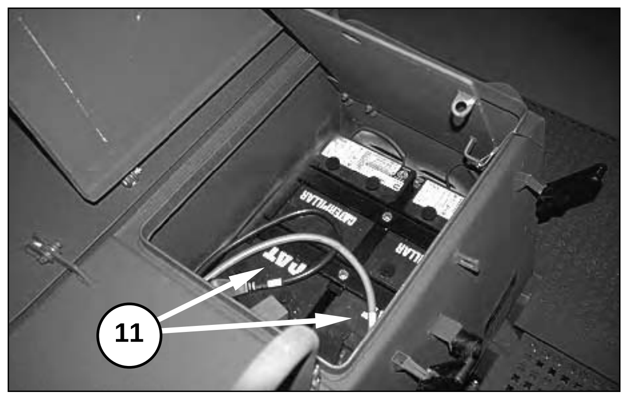
(1) Start switch - 10 amps
(2) Start-aid - 15 amps
(3) Engine coolant heater - 30 amps
(4) Main power - 105 amps
(5) Alternator - 105 amps
(6) Intake air heater - 80 amps

Power buss bar (14), main power relay (7), and start relay (8) are mounted on the inside of the rear circuit breaker panel. The power buss bar distributes power to the circuit breakers in the panel. The main power and start relays are normally open.



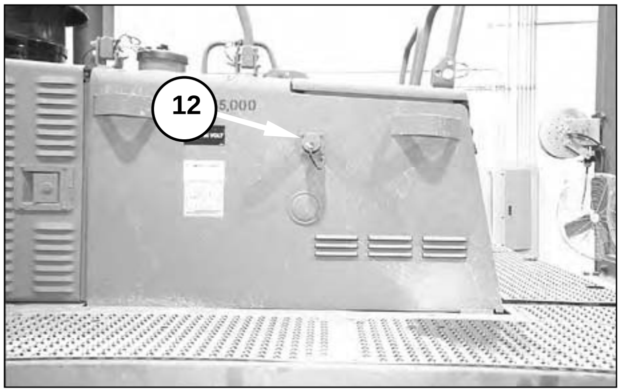
Left Rear Corner of Cab.
(10) SINCGARS power strip.

SINCGARS power strip (10) is in the left rear corner of the cab. The power strip provides power for the SINCGARS and the precision lightweight global positioning system receiver (PLGR). Power can be delivered to the strip from an external source, through the auxiliary start receptacle.



Rear of Machine, Top Deck, Far Right Compartment.
(11) Batteries.

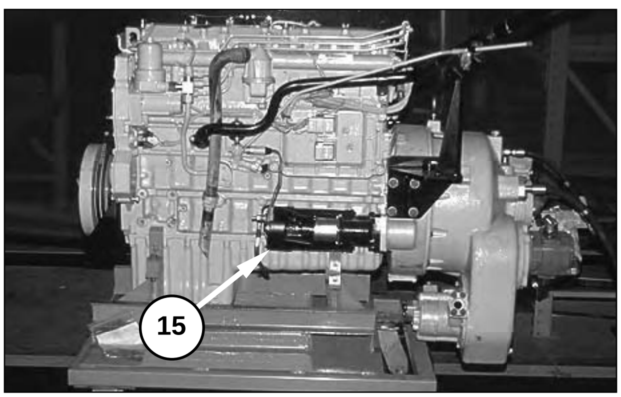
Two 12-volt batteries (11), connected in series, provide power to start the machine. The batteries are inside the right compartment on the top deck, at the rear of the machine.



Rear of Machine, Right of Center.
(12) Auxiliary start receptacle.

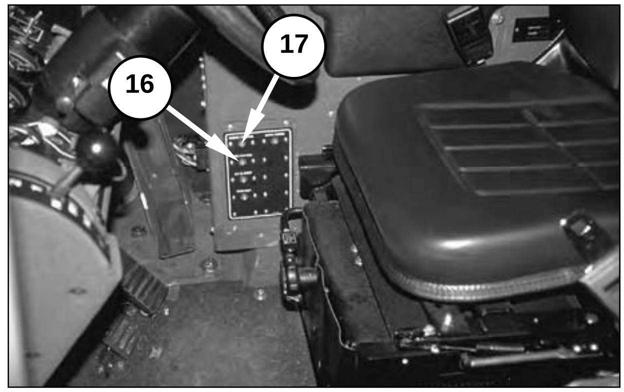
Auxiliary start receptacle (12) allows the machine to be jump started from ground level (without connecting cables to the batteries). The receptacle is towards the rear of the machine, on the left side. The SINCGARS power strip can be powered through the receptacle.

NOTE: Auxiliary start receptacle (12) is also called the North Atlantic Treaty Organization (NATO) slave receptacle.



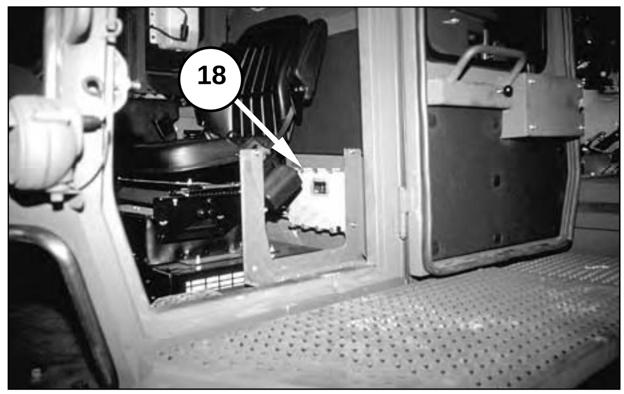
Left Side of Engine, Engine Removed From Machine.
(15) Starter.

Starter (15) is on the left side of the engine. The starter rotates in a clockwise direction (as viewed from the pinion gear end).



Console to Right of Operator's Seat.
(16) EPTC II circuit breaker. (17) ECM circuit breaker.

EPTC II circuit breaker (16) and ECM circuit breaker (17) are in the console panel to the right of the operator's seat. Both of these circuit breakers are rated at 20 amps.

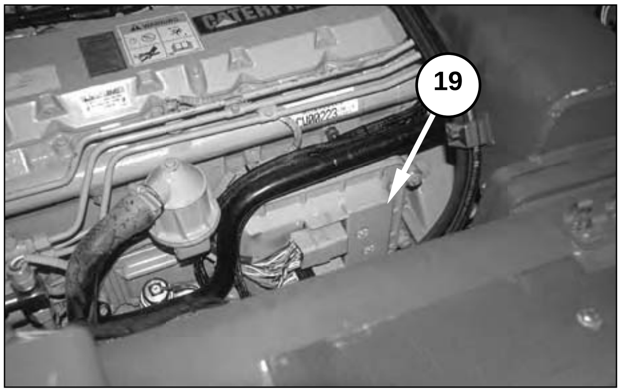


Left Side of Operator's Station.
(18) EPTC II.

EPTC II (18) is on the back wall, inside the cab, to the left of the operator's seat. The EPTC II continuously monitors the machine conditions which govern transmission shifting and other vital machine functions. The EPTC II has two harness connectors: one contains 40 input and/or output terminals, and the other contains 10.

Components around the machine monitor the machine's condition and send electrical signals to the input terminals of the EPTC II. The EPTC II compares the input with information stored in its memory and then generates a response to match current machine conditions. This response is sent through the output terminals of the EPTC II, in the form of an electrical signal, to the corresponding component.

Terminal A-1 of the EPTC II receives power from the EPTC II circuit breaker.



Left Side of Engine.
(19) ECM.

ECM (19) is on the left side of the engine. The ECM electronically controls the engine by continuously monitoring the engine conditions. The ECM has two 40-pin harness connectors.

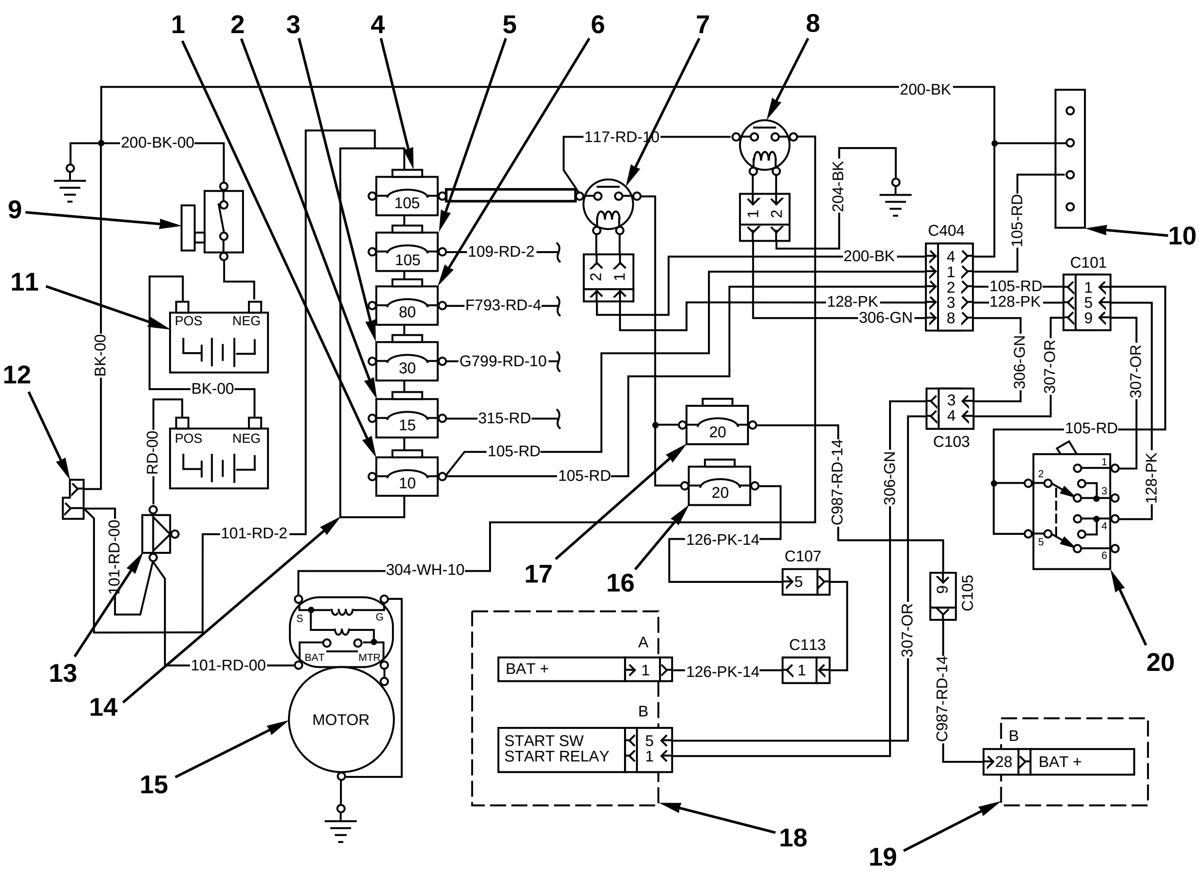
Components around the engine monitor the condition of the engine and send electrical signals to the input terminals of the ECM. The ECM compares the input information with information stored in the system's memory and then generates the proper output response to match the current engine conditions. After deciding on the necessary output, an electrical signal is sent through the output terminals of the ECM to the corresponding component.

Terminal B-28 of the ECM receives power from the ECM circuit breaker.

Instrument Panel.
(20) Start switch.

Start switch (20) is at the bottom left corner of the instrument panel. The start switch has three positions: OFF, ON, and START.

Circuit Operation



Power Distribution Circuit, Major Components.
(1) Start switch circuit breaker. (2) Start-aid circuit breaker. (3) Engine coolant heater circuit breaker. (4) Main power circuit breaker. (5) Alternator circuit breaker. (6) Intake air heater circuit breaker. (7) Main power relay. (8) Start relay. (9) Main disconnect switch. (10) SINCGARS power strip. (11) Batteries. (12) Auxiliary start receptacle. (13) Power buss bar. (14) Power buss bar. (15) Starter. (16) EPTC II circuit breaker. (17) ECM circuit breaker. (18) EPTC II. (19) ECM. (20) Start switch.

In the ON position, main disconnect switch (9) connects the negative side of batteries (11) to the frame ground.

When the negative side of the batteries is connected to ground, system voltage is available at power buss bar (13), power buss bar (14), and the battery terminal of starter (15). Power buss bar (14) distributes power to main power circuit breaker (4), alternator circuit breaker (5), intake air heater circuit breaker (6), engine coolant heater circuit breaker (3), start-aid circuit breaker (2), and start switch circuit breaker (1).

If main power circuit breaker (4) is closed (not tripped), power is available to main power relay (7) and start relay (8). If start switch circuit breaker (1) is closed, power is available to contacts 2 and 5 of start switch (20).

In the ON position, start switch (20) conducts current from contact 5 to contact 4 of the start switch and to the coil of main power relay (7). The coil in the main power relay energizes, and the relay closes.

Current at main power circuit breaker (4) flows across main power relay (7) to ECM circuit breaker (17) and EPTC II circuit breaker (16). If the ECM circuit breaker is closed, current flows to terminal B-28 of ECM (19), providing power to the ECM.

If EPTC II circuit breaker (16) is closed, current flows to terminal A-1 of EPTC II (18), providing power to the EPTC II.

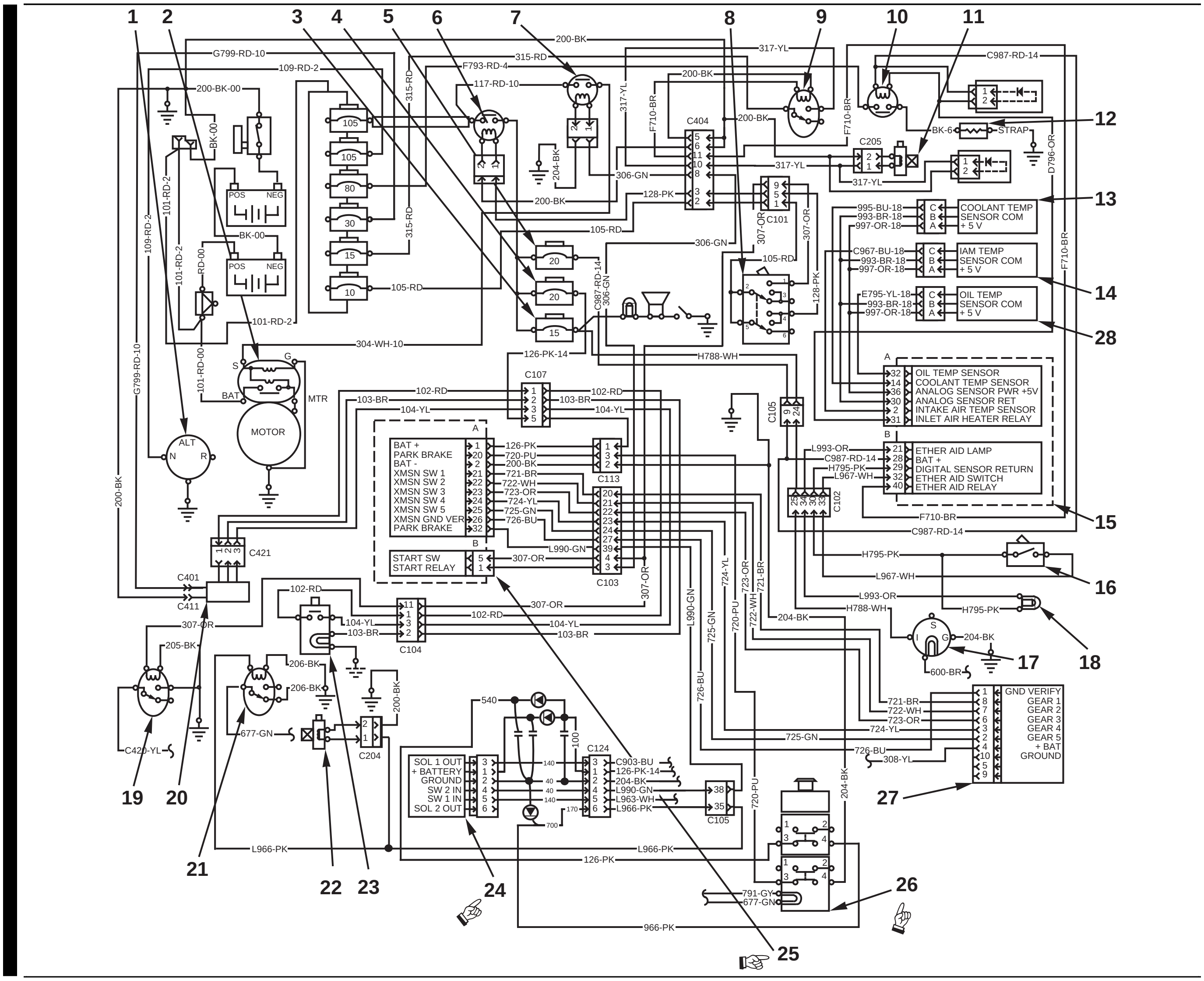
If start switch circuit breaker (1) is open (tripped), power is not available at contacts 2 and 5 of start switch (20). Therefore, in the ON position the start switch will not energize the coil in main power relay (7), and power will not reach ECM (19) or EPTC II (18).

If main power circuit breaker (4) is open, power is not available at main power relay (7) or start relay (8). In the ON position, start switch (20) will energize the main power relay coil and engage the relay. However, no power will reach ECM circuit breaker (17) or EPTC II circuit breaker (16).

Auxiliary start receptacle (12) allows the machine to be started with an outside power source. When the receptacle is in use, voltage from the outside power source is available at power buss bar (13). Power buss bar (13) distributes power to power buss bar (14) and to the battery terminal of starter (15).

When power is delivered to the machine through auxiliary start receptacle (12), the machine can be started and/or SINCGARS power strip (10) can be powered, regardless of the condition of batteries (11).

Start, Charge, and Stop Circuit



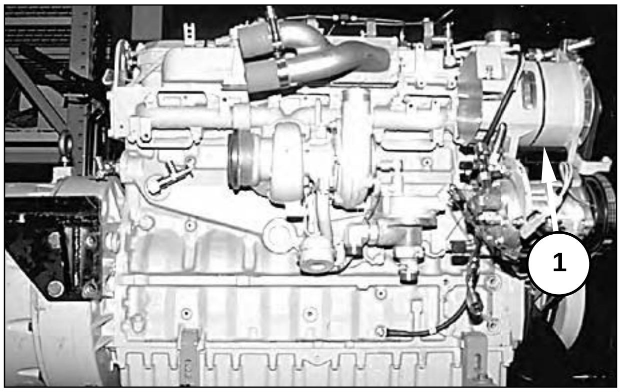
Start, Charge, and Stop Circuit Major Components.
(1) Alternator. (2) Starter. (3) Auxiliary circuit breaker. (4) EPTC II circuit breaker. (5) ECM circuit breaker. (6) Main power relay. (7) Start relay. (8) Start switch. (9) Start-aid relay. (10) Intake air heater relay. (11) Start-aid solenoid. (12) Intake air heater. (13) Coolant temperature sensor. (14) Intake air temperature sensor. (15) ECM. (16) Start-aid switch. (17) Voltmeter. (18) Start-aid lamp. (19) Lamp test relay. (20) Engine coolant heater. (21) Park brake relay. (22) Park brake solenoid. (23) Engine coolant heater switch. (24) Number-2 solenoid driver. (25) EPTC II. (26) Park brake switch. (27) Transmission gear switch. (28) Engine oil temperature sensor.

In the start, charge, and stop circuit, the EPTC II and the ECM control the conditions under which the engine will start and stop by monitoring input signals from and sending output signals to the circuit's other components. During cold weather starting, the ECM controls the intake air heater, determines if ether is injected after activation of the start-aid switch, low-idle engine speed, and engine output power.

The start, charge, and stop circuit contains the alternator, which recharges the batteries while the engine is running.

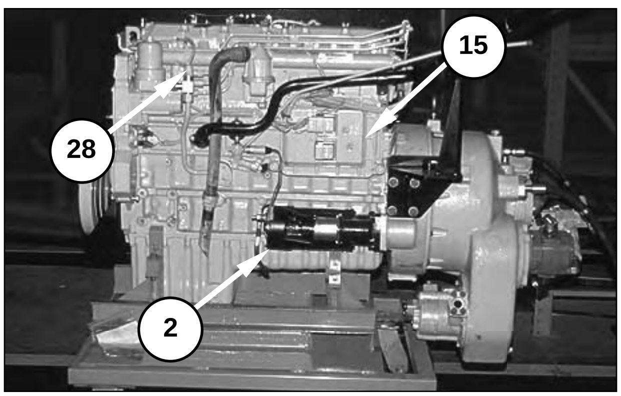
The main components of the circuit are: alternator (1), starter (2), auxiliary circuit breaker (3), EPTC II circuit breaker (4), ECM circuit breaker (5), main power relay (6), start relay (7), start switch (8), start-aid relay (9), intake air heater relay (10), start-aid solenoid (11), intake air heater (12), coolant temperature sensor (13), intake air temperature sensor (14), ECM (15), start-aid switch (16), voltmeter (17), start-aid lamp (18), lamp test relay (19), engine coolant heater (20), park brake relay (21), park brake solenoid (22), engine coolant heater switch (23), number-2 solenoid driver (24), EPTC II (25), park brake switch (26), transmission gear switch (27), and engine oil temperature sensor (28).

Component Location



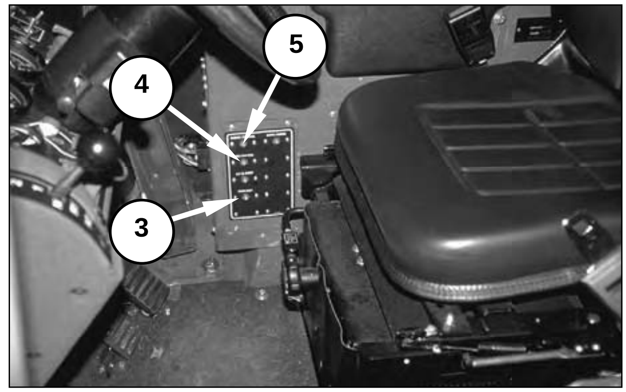
Right Side of Engine, Engine Removed from Machine.
(1) Alternator.

Alternator (1) is on the right side of the machine, directly behind the cab. The alternator charges the batteries while the engine is running.



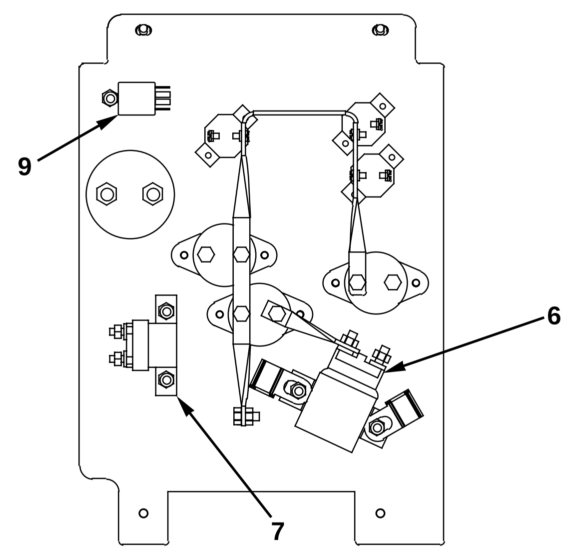
Left Side of Engine, Engine Removed from Machine.
(2) Starter. (15) ECM. (28) Engine oil temperature sensor.

Starter (2), ECM (15), and engine oil temperature sensor (28) are on the left side of the engine. System voltage turns the starter when the key switch is moved to the START position.



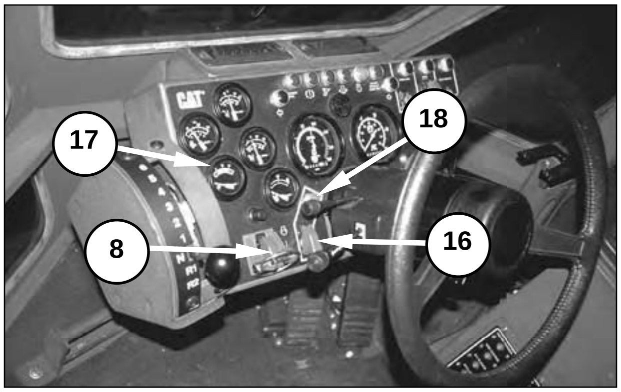
Front Circuit Breaker Panel.
(3) Auxiliary circuit breaker. (4) EPTC II circuit breaker. (5) ECM circuit breaker].

ECM circuit breaker (5), EPTC II circuit breaker (4) and auxiliary circuit breaker (3) are in the circuit breaker panel at the base of the right console. The ECM and EPTC II circuit breakers are manual reset breakers rated at 20 amps. The auxiliary circuit breaker is a manual reset breaker rated at 15 amps.



View of Rear Circuit Panel.
(6) Main power relay. (7) Start relay. (9) Start-aid relay.

Main power relay (6), start relay (7), and start-aid relay (9) are mounted to the bottom of the rear circuit panel. These relays are normally open.



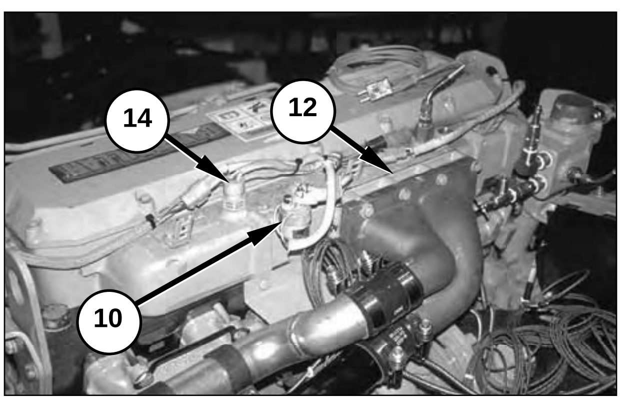
Instrument Panel.
(8) Start switch. (16) Start-aid switch. (17) Voltmeter. (18) Start-aid lamp.

Start switch (8), which is at the bottom left corner of the instrument panel, has three positions: OFF, ON, and START.

Voltmeter (17) is on the left side of the instrument panel. The voltmeter monitors the charge level of the batteries when the start switch is in the ON position and the engine is not running. When the start switch is in the ON position with the engine running, the voltmeter monitors the output from the alternator.

The ECM determines when to allow start-aid switch (16) to function by monitoring the inlet air temperature, the engine coolant temperature, the engine oil temperature, and the engine speed. If the monitored conditions do not meet the parameters stored in the ECM software, the ECM will not allow ether to be injected into the engine, regardless of the position of the start-aid switch.

Start-aid lamp (18) is above the start-aid switch. The start-aid lamp illuminates any time the intake air heater is operating and/or any time ether is being injected into the engine.

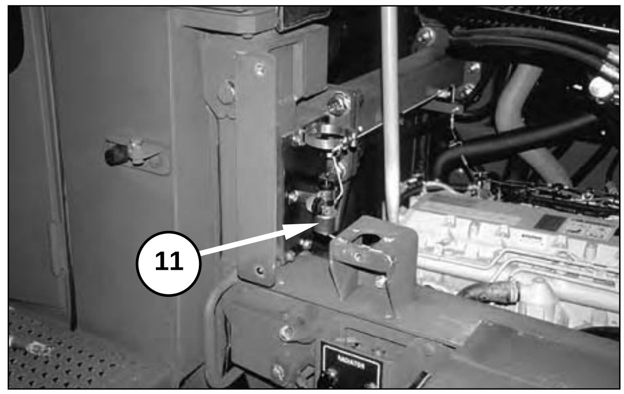


Right Side of Engine, Engine Removed from Machine.
(10) Intake air heater relay. (12) Intake air heater. (14) Intake air temperature sensor.

Intake air heater relay (10) is attached to the inlet manifold cover, on top of the engine. The ECM uses this relay to control the operation of the intake air heater. The relay is normally open.

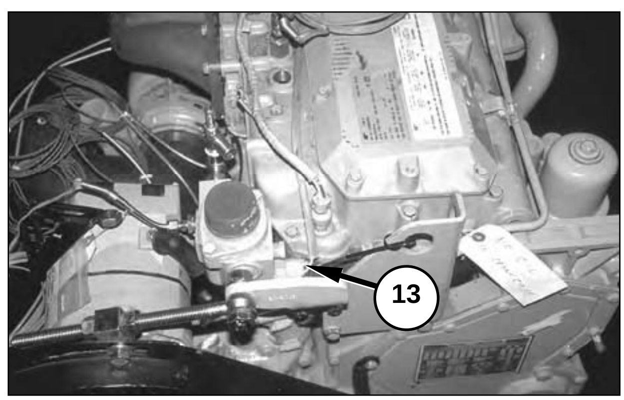
Intake air heater (12) warms the intake air to aid in machine starting and to reduce white smoke during cold weather starts. The ECM controls the operation of the intake air heater through the intake air heater relay.

Intake air temperature sensor (14) monitors the temperature of the intake air and sends temperature information to the ECM. The ECM uses this input signal to determine when to activate the intake air heater.



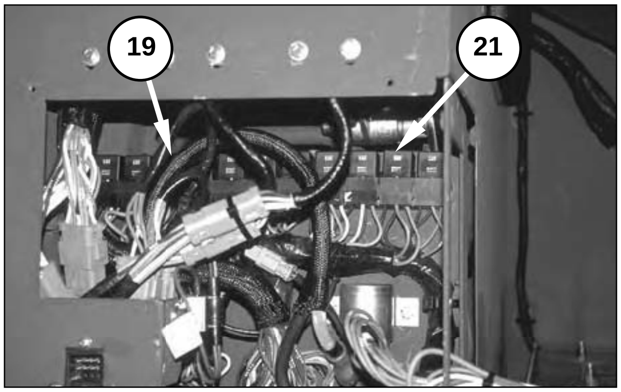
Left Side of Machine, In Front of Radiator.
(11) Start-aid solenoid.

Start-aid solenoid (11) is on the left side of the machine, in front of the radiator. The ECM energizes the start-aid relay coil and closes the relay when the conditions are right and the start-aid switch is in the ON position. When the start-aid relay is closed, the start-aid solenoid is energized and ether is injected into the engine.



Right Side of Engine.
(13) Coolant temperature sensor.

Coolant temperature sensor (13) is at the front of the engine on the right side, just behind the cab. The coolant temperature sensor monitors the temperature of the engine coolant and sends the temperature information to the ECM. The ECM uses this input signal as one of the inputs to determine when to activate the intake air heater.

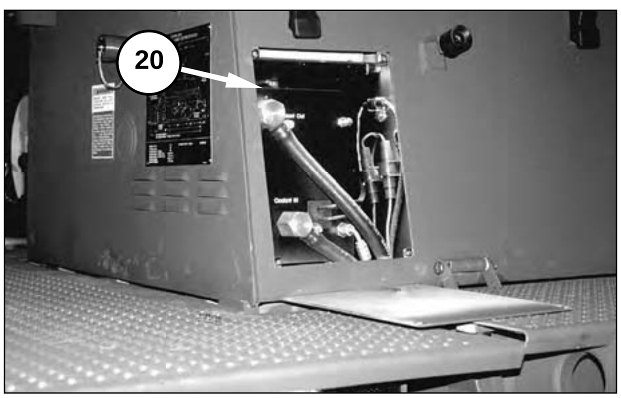


Right Console, Front View, Cover Removed.
(19) Lamp test relay. (21) Park brake relay.

Lamp test relay (19) and park brake relay (21) are inside the right console, behind the circuit breaker panel. The lamp test relay is normally open and the park brake relay is normally closed.

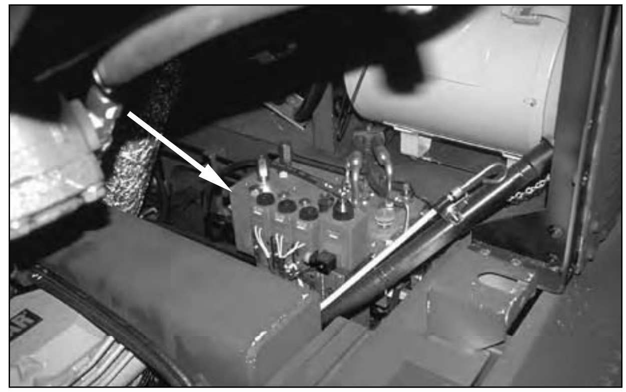
When the start switch is in the START position, the lamp test relay provides a closed circuit to sound the blade down warning horn and to illuminate ten lamps: tension fail, low brake pressure, blade down, engine oil pressure, hydraulic oil temperature, kneeling, winch enable, remote throttle, park brake, and self-deploy warning lamps.

The park brake relay controls operation of the park brake indicator lamp.

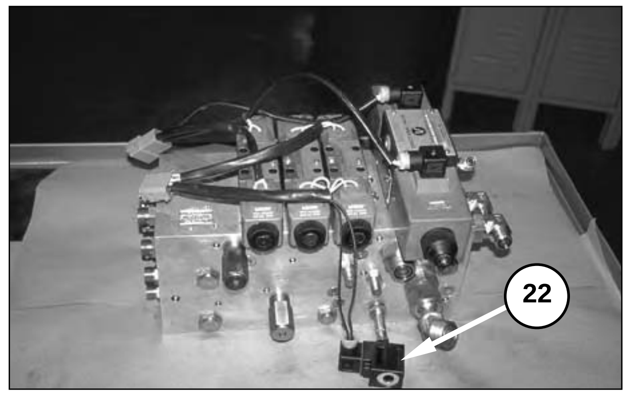


Rear of Machine, Panel Removed.
(20) Engine coolant heater.

Engine coolant heater (20) warms the engine coolant to aid with machine starting during cold weather starts. The engine coolant heater switch in the cab controls the operation of the heater.

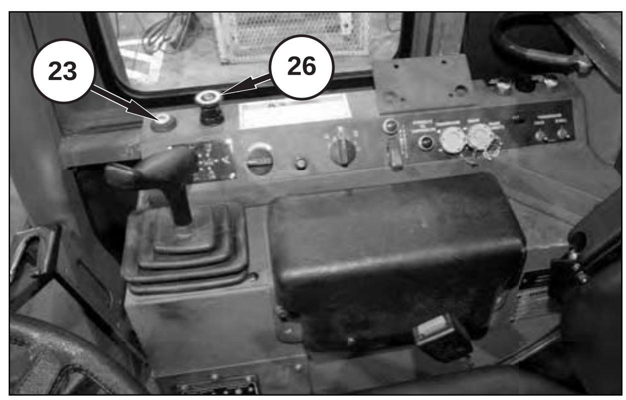


Multifunction Control Valve, Left Side of Machine.



Multifunction Control Valve, Removed From Machine.
(22) Park brake solenoid.

Park brake solenoid (22) is on the bottom face of the multifunction control valve. When the solenoid is energized, the park brake is OFF. The EPTC II controls the park brake solenoid through the number-2 solenoid driver.

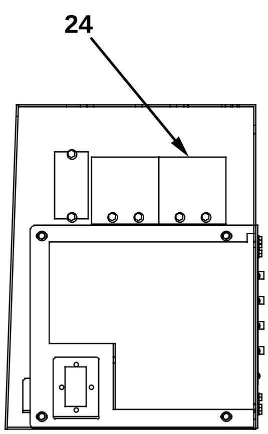


Right Console.
(23) Engine coolant heater switch. (26) Park brake switch.

Engine coolant heater switch (23) and park brake switch (26) are on the console to the right of the operator's seat. The park brake switch contains a lamp to indicate when the park brake is engaged. When the park brake switch is in the down position (RELEASED), the EPTC II receives an input from the switch and battery voltage is sent to the park brake solenoid.

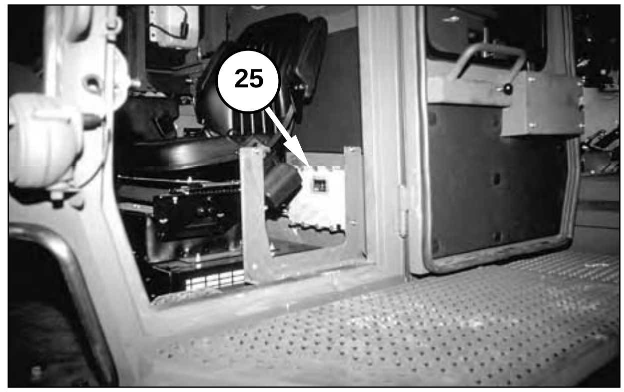
Engine coolant heater switch (23) controls the operation of the engine coolant heater. A light in the switch illuminates when the engine coolant heater is in operation.

Mounting Location (Arrows) for Number-2 Solenoid Driver–Right Console, Front View, Cover Removed.



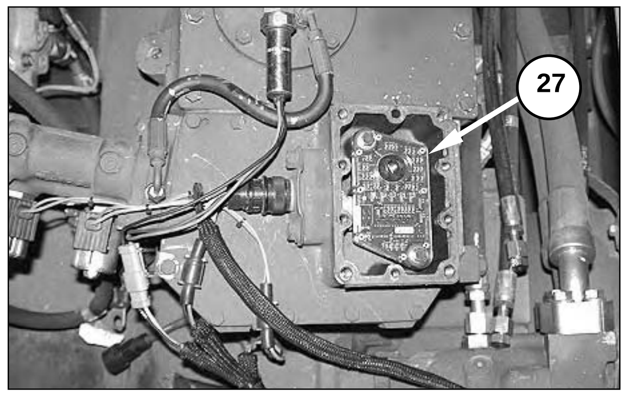
View Inside Right Console, Behind Circuit Breaker Panel.
(24) Number-2 solenoid driver.

NOTE: If the operator attempts to start the engine with the park brake OFF, the EPTC II will not engage the starter.



Left Side of Operator's Station.
(25) EPTC II.

EPTC II (25) is on the back wall, inside the cab, to the left of the operator's seat. The EPTC II continuously monitors the machine conditions which govern transmission shifting and other vital machine functions.

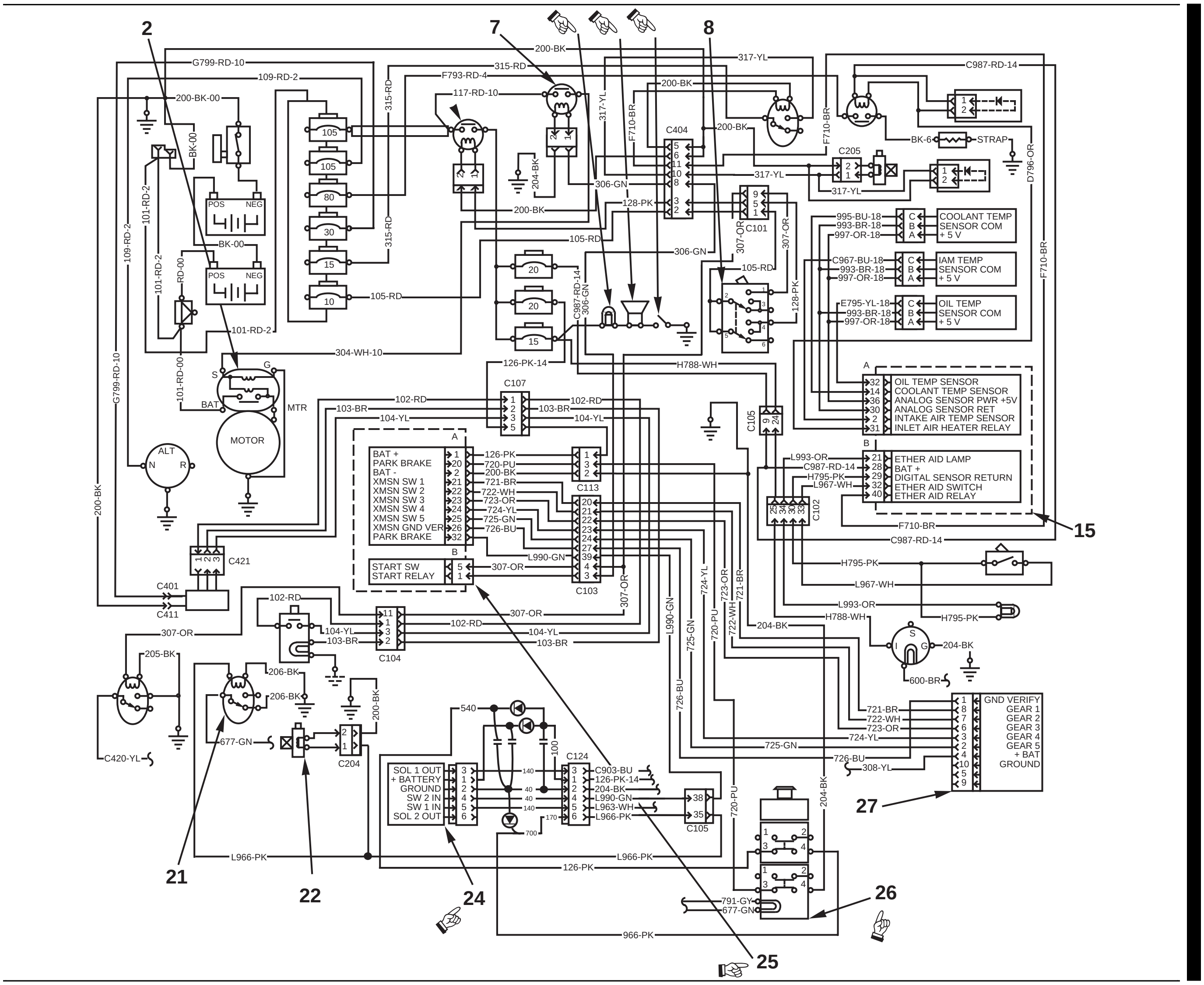


Transmission Case, Transmission Removed From Machine.
(27) Transmission gear switch.

Transmission gear switch (27) is mounted to the transmission case. The transmission gear switch input to the EPTC II tells the EPTC II which transmission gear is currently engaged.

Circuit Operation

Start



Start, Charge, and Stop Circuit—Start.
(2) Starter. (3) Auxiliary circuit breaker. (4) EPTC II circuit breaker. (5) ECM circuit breaker. (6) Main power relay. (7) Start relay. (8) Start switch. (10) Intake air heater relay. (15) ECM. (17) Voltmeter. (19) Lamp test relay. (21) Park brake relay. (24) Number-2 solenoid driver. (25) EPTC II. (26) Park brake switch. (27) Transmission gear switch.

Moving start switch (8) to the START position conducts current from contact 2 to contact 1 of the start switch and to the coil of lamp test relay (19). The coil in the lamp test relay energizes, closing the relay and illuminating the warning indicator lamps.

NOTE: For details of the lamp test function, refer to “Lamp Test Circuit” in the “Systems Operation” section of this module.

Moving start switch (8) to the START position also conducts current across contact 5 to contact 4 of the switch and to the coil of main power relay (6). The coil in the main power relay energizes and the relay closes.

Current from the main power breaker flows across main power relay (6) to ECM circuit breaker (5), EPTC II circuit breaker (4), and auxiliary circuit breaker (3). If the ECM circuit breaker is closed, current flows to terminal B-28 of ECM (15) and to the coil in intake air heater relay (10), providing power to the ECM and the relay coil. If the auxiliary circuit breaker is closed, current flows to voltmeter (17).

If EPTC II circuit breaker (4) is closed, current flows to terminal 1 of EPTC II (25), terminal 4 of transmission gear switch (27), and terminal 1 of number-2 solenoid driver (24). This provides power to the EPTC II, transmission gear switch, and number-2 solenoid driver.

Transmission gear switch (27) transmits a ground verify signal from terminal 1 to terminal A-26 of EPTC II (25). When the transmission is in NEUTRAL, the transmission gear switch transmits a 0.5-volt signal from terminals 2 and 3 to terminals A-25 and A-24 of the EPTC II. The transmission gear switch simultaneously transmits a 5.0-volt signal from terminals 6, 7, and 8 to terminals A-21, A-22, and A-23 of the EPTC II. This confirms that the transmission is in NEUTRAL.

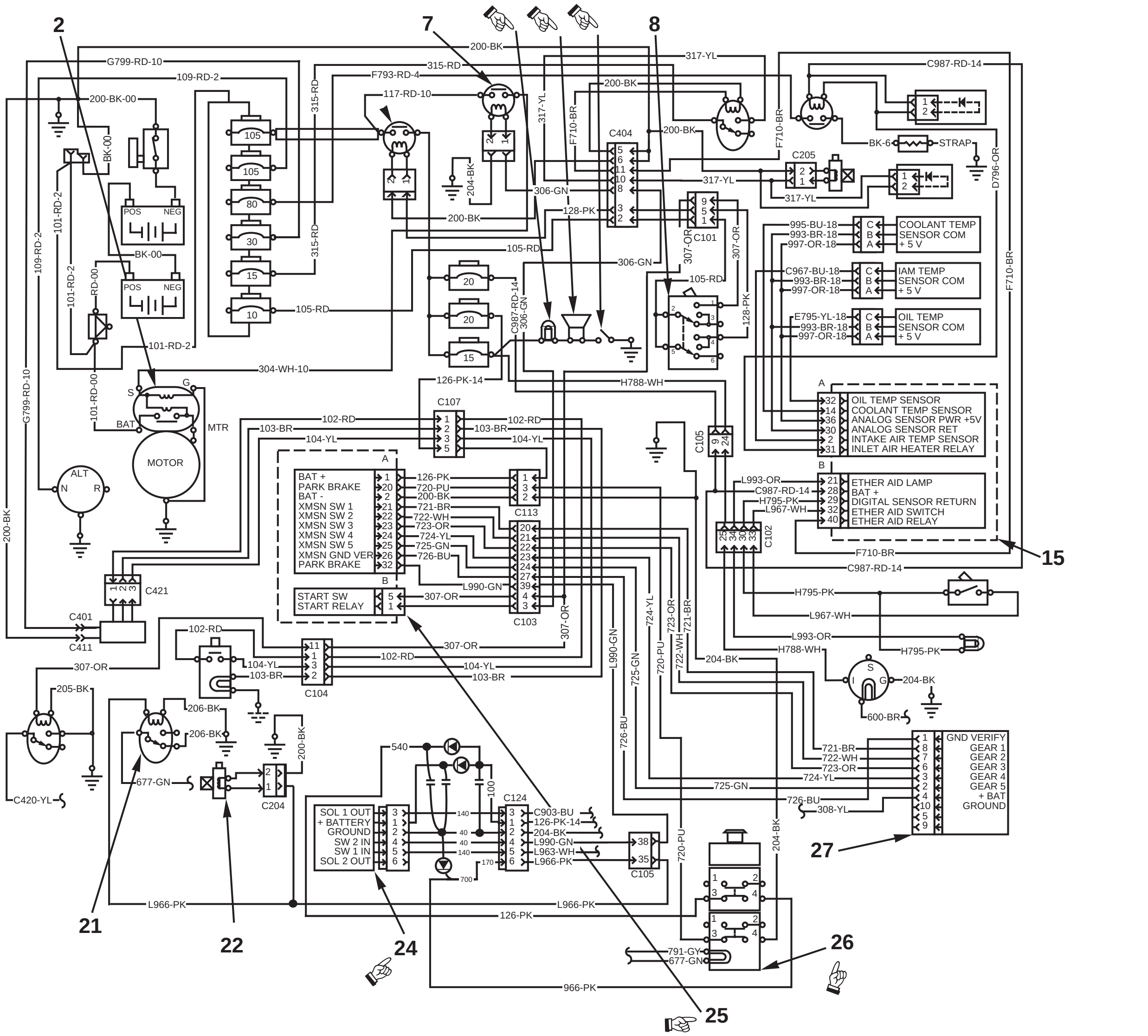
Terminal A-20 of EPTC II (25) is connected to park brake switch (26). When the park brake switch is in the ON position (up), the EPTC II does not receive a ground signal at terminal A-20. This confirms that the park brake is engaged.

After EPTC II (25) confirms that the transmission is in NEUTRAL and the park brake is engaged, the EPTC II completes the circuit from terminal B-1 to the coil of start relay (7). The coil energizes and the relay closes. Current flows across the start relay to the S-terminal of the starter coil, allowing current from the batteries, available at the battery terminal of starter (2), to crank the engine.

Engine sensors provide input which tells ECM (15) that the engine is cranking. The ECM then controls fuel delivery, and the engine starts.

NOTE: For complete description of the ECM, refer to “ECM Circuit” in the “Systems Operation” section of this module.

Neutral Start



Start, Charge, and Stop Circuit—Neutral Start.
(2) Starter. (7) Start relay. (8) Start switch. (15) ECM. (21) Park brake relay. (22) Park brake solenoid. (24) Number-2 solenoid driver. (25) EPTC II. (26) Park brake switch. (27) Transmission gear switch.

When the transmission is not in NEUTRAL, transmission gear switch (27) transmits a 5.0-volt signal from terminals 2 and 3 to terminals A-25 and A-24 of EPTC II (25). This confirms that the transmission is not in NEUTRAL. Since the transmission is not in NEUTRAL, the EPTC II will not energize the coil in start relay (7), and the machine will not start. To start the machine, the transmission control lever must be moved to the NEUTRAL position before start switch (8) is moved to the START position.

NOTE: For a complete description of transmission gear switch (27), refer to “Transmission Control Circuit” in the “Systems Operation” section of this module.

When park brake switch (26) is in the OFF position (down), and start switch (8) is in the START position (with the engine not yet running), EPTC II (25) receives a ground signal at terminal A-20 from the park brake switch. This confirms that the park brake switch is in the OFF position. Under this condition, the EPTC II does not send a signal to energize the start relay.

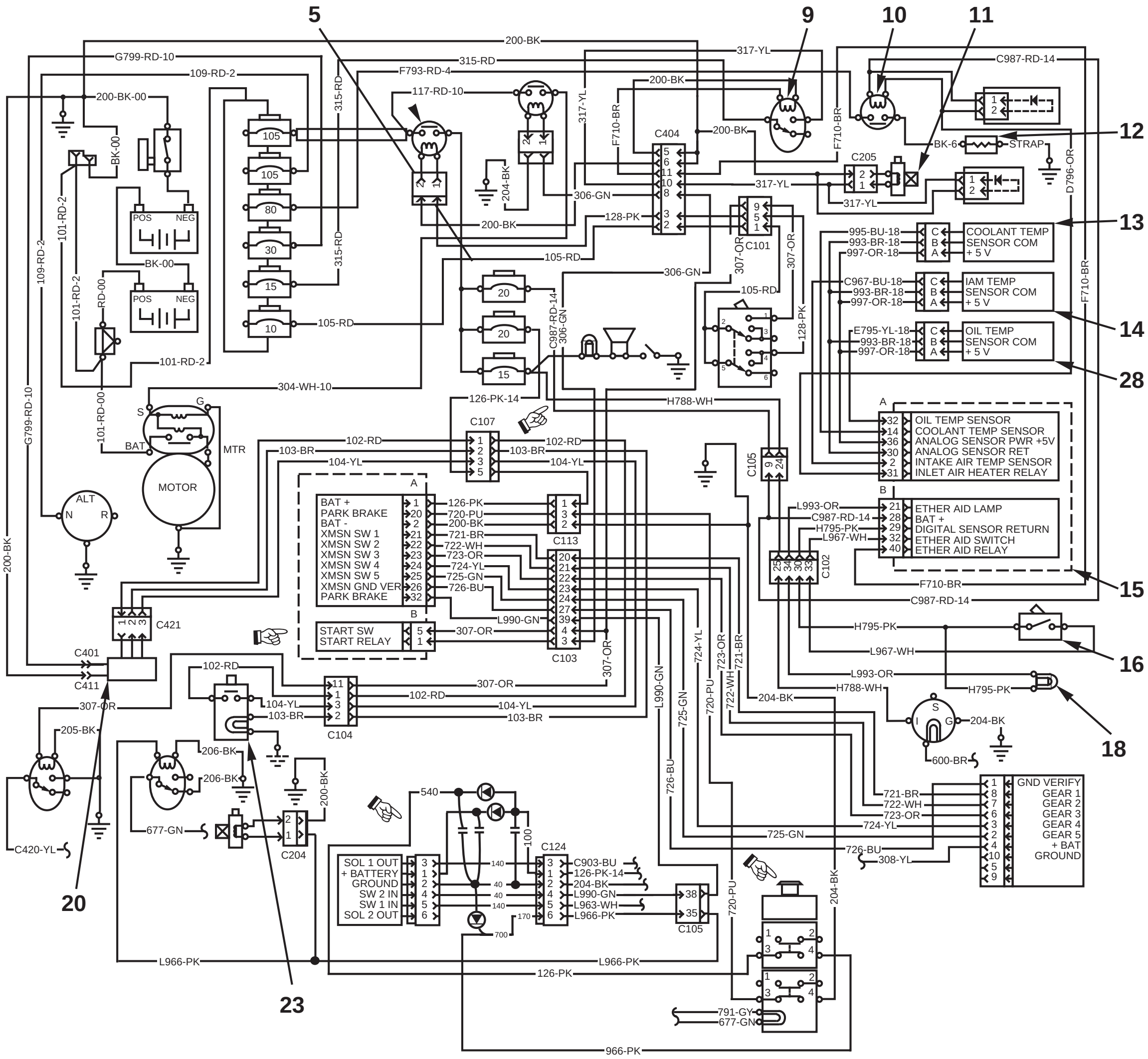
After EPTC II (25) confirms that the transmission is in NEUTRAL and the park brake is engaged, the EPTC II completes the circuit from terminal B-1 to the coil of start relay (7). The coil energizes and the relay closes. Current flows across the start relay to the S-terminal of the starter coil, allowing current from the batteries, available at the battery terminal of the starter (2), to crank the engine.

Engine sensors provide input which tells ECM (15) that the engine is cranking. The ECM then controls fuel delivery, and the engine starts.

NOTE: For a complete description of the ECM, refer to “ECM Circuit” in the “Systems Operation” section of this module.

Parking brake data “Deleted”

Start-Aid



Start, Charge, and Stop Circuit—Start-Aid.
(5) ECM circuit breaker. (9) Start-aid relay. (10) Intake air heater relay. (11) Start-aid solenoid. (12) Intake air heater. (13) Coolant temperature sensor. (14) Intake air temperature sensor. (15) ECM. (16) Start-aid switch. (18) Start-aid lamp. (20) Engine coolant heater. (23) Engine coolant heater switch. (28) Engine oil temperature sensor.

When terminal B-28 of ECM (15) receives power from ECM circuit breaker (5), terminal A-36 of the ECM transfers 5 volts of power to terminal A of intake air temperature sensor (14), terminal A of coolant temperature sensor (13), and terminal A of engine oil temperature sensor (28). Terminal B of the three sensors is the common ground line to terminal A-30 of the ECM.

Intake air temperature sensor (14) monitors the temperature of the inlet air. Terminal C of the intake air temperature sensor generates an analog voltage output signal of between 0.5005 and 4.463 volts, based on temperatures ranging from -40 to +120°C (-40 to +248°F). Terminal A-2 of ECM (15) reads the voltage signal from intake air temperature sensor (14) and converts the voltage value to a temperature value.

Coolant temperature sensor (13) monitors the temperature of the engine coolant. Terminal C of the coolant temperature sensor generates an analog voltage output signal of between 0.2 and 4.37 volts, based on temperatures ranging from -40 to +120°C (-40 to +248°F). Terminal A-14 of ECM (15) reads the voltage signal from the coolant temperature sensor and converts the voltage value to a temperature value.

Oil temperature sensor (28) monitors the temperature of the engine oil. Terminal C of the oil temperature sensor generates an analog voltage output signal based on the oil temperature. Terminal A-32 of ECM (15) reads the voltage signal from the oil temperature sensor and converts the voltage value to a temperature value.

ECM (15) monitors the inlet air temperature and the engine oil temperature to determine when to initiate cold-mode operation. During cold mode operation, the ECM increases the low idle rpm to 1000 rpm, limits the engine output power, and enables the start-aid functions.

NOTE: For more details about engine control, refer to "ECM Circuit" in the "Systems Operation" section of this module, and/or refer to *Specifications, Systems Operation, Testing and Adjusting Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine*.

To initiate the start-aid function, ECM (15) prompts two actions: First, the ECM completes a circuit from the coil in intake air heater relay (10) to terminal A-31 of the ECM. Then, the ECM sends an output signal from terminal B-21 to start-aid lamp (18), and from terminal B-32 to start-aid switch (16).

NOTE: ECM (15) will only illuminate the start-aid lamp if the blackout switch is in the SERVICE DRIVE or STOP LIGHT position. For additional details, refer to "ECM Circuit" in the "Systems Operation" section of this module.

Completing the circuit at terminal A-31 allows current from ECM circuit breaker (5) to energize the coil in intake air heater relay (10). The relay closes, and current from the intake air heater circuit breaker flows across the relay and activates intake air heater (12).

NOTE: ECM (15) activates the intake air heater and illuminates the start-aid lamp in one of the following four modes:

1. Power-up mode. Regardless of the temperature, the ECM activates intake air heater (12) and illuminates start-aid lamp (18) for two seconds after the start switch is first moved to the ON position.

2. Preheat mode. When the sum of the oil temperature and the inlet air temperature is less than the set parameter, the ECM activates the intake air heater and illuminates the start-aid lamp for 30 seconds. If the operator attempts to start the engine while in the preheat mode, the ECM returns to the cranking mode for heater control.

3. Cranking mode. When the starter is cranking the engine, the ECM will activate the intake air heater and illuminate the start-aid lamp if the sum of the oil temperature and inlet manifold temperature is less than the set parameter. The intake air heater will remain ON while the engine is being cranked. If the engine fails to start, the ECM reverts to preheat mode and will activate the heater for another 30 seconds.

4. Engine running cycle. If, after the engine has started, the sum of the oil temperature and the inlet air temperature is less than the set parameter, the heater remains activated. The engine running cycle has two segments. In the continuous segment, the heater remains ON steadily for a maximum of 10 minutes after starting.

   If, after 10 minutes, the sum of the oil temperature and the inlet air temperature remains at less than the set parameter, the ECM shifts to ON-OFF mode. In the ON-OFF mode, the heater is cycled continuously, ON for 10 seconds and OFF for 10 seconds, for a maximum of 13 minutes. After completing this cycle, the ECM turns the heater off.

NOTE: During the running cycle, ECM (15) will turn intake air heater (12) OFF any time the sum of the oil temperature and the inlet air temperature exceeds the set parameter.

The current from terminal B-21 of ECM (15) flows through to start-aid lamp (18) and to terminal B-29 of the ECM. The start-aid lamp illuminates. Terminal B-32 transmits power to enable start-aid switch (16) to function.

When power is available at start-aid switch (16), moving the switch to the ON position conducts current across the switch to terminal B-29 of ECM (15). If the start-aid switch remains in the ON position for at least half of one second, the ECM will determine if conditions are right to inject ether into the engine.

If the inlet air and the engine oil temperatures are below the set parameter, and the engine speed is less than 1000 rpm, ECM (15) completes a circuit between terminals B-40 and B-32. This circuit allows current to flow through the coil in start-aid relay (9). The coil then energizes and the relay closes.

Current available from the start-aid circuit breaker flows across start-aid relay (9) to start-aid solenoid (11).

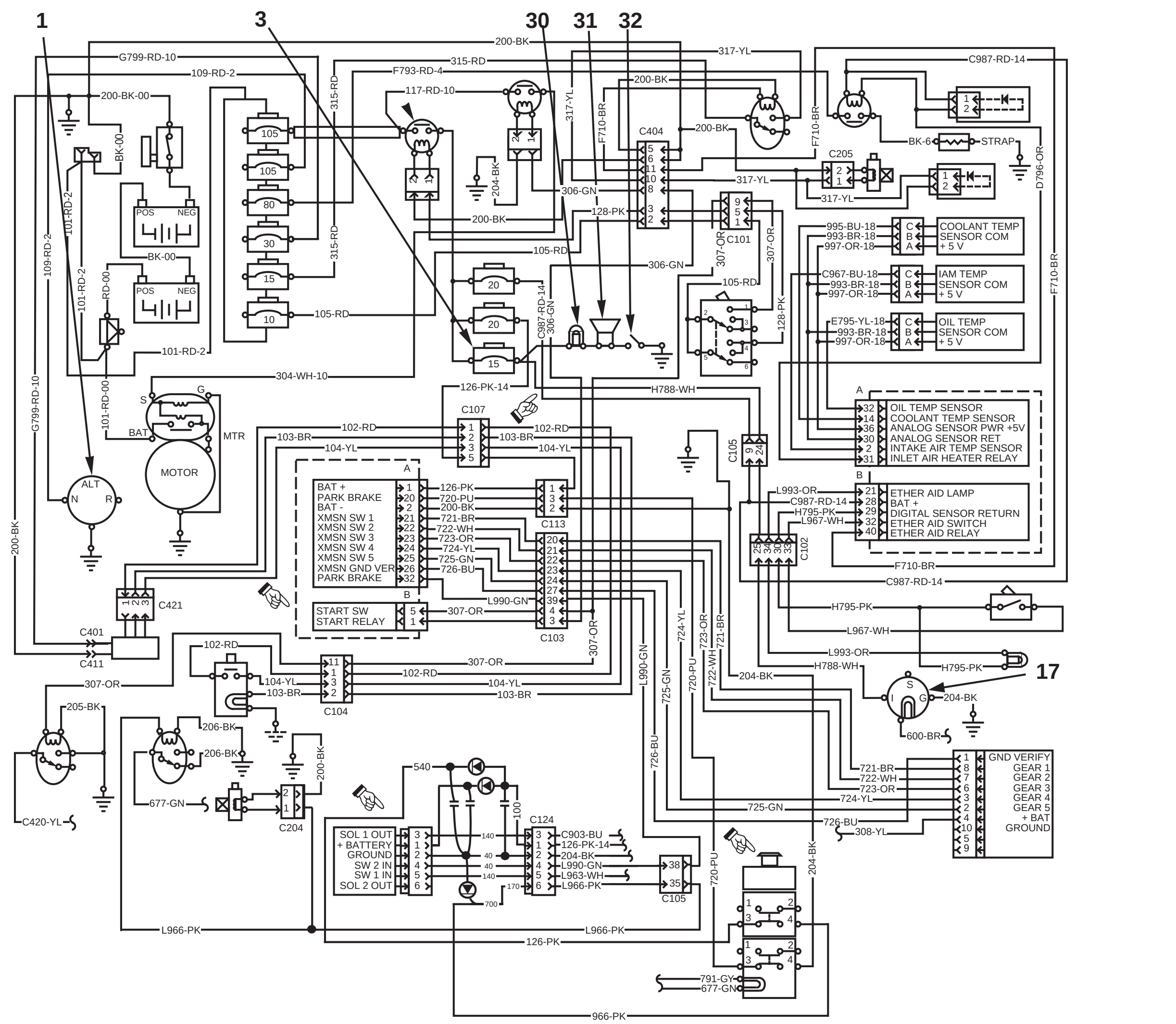
NOTE: If the injection conditions are not met, the ECM will not allow ether to be injected into the engine, regardless of the position of start-aid switch (16).

Voltage is also available at contact 1 of engine coolant heater switch (23) from the engine coolant heater circuit breaker. Closing the engine heater switch conducts current from contact 1 to contact 3 of the switch. Current from contact 3 of the switch flows to terminal 3 of engine coolant heater (20), and the heater control unit operates the heater.

The control unit of engine coolant heater (20) directs current out terminal 2 of the heater to contact 2 of engine coolant heater switch (23). Current at contact 2 of the engine coolant heater switch flows to ground through the light in the switch, illuminating the light.

NOTE: For additional information about engine coolant heater (20), refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Machine Systems.*

Charge



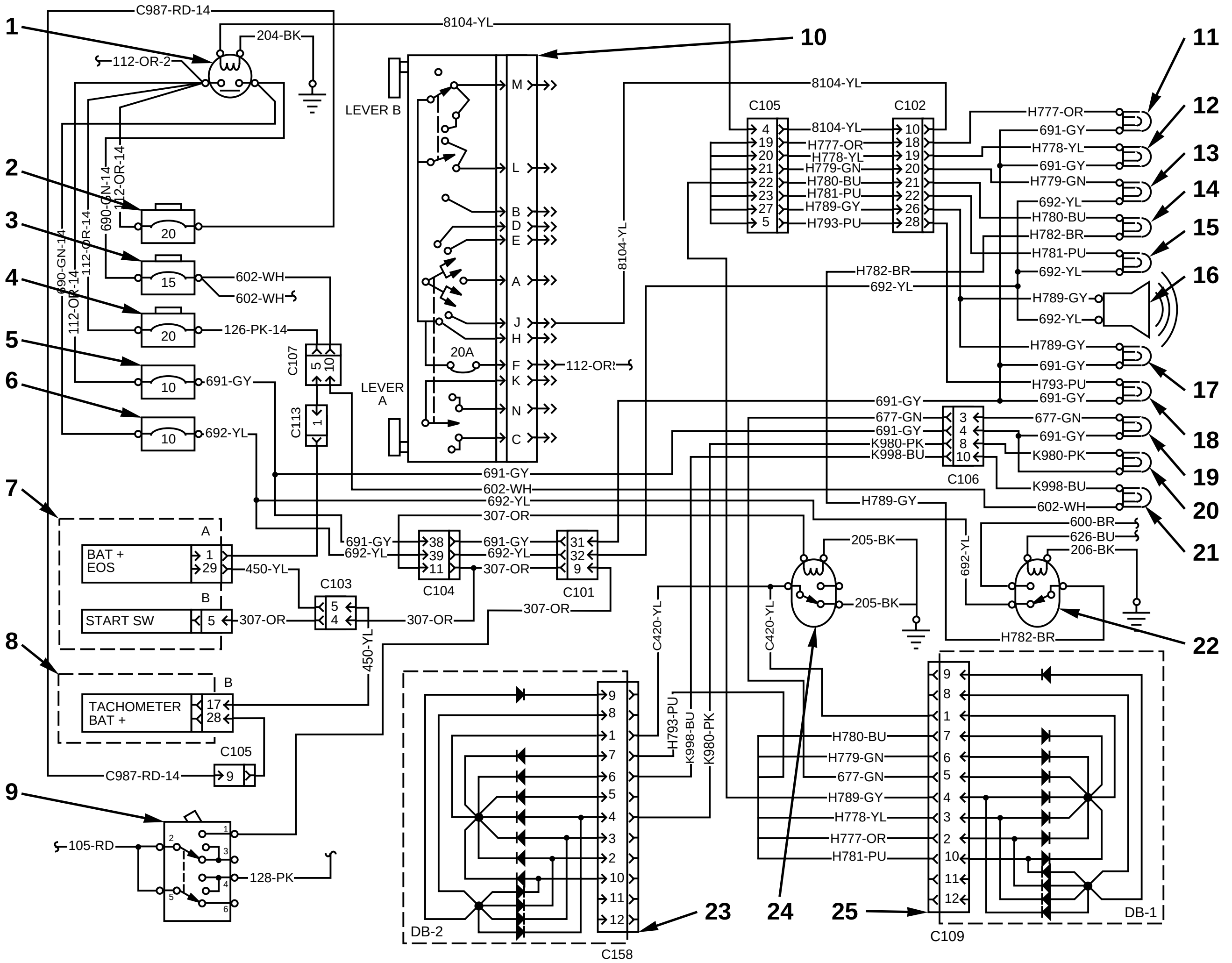
Start, Charge, and Stop Circuit—Charge.
(1) Alternator. (3) Auxiliary circuit breaker. (17) Voltmeter. (30) Light.. (31) Alarm. (32) Switch.

When the engine is running, alternator (1) generates power to recharge the batteries and run the machine's electrical components.

Voltmeter (17) monitors system voltage from auxiliary circuit breaker (3). With the auxiliary circuit breaker closed and the engine running, the needle on the voltmeter should register in the second green zone. If the needle registers below the second green zone, the alternator is not producing sufficient voltage to charge the batteries or to supply current to the electrical components. If the needle registers above the second green zone, the alternator is overcharging

NOTE: When recoil travel accuates switch (32), current from auxillary breaker (3) travels through light (30) and alarm (31) and switch (32) to ground, causing light (30) to illuminate and alarm (31) to sound.

Lamp Test Circuit

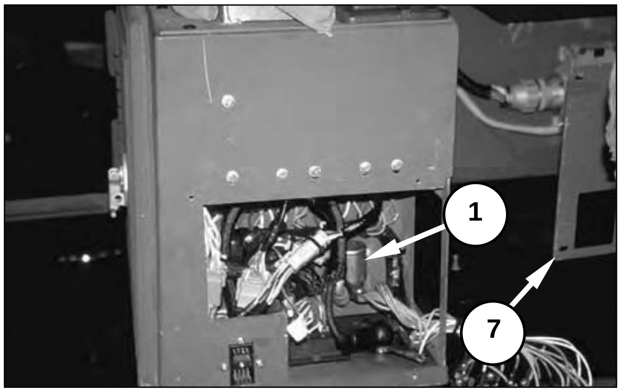


Lamp Test Circuit.
(1) Blackout relay. (2) ECM circuit breaker. (3) Horn/dome circuit breaker. (4) EPTC II circuit breaker. (5) Warning lights circuit breaker. (6) Turn/flasher circuit breaker. (7) EPTC II. (8) ECM. (9) Start switch. (10) Blackout switch. (11) Tension fail lamp. (12) Low brake pressure lamp. (13) Kneeling lamp. (14) Self-deploy lamp. (15) Winch lamp. (16) Blade down alarm. (17) Blade down lamp. (18) Engine oil pressure lamp. (19) Park brake lamp. (20) Hydraulic oil temperature lamp. (21) Remote throttle lamp. (22) Diagnostic relay. (23) Diode block. (24) Lamp test relay. (25) Diode block.

The lamp test circuit tests the operation of the blade down alarm and the warning lamps. EPTC II (7) enables the lamp test when start switch (9) is moved from OFF (or ON) to START (during engine starting), and when the start switch is held in the start position with the engine running at greater than 200 rpm.

The components of the lamp test circuit are blackout relay (1), ECM circuit breaker (2), horn/dome circuit breaker (3), EPTC II circuit breaker (4), warning lights circuit breaker (5), turn/flasher circuit breaker (6), EPTC II (7), ECM (8), start switch (9), blackout switch (10), tension fail lamp (11), low brake pressure lamp (12), kneeling lamp (13), self-deploy lamp (14), winch lamp (15), blade down alarm (16), blade down lamp (17), engine oil pressure lamp (18), park brake lamp (19), hydraulic oil temperature lamp (20), remote throttle lamp (21), diagnostic relay (22), diode block (23), lamp test relay (24), and diode block (25).

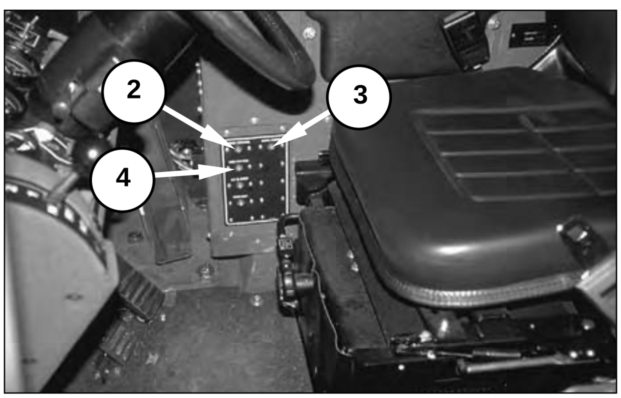
Component Location



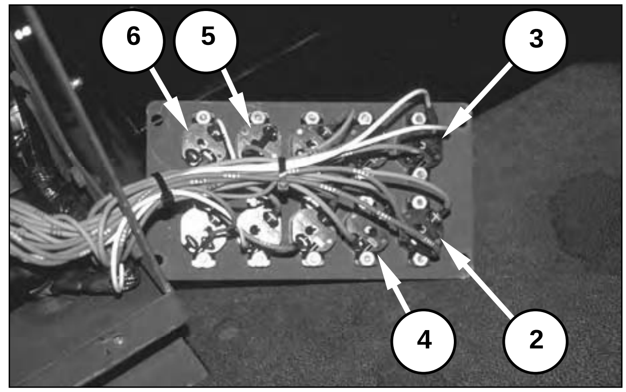
Right Console, Front View With Cover Removed.
(1) Blackout relay. (7) EPTC II.

Blackout relay (1) is located inside the console, to the right of the operator. The blackout relay is normally open. The coil of the blackout relay receives power when blackout switch (10) is in the STOP LIGHT or one of the SERVICE DRIVE positions.

EPTC II (7) is mounted on the back wall of the cab, behind the operator's seat. The EPTC II reads the engine speed and monitors the position of the start switch.



Front Circuit Breaker Panel.
(2) ECM circuit breaker. (3) Horn/dome circuit breaker.
(4) EPTC II circuit breaker.

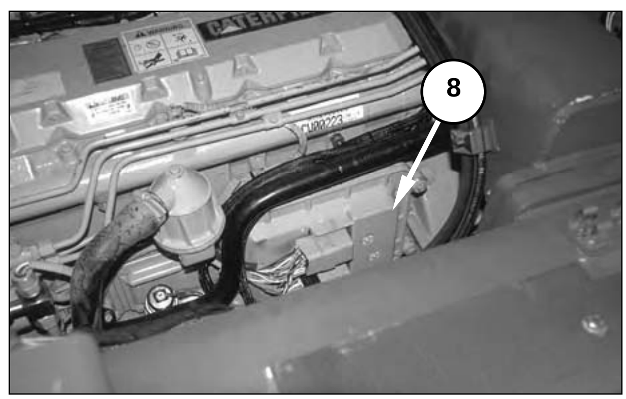


Front Circuit Breaker Panel, Back Side.
(2) ECM circuit breaker. (3) Horn/dome circuit breaker.
(4) EPTC II circuit breaker. (5) Warning lights circuit breaker.
(6) Turn/flasher circuit breaker.

The right console circuit panel contains circuit breakers. ECM circuit breaker (2) and EPTC II circuit breaker (4) are rated at 20 amps. Horn/dome circuit breaker (3) is rated at 15 amps, and warning lights circuit breaker (5) and turn/flasher circuit breaker (6) are rated at 10 amps.

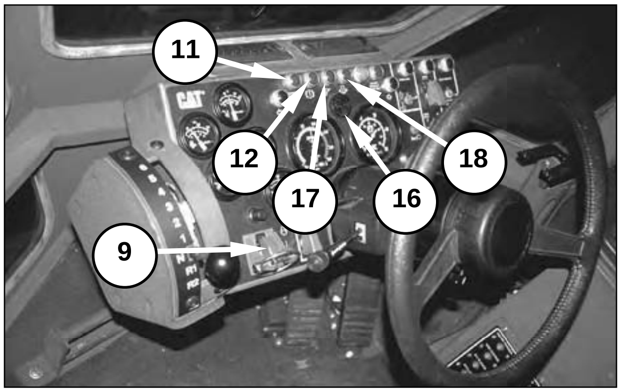
ECM circuit breaker (2), horn/dome circuit breaker (3), and EPTC II circuit breaker (4) are manual-reset breakers. Warning lights circuit breaker (5) and turn flasher circuit breaker (6) are automatic-reset breakers.

Blackout switch (10) must be in the STOP LIGHT or one of the SERVICE DRIVE positions for horn/dome circuit breaker (3) and turn/flasher circuit breaker (6) to receive power.



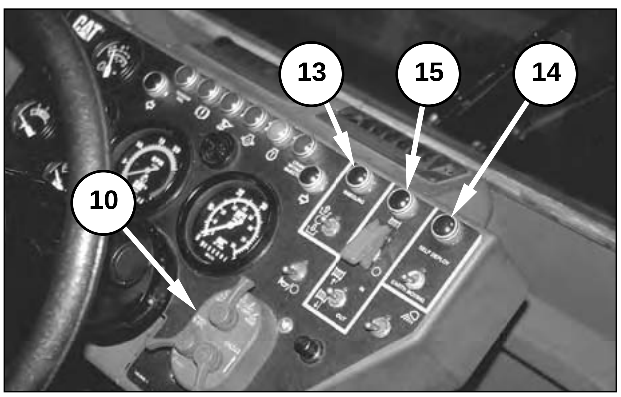
Engine, Left Side.
(8) ECM.

ECM (8) is on the left side of the engine, under the radiator. The ECM sends the engine output speed signal to EPTC II (7).



Left Side of Instrument Panel.
(9) Start switch. (11) Tension fail lamp. (12) Low brake pressure lamp. (16) Blade down alarm. (17) Blade down lamp. (18) Engine oil pressure lamp.

Start switch (9) is on the left side of the instrument panel. Tension fail lamp (11), low brake pressure lamp (12), blade down lamp (17), and engine oil pressure lamp (18) are along the top of the instrument panel. When the engine is running, if the start switch is held in the START position, the lamp test circuit is activated. During the lamp test, the indicator lamps illuminate, and blade down alarm (16) sounds.

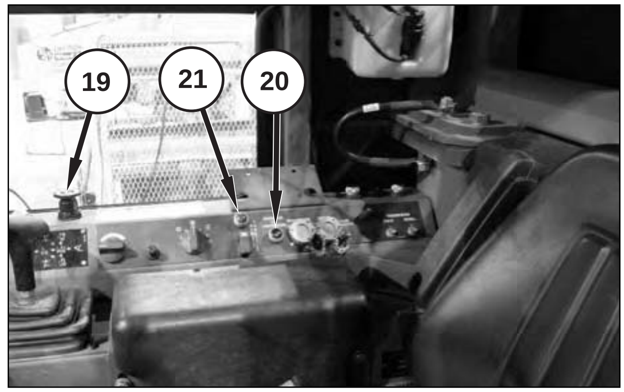


Right Side of Instrument Panel.
(10) Blackout switch. (13) Kneeling lamp. (14) Self-deploy lamp. (15) Winch lamp.

Blackout switch (10) is on the right side of the instrument panel. The blackout switch must be in the STOP LIGHT or one of the SERVICE DRIVE positions for the lamp test operation to function.

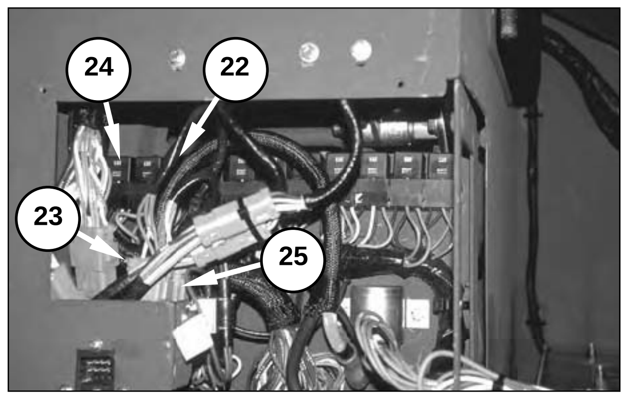
NOTE: For additional information about the positions of blackout switch (10), refer to “Systems Operation, Lighting Circuit, Component Location” in this module.

Kneeling lamp (13), self-deploy lamp (14), and winch lamp (15) illuminate during the lamp test.



Right Console.
(19) Park brake lamp. (20) Hydraulic oil temperature lamp. (21) Remote throttle lamp.

Park brake lamp (19), hydraulic oil temperature lamp (20), and remote throttle lamp (21) are on the console to the right of the operator’s seat. These lamps illuminate during the lamp test.

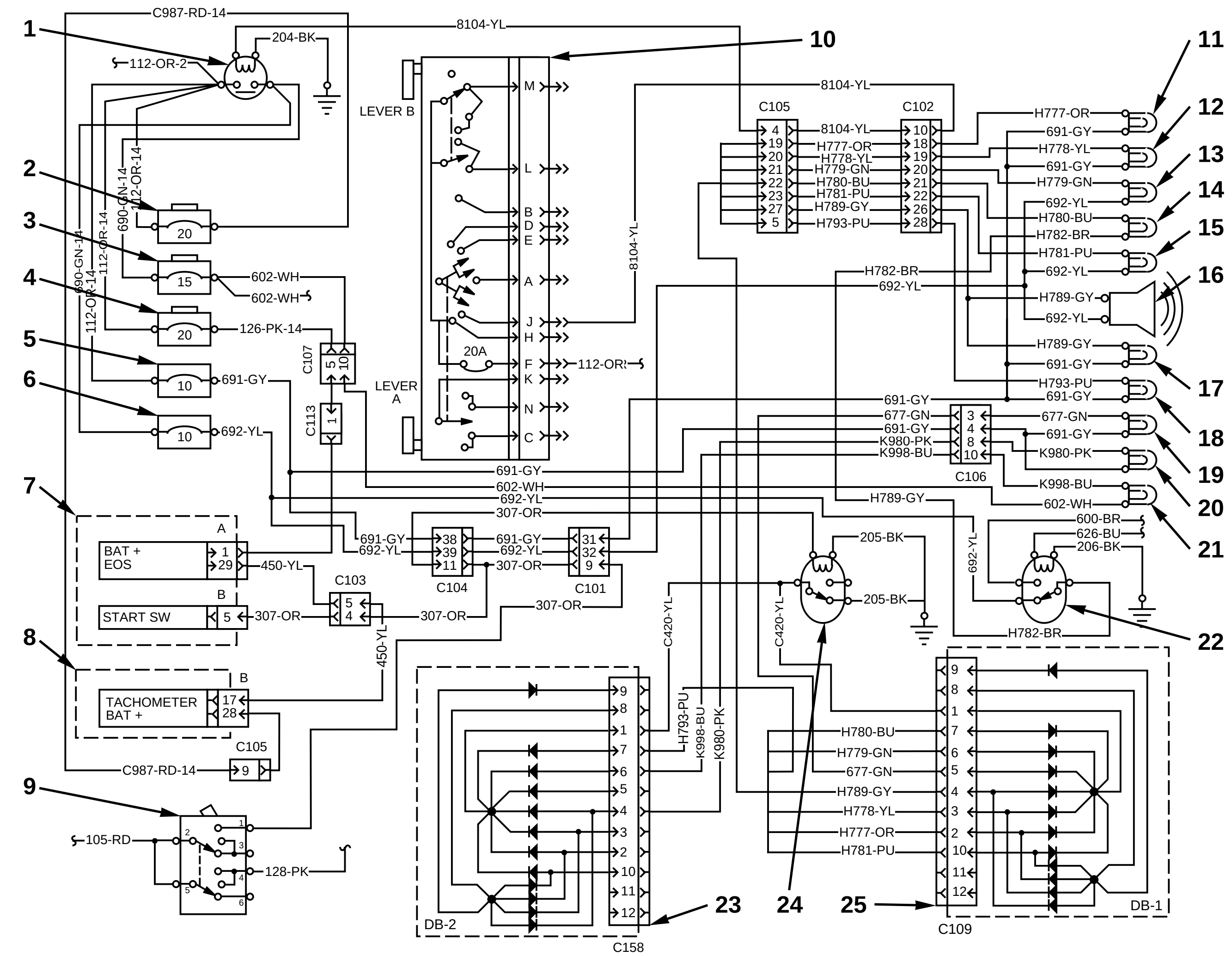


Right Console, Front View With Cover Removed.
(22) Diagnostic relay. (23) Diode block. (24) Lamp test relay. (25) Diode block.

Diagnostic relay (22) and lamp test relay (24) are in the relay bank, inside the right console. Power available to the self-deploy lamp is routed through the diagnostic relay. When blackout switch (10) is in the SERVICE DRIVE/PARK or SERVICE DRIVE/PANEL DIM position, the self-deploy lamp illuminates at the dim setting. When the blackout switch is in the STOP LIGHT or SERVICE DRIVE/PANEL BRIGHT, or SERVICE DRIVE/OFF position, the self-deploy indicator illuminates at the bright setting.

Lamp test relay (24) is normally open. The relay closes when start switch (9) is moved to the START position. When the lamp test relay is closed, a ground path is provided through diode blocks (23 and 25) for current to flow through the indicator lamps.

Circuit Operation



Lamp Test Circuit.
(1) Blackout relay. (2) ECM circuit breaker. (3) Horn/dome circuit breaker. (4) EPTC II circuit breaker. (5) Warning lights circuit breaker. (6) Turn/flasher circuit breaker. (7) EPTC II. (8) ECM. (9) Start switch. (10) Blackout switch. (11) Tension fail lamp. (12) Low brake pressure lamp. (13) Kneeling lamp. (14) Self-deploy lamp. (15) Winch lamp. (16) Blade down alarm. (17) Blade down lamp. (18) Engine oil pressure lamp. (19) Park brake lamp. (20) Hydraulic oil temperature lamp. (21) Remote throttle lamp. (22) Diagnostic relay. (23) Diode block. (24) Lamp test relay. (25) Diode block.

When start switch (9) is moved from the OFF to the ON position, power from the main power relay is available at blackout relay (1), contact F of blackout switch (10), ECM circuit breaker (2), EPTC II circuit breaker (4), and warning lights circuit breaker (5).

Current is conducted across ECM circuit breaker (2) to terminal B-28 of ECM (8) and across EPTC II circuit breaker (4) to terminal A-1 of EPTC II (7). This provides power to the ECM and the EPTC II.

When blackout switch (10) is in either the STOP LIGHT or one of the SERVICE DRIVE positions, current flows through the switch, delivering power to contact J. Current flows from contact J to the coil in blackout relay (1), causing the coil in the blackout relay to energize and the relay to close. Current then flows across the blackout relay to horn/dome circuit breaker (3), and turn/flasher circuit breaker (6).

Power from horn/dome circuit breaker (3) is available at remote throttle lamp (21). Power from warning lights circuit breaker (5) is available at tension fail lamp (11), low brake pressure lamp (12), blade down lamp (17), engine oil pressure lamp (18), park brake lamp (19), and hydraulic oil temperature lamp (20). Power from turn/flasher circuit breaker (6) is available at kneeling lamp (13), winch lamp (15), blade down alarm (16), and the gate of diagnostic relay (22).

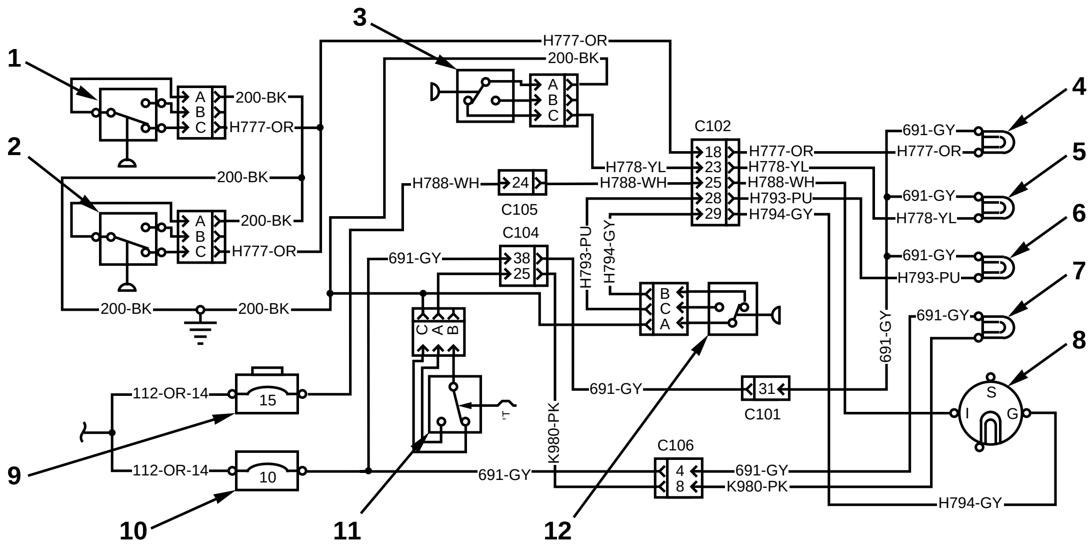
NOTE: Blackout switch (10) must be in either the SERVICE DRIVE or STOP LIGHT position for kneeling lamp (13), winch lamp (15), and self-deploy mode lamp (14) to function.

When start switch (9) is moved from the ON position to the START position, current is conducted from contact 2 to contact 1 of the start switch. Current simultaneously flows to terminal B-5 of EPTC II (7) and to the coil of lamp test relay (24). If starting conditions are met, the EPTC II completes a circuit from terminal B-1 to the start relay and the starter then cranks the engine. Current at the lamp test relay coil energizes the coil and closes the relay.

When closed, lamp test relay (24) provides a ground path through diode block (23) for engine oil pressure lamp (18), hydraulic oil temperature lamp (20), and remote throttle lamp (21). The lamp test relay also provides a ground path through diode block (25) for tension fail lamp (11), low brake pressure lamp (12), kneeling lamp (13), self-deploy lamp (14), winch lamp (15), blade down alarm (16), blade down lamp (17), and park brake lamp (19). The lamps illuminate, and the alarm sounds until start switch (9) is returned to the ON position. The system tests the lamps each time the engine is started.

The lamps can also be tested when the engine is running. When the engine is running, terminal B-17 of ECM (8) sends an engine output speed signal to terminal A-29 of EPTC II (7). If the engine speed is greater than 200 rpm when start switch (9) is moved from the ON position to the START position, the EPTC II will not complete a circuit from terminal B-1 to the start relay, and the starter will not engage. However, current from the start switch does energize the coil in lamp test relay (24), which enables the lamp test to function.

Operating Pressure and Temperature Circuit

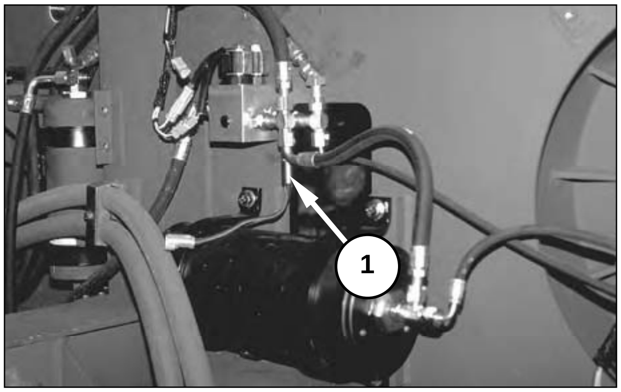


Operating Pressure and Temperature Circuit.
(1) Right track tension pressure switch. (2) Left track tension pressure switch. (3) Brake pressure switch. (4) Tension fail lamp. (5) Low brake pressure lamp. (6) Engine oil pressure lamp. (7) Hydraulic oil temperature lamp. (8) Tachometer. (9) Auxiliary circuit breaker. (10) Warning lights circuit breaker. (11) Hydraulic oil temperature switch. (12) Engine oil pressure sensor.

The operating pressure and temperature circuit contains sensors, switches and lamps which monitor engine oil pressure, hydraulic oil temperature, brake pressure, and track tension pressure.

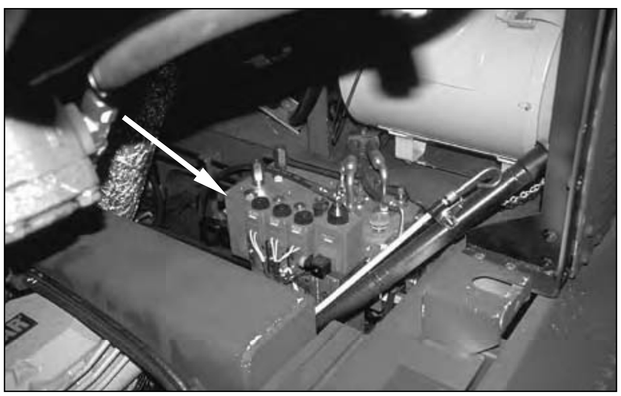
The components of the operating pressure and temperature circuit are right track tension pressure switch (1), left track tension pressure switch (2), brake pressure switch (3), tension fail lamp (4), low brake pressure lamp (5), engine oil pressure lamp (6), hydraulic oil temperature lamp (7), tachometer (8), auxiliary circuit breaker (9), warning lights circuit breaker (10), hydraulic oil temperature switch (11), and engine oil pressure sensor (12).

Component Location

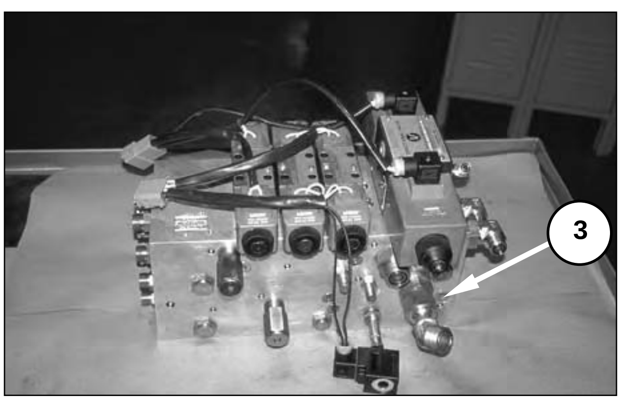


Inside of Frame, Transmission Removed.
(1) Right track tension pressure switch.

Right track tension pressure switch (1) is mounted to the inside of the machine frame, in front of the transmission on the right side of the machine. Left track tension pressure switch (2) (not shown) is mounted on the left side of the machine. The track tension pressure switches monitor pressure in the recoil cylinders.

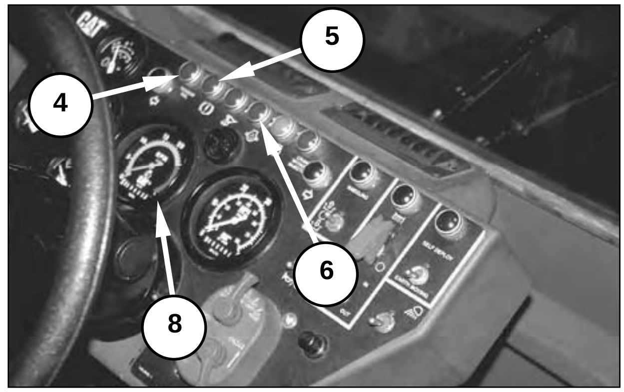


Multifunction Control Valve, Left Side of Machine.



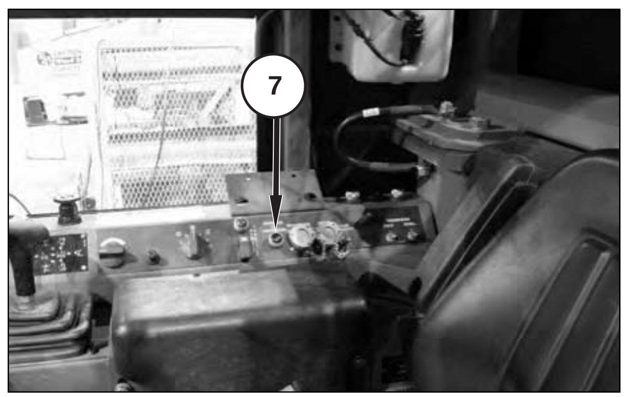
Multifunction Control Valve, Removed from Machine.
(3) Brake pressure switch.

Brake pressure switch (3) is located on the bottom face of the multifunction control valve. The brake pressure switch monitors pressure in the brake system. Brake pressure switch actuation pressure is 9500 kPa (1375 psi).



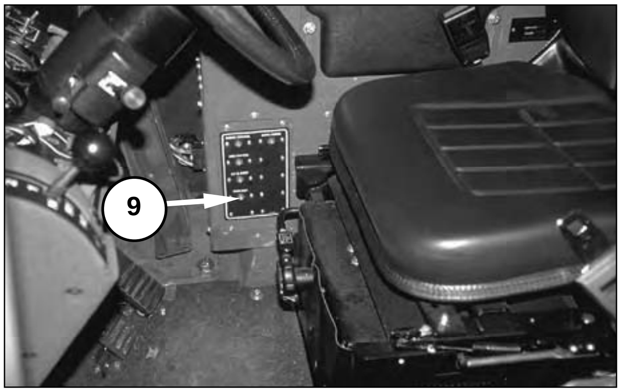
Instrument Panel.
(4) Tension fail lamp. (5) Low brake pressure lamp. (6) Engine oil pressure lamp. (8) Tachometer.

Tension fail lamp (4) illuminates when the pressure in the belt tension system is below 8300 ± 350 kPa (1245 ± 50 psi). Low brake pressure lamp (5) illuminates when the pressure in the brake system is less than 8300 ± 350 kPa (1245 ± 50 psi). Engine oil pressure lamp (6) illuminates when the engine oil pressure is less than 35 ± 21 kPa (5 ± 3 psi). Tachometer (8) displays the engine speed.

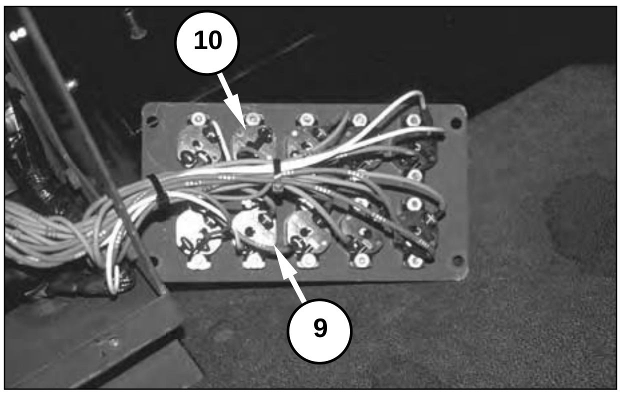


Right Console.
(7) Hydraulic oil temperature lamp.

Hydraulic oil temperature lamp (7) is on the console to the right of the operator’s seat. The hydraulic oil temperature lamp illuminates when the hydraulic oil temperature is greater than 92 ± 1.5°C (197.6 ± 2.7°F).

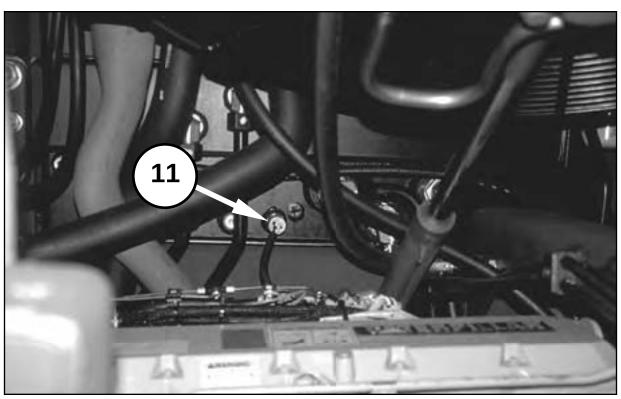


Front Circuit Breaker Panel.
(9) Auxiliary circuit breaker.



Front Circuit Breaker Panel, Back Side.
(9) Auxiliary circuit breaker. (10) Warning lights circuit breaker.

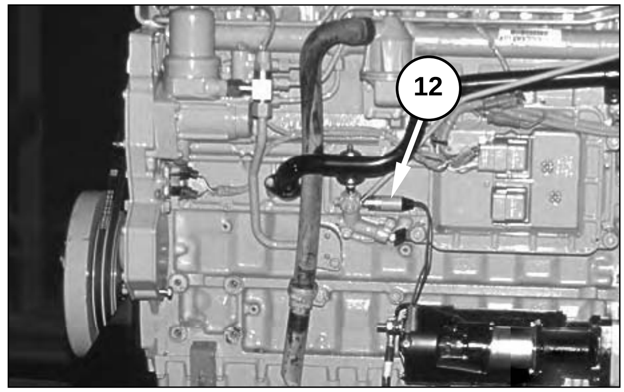
Auxiliary circuit breaker (9) is a manual-reset breaker rated at 15 amps, and warning lights circuit breaker (10) is an automatic-reset breaker rated at 10 amps.



Left Side of Hydraulic Tank, Radiator Raised.
(11) Hydraulic oil temperature switch.

Hydraulic oil temperature switch (11) is located on the bottom, left side of the hydraulic tank. The hydraulic oil temperature switch monitors the oil temperature in the hydraulic tank. The hydraulic oil temperature switch closes when the oil temperature reaches 92 ± 1.5°C (197.6 ± 2.7°F).

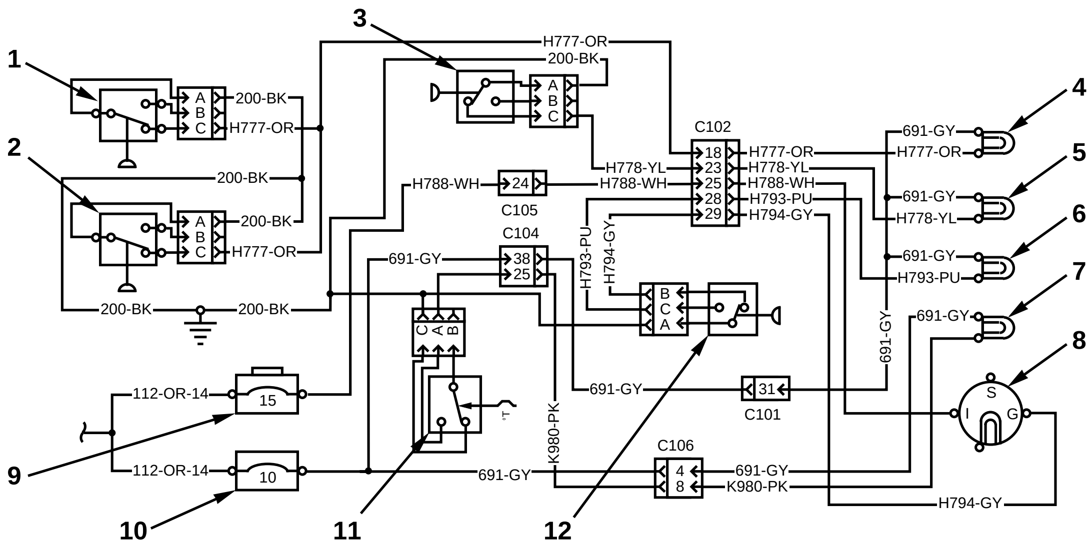
NOTE: The radiator must be raised to provide access to hydraulic oil temperature switch (11).



Left Side of Engine, Engine Removed from Machine.
(12) Engine oil pressure sensor.

Engine oil pressure sensor (12) is on the left side of the engine. The engine oil pressure switch monitors the pressure in the lubrication system. Actuation pressure of the engine oil pressure switch is 85 kPa (12.3 psi), and deactuation pressure is 35 ± 21 kPa (5 ± 3 psi).

Circuit Operation



Operating Pressure and Temperature Circuit.
(1) Track tension pressure switch. (2) Track tension pressure switch. (3) Brake pressure switch. (4) Tension fail lamp. (5) Low brake pressure lamp. (6) Engine oil pressure lamp. (7) Hydraulic oil temperature lamp. (8) Tachometer. (9) Auxiliary circuit breaker. (10) Warning lights circuit breaker. (11) Hydraulic oil temperature switch. (12) Engine oil pressure switch.

After the engine starts, oil pressure increases. When oil pressure is below 85 kPa (12.3 psi), contact A and contact C of engine oil pressure switch (12) close. This condition illuminates engine oil pressure lamp (6) by completing a circuit for current to flow from warning lights circuit breaker (10) through the engine oil pressure lamp, across contacts C and A of the oil pressure switch, and finally, to ground.

When the engine oil pressure is greater than 85 kPa (12.3 psi), contact A and contact C of engine oil pressure switch (12) open, while contact A and contact B close. Current from auxiliary circuit breaker (9) flows to the I-terminal of tachometer (8), out the G-terminal of the tachometer and to ground, across contacts B and A of the engine oil pressure switch.

If the engine oil pressure decreases to 35 ± 21 kPa (5 ± 3 psi), contacts A and B of engine oil pressure switch (12) open. At the same time, contact A and contact C close, and engine oil pressure lamp (6) illuminates.

If the hydraulic oil temperature rises above 92 ± 1.5°C (197.6 ± 2.7°F), hydraulic oil temperature switch (11) closes. Closing the hydraulic oil temperature switch illuminates hydraulic oil temperature lamp (7) by completing a circuit for current to flow from warning lights breaker (10), through the hydraulic oil temperature lamp and to ground, across the hydraulic oil temperature switch.

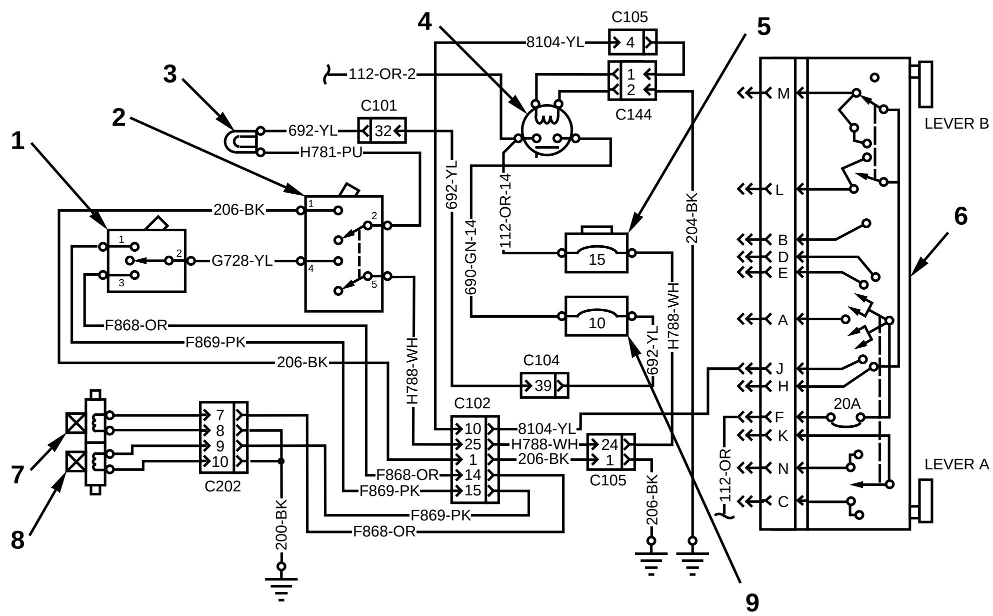
The hydraulic oil temperature must fall below 85°C (185°F) before hydraulic oil temperature switch (11) will open again.

If the brake pressure is above 9500 kPa (1375 psi), brake pressure switch (3) is open, and low brake pressure lamp (5) is not illuminated. If the brake pressure falls below 8300 ± 350 kPa (1245 ± 50 psi), the brake pressure switch closes. This condition illuminates the low brake pressure lamp by allowing current to flow from warning lights circuit breaker (10), through the low brake pressure lamp, and to ground through the brake pressure switch. The low brake pressure lamp remains illuminated until the brake pressure rises above 9500 kPa (1375 psi).

If pressure in the left and right drive belt tension systems rises above 9500 kPa (1375 psi), contacts A and C of track tension pressure switches (1 and 2) open. If the pressure in either the right and/or the left belt tension systems decreases below 8300 ± 350 kPa (1245 ± 50 psi), contacts A and C of the corresponding track tension switch close.

When contacts A and C of one of track tension pressure switches (1 and 2) are closed, tension fail lamp (4) is illuminated because a circuit is completed for current to flow from warning lights circuit breaker (10), through the tension fail lamp and to ground, across the track tension switch. The tension fail lamp remains illuminated until the pressure in the corresponding belt drive system rises to 9500 kPa (1375 psi).

Winch Control Circuit

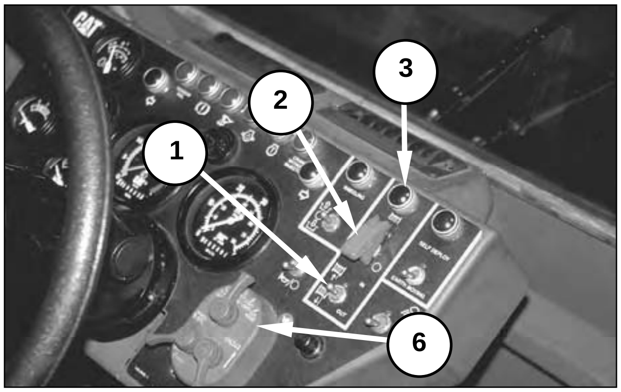


Winch Control Circuit.
(1) Winch control switch. (2) Winch enable switch. (3) Winch lamp. (4) Blackout relay. (5) Auxiliary circuit breaker. (6) Blackout switch. (7) Winch-in coil of winch solenoid. (8) Winch-out coil of winch solenoid. (9) Turn/flasher circuit breaker.

A lamp in the winch control circuit alerts the operator as to the position of the winch control switches and the current condition of the winch.

The components of the winch control circuit are: winch control switch (1), winch enable switch (2), winch lamp (3), blackout relay (4), auxiliary circuit breaker (5), blackout switch (6), winch-in coil of winch solenoid (7), winch-out coil of winch solenoid (8), and turn/flasher circuit breaker (9).

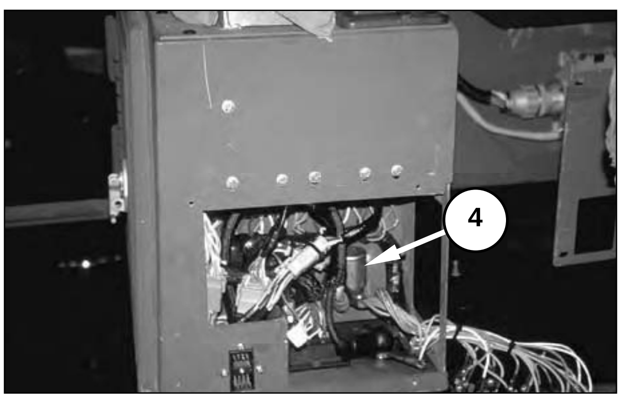
Component Location



Right Side of Instrument Panel.
(1) Winch control switch. (2) Winch enable switch. (3) Winch lamp. (6) Blackout switch.

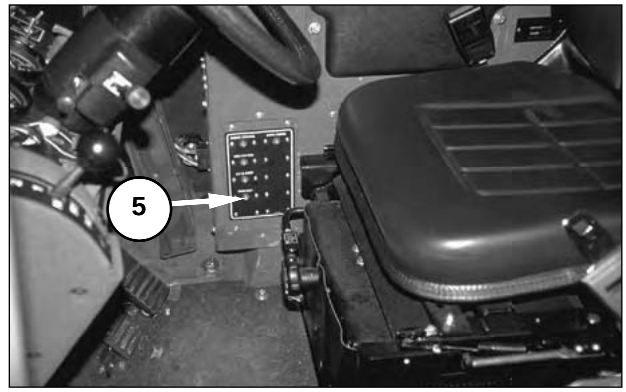
Winch lamp (3) illuminates when winch enable switch (2) is in the ON position. Winch control switch (1) activates the winch when the winch enable switch is in the ON position. Blackout switch (6) must be in the STOP LIGHT or one of the SERVICE DRIVE positions for the winch lamp to illuminate.

NOTE: The cover on winch enable switch (2) must be raised to move the winch enable switch out of the OFF position.

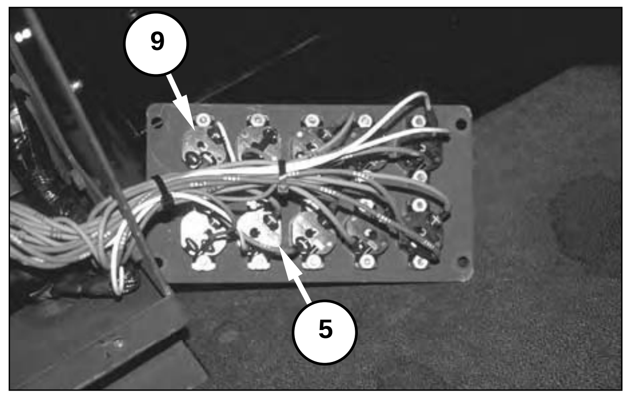


Right Console, Front View With Cover Removed.
(4) Blackout relay.

Blackout relay (4) is located inside the console to the right of the operator. The blackout relay is normally open. The coil of the blackout relay receives power when blackout switch (6) is in the STOP LIGHT or one of the SERVICE DRIVE positions.

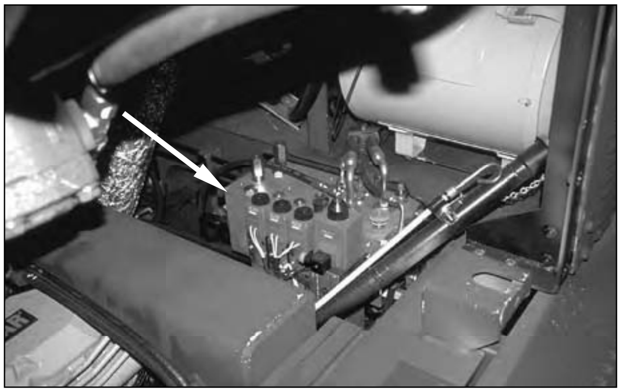


Front Circuit Breaker Panel.
(5) Auxiliary circuit breaker.

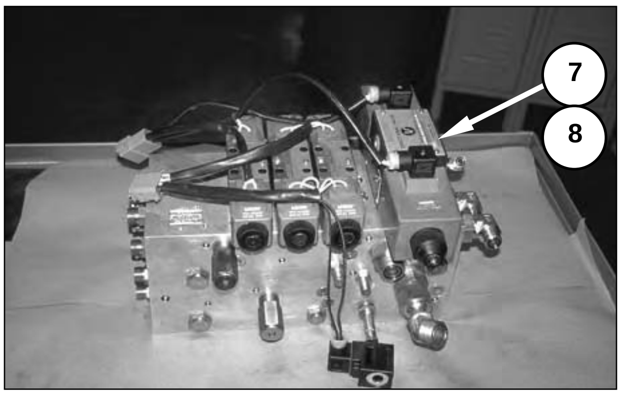


Front Circuit Breaker Panel, Back Side.
(5) Auxiliary circuit breaker. (9) Turn/flasher circuit breaker.

Auxiliary circuit breaker (5) is a manual-reset breaker rated at 15 amps, and turn/flasher circuit breaker (9) is an automatic-reset breaker rated at 10 amps.



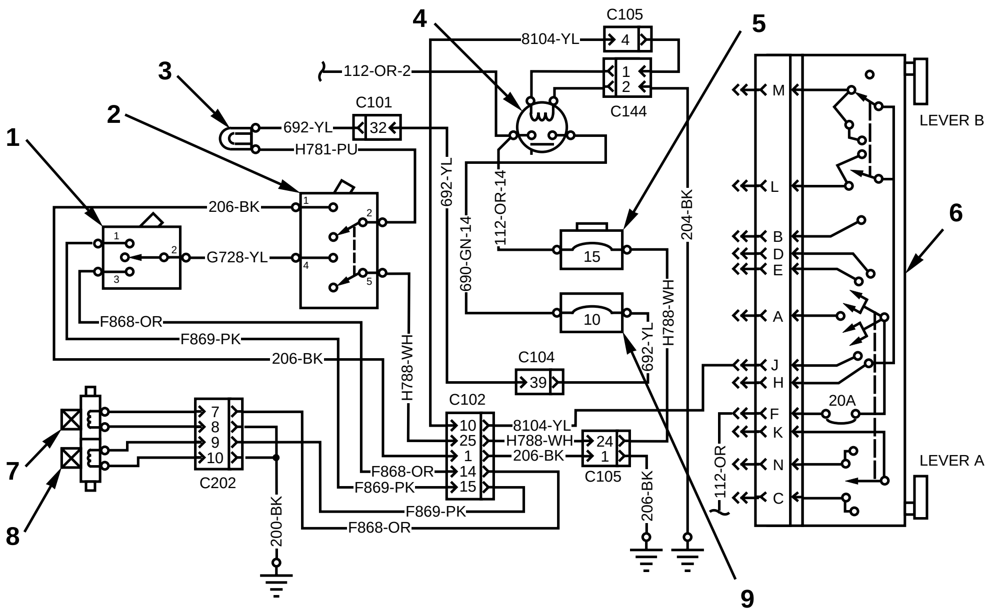
Multifunction Control Valve, Left Side of Machine.



Multifunction Control Valve, Removed from Machine.
(7) Winch-in coil of winch solenoid. (8) Winch-out coil of winch solenoid.

Winch-in coil of winch solenoid (7) and winch-out coil of winch solenoid (8) are mounted to the front face of the multifunction control valve.

Circuit Operation



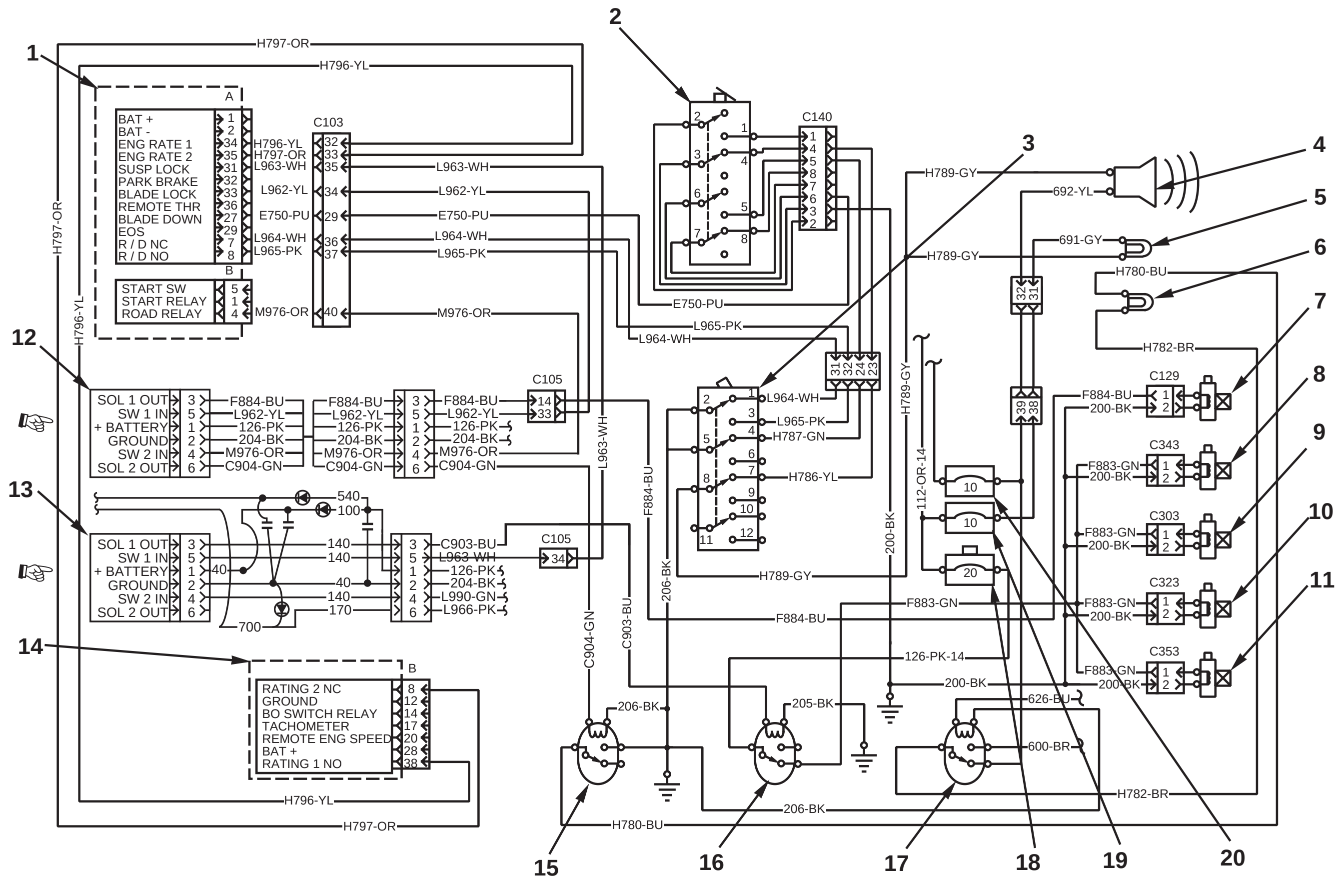
Winch Control Circuit.
(1) Winch control switch. (2) Winch enable switch. (3) Winch lamp. (4) Blackout relay. (5) Auxiliary circuit breaker. (6) Blackout switch. (7) Winch-in coil of winch solenoid. (8) Winch-out coil of winch solenoid. (9) Turn/flasher circuit breaker.

If blackout switch (6) is in either the SERVICE DRIVE position or one of the STOP LIGHT positions, blackout relay (4) is energized, and power from turn/flasher circuit breaker (9) is available at winch lamp (3). Moving winch enable switch (2) to the ON position illuminates the winch lamp by conducting current through the winch lamp and to ground, across contacts 2 and 1 of the winch enable switch.

When winch enable switch (2) is in the ON position, power from auxiliary circuit breaker (5), at contact 5 of the winch enable switch, becomes available at contact 2 of winch control switch (1). Moving the winch control switch from the HOLD position to the IN position sends power from contact 3 of the switch to winch-in coil of winch solenoid (7). The winch-in coil of the winch solenoid energizes and the winch reels the cable in until the winch control switch returns to the OFF position.

When winch control switch (1) is moved to the OUT position, power is sent from contact 1 of the switch to winch-out coil of winch solenoid (8). The winch-out coil of the winch solenoid energizes, causing the winch to reel the cable out until the winch control switch returns to the OFF position.

Self-Deploy/Earthmoving Circuit



Self-Deploy/Earthmoving Circuit.

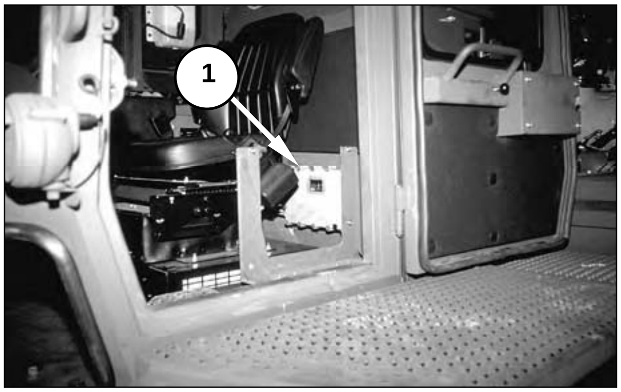
(1) EPTC II. (2) Blade position switch. (3) Self-Deploy/Earthmoving switch. (4) Blade down alarm. (5) Blade down lamp. (6) Self-deploy lamp. (7) Blade lock solenoid. (8) Suspension lock solenoid. (9) Suspension lock solenoid. (10) Suspension lock solenoid. (11) Suspension lock solenoid. (12) Number-1 solenoid driver. (13) Number-2 solenoid driver. (14) ECM. (15) Roading relay. (16) Suspension relay. (17) Diagnostic relay. (18) EPTC II circuit breaker. (19) Warning lights circuit breaker. (20) Turn/flasher circuit breaker.

The self-deploy/earthmoving circuit contains lamps to alert the operator as to current machine conditions. Other components within the circuit prevent the machine from operating in the SELF-DEPLOY mode while the blade is down.

The components of the self-deploy/earthmoving circuit are EPTC II (1), blade position switch (2), self-deploy/earthmoving switch (3), blade down alarm (4), blade down lamp (5), self-deploy lamp (6), blade lock solenoid (7), suspension lock solenoid (8), suspension lock solenoid (9), suspension lock solenoid (10), suspension lock solenoid (11), number-1 solenoid driver (12), number-2 solenoid driver (13), ECM (14), roading relay (15), suspension relay (16), diagnostic relay (17), EPTC II circuit breaker (18), warning lights circuit breaker (19), and turn/flasher circuit breaker (20).

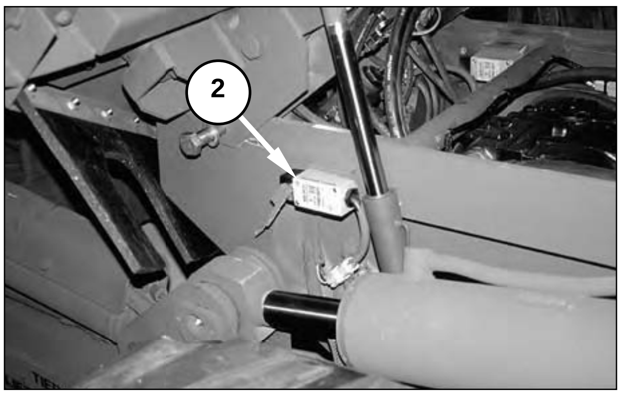
NOTE: The self-deploy/earthmoving circuit provides one of two inputs to the torque map logic in the ECM software. For more information about the torque map logic, refer to information in this section about horsepower setting, and to “Systems Operation, ECM Circuit” in this module.

Component Location



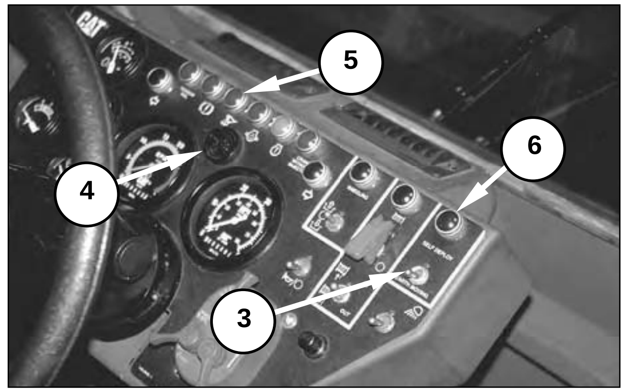
Inside Cab, Back Wall, Cover Removed.
(1) EPTC II.

EPTC II (1) is mounted to the inside of the cab, on the back wall. The EPTC II controls operation of the self-deploy/earthmoving circuit.



Left Side of Machine, Under Cab.
(2) Blade position switch.

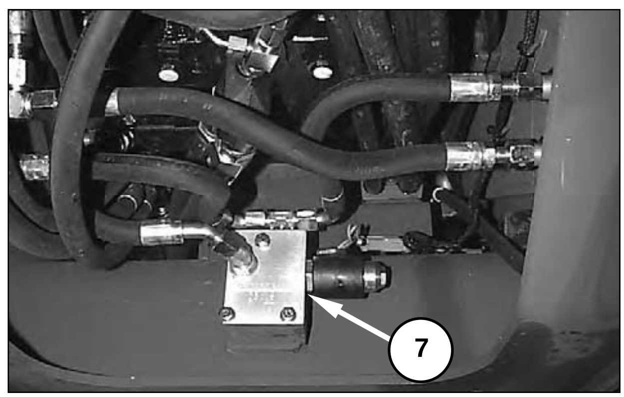
Blade position switch (2) is on the left side of the machine, under the cab. When the blade is fully RAISED, contacts 3 and 4 of the blade position switch are open, and contacts 5 and 6 are closed.



Right Side of Instrument Panel.
(3) Self-deploy/earthmoving switch. (4) Blade down alarm.
(5) Blade down lamp. (6) Self-deploy lamp.

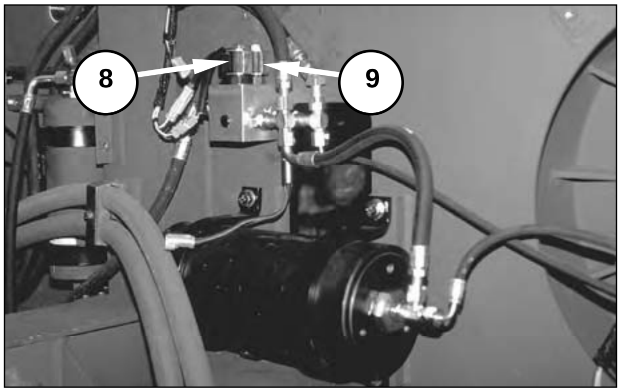
Self-deploy lamp (6) illuminates when self-deploy/earthmoving switch (3) is in the SELF-DEPLOY position. If the blade is not fully raised when the self-deploy/earthmoving switch is in SELF-DEPLOY, blade down alarm (4) sounds, and blade down lamp (5) illuminates.

NOTE: The blackout switch must be in STOP LIGHT or one of the SERVICE DRIVE positions for blade down alarm (4) to sound, and for blade down lamp (5) and self-deploy lamp (6) to illuminate.



Front of Machine, Behind Cover Plate.
(7) Blade lock solenoid.

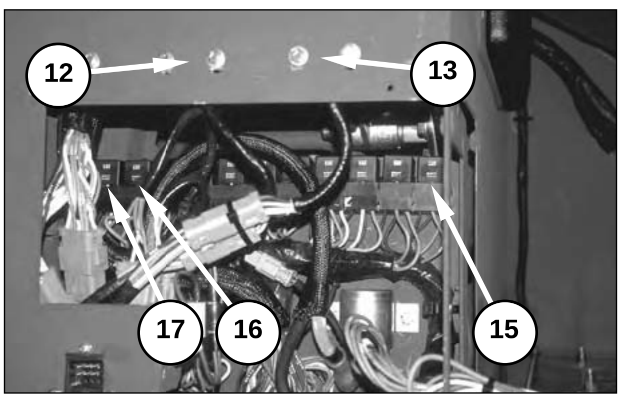
Blade lock solenoid (7) is behind the cover plate, under the cab. EPTC II (1) controls the blade lock solenoid through number-1 solenoid driver (12). When energized, the blade lock solenoid disables the blade LOWER function of the implement hydraulic system.



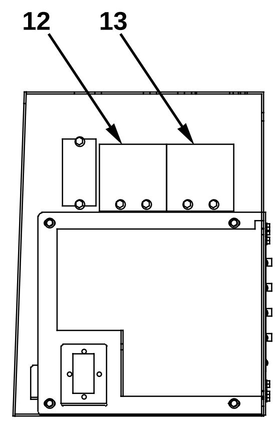
Inside of Frame, Transmission Removed.
(8) Suspension lock solenoid. (9) Suspension lock solenoid.

Suspension lock solenoids (8 and 9) are mounted to the inside of the machine frame, in front of the transmission. The suspension lock solenoids for the left track are mounted on the left side of the machine, and the suspension lock solenoids for the right track are mounted on the right side of the machine.

NOTE: Suspension lock solenoids (10 and 11) are not shown. These solenoids are located on the opposite side of the machine.



Right Console, Front View With Cover Removed.
(12) Number-1 solenoid driver. (13) Number-2 solenoid driver. (15) Roading relay. (16) Suspension relay. (17) Diagnostic relay.



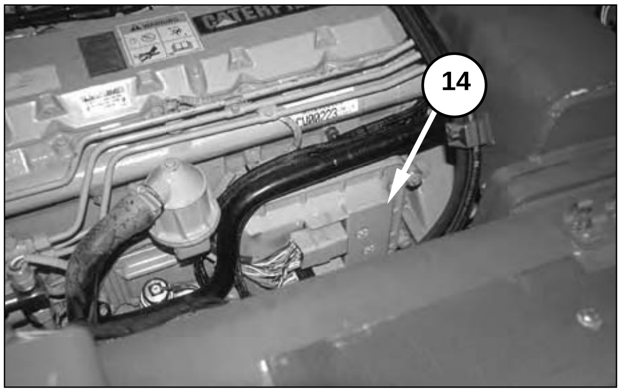
Right Console, Front View.
(12) Number-1 solenoid driver. (13) Number-2 solenoid driver.

NOTE: Number-1 solenoid driver (12) and number-2 solenoid driver (13) are mounted to the back wall of the right console, behind the circuit breaker panel.

EPTC II (1) controls the suspension lock solenoids through number-2 solenoid driver (13). Energizing the suspension lock solenoids disengages the undercarriage suspension system to allow better control during earthmoving.

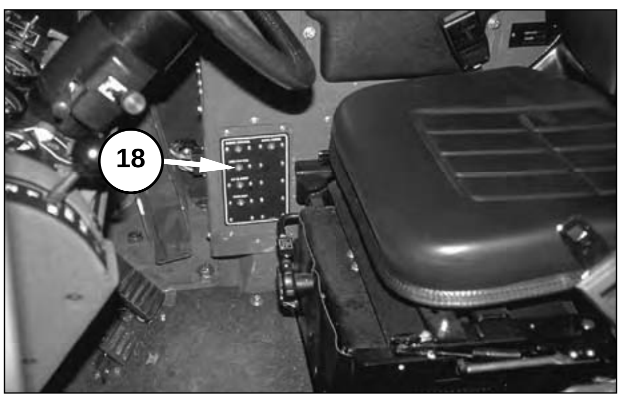
Roading relay (15) provides the ground path to illuminate self-deploy lamp (6). The roading relay is open when the machine is in the EARTHMOVING mode. Suspension relay (16) transfers power to the suspension lock solenoids (8, 9, 10, and 11) when the machine is traveling in the FORWARD direction in EARTHMOVING mode. Diagnostic relay (17) controls the brightness of the self-deploy lamp. When the coil in the diagnostic relay is energized, the self-deploy lamp illuminates at the dim setting. When the coil in the diagnostic relay is not energized, the self-deploy lamp illuminates at the bright setting.

EPTC II (1) controls the operation of blade lock solenoid (7) and roading relay (15) through the number-1 solenoid driver. The EPTC II controls suspension relay (16) through the number-2 solenoid driver. The solenoid drivers receive low voltage signals from the EPTC II and transmit higher voltage signals to the relays.

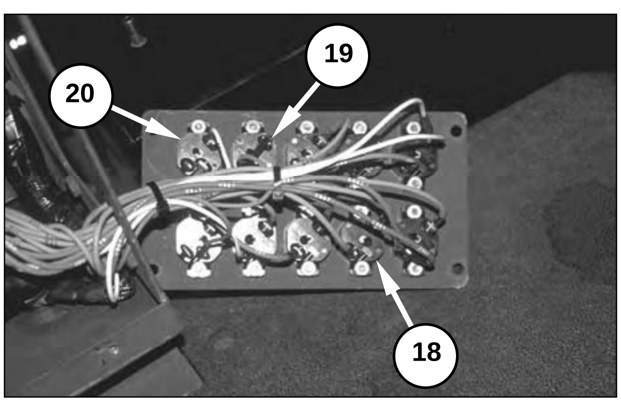


Left Side of Engine, Under Radiator.
(14) ECM.

ECM (14) is on the left side of the engine, under the radiator. The ECM controls the horsepower rating of the engine. The ECM operates the engine at the low horsepower setting in the EARTHMOVING mode, and in the SELF-DEPLOY mode with the transmission below THIRD FORWARD. The ECM operates the engine at the high horsepower setting while the machine is in the SELF-DEPLOY mode and the transmission is in THIRD, FOURTH, FIFTH, or SIXTH gear. The ECM uses an input from EPTC II (1) to determine the current operating mode.



Front Circuit Breaker Panel.
(18) EPTC II circuit breaker.

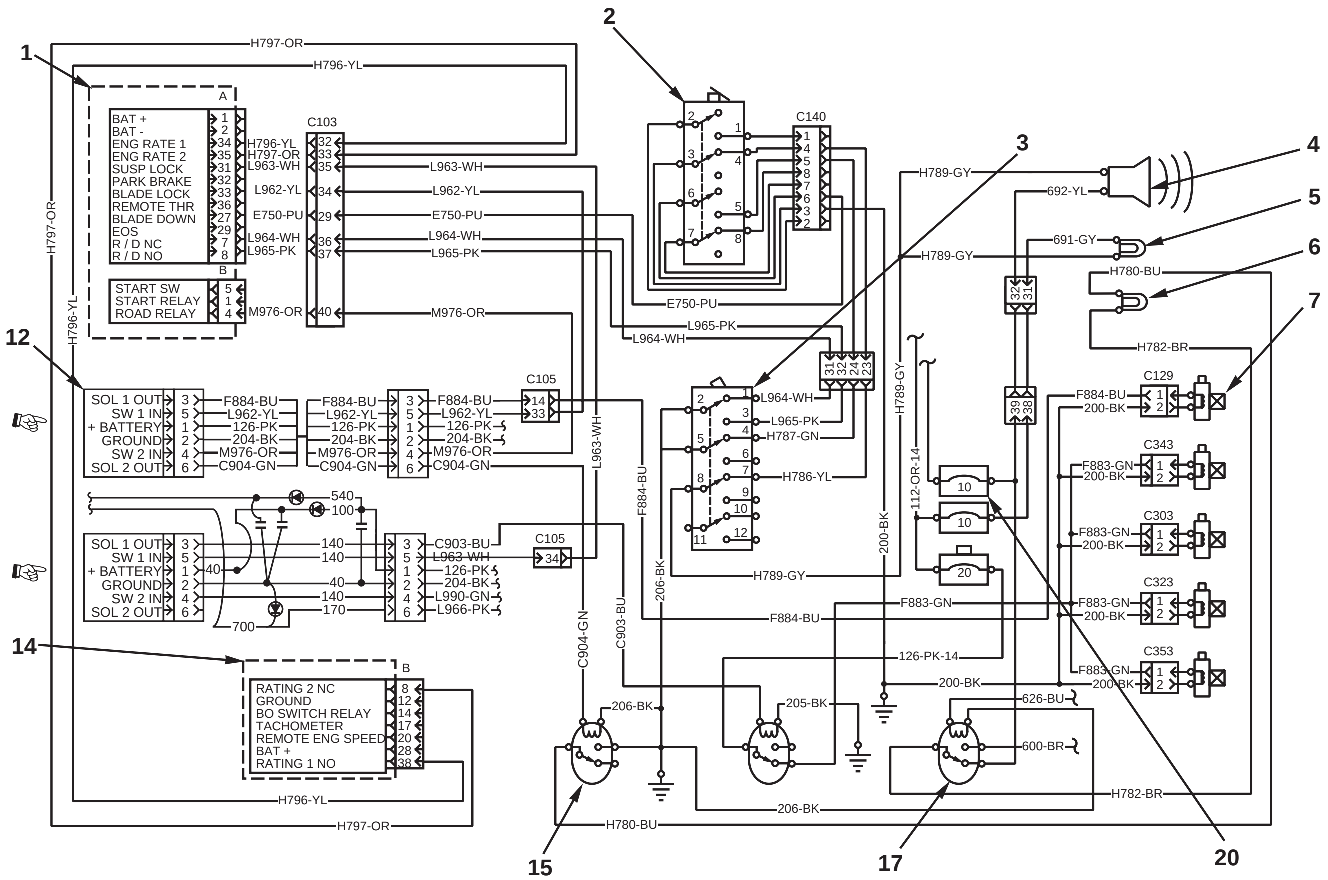


Front Circuit Breaker Panel, Back Side.
(18) EPTC II circuit breaker. (19) Warning lights circuit breaker.
(20) Turn/flasher circuit breaker.

EPTC II circuit breaker (18) is a manual-reset breaker rated at 20 amps. Warning lights circuit breaker (19) and turn/flasher circuit breaker (20) are automatic-reset breakers rated at 10 amps.

Circuit Operation

SELF-DEPLOY, Blade Fully RAISED



Self-Deploy/Earthmoving Circuit—SELF-DEPLOY, Blade Fully RAISED.
(1) EPTC II. (2) Blade position switch. (3) Self-deploy/earthmoving switch. (4) Blade down alarm. (5) Blade down lamp. (6) Self-deploy lamp. (7) Blade lock solenoid. (12) Number-1 solenoid driver. (14) ECM. (15) Roading relay. (17) Diagnostic relay. (20) Turn/flasher circuit breaker.

When self-deploy/earthmoving switch (3) is in the SELF-DEPLOY position, contacts 1 and 2, 4 and 5, and 7 and 8 are closed. Contacts 1 and 2 complete a circuit for current to flow from terminal A-7 of EPTC II (1) to ground. This ground signal confirms to the EPTC II that the self-deploy/earthmoving switch is in the SELF-DEPLOY position.

When the blade is in the fully RAISED position, contacts 3 and 4 of blade position switch (2) are open and contacts 5 and 6 are closed. An open between contacts 3 and 4 of the blade position switch prevents blade down alarm (4) from sounding, and blade down lamp (5) from illuminating.

With contacts 5 and 6 of blade position switch (2) closed, current flows from terminal A-27 of EPTC II (1), across contacts 5 and 6 of the blade position switch, and to ground across contacts 4 and 5 of self-deploy/earthmoving switch (3). This ground signal confirms to the EPTC II that the blade is in the fully RAISED position.

Under these conditions, EPTC II (1) illuminates self-deploy lamp (6), prevents the blade from lowering, automatically shifts the transmission depending on the shift lever position (between first and sixth gears FORWARD), and signals ECM (14) to operate the engine in the high horsepower mode, while the transmission is above SECOND gear.

Terminal B-4 of EPTC II (1) transmits a ground signal to terminal 4 of number-1 solenoid driver (12). Terminal 6 of the number-1 solenoid driver generates an output signal to the coil of roading relay (15). The coil in the roading relay energizes and the relay closes.

When roading relay (15) is closed, current flows from turn/flasher circuit breaker (20), through diagnostic relay (17), through self-deploy lamp (6), and to ground through the roading relay. This causes the self-deploy lamp to illuminate at the bright setting.

NOTE: The blackout switch must be in the STOP LIGHT, SERVICE DRIVE/OFF, or SERVICE DRIVE/PANEL BRIGHT position for self-deploy lamp (6) to illuminate at the bright setting. If the blackout switch is in the SERVICE DRIVE/PANEL DIM or SERVICE DRIVE/PARK position, the coil in diagnostic relay (17) is energized, and the self-deploy lamp illuminates at the dim setting. For more information, refer to “Systems Operation, Lighting Circuit” in this module.

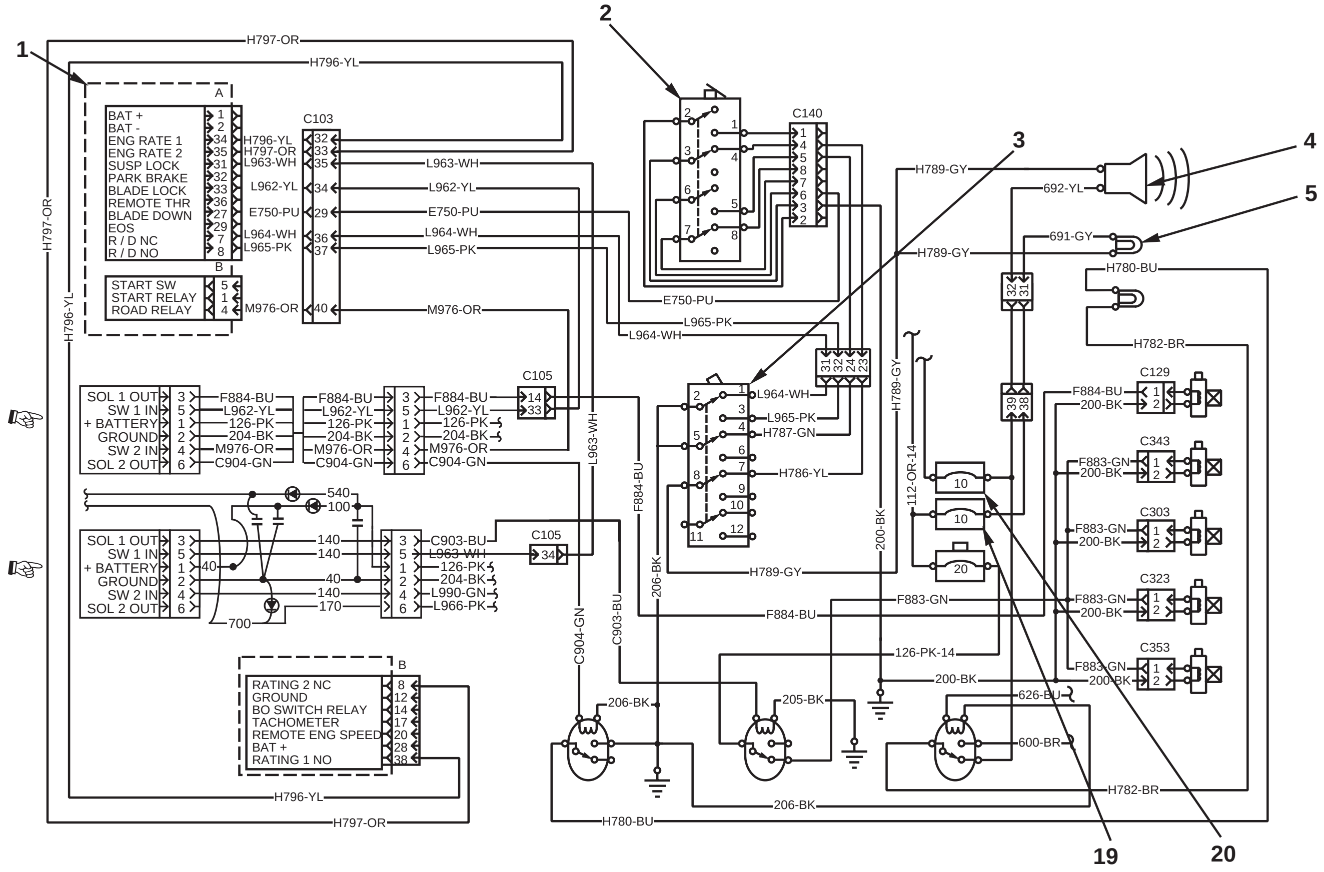
Terminal A-33 of EPTC II (1) transmits a ground signal to terminal 5 of number-1 solenoid driver (12). Terminal 3 of the number-1 solenoid driver generates an output signal to blade lock solenoid (7). The blade LOWER function of the hydraulic circuit cannot operate when the blade lock solenoid is energized.

When the transmission is in REVERSE, FIRST, or SECOND FORWARD, terminal A-35 of EPTC II (1) sends an output signal to terminal B-8 of ECM (14). A signal at terminal B-8 causes the ECM to operate the machine at the low horsepower rating.

When the transmission is in THIRD FORWARD or above, terminal A-34 of EPTC II (1) generates an output signal to terminal B-38 of ECM (14). The ECM operates the engine at the high horsepower rating.

NOTE: For details about the engine control, refer to “Systems Operation, ECM Circuit” in this module. For a detailed description of the transmission control function of EPTC II (1), refer to “Systems Operation, Transmission Control Circuit” in this module.

SELF-DEPLOY, Blade DOWN



Self-Deploy/Earthmoving Circuit—SELF-DEPLOY, Blade DOWN.
(1) EPTC II. (2) Blade position switch. (3) Self-deploy/earthmoving switch. (4) Blade down alarm. (5) Blade down lamp. (19) Warning lights circuit breaker. (20) Turn/flasher circuit breaker.

When the blade is not fully RAISED, contacts 3 and 4 of blade position switch (2) are closed, and contacts 5 and 6 are open. When the self-deploy/earthmoving switch (3) is moved to the SELF-DEPLOY position while contacts 3 and 4 of the blade position switch are closed, blade down alarm (4) sounds, and blade down lamp (5) illuminates.

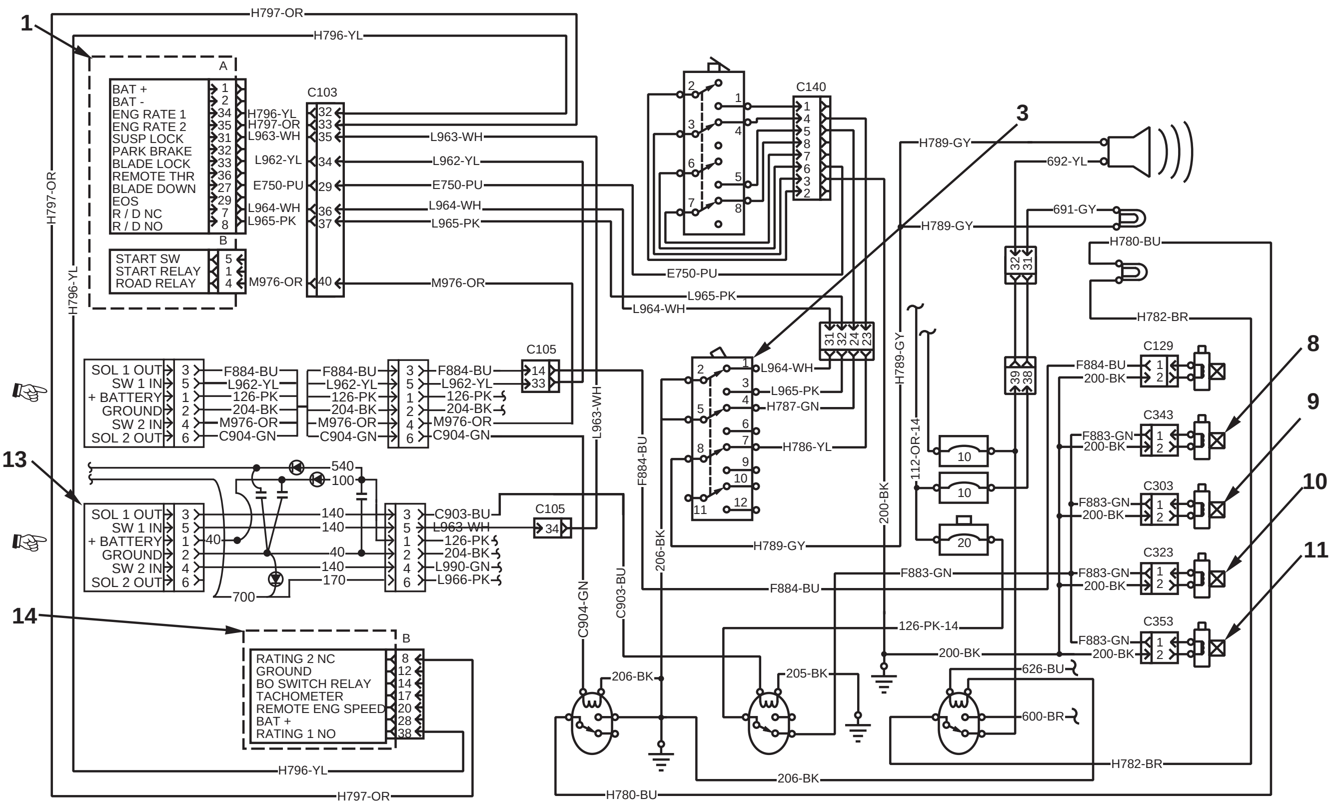
When contacts 3 and 4 of blade position switch (2) are closed, a circuit is complete for current to flow from turn/flasher circuit breaker (20) through blade down alarm (4), and from warning lights circuit breaker (19) through blade down lamp (5). The negative terminals of the blade down alarm and the blade down lamp are connected to contact 8 of self-deploy/earthmoving switch (3).

Current flows from contact 8 to contact 7 of self-deploy/earthmoving switch (3) and continues to ground across contacts 3 and 4 of blade position switch (2). Blade down alarm (4) sounds and blade down lamp (5) illuminates.

NOTE: The blackout switch must be in the STOP LIGHT or one of the SERVICE DRIVE positions for blade down alarm (4) to sound.

When contacts 5 and 6 of blade position switch (2) are open, the ground from terminal A-27 of EPTC II (1) is interrupted. The lack of a ground at terminal A-27 confirms to the EPTC II that the blade is not in the fully RAISED position. Under these conditions, the EPTC II prevents the machine from entering the self-deploy mode, regardless of the position of self-deploy/earthmoving switch (3).

EARTHMOVING



Self-Deploy/Earthmoving Circuit—EARTHMOVING.
(1) EPTC II. (3) Self-deploy/earthmoving switch. (8) Suspension lock solenoid. (9) Suspension lock solenoid. (10) Suspension lock solenoid. (11) Suspension lock solenoid. (13) Number-2 solenoid driver. (14) ECM.

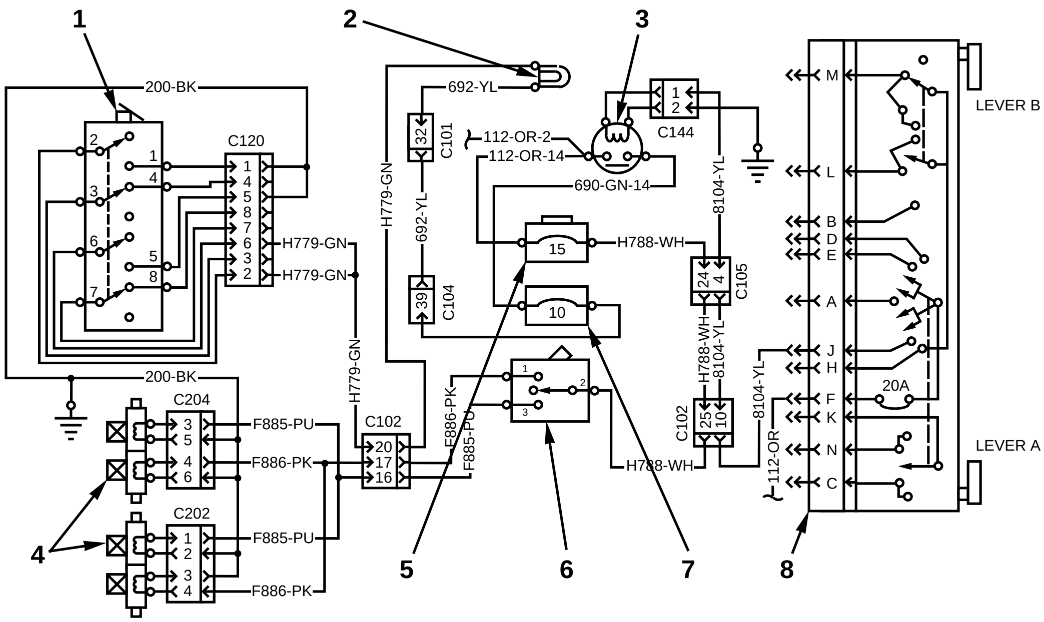
When self-deploy/earthmoving switch (3) is in the EARTHMOVING position, contacts 2 and 3 are closed and contacts 4 and 5, and 7 and 8 are open. Contacts 2 and 3 complete a circuit for current to flow from terminal A-8 of EPTC II (1) to ground. This ground signal confirms to the EPTC II that the self-deploy/earthmoving switch is in the EARTHMOVING position.

Under this condition, EPTC II (1) locks the suspension while the machine travels FORWARD, unlocks the suspension while the machine travels in REVERSE, limits the transmission to three forward speeds, requires manual shifting of the transmission, and signals ECM (14) to operate the engine in the low horsepower mode.

NOTE: For a detailed description of the transmission control function of EPTC II (1), refer to “Systems Operation, Transmission Control Circuit” in this module.

After confirming that the shift lever is in a FORWARD gear, EPTC II (1) locks the suspension by transmitting a ground signal from terminal A-31 to terminal 5 of number-2 solenoid driver (13). Terminal 3 of the number-2 solenoid driver sends an output signal to the coil of suspension lock solenoids (8, 9, 10, and 11). The suspension lock solenoids energize, locking the recoil, front, and rear suspension cylinders.

Kneeling Circuit

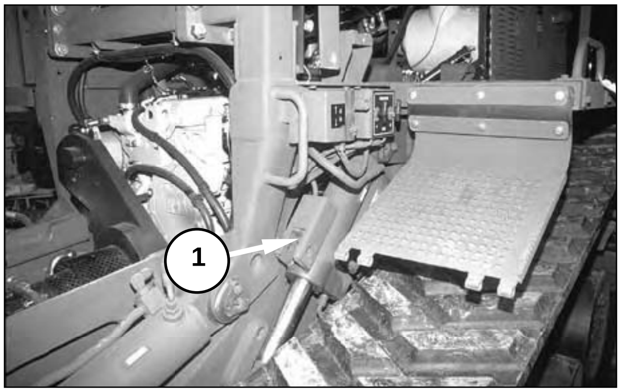


Kneeling Circuit.
(1) Kneeling limit switch. (2) Kneeling lamp. (3) Blackout relay. (4) Kneeling solenoids. (5) Auxiliary circuit breaker. (6) Kneeling switch. (7) Turn/flasher circuit breaker. (8) Blackout switch.

A lamp in the kneeling mode circuit alerts the operator when the machine is in the kneeling position. Switches in the circuit control operation of the kneeling mode and illumination of the kneeling lamp.

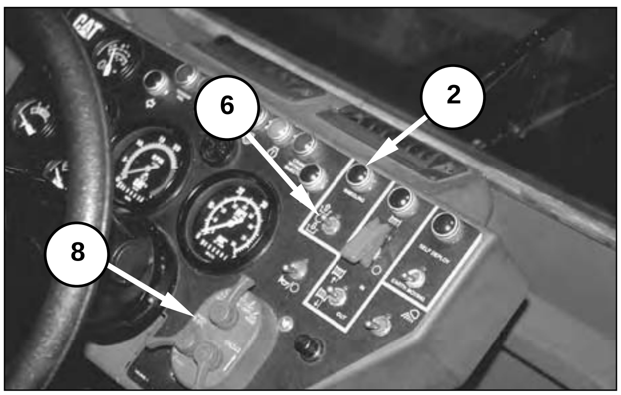
The components of the kneeling mode circuit are kneeling limit switch (1), kneeling lamp (2), blackout relay (3), kneeling solenoids (4), auxiliary circuit breaker (5), kneeling switch (6), turn/flasher circuit breaker (7), and blackout switch (8).

Component Location



Left Side of Machine, On Front Cylinder.
(1) Kneeling limit switch.

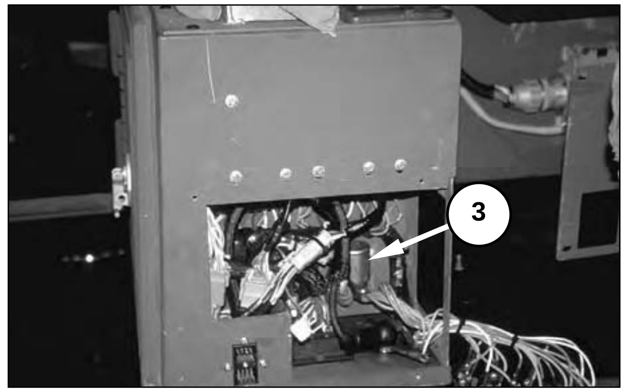
Kneeling limit switch (1) is mounted to the head end of the left front cylinder, inside the housing. The kneeling limit switch closes when the machine is in the fully LOWERED position.



Right Side of Instrument Panel.
(2) Kneeling lamp. (6) Kneeling switch. (8) Blackout switch.

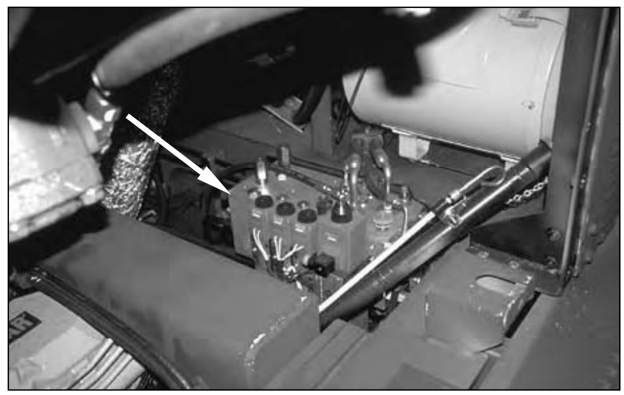
Kneeling switch (6) controls the raising and lowering of the front of the machine. When the front of the machine is lowered, kneeling limit switch (1) is closed, and kneeling lamp (2) is illuminated.

NOTE: Blackout switch (8) must be in the STOP LIGHT or one of the SERVICE DRIVE positions for kneeling lamp (2) to illuminate.

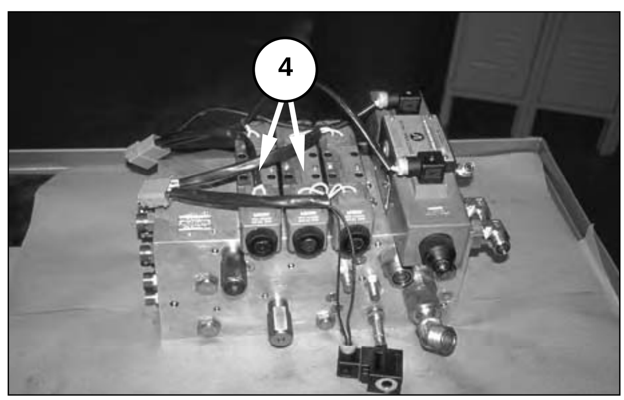


Right Console, Front View With Cover Removed.
(3) Blackout relay.

Blackout relay (3) is located inside the console, to the right of the operator. The blackout relay is normally open. The coil of the blackout relay receives power when blackout switch (8) is in the STOP LIGHT or one of the SERVICE DRIVE positions.

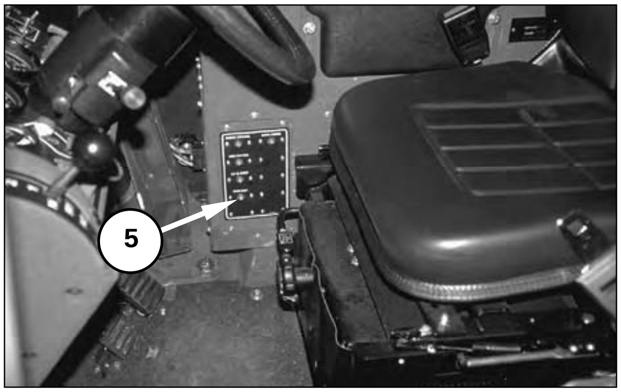


Multifunction Control Valve, Left Side of Machine.

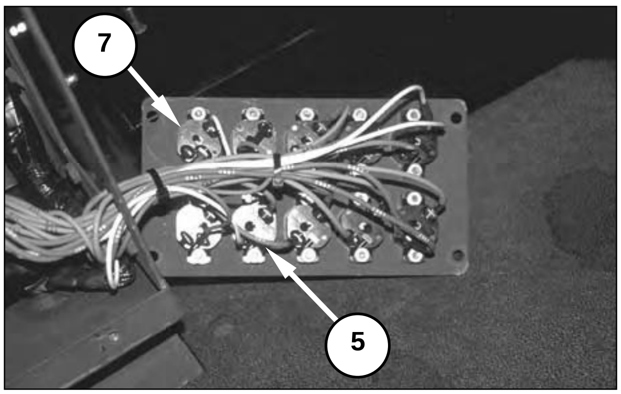


Multifunction Control Valve, Removed from Machine.
(4) Kneeling solenoids.

Kneeling solenoids (4) are mounted to the front face of the multifunction control valve. Kneeling switch (6) controls the operation of the kneeling solenoids.



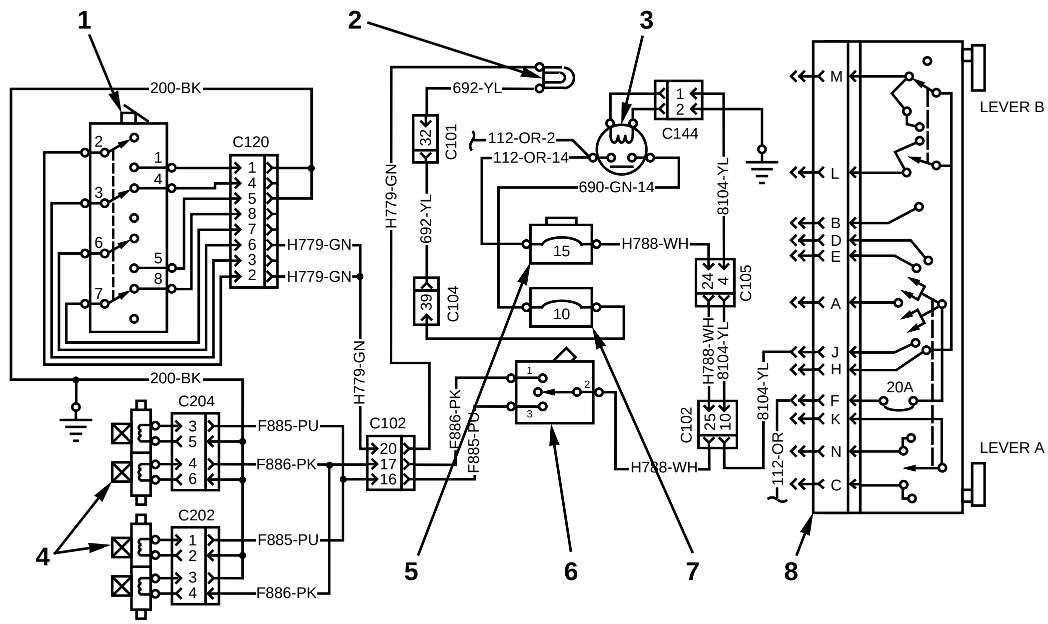
Front Circuit Breaker Panel.
(5) Auxiliary circuit breaker.



Front Circuit Breaker Panel, Back Side.
(5) Auxiliary circuit breaker. (7) Turn/flasher circuit breaker.

Auxiliary circuit breaker (5) is a manual-reset breaker rated at 15 amps. Turn/flasher circuit breaker (7) is an automatic-reset breaker rated at 10 amps.

Circuit Operation



Kneeling Circuit.
(1) Kneeling limit switch. (2) Kneeling lamp. (3) Blackout relay. (4) Kneeling solenoid. (5) Auxiliary circuit breaker. (6) Kneeling switch. (7) Turn/flasher circuit breaker. (8) Blackout switch.

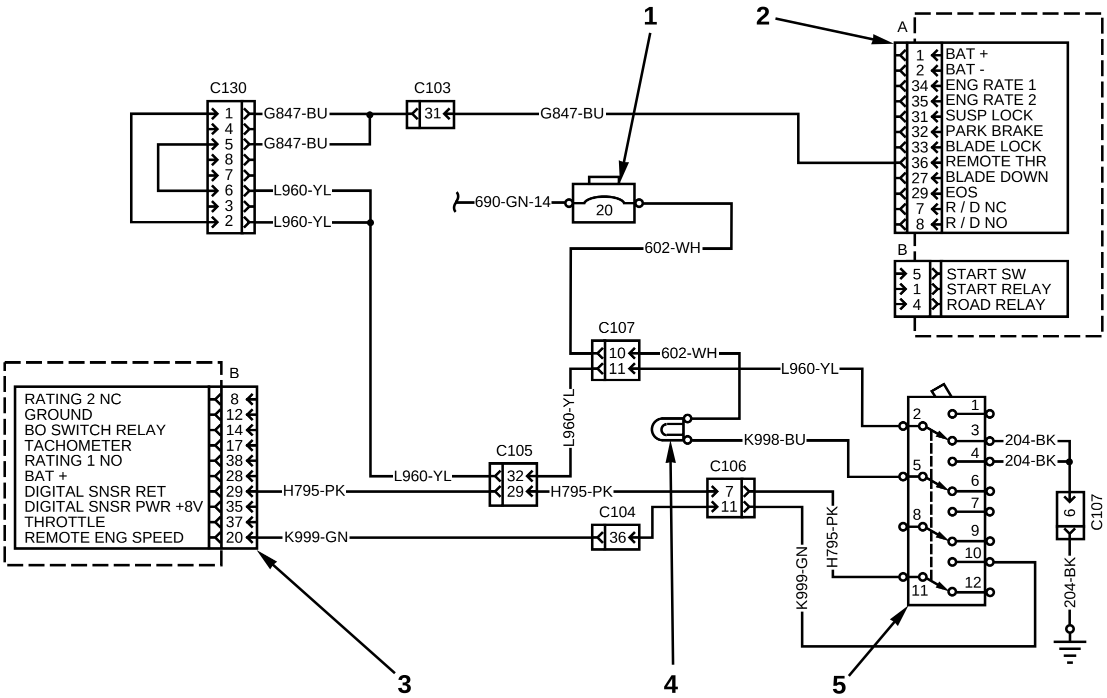
When blackout switch (8) is in the STOP LIGHT or one of the SERVICE DRIVE positions, blackout relay (3) is energized, and power from turn/flasher circuit breaker (7) is available at kneeling lamp (2). The ground path for the kneeling lamp is through kneeling limit switch (1). Contacts 1 and 2, and 5 and 6 of the kneeling limit switch are open when the machine is fully raised. Since power available at the kneeling lamp does not have a path to ground, the kneeling lamp does not illuminate.

Moving kneeling switch (6) to the LOWER position completes a ground path for power to flow from auxiliary circuit breaker (5) across contacts 1 and 2 of the kneeling switch to kneeling solenoid (4). The kneeling solenoid energizes, and the machine lowers.

As the machine lowers, contacts 1 and 2 and 5 and 6 of kneeling limit switch (1) close. When the kneeling limit switch is closed, a ground path is complete for current to flow through kneeling lamp (2), which illuminates.

When kneeling switch (6) is moved to the RAISE position, current is sent from auxiliary circuit breaker (5) across contacts 2 and 3 of the kneeling switch, to kneeling solenoid (4). The kneeling solenoid energizes, and the machine raises. As the machine raises, kneeling limit switch (1) opens, disconnecting the ground path for kneeling lamp (2) and causing the kneeling lamp to go out.

Remote Throttle Circuit

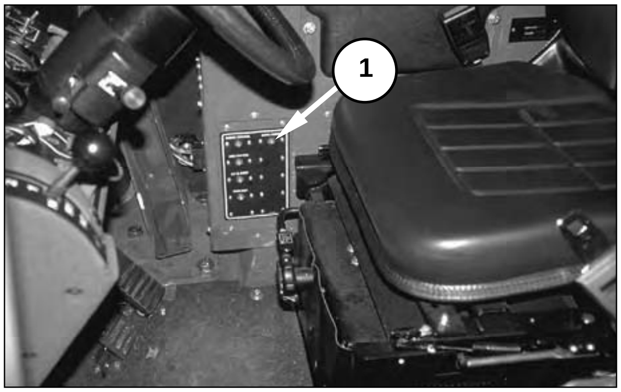


Remote Throttle Circuit.
(1) Horn/dome circuit breaker. (2) EPTC II. (3) ECM. (4) Remote throttle lamp. (5) Remote throttle switch.

The remote throttle circuit contains a lamp and the remote throttle switch. This circuit prevents the machine from moving when the remote throttle switch is ON.

The components of the remote throttle circuit are horn/dome circuit breaker (1), EPTC II (2), ECM (3), remote throttle lamp (4), and remote throttle switch (5).

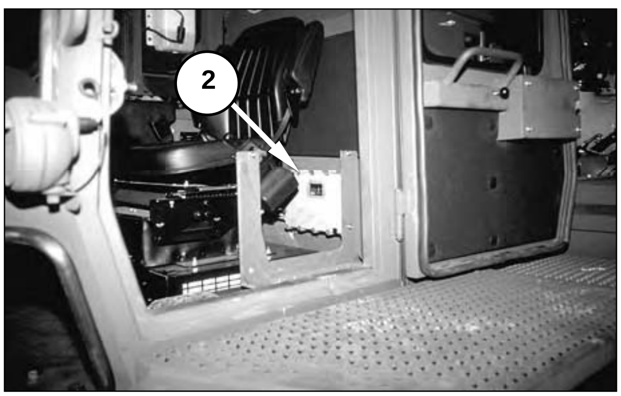
Component Location



Front Circuit Breaker Panel.
(1) Horn/dome circuit breaker.

Horn/dome circuit breaker (1) is a manual-reset breaker rated at 20 amps.

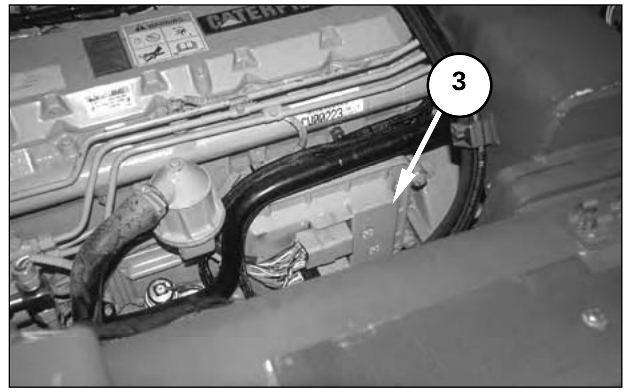
NOTE: The blackout switch must be in the STOP LIGHT or one of the SERVICE DRIVE positions for power to be available at horn/dome circuit breaker (1).



Inside Cab, Back Wall, Cover Removed.
(2) EPTC II.

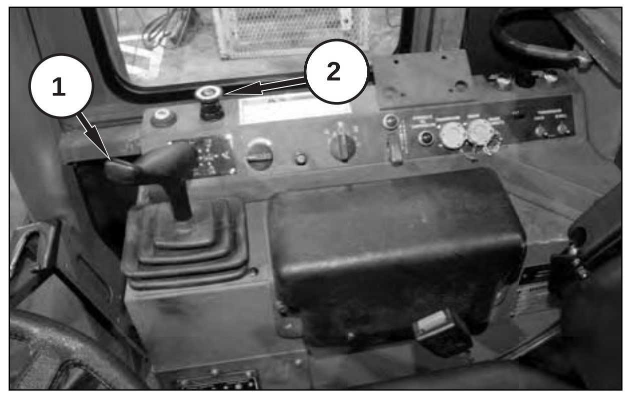
EPTC II (2) is mounted to the back wall of the cab. The EPTC II monitors the position of the remote throttle switch. When the remote throttle switch is in the ON position, the EPTC II checks the position of the park brake switch and shifts the transmission into NEUTRAL. EPTC II monitors the park brake switch. When the switch is down, the park brake disengages and the EPTC II will not send a signal to the engine ECM, and the remote throttle cannot be engaged.

NOTE: For additional information about the park brake, refer to “Systems Operation, Start, Charge, and Stop Circuit” in this module. For additional information about transmission control, refer to “Systems Operation, Transmission Control Circuit” in this module.



Left Side of Engine, Under Radiator.
(3) ECM.

ECM (3) is on the left side of the engine, under the radiator. The ECM monitors the position of remote throttle switch (5). When the remote throttle switch ON, the ECM disables the accelerator pedal and operates the engine at a constant 2400 rpm.

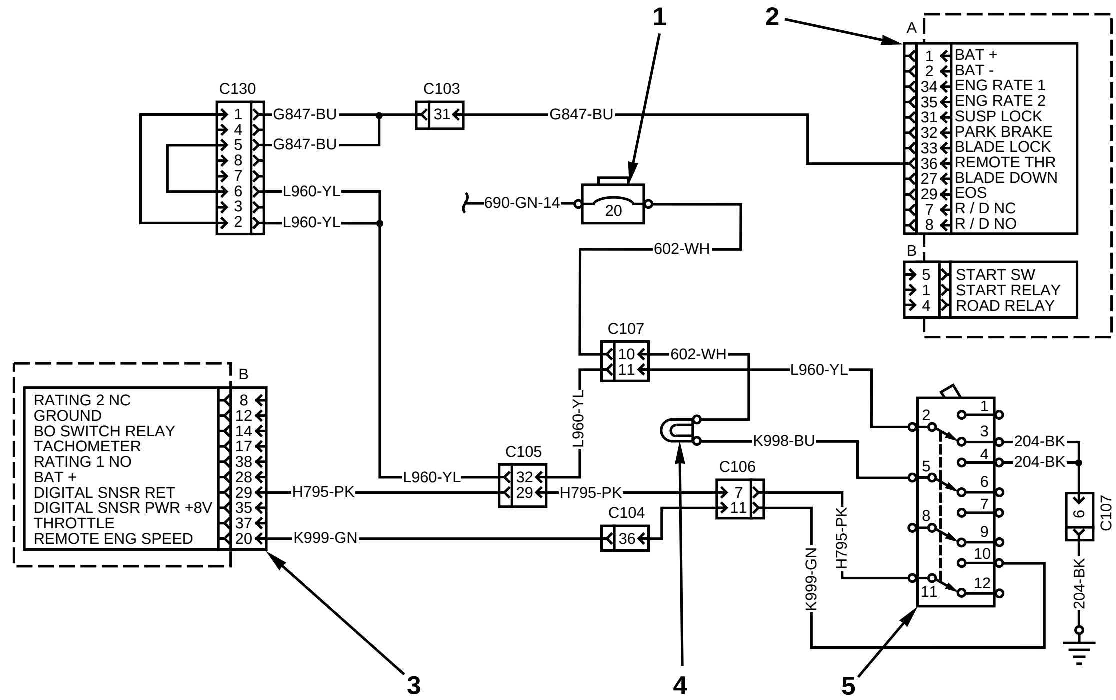


Right Console.
(4) Remote throttle lamp. (5) Remote throttle switch.

Remote throttle lamp (4) illuminates when remote throttle switch (5) is in the ON position.

NOTE: The blackout switch must be in the STOP LIGHT or one of the SERVICE DRIVE positions for remote throttle lamp (4) to illuminate.

Circuit Operation



Remote Throttle Circuit.
(1) Horn/dome circuit breaker. (2) EPTC II. (3) ECM. (4) Remote throttle lamp. (5) Remote throttle switch.

Remote Throttle Switch OFF

When the blackout switch is in the STOP LIGHT or one of the SERVICE DRIVE positions, power from horn/dome circuit breaker (1) is available at remote throttle lamp (4).

The ground path that allows power from horn/dome circuit breaker (1) to illuminate remote throttle lamp (4) is across contacts 5 and 4 of remote throttle switch (5). In the OFF position, contacts 5 and 4 of the remote throttle switch are open. Since no ground is present, the remote throttle lamp does not illuminate.

With remote throttle switch (5) in the OFF position, contacts 10 and 11 are open and the circuit between terminals B-20 and B-29 of ECM (3) is incomplete. The lack of a complete circuit between terminals B-20 and B-29 confirms to the ECM that the remote throttle switch is in the OFF position.

When remote throttle switch (5) is in the OFF position, contacts 2 and 3 of the switch are closed, and the ground circuit at terminal A-36 of EPTC II (2) is complete. The ground signal at terminal A-36 of the EPTC II confirms to the EPTC II that the remote throttle switch is in the OFF position.

Under these conditions, ECM (3) allows the input from the throttle control sensor to determine the engine speed.

NOTE: For information about engine control and the throttle control sensor, refer to “Systems Operation, ECM Circuit” in this module.

Remote Throttle Switch ON

When remote throttle switch (5) is in the ON position, contacts 2 and 3 are open, contacts 4 and 5 are closed, and contacts 10 and 11 are closed.

When contacts 2 and 3 of remote throttle switch (5) are open, the ground signal at terminal A-36 of EPTC II (2) is interrupted. The absence of a ground signal at terminal A-36 of the EPTC II confirms that the remote throttle switch is in the ON position.

With no ground signal at terminal A-36, EPTC II (2) generates an output signal which shifts the transmission to NEUTRAL, regardless of the position of the transmission gear lever.

NOTE: For a detailed description of park brake operation, refer to “Systems Operation, Start, Charge, and Stop Circuit” in this module. For a detailed description of the transmission control function of EPTC II (2), refer to “Systems Operation, Transmission Control Circuit” in this module.

EPTC II (2) prevents holds the transmission in NEUTRAL even after remote throttle switch (5) is returned to the OFF position, regardless of the position of the transmission gear lever.

The transmission control lever must be cycled into and out of NEUTRAL before EPTC II (2) will allow the transmission to shift.

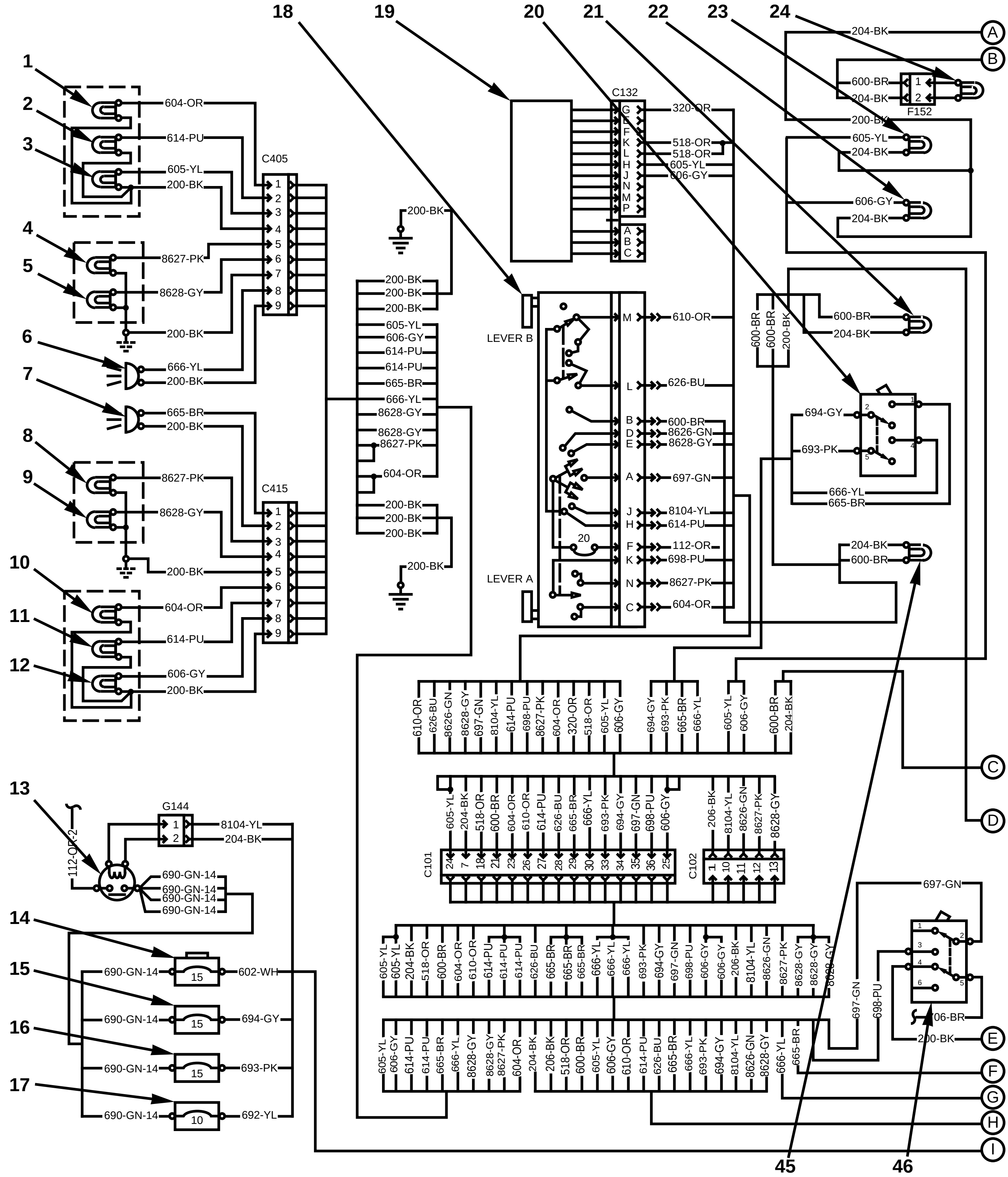
In the ON position, contacts 5 and 4 of remote throttle switch (5) are closed. Contacts 5 and 4 of the remote throttle switch provide the path for current to flow to ground from horn/dome circuit breaker (1) through remote throttle lamp (4). Since a ground path is present, the remote throttle lamp illuminates. The remote throttle lamp remains illuminated until the remote throttle switch returns to the OFF position.

With remote throttle switch (5) in the ON position, contacts 10 and 11 are closed, and the circuit between terminals B-20 and B-29 of ECM (3) is complete. The completed circuit between terminals B-20 and B-29 confirms to the ECM that the remote throttle switch is in the ON position.

After confirming that remote throttle switch (5) is ON, the ECM generates outputs which disengage the throttle control sensor and hold the engine speed at 2400 rpm.

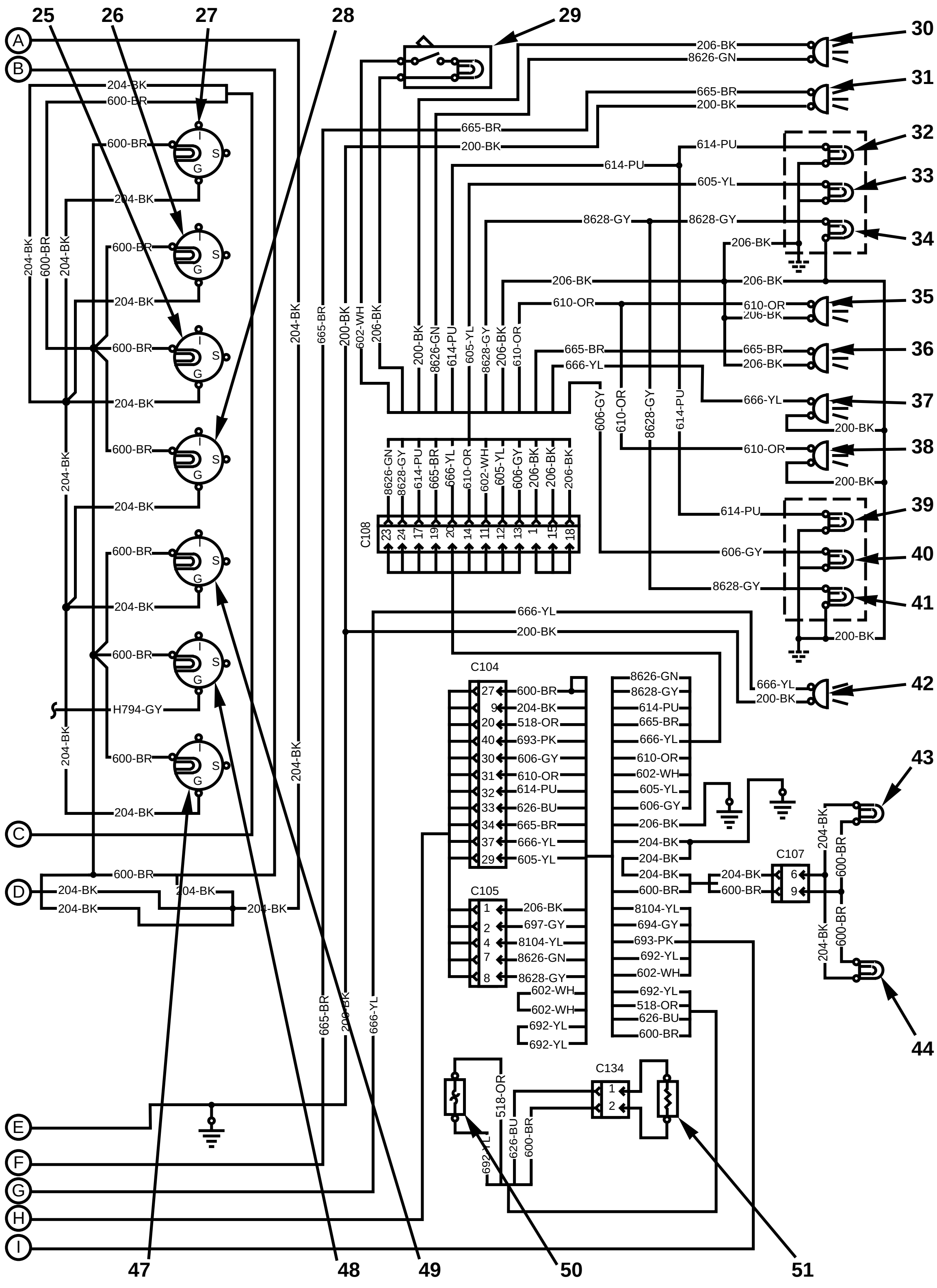
NOTE: For information about engine control and the throttle control sensor, refer to “Systems Operation, ECM Circuit” in this module.

Lighting Circuit



Lighting Circuit Schematic (Sheet 1).

(1) Left brake lamp. (2) Left tail lamp. (3) Left rear turn lamp. (4) Left blackout brake lamp. (5) Left blackout tail lamp. (6) Left rear work lamp. (7) Right rear work lamp. (8) Right blackout brake lamp. (9) Right blackout tail lamp. (10) Right brake lamp. (11) Right tail lamp. (12) Right rear turn lamp. (13) Blackout relay. (14) Horn/dome circuit breaker. (15) Left work lights circuit breaker. (16) Right work lights circuit breaker. (17) Turn/flasher circuit breaker. (18) Blackout switch. (19) Turn/hazard/horn switch. (20) Work lamp switch. (21) Panel lamp. (22) Right turn lamp. (23) Left turn lamp. (24) Shifter indicator lamp. (45) Panel lamp. (46) Service brake switch.



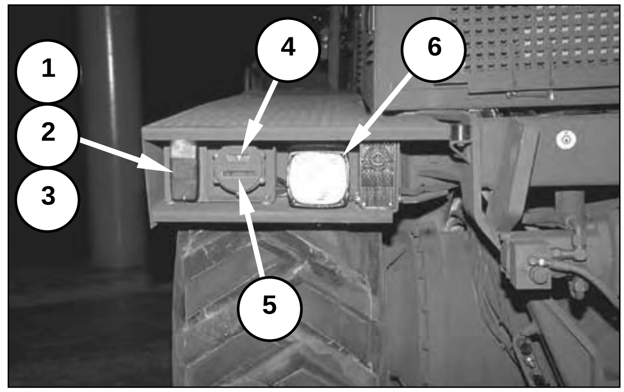
Lighting Circuit Schematic (Sheet 2).
(25) Gauge lamp. (26) Gauge lamp. (27) Gauge lamp. (28) Gauge lamp. (29) Dome lamp and switch. (30) Blackout head lamp. (31) Left front work lamp. (32) Left front marker lamp. (33) Left front turn lamp. (34) Left blackout marker lamp. (35) Left head lamp. (36) Left center work lamp. (37) Right center work lamp. (38) Right head lamp. (39) Right front marker lamp. (40) Right front turn lamp. (41) Right blackout marker lamp. (42) Right front work lamp. (43) Panel lamp. (47) Gauge lamp. (48) Gauge lamp. (49) Gauge lamp. (50) Flasher. (51) Dimmer resistor.

The lighting circuit controls operation of all lights on the machine except the tension fail, low brake pressure, blade down, engine oil pressure, start-aid, remote throttle, and hydraulic oil temperature warning lamps.

The main power relay supplies power to blackout switch (18). The position of the blackout switch dictates which of the machine lights operates.

The components of the lighting circuit are: left brake lamp (1), left tail lamp (2), left rear turn lamp (3), left blackout brake lamp (4), left blackout tail lamp (5), left rear work lamp (6), right rear work lamp (7), right blackout brake lamp (8), right blackout tail lamp (9), right brake lamp (10), right tail lamp (11), right rear turn lamp (12), blackout relay (13), horn/dome circuit breaker (14), left work lights circuit breaker (15), right work lights circuit breaker (16), turn/flasher circuit breaker (17), blackout switch (18), turn/hazard/horn switch (19), work lamp switch (20), panel lamp (21), right turn lamp (22), left turn lamp (23), shifter indicator lamp (24), gauge lamp (25), gauge lamp (26), gauge lamp (27), gauge lamp (28), dome lamp and switch (29), blackout head lamp (30), left front work lamp (31), left front marker lamp (32), left front turn lamp (33), left blackout marker lamp (34), left head lamp (35), left center work lamp (36), right center work lamp (37), right head lamp (38), right front marker lamp (39), right front turn lamp (40), right blackout marker lamp (41), right front work lamp (42), panel lamp (43), panel lamp (44), panel lamp (45), service brake switch (46), gauge lamp (47), gauge lamp (48), gauge lamp (49), flasher (50), and dimmer resistor (51).

Component Location

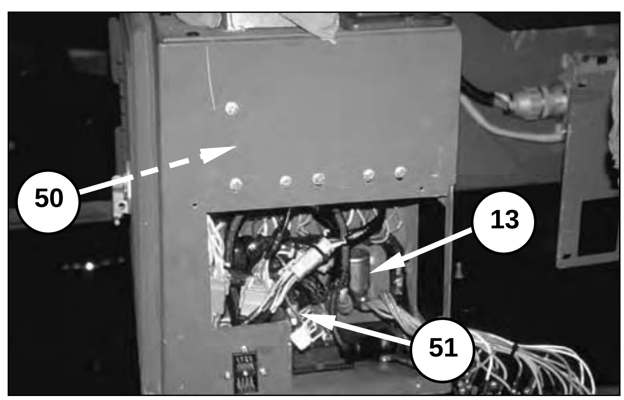


Rear of Machine, Left Side.
(1) Left brake lamp. (2) Left tail lamp. (3) Left rear turn lamp. (4) Left blackout brake lamp. (5) Left blackout tail lamp. (6) Left rear work lamp.

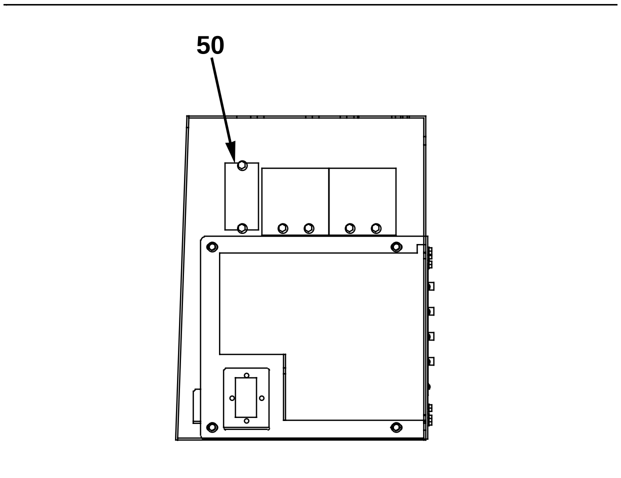
NOTE: The light configuration on the right rear of the machine (components [7] through [12]) is a mirror image of the left rear lights.

The left rear of the machine contains three lamp assemblies. The left lamp assembly contains left brake lamp (1), left tail lamp (2), and left rear turn lamp (3). The center lamp assembly contains left blackout brake lamp (4) and left blackout tail lamp (5). The right lamp assembly is left rear work lamp (6).

Blackout switch (18) must be in either the BLACKOUT DRIVE or BLACKOUT MARKER position for the blackout tail lamps and the blackout brake lamps to illuminate. To illuminate the brake lamps, rear work lamps, and rear turn lamps, the blackout switch must be in either the STOP LIGHT or SERVICE DRIVE position. The tail lamps will only illuminate when the blackout switch is in the SERVICE DRIVE position.



Right Console, Front View With Cover Removed.
(13) Blackout relay. (50) Flasher. (51) Dimmer resistor.

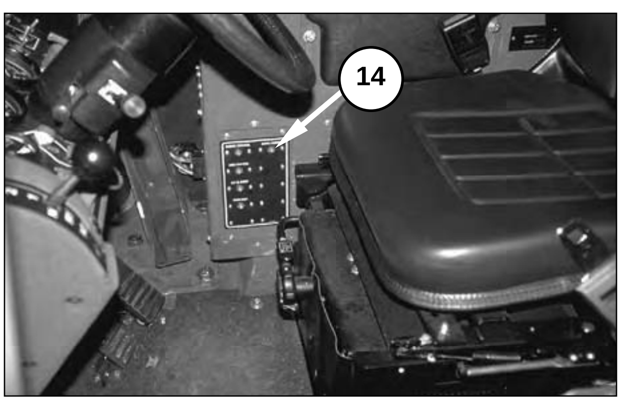


Right Console, Front View.
(50) Flasher.

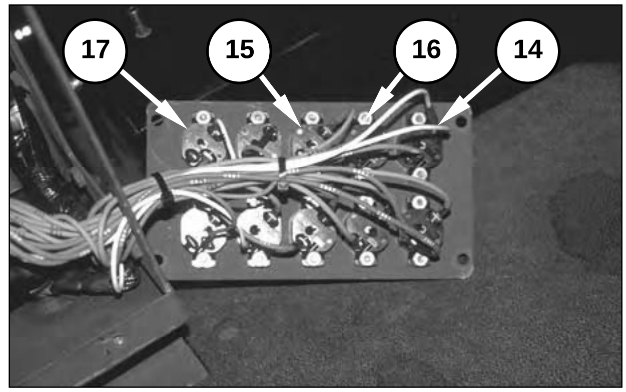
Blackout relay (13) is located inside the console, to the right of the operator. The blackout relay is normally open. The coil of the blackout relay receives power when blackout switch (18) is in the STOP LIGHT or one of the SERVICE DRIVE positions.

Flasher (50) is mounted on the bottom of the right console, behind the circuit breaker panel. The blackout switch must be in the STOP LIGHT or SERVICE DRIVE position for the flasher to receive power. When turn/hazard/horn switch (19, shown on next page) is in the LEFT TURN, RIGHT TURN, or FLASHER position, the flasher causes the signal lamps to flash 75 ± 15 times per minute.

Dimmer resistor (51) is mounted under the right console, behind the circuit breaker panel. When the top lever of blackout switch (18) is in the SERVICE DRIVE position and bottom left lever is in the PARK or PANEL DIM position, current flows through dimmer resistor (51) before flowing to the panel and gauge lamps.

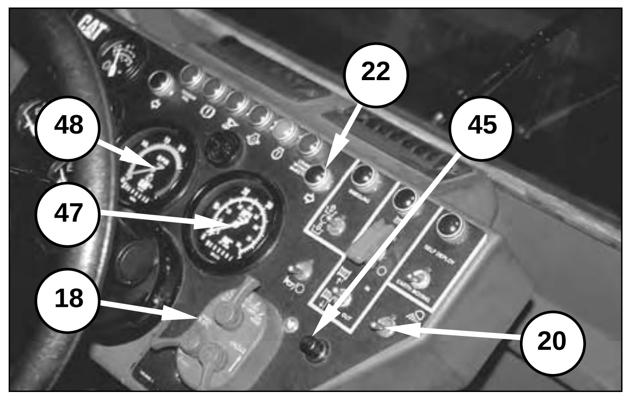


Front Circuit Breaker Panel.
(14) Horn/dome circuit breaker.



Front Circuit Breaker Panel, Back Side.
(14) Horn/dome circuit breaker. (15) Left work lights circuit breaker. (16) Right work lights circuit breaker. (17) Turn/flasher circuit breaker.

Horn/dome circuit breaker (14) is a manual-reset breaker rated at 15 amps. Left work lights circuit breaker (15) and right work lights circuit breaker (16) are automatic-reset breakers rated at 15 amps. Turn/flasher circuit breaker (17) is an automatic-reset breaker rated at 10 amps.



Right Side of Instrument Panel.
(18) Blackout switch. (20) Work lamp switch. (22) Right turn lamp. (45) Panel lamp. (47) Gauge lamp. (48) Gauge lamp.

Blackout switch (18) is on the lower right side of the instrument panel. The blackout switch contains three control levers. The lever at the top of the switch can be moved into one of five positions. Beginning from the far left position and moving clockwise, the function of each switch position is:

- BLACKOUT DRIVE
- BLACKOUT MARKER
- OFF
- STOP LIGHT
- SERVICE DRIVE

The bottom left lever on blackout switch (18) has four positions. Beginning from the top position and moving counterclockwise, the function of each switch position is:

- PANEL BRIGHT
- PANEL DIM
- OFF
- PARK

NOTE: The top lever must be in the SERVICE DRIVE position for the bottom left lever to work.

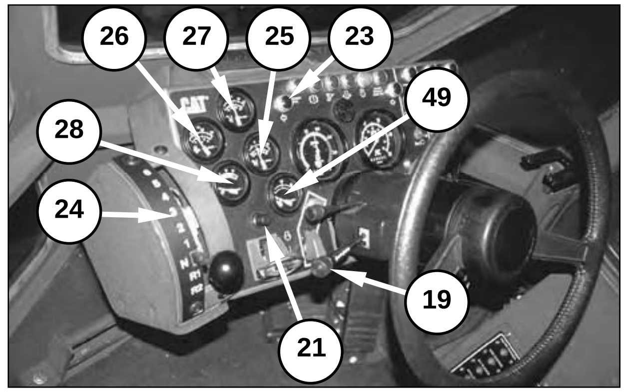
The bottom right lever on blackout switch (18) is a locking mechanism for the blackout switch. This locking lever contains two positions. The upper position is the UNLOCK position. When the bottom right lever is in the UNLOCK position, the left lever and top lever of the blackout switch can be freely moved. The bottom position is the LOCK position.

Work lamp switch (20) controls the front and rear work lamps and working lights. Blackout switch (18) must be in the STOP LIGHT or the SERVICE DRIVE position to enable the work lamp switch to function.

Right turn lamp (22) flashes when the turn/hazard/horn switch is in the RIGHT TURN position. Blackout switch (18) must be in the STOP LIGHT or the SERVICE DRIVE position for the right turn lamp to illuminate.

Panel lamp (45) is one of four panel lamps in the lighting circuit. Gauge lamps (47 and 48) illuminate the faces of the speedometer and tachometer.

The top lever of blackout switch (18) must be in the SERVICE DRIVE position while the bottom left lever of the blackout switch is in the PARK, PANEL DIM, or PANEL BRIGHT position for the panel and gauge lamps to illuminate. In the PARK and PANEL DIM positions, the panel and gauge lamps will not be as brightly illuminated as they are when the left lever on the blackout switch is in the PANEL BRIGHT position.

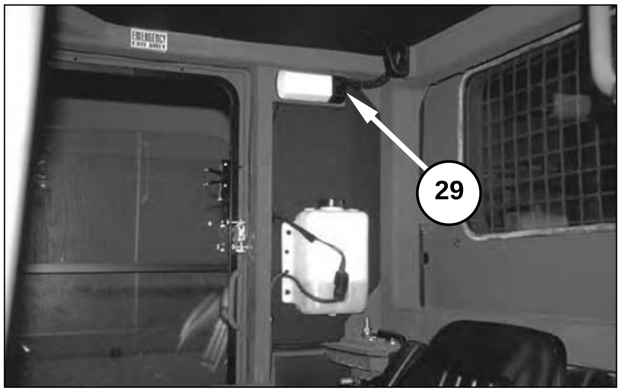


Left Side of Instrument Panel.
(19) Turn/hazard/horn switch. (21) Panel lamp. (23) Left turn lamp. (24) Shifter indicator lamp. (25) Gauge lamp. (26) Gauge lamp. (27) Gauge lamp. (28) Gauge lamp. (49) Gauge lamp.

Turn/hazard/horn switch (19) is at the base of the turn signal lever. Left turn lamp (23) illuminates when the turn/hazard/horn switch is in the LEFT TURN position. Blackout switch (18) must be in the STOP LIGHT or SERVICE DRIVE position for the turn/horn/hazard switch to receive power and the left turn lamp to illuminate.

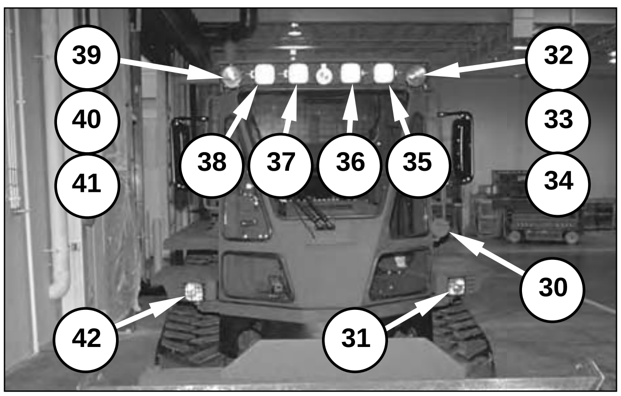
Panel lamp (21) is one of four panel lamps in the lighting circuit. Shifter indicator lamp (24) illuminates the face of the transmission control lever. Gauge lamps (25, 26, 27, 28, and 49) illuminate the faces of the transmission oil temperature gauge, engine oil pressure gauge, coolant temperature gauge, voltmeter, and fuel level gauge.

The top lever of blackout switch (18) must be in the SERVICE DRIVE position while the bottom left lever of the blackout switch is in the PARK, PANEL DIM, or PANEL BRIGHT position for the panel, shifter indicator, and gauge lamps to illuminate. In the PARK and PANEL DIM positions, the lamps will not be as brightly illuminated as they are when the left lever on the blackout switch is in the PANEL BRIGHT position.



Right Rear Corner of Cab.
(29) Dome lamp and switch.

Dome lamp and switch (29) is in the right rear corner of the cab, near the roof. The blackout switch must be in the STOP LIGHT or SERVICE DRIVE position for the dome lamp switch to illuminate the dome lamp.



Front of Machine.
(30) Blackout head lamp. (31) Left front work lamp. (32) Left front marker lamp. (33) Left front turn lamp. (34) Left blackout marker lamp. (35) Left head lamp. (36) Left center work lamp. (37) Right center work lamp. (38) Right head lamp. (39) Right front marker lamp. (40) Right front turn lamp. (41) Right blackout marker lamp. (42) Right front work lamp.

Blackout head lamp (30) is mounted below the mirror, on the left side of the machine. Blackout switch (18) must be in the BLACKOUT DRIVE position for the blackout head lamp to illuminate.

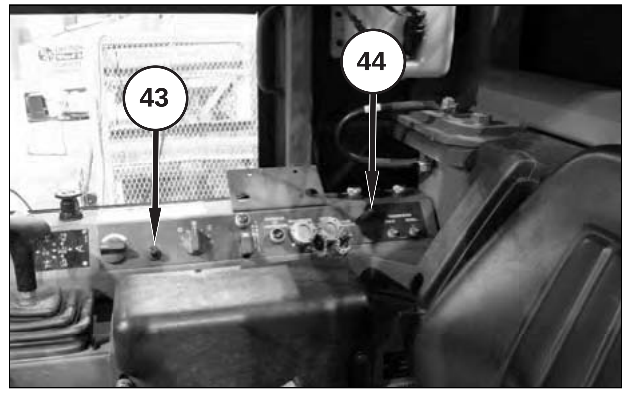
Left and right blackout marker lamps (34 and 41) illuminate when blackout switch (18) is in either the BLACKOUT DRIVE or BLACKOUT MARKER position.

Left and right center work lamps (36 and 37), and left and right front work lamps (31 and 42) illuminate when blackout switch (18) is in STOP LIGHT or the SERVICE DRIVE position and the work lamp switch is ON.

Left front and right front turn lamps (33 and 40) illuminate when blackout switch (18) is in the STOP LIGHT or the SERVICE DRIVE position.

Left and right front marker lamps (32 and 39) illuminate when blackout switch (18) is in the SERVICE DRIVE position.

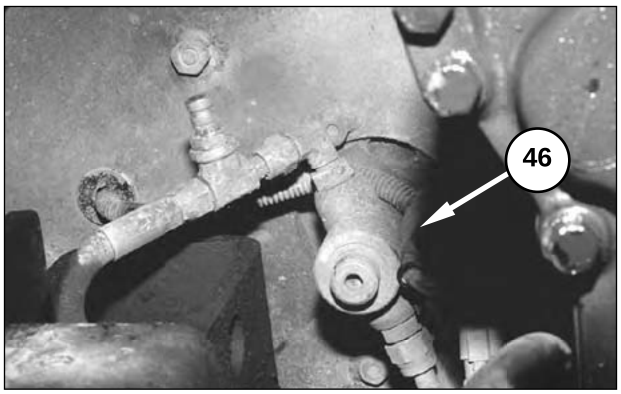
Left and right head lamps (35 and 38) illuminate when the top lever of blackout switch (18) is in the SERVICE DRIVE position and the bottom left lever of the blackout switch is in the OFF, PANEL DIM, or PANEL BRIGHT position.



Right Console.
(43) Panel lamp. (44) Panel lamp.

Panel lamps (43 and 44) are on the right console. The top lever of blackout switch (18) must be in the SERVICE DRIVE position while the bottom left lever of the blackout switch is in the PARK, PANEL DIM, or PANEL BRIGHT position for the panel lamps to illuminate. In the PARK and PANEL DIM positions, the panel lamps will not be as brightly illuminated as they are when the left lever on the blackout switch is in the PANEL BRIGHT position.

Inside Cab (Brake Pedal [Arrow] Shown for Location Reference).

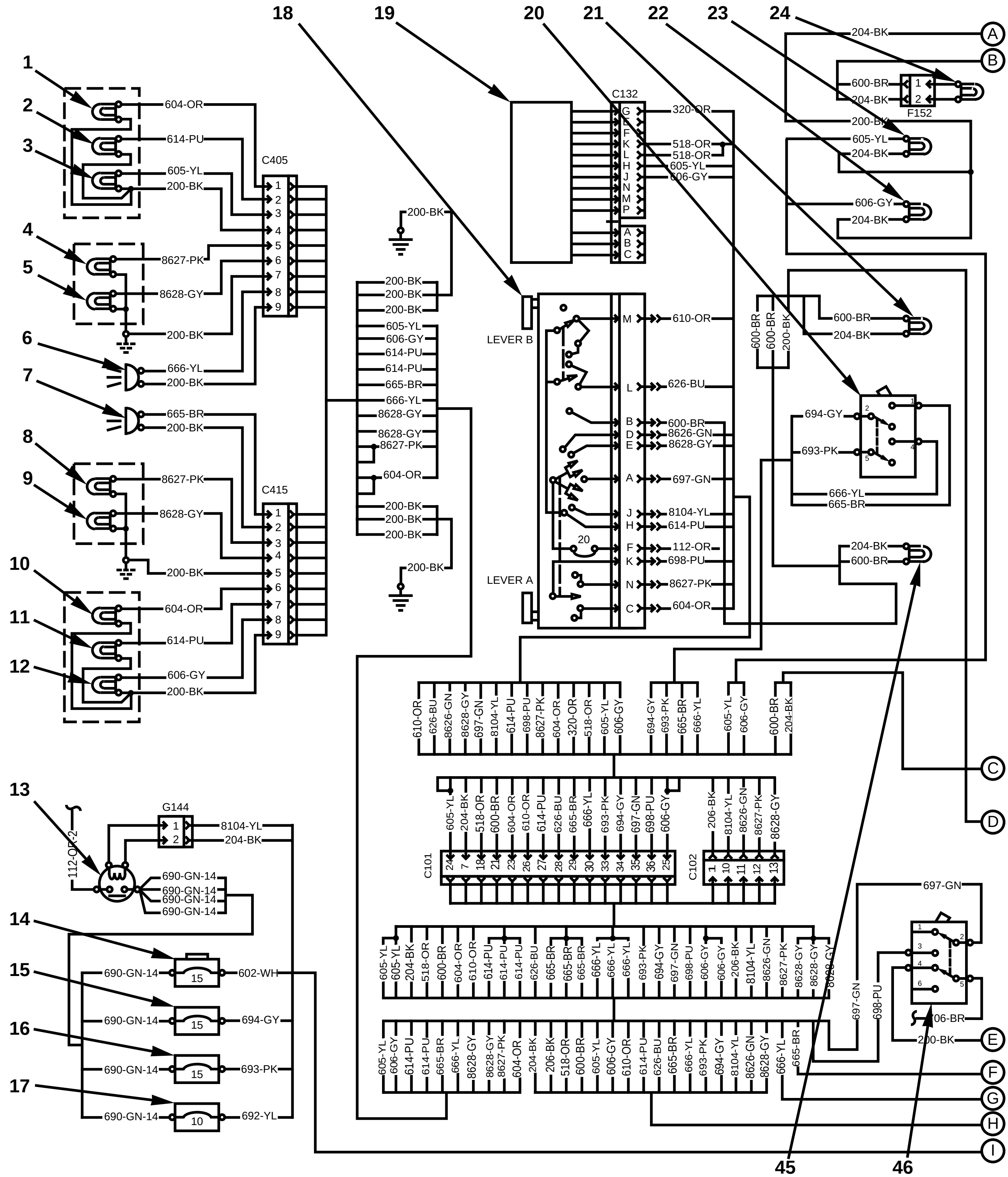


Front of Machine, Under Cab, Attached to Brake Pedal.
(46) Service brake switch.

Service brake switch (46) is under the brake pedal. Two power input sources allow the service brake switch to serve two functions: the switch confirms the status of the brakes (ENGAGED or RELEASED) to the EPTC II and also illuminates the brake lamps when the brake pedal is depressed.

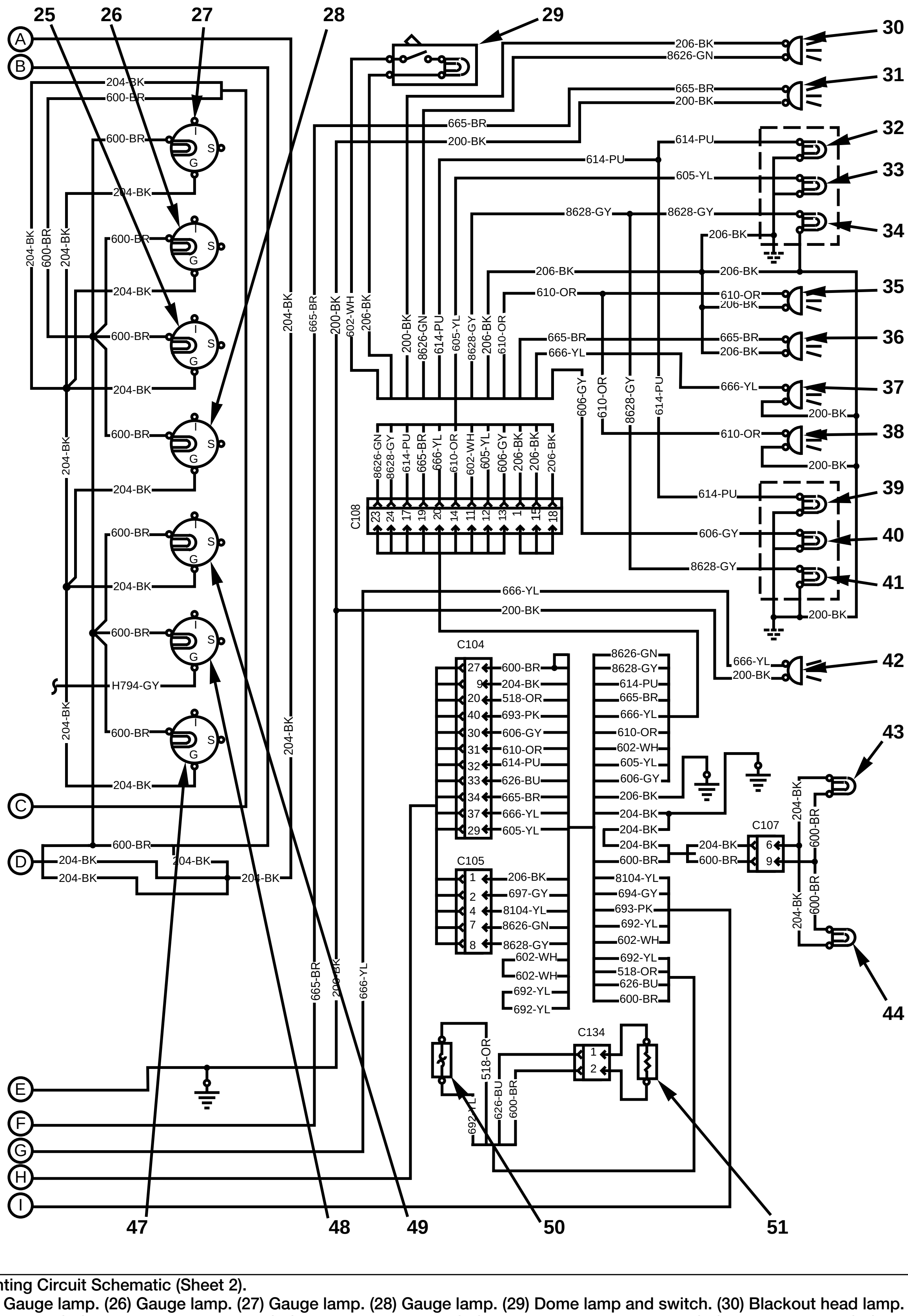
The position of blackout switch (18) controls one of the power inputs to service brake switch (46). In all positions of the blackout switch except for when the top lever of the blackout switch is in the OFF position, power is available to illuminate the brake lamps. The EPTC II function of the switch is independent of the position of the blackout switch.

Circuit Operation



Lighting Circuit Schematic (Sheet 1).

(1) Left brake lamp. (2) Left tail lamp. (3) Left rear turn lamp. (4) Left blackout brake lamp. (5) Left blackout tail lamp. (6) Left rear work lamp. (7) Right rear work lamp. (8) Right blackout brake lamp. (9) Right blackout tail lamp. (10) Right brake lamp. (11) Right tail lamp. (12) Right rear turn lamp. (13) Blackout relay. (14) Horn/dome circuit breaker. (15) Left work lights circuit breaker. (16) Right work lights circuit breaker. (17) Turn/flasher circuit breaker. (18) Blackout switch. (19) Turn/hazard/horn switch. (20) Work lamp switch. (21) Panel lamp. (22) Right turn lamp. (23) Left turn lamp. (24) Shifter indicator lamp. (45) Panel lamp. (46) Service brake switch.



Lighting Circuit Schematic (Sheet 2).

(25) Gauge lamp. (26) Gauge lamp. (27) Gauge lamp. (28) Gauge lamp. (29) Dome lamp and switch. (30) Blackout head lamp. (31) Left front work lamp. (32) Left front marker lamp. (33) Left front turn lamp. (34) Left blackout marker lamp. (35) Left head lamp. (36) Left center work lamp. (37) Right center work lamp. (38) Right head lamp. (39) Right front marker lamp. (40) Right front turn lamp. (41) Right blackout marker lamp. (42) Right front work lamp. (43) Panel lamp. (47) Gauge lamp. (48) Gauge lamp. (49) Gauge lamp. (50) Flasher. (51) Dimmer resistor.

Blackout Switch OFF

Contact F of blackout switch (18) receives power from the main power relay. When lever A of the blackout switch is in the OFF position, the blackout switch prevents all lamps from illuminating except five warning lamps: tension fail, low brake pressure, blade down, engine oil pressure, and hydraulic oil temperature.

NOTE: For a detailed description of operation of the warning lamps, refer to "Systems Operation, Lamp Test Circuit" in this module.

Blackout Switch BLACKOUT DRIVE

NOTE: When blackout switch (18) is in the BLACKOUT DRIVE position, several lamps operate: blackout head lamp (30); left and right blackout tail lamps (5 and 9); left and right blackout marker lamps (34 and 41); left and right blackout brake lamps (4 and 8); and the warning lamps for tension fail, low brake pressure, blade down, engine oil pressure, and hydraulic oil temperature. For a detailed description of operation of the warning lamps, refer to "Systems Operation, Lamp Test Circuit" in this module.

Moving lever A of blackout switch (18) to the BLACKOUT DRIVE position delivers power to contacts D, E, and A of the switch. Power at contact D of the blackout switch transfers to blackout head lamp (30). Current flowing through the blackout head lamp illuminates the lamp.

Power at contact E of blackout switch (18) transfers to left and right blackout tail lamps (5 and 9) and left and right blackout marker lamps (34 and 41). Current flowing through these lamps causes the lamps to illuminate.

Power at contact A of blackout switch (18) transfers to contact 2 of service brake switch (46). When the service brakes are released, contacts 2 and 3 of the service brake switch open. Contacts 2 and 3 close when the service brakes are engaged.

When the service brakes are engaged, current flows from contact 2 to contact 3 of service brake switch (46) and to contact K of blackout switch (18). Current flows from contact K to contact N of the blackout switch and to left and right blackout brake lamps (4 and 8). The right and left blackout brake lamps illuminate to indicate that the brakes are engaged.

Blackout Switch BLACKOUT MARKER

NOTE: In the BLACKOUT MARKER position, several lamps operate: left and right blackout tail lamps (5 and 9); left and right blackout marker lamps (34 and 41); left and right blackout brake lamps (4 and 8); and tension fail, low brake pressure, blade down, engine oil pressure, and hydraulic oil temperature warning lamps.

Moving lever A of blackout switch (18) to the BLACKOUT MARKER position delivers power to contacts E and A of the switch. Power at contact E of the blackout switch transfers to left and right blackout tail lamps (5 and 9) and left and right blackout marker lamps (34 and 41). Current flowing through these lamps causes the lamps to illuminate.

Power at contact A of blackout switch (18) transfers to contact 2 of service brake switch (46). When the service brakes are released, contacts 2 and 3 of the service brake switch open. Contacts 2 and 3 close when the service brakes are engaged.

Power available at contact 2 of service brake switch (46) transfers to contact K of blackout switch (18). Current flows from contact K to contact N of the blackout switch and to left and right blackout brake lamps (4 and 8). The right and left blackout brake lamps illuminate to indicate that the brakes are engaged.

Blackout Switch STOP LIGHT

NOTE: Several lamps operate in the STOP LIGHT position: left and right brake lamps (1 and 10); dome lamp (29); left and right rear work lamps (6 and 7); left and right center work lamps (36 and 37); left and right front work lamps (31 and 42); right and left turn lamps (22 and 23); left and right rear turn signal lamps (3 and 12); left and right front turn signal lamps (33 and 40). The tension fail, low brake pressure, blade down, engine oil pressure, and hydraulic oil temperature warning lamps also operate in this position. For a detailed description of operation of the warning lamps, refer to "Systems Operation, Lamp Test Circuit" in this module.

Moving lever A of blackout switch (18) to the STOP LIGHT position delivers power to contacts A and J of the switch. Power at contact A of the blackout switch transfers to contact 2 of service brake switch (46). When the service brakes are released, contacts 2 and 3 of the service brake switch open. Engaging the service brake closes contacts 2 and 3.

When the service brakes are engaged, current flows from contact 2 to contact 3 of service brake switch (46) and to contact K of blackout switch (18). Current flows from contact K to contact C of the blackout switch and to left and right brake lamps (1 and 10). The right and left brake lamps illuminate to indicate that the brakes are engaged.

Power at contact J of blackout switch (18) transfers to the coil of blackout relay (13). The coil energizes and the relay closes, allowing current from the main power relay (in the 112-OR-2 wire) to flow to horn/dome circuit breaker (14), left work lights circuit breaker (15), right work lights circuit breaker (16), and turn/flasher circuit breaker (17).

Power from horn/dome circuit breaker (14) is available at dome lamp (29). The dome light illuminates when the dome light switch is in the ON position.

NOTE: Horn/dome circuit breaker (14) also transfers power to other components. For descriptions of other components the horn/dome circuit breaker supplies, refer to “Remote Throttle Circuit” and “Gauges and Auxiliary Circuit.”

Power from left work lights circuit breaker (15) transfers to contact 2 of work lamp switch (20), and power from right work lights circuit breaker (16) transfers to contact 5 of the work lamp switch. In the OFF position, the work lamp switch contacts are open. Moving the work lamp switch to the ON position closes the switch contacts.

With work lamp switch (20) in the ON position, current flows from contact 2 of the work lamp switch to right rear work lamp (7), left center work lamp (36), and left front work lamp (31). Current from contact 5 of the work lamp switch flows to left rear work lamp (6), right center work lamp (37), and right front work lamp (42).

Power from turn/flasher circuit breaker (17) transfers to flasher (50). Beyond the flasher, voltage is present at terminals K and L of turn/hazard/horn switch (19). When the turn/hazard/horn switch is in the OFF position, terminals K and L are not connected to ground.

NOTE: Turn/flasher circuit breaker (17) also transfers power to other components also. For descriptions of other components the turn/flasher circuit breaker supplies, refer to the following sections in the “Systems Operation” section of this module: “Winch Control Circuit,” “Self-Deploy/Earthmoving Circuit,” and “Kneeling Circuit” in the “Systems Operation.”

Moving turn/hazard/horn switch (19) to the RIGHT TURN position connects terminal L to terminal J. Flasher (50) cycles current flow through terminal J of the turn/hazard/horn switch at 75 ± 15 cycles per minute. This cycling of current causes right turn lamp (22), right rear turn lamp (12), and right front turn lamp (40) to flash.

Moving turn/hazard/horn switch (19) to the LEFT TURN position connects terminal L to terminal H. Flasher (50) cycles current flow through terminal H of the turn/hazard/horn switch at 75 ± 15 cycles per minute. This cycling of current causes left turn lamp (23), left rear turn lamp (3), and left front turn lamp (33) to flash.

Moving turn/hazard/horn switch (19) to the HAZARD position connects terminals K and L to terminals H and J. Flasher (50) cycles current flow to right and left turn lamps (22 and 23), left and right rear turn lamps (3 and 12), and left and right front turn lamps (33 and 40), causing the lights to flash.

Blackout Switch, SERVICE DRIVE, OFF

NOTE: The SERVICE DRIVE position enables all lights, except the blackout lamps, on the machine to function.

Moving lever A of blackout switch (18) to the SERVICE DRIVE position delivers power to contacts A, J, and H and enables lever B to function.

Power at contact A enables service brake switch (46) to illuminate left and right brake lamps (1 and 10) when the brakes are engaged. Refer to “Blackout Switch STOP LIGHT” in this section for a description of this circuit.

Power at contact J of blackout switch (18) energizes the coil of blackout relay (13), delivering power to horn/dome circuit breaker (14), left work lights circuit breaker (15), right work lights circuit breaker (16), and turn/flasher circuit breaker (17). Refer to “Blackout Switch STOP LIGHT” in this section for a description of this circuit.

Power at contact H of blackout switch (18) sends current to illuminate left and right tail lamps (2 and 11) and left and right front marker lamps (32 and 39). Also, when lever B is in the OFF position, current from contact H flows to contact M of the blackout switch. Current from contact H of lever B illuminates left and right head lamps (35 and 38).

NOTE: With lever B of blackout switch (18) in the OFF position, none of the panel lamps will illuminate.

Blackout Switch, SERVICE DRIVE, PARK

NOTE: Refer to the above description for information on the SERVICE DRIVE position.

When lever B of blackout switch (18) is moved to the PARK position, with lever A in the SERVICE DRIVE position, power transfers to contact L, but power is removed from contact M of the blackout switch. The circuit to left and right head lamps (35 and 38) is broken when power is removed from contact M.

Power available at contact L transfers to dimmer resistor (51). The dimmer resistor reduces the voltage, transferring a lower power level to panel lamps (21, 43, 44, and 45), shifter indicator lamp (24), and gauge lamps (25, 26, 27, 28, 47, 48, and 49). The lights illuminate at the dim setting.

Blackout Switch, SERVICE DRIVE, PANEL DIM

NOTE: Refer to the above description for information on the SERVICE DRIVE position.

Moving lever B of blackout switch (18) to the PANEL DIM position, with lever A in the SERVICE DRIVE position, transfers power to contacts M and L of the blackout switch. Power from contact M illuminates left and right head lamps (35 and 38). After flowing through dimmer resistor (51), current from contact L illuminates panel lamps (21, 43, 44, and 45), shifter indicator lamp (24), and gauge lamps (25, 26, 27, 28, 47, 48, and 49) at the dim setting.

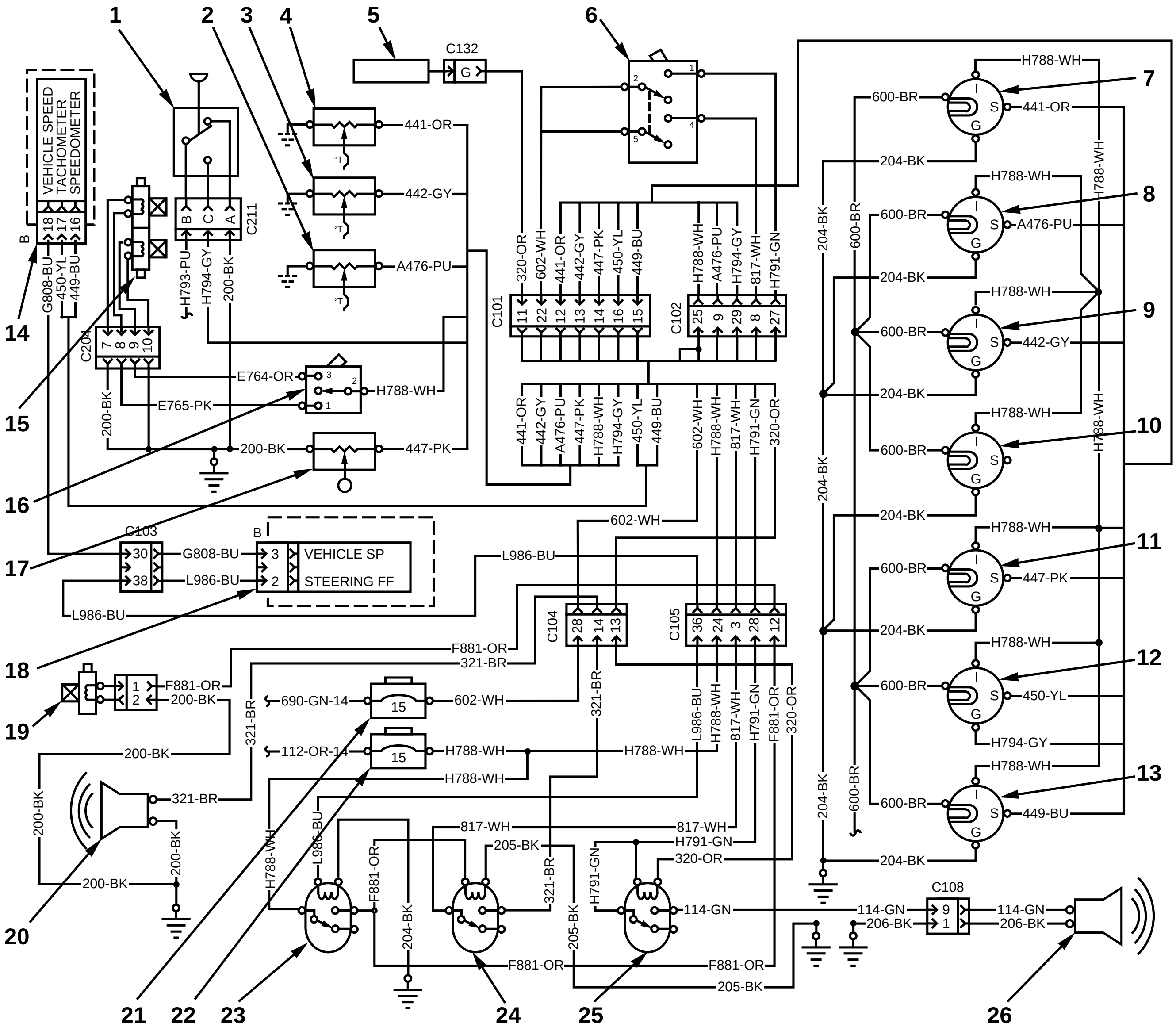
Blackout Switch, SERVICE DRIVE, PANEL BRIGHT

NOTE: Refer to the above description for information on the SERVICE DRIVE position.

When lever B of blackout switch (18) is moved to the PANEL BRIGHT position, power transfers to contacts M and B of the blackout switch. Power from contact M illuminates left and right head lamps (35 and 38).

Power available at contact B of blackout switch (18) transfers undiminished to panel lamps (21, 43, 44, and 45), shifter indicator lamp (24), and gauge lamps (25, 26, 27, 28, 47, 48, and 49). The lamps illuminate at the bright setting.

Gauges and Auxiliary Circuit



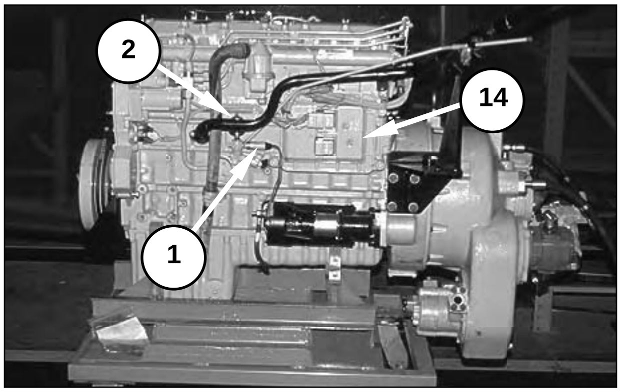
Gauges and Auxiliary Circuit Schematic.

(1) Engine oil pressure switch. (2) Engine oil pressure sensor. (3) Transmission oil temperature sensor. (4) Coolant temperature sensor. (5) Turn/hazard/horn switch. (6) Horn on/off switch. (7) Engine coolant temperature gauge. (8) Engine oil pressure gauge. (9) Transmission oil temperature gauge. (10) Voltmeter. (11) Fuel level gauge. (12) Tachometer. (13) Speedometer. (14) ECM. (15) Charge solenoid. (16) Charge switch. (17) Fuel level sender. (18) EPTC II. (19) Steering solenoid. (20) Backup alarm. (21) Horn/dome circuit breaker. (22) Auxiliary circuit breaker. (23) Steering relay. (24) Backup relay. (25) Horn relay. (26) Horn.

The gauges and auxiliary circuit contains gauges and sensors which monitor the operating condition of various machine systems. This circuit also controls operation of the horn and backup alarm, as well as the track tension charge system.

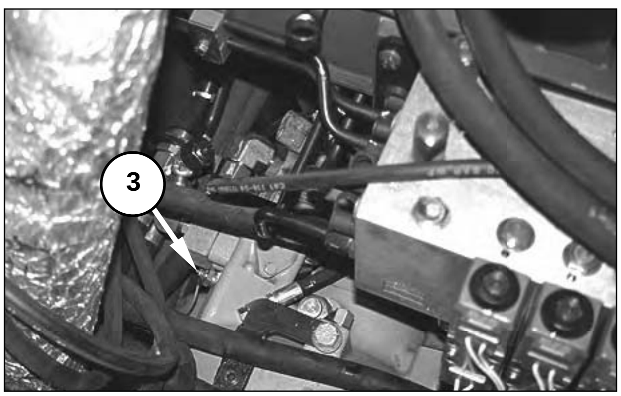
Several main components make up the gauges and auxiliary circuit: engine oil pressure switch (1), engine oil pressure sensor (2), transmission oil temperature sensor (3), coolant temperature sensor (4), turn/hazard/horn switch (5), horn on/off switch (6), engine coolant temperature gauge (7), engine oil pressure gauge (8), transmission oil temperature gauge (9), voltmeter (10), fuel level gauge (11), tachometer (12), speedometer (13), ECM (14), charge solenoid (15), charge switch (16), fuel level sender (17),
EPTC II (18), steering solenoid (19), backup alarm (20), horn/dome circuit breaker (21), auxiliary circuit breaker (22), steering relay (23), backup relay (24), horn relay (25), horn (26).

Component Location



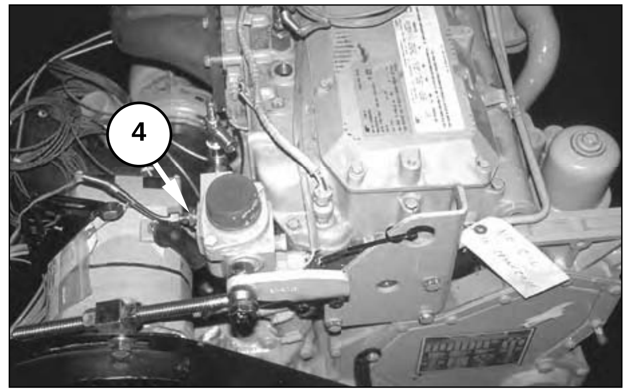
Left Side of Engine.
(1) Engine oil pressure switch. (2) Engine oil pressure sensor. (14) ECM.

Engine oil pressure switch (1) and engine oil pressure sensor (2) are on the left side of the engine, in front of ECM (14). The engine oil pressure sensor is the sender for the engine oil pressure gauge. The engine oil pressure switch must be closed before the tachometer will function. The ECM acts as the sender for the speedometer and the tachometer.



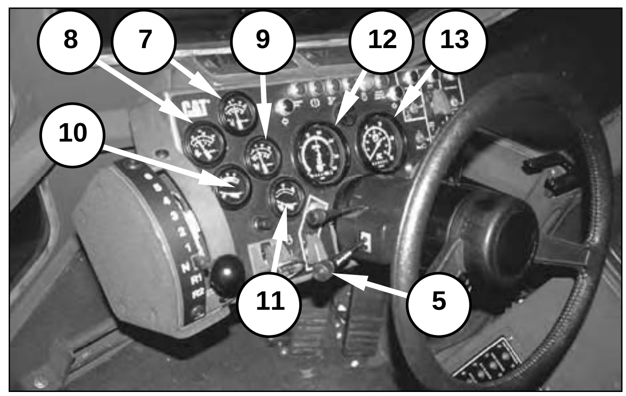
Torque Converter.
(3) Transmission oil temperature sensor.

Transmission oil temperature sensor (3) is mounted in a port in the torque converter housing. The transmission oil temperature sensor is the sender for the transmission oil temperature gauge.



Front of Engine, Right Side, Engine Removed From Machine.
(4) Coolant temperature sensor.

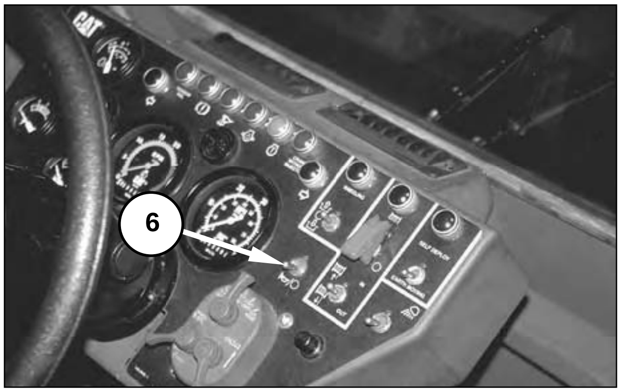
Coolant temperature sensor (4) is at the front, right side of the engine. The coolant temperature sensor acts as the sender for the engine coolant temperature gauge.



Left Side of Instrument Panel.
(5) Turn/hazard/horn switch. (7) Engine coolant temperature gauge. (8) Engine oil pressure gauge. (9) Transmission oil temperature gauge. (10) Voltmeter. (11) Fuel level gauge. (12) Tachometer. (13) Speedometer.

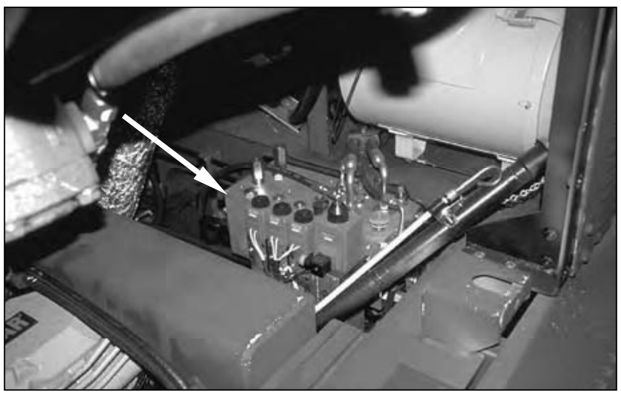
Turn/hazard/horn switch (5) is at the base of the turn signal lever. The horn button is in the center of the steering wheel.

Engine coolant temperature gauge (7), engine oil pressure gauge (8), transmission oil temperature gauge (9), voltmeter (10), fuel level gauge (11), tachometer (12), and speedometer (13), are on the instrument panel. Each gauge (except the voltmeter) works in conjunction with a sender. The pointer position depends on the resistance of the corresponding sender.

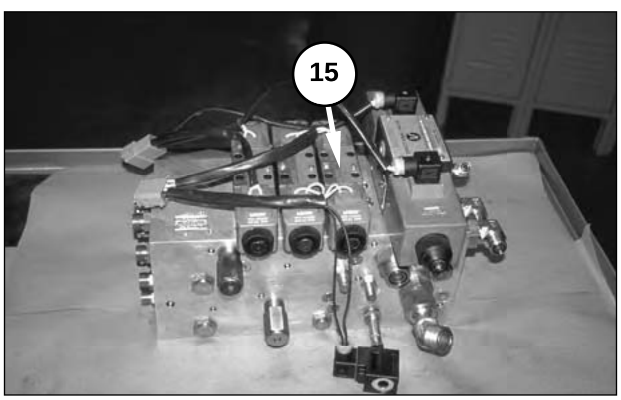


Right Side of Instrument Panel.
(6) Horn on/off switch.

Horn on/off switch (6) is on the right side of the instrument panel. The horn on/off switch enables and disables the horn and the backup alarm. The blackout switch must be in the STOP LIGHT or the SERVICE DRIVE position to enable the horn switch.

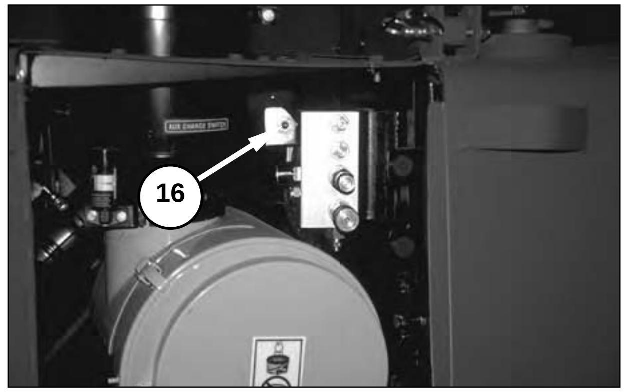


Multifunction Control Valve, Left Side of Machine.



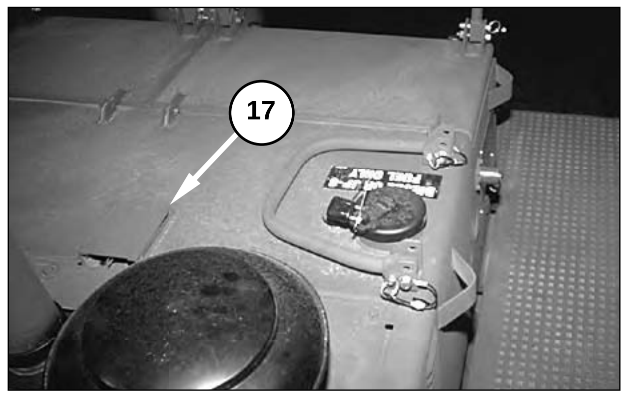
Multifunction Control Valve, Removed from Machine.
(15) Charge solenoid.

Charge solenoid (15) is located in the air filter compartment. When the charge solenoid is energized, oil from the hydraulic tank can be directed into the suspension cylinders.



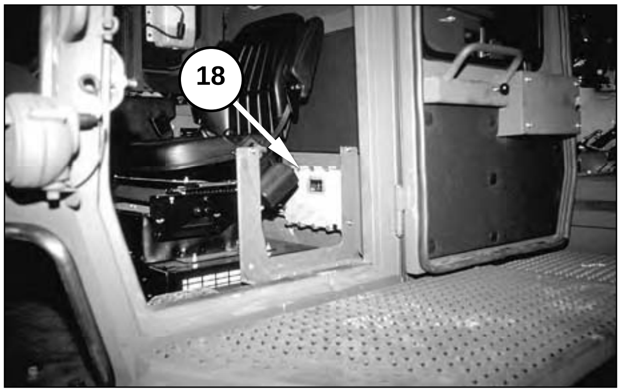
Left Side of Machine, Behind Radiator.
(16) Charge switch.

Charge switch (16) is on the left side of the machine, near the air cleaner. When the switch is closed, the charge solenoid is energized.



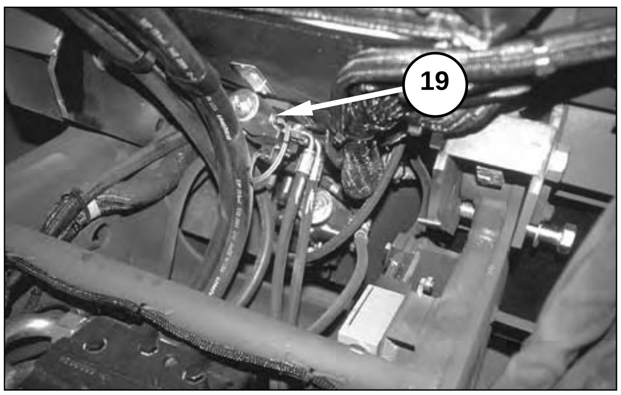
Rear of Machine, Top Deck.
(17) Fuel level sender.

Fuel level sender (17) can be accessed through the cover. The fuel level sender is attached to the fuel tank. The fuel level sender is the sender for the fuel level gauge.



Inside Cab, Back Wall, Cover Removed.
(18) EPTC II.

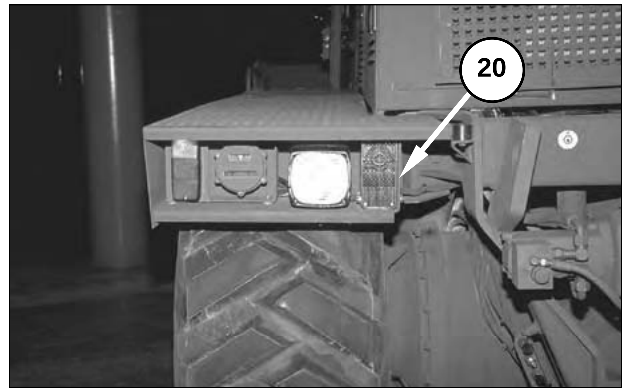
EPTC II (18) is inside the cab, on the back wall. The EPTC II sends the machine speed reading to ECM (14) and monitors the machine's direction. When the transmission is in REVERSE, the EPTC II energizes the coil in the steering relay.



Under Cab, Center of Machine.
(19) Steering solenoid.

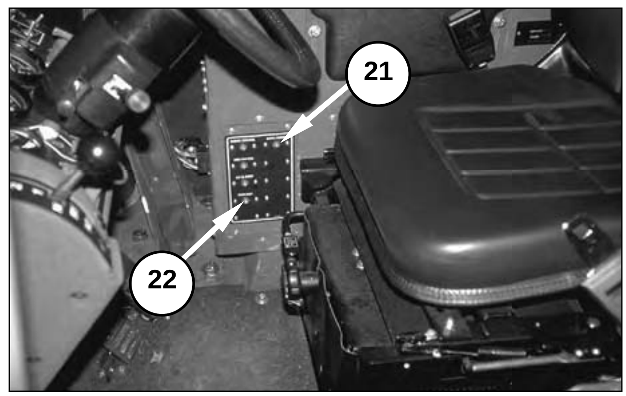
Steering solenoid (19) is under the cab. The steering relay controls the steering solenoid. When the transmission is in REVERSE, EPTC II (18) energizes the steering relay which, in turn, causes the steering solenoid to energize. Energizing the steering solenoid enables the C-turn steering logic.

NOTE: C-turn steering logic allows the machine to steer like an automobile. When the steering wheel is turned to the RIGHT, the machine turns to the right while traveling in both FORWARD and REVERSE. The travel of the machine in FORWARD and REVERSE follows the shape of a "C." If steering solenoid (19) were to fail, the differential steering system on this machine would cause the machine to follow S-turn logic. If the steering wheel were turned to the RIGHT on a machine with a failed steering solenoid, the machine would turn to the right while traveling in FORWARD, and to the left while traveling in REVERSE. The travel of the machine would follow the shape of an "S."



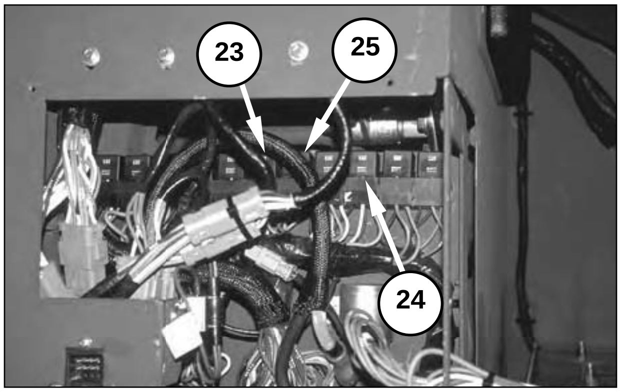
Rear of Machine, Left Side.
(20) Backup alarm.

Backup alarm (20) is at the rear of the machine, on the left side. The blackout switch must be in the STOP LIGHT or SERVICE DRIVE position, the horn on/off switch must be in the ON position, and the transmission must be in REVERSE to enable the backup alarm to function.



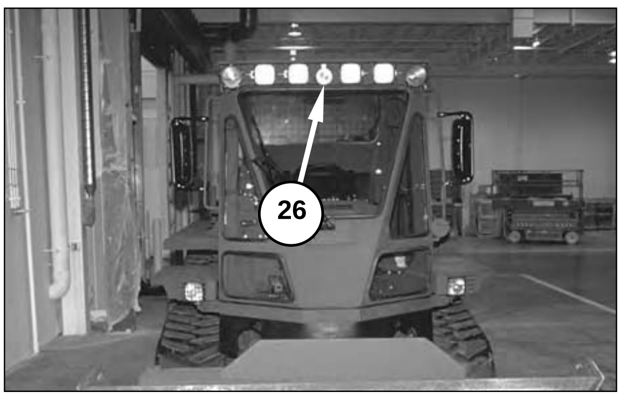
Front Circuit Breaker Panel.
(21) Horn/dome circuit breaker. (22) Auxiliary circuit breaker.

Horn/dome circuit breaker (21) and auxiliary circuit breaker (22) are manual-reset breakers rated at 15 amps.



Behind Right Console Circuit Breaker Panel.
(23) Steering relay. (24) Backup relay. (25) Horn relay.

Steering relay (23), backup relay (24), and horn relay (25) are behind the right console circuit breaker panel. These relays are normally open. The horn on/off switch and the turn/hazard/horn switch control the horn relay; the steering relay controls the backup relay, and the EPTC II controls the steering relay.

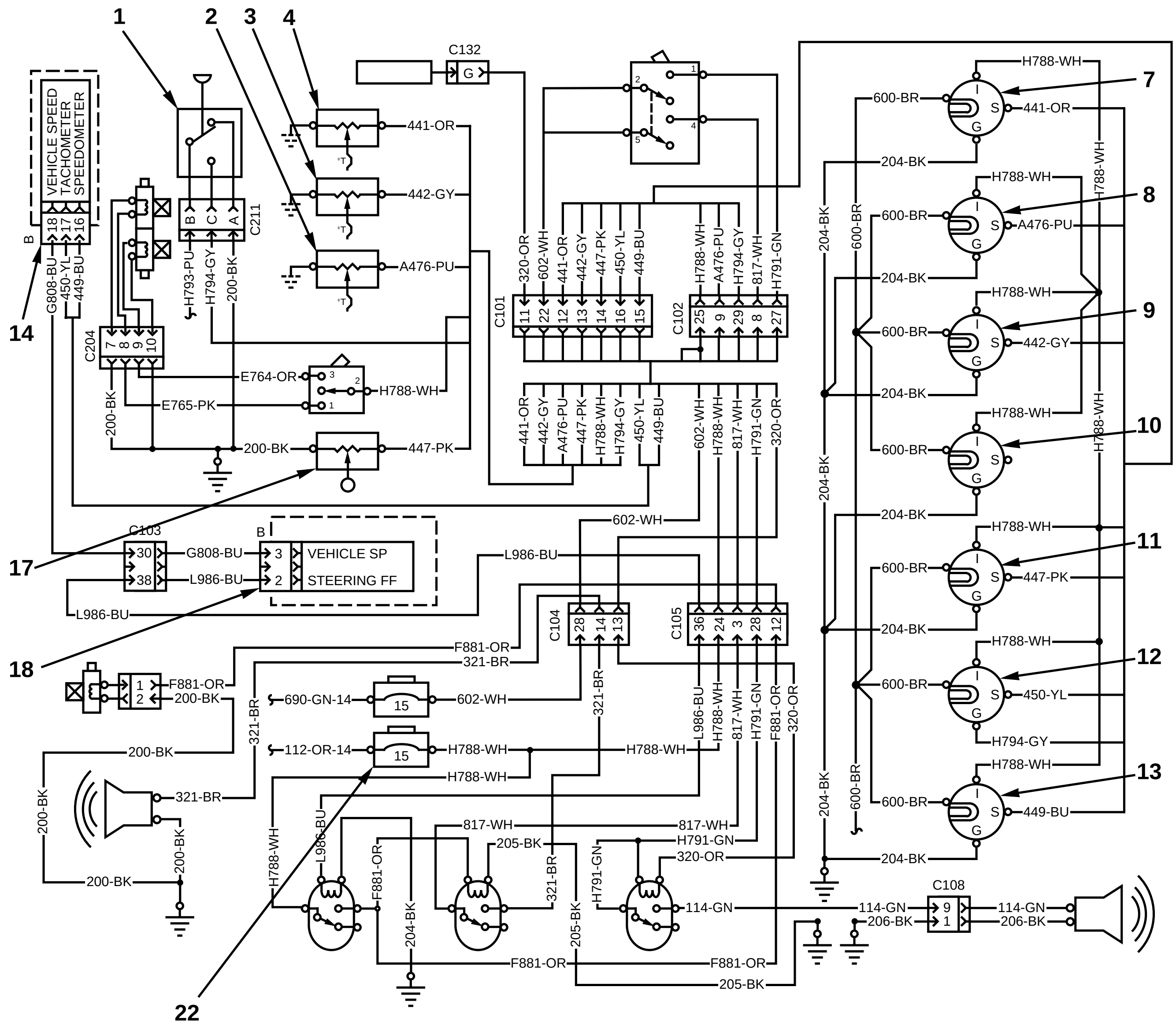


Front of Machine.
(26) Horn.

Horn (26) is between the machine lights, at the front of the machine. The blackout switch must be in the STOP LIGHT or SERVICE DRIVE position, and the horn on/off switch must be in the ON position to enable the horn to function.

Circuit Operation

Gauges



Gauges and Auxiliary Circuit Schematic.
(1) Engine oil pressure switch. (2) Engine oil pressure sensor. (3) Transmission oil temperature sensor. (4) Coolant temperature sensor. (7) Engine coolant temperature gauge. (8) Engine oil pressure gauge. (9) Transmission oil temperature gauge. (10) Voltmeter. (11) Fuel level gauge. (12) Tachometer. (13) Speedometer. (14) ECM. (17) Fuel level sender. (18) EPTC II. (22) Auxiliary circuit breaker.

When the start switch is in the ON position, power from auxiliary circuit breaker (22) is available at the input, or I-terminals, of engine coolant temperature gauge (7), engine oil pressure gauge (8), transmission oil temperature gauge (9), voltmeter (10), fuel level gauge (11), and speedometer (13). The ground, or G-terminal, of each gauge is connected to ground. The sender, or S-terminal, of each gauge (except for the voltmeter) is connected to a sender.

The S-terminal of engine coolant temperature gauge (7) connects to the coolant temperature sensor (4). The S-terminal of engine oil pressure gauge (8) is connected to engine oil pressure sensor (2). Transmission oil temperature gauge (9) is connected to transmission oil temperature sensor (3). The sender terminal of fuel level gauge (11) connects to fuel level sender (17). The S-terminal of speedometer (13) is connected to ECM (14). Each sender provides variable resistance and is internally grounded.

Coolant temperature sensor (4) monitors the temperature of the engine coolant by providing resistance in the line from the S-terminal of engine coolant temperature gauge (7). The resistance created by the sensor depends on the temperature of the coolant. The higher the coolant temperature, the less resistance in the line. Likewise, the lower the temperature, the greater the resistance in the line.

The pointer in engine coolant temperature gauge (7) indicates the coolant temperature. The movement of the pointer is calibrated to the resistance in the line. The lower the resistance (higher temperature), the more the pointer rotates. The higher the resistance (lower temperature), the less the pointer rotates.

Engine oil pressure gauge (8), transmission oil temperature gauge (9), and fuel level gauge (11) operate the same as engine coolant temperature gauge (7).

Voltmeter (10) does not have a sender connection. The voltmeter monitors the voltage in the line from auxiliary circuit breaker (22) at the I-terminal. The movement of the pointer in the voltmeter is calibrated to different voltage levels. The position of the pointer depends on the voltage present at the I-terminal. The higher the voltage, the more the pointer rotates and the lower the voltage, the less the pointer rotates.

The S-terminal of speedometer (13) receives a frequency-modulated, fixed, pulse width signal from terminal B-16 of ECM (14). The frequency of the signal from the ECM is proportional to the transmission speed. Movement of the speedometer needle is calibrated to the frequency of the signal. At 1.7 km/hr (1 mile/hr), the signal frequency is 16.6 Hz. The ECM generates a total of 35 845 pulses/km (59,742 pulses/mile).

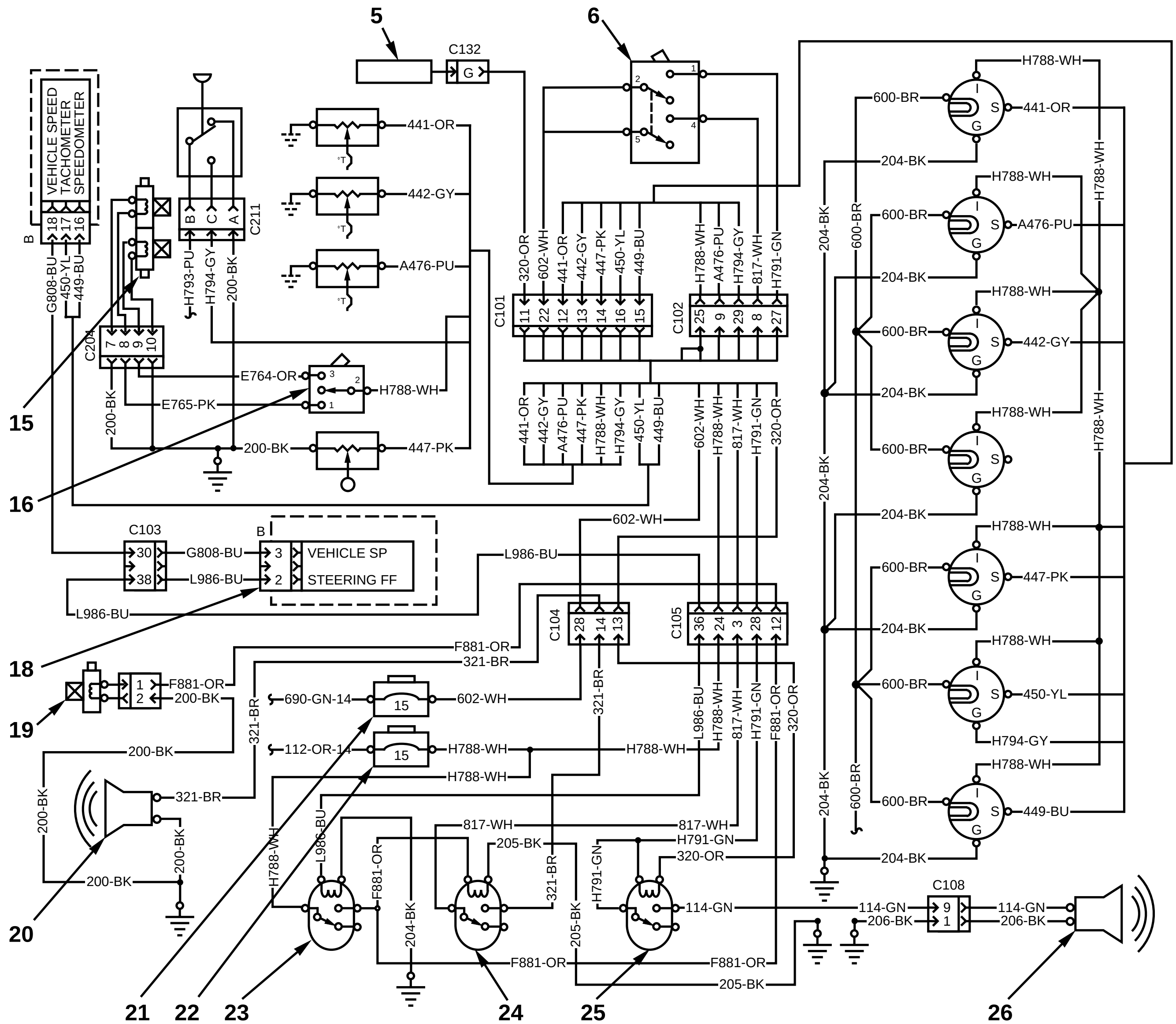
NOTE: Terminal B-3 of EPTC ll (18) sends the vehicle speed signal to terminal B-18 of ECM (14). For more detail on this function, refer to “Transmission Control Circuit” and “ECM Circuit” in the “Systems Operation” sections of this module.

The I-terminal of tachometer (12) is connected to contact C of engine oil pressure switch (1). The engine oil pressure switch must be closed before the tachometer will function.

The S-terminal of tachometer (12) receives a frequency-modulated, fixed, pulse width signal from terminal B-17 of ECM (14). Movement of the tachometer needle is calibrated to the frequency of the signal from the ECM. The pulse frequency is proportional to the engine speed at 113 pulses per engine revolution.

NOTE: ECM (14) uses input received from the top and bottom speed/timing sensors (terminals A-8 and A-9 and terminals A-3 and A-15) to calculate the frequency of the pulse sent to tachometer (12). For details about the speed/timing sensors, refer to “Systems Operation, ECM Circuit” in this module.

Horn On/off Switch ON, FORWARD Travel



Gauges and Auxiliary Circuit Schematic.
(5) Turn/hazard/horn switch. (6) Horn on/off switch. (15) Charge solenoid. (16) Charge switch. (18) EPTC II. (19) Steering solenoid. (20) Backup alarm. (21) Horn/dome circuit breaker. (22) Auxiliary circuit breaker. (23) Steering relay. (24) Backup relay. (25) Horn relay. (26) Horn.

When the blackout switch is in the STOP LIGHT or one of the SERVICE DRIVE positions, power from horn/dome circuit breaker (21) transfers to contacts 2 and 5 of horn on/off switch (6). When the horn on/off switch is in the OFF position, neither the horn nor the back-up alarm will sound.

NOTE: For a description of the blackout switch operation, refer to "Systems Operation, Lighting Circuit" in this module.

Moving horn on/off switch (6) to the ON position closes contacts 1 and 2 and contacts 4 and 5 of the switch. Power at contact 1 transfers to the horn relay (25) gate and coil. The negative side of the horn relay coil is connected to terminal G of turn/hazard/horn switch (5).

When the horn button is depressed, turn/hazard/horn switch (5) causes the coil of horn relay (25) to energize, closing the relay. With the horn relay closed, power from horn on/off switch (6) becomes available to front horn (26). Current flows through the front horn and the horn sounds.

Power at contact 4 of horn on/off switch (6) transfers to backup relay (24). Steering relay (23) controls the backup relay. When the transmission is in NEUTRAL or a FORWARD gear, the steering relay is open, and therefore, the backup relay is open. This condition prevents backup alarm (20) from sounding.

NOTE: For a detailed description of the transmission control function of the EPTC II, refer to “Systems Operation, Transmission Control Circuit” in this module.

Horn On/Off Switch ON, REVERSE Travel

EPTC II (18) monitors the machine’s direction of travel. When the transmission is in REVERSE, the EPTC II sends an output signal from terminal B-2 to the coil in steering relay (23). The coil energizes and the steering relay closes.

NOTE: For a detailed description of the transmission control function of the EPTC II, refer to “Systems Operation, Transmission Control Circuit” in this module.

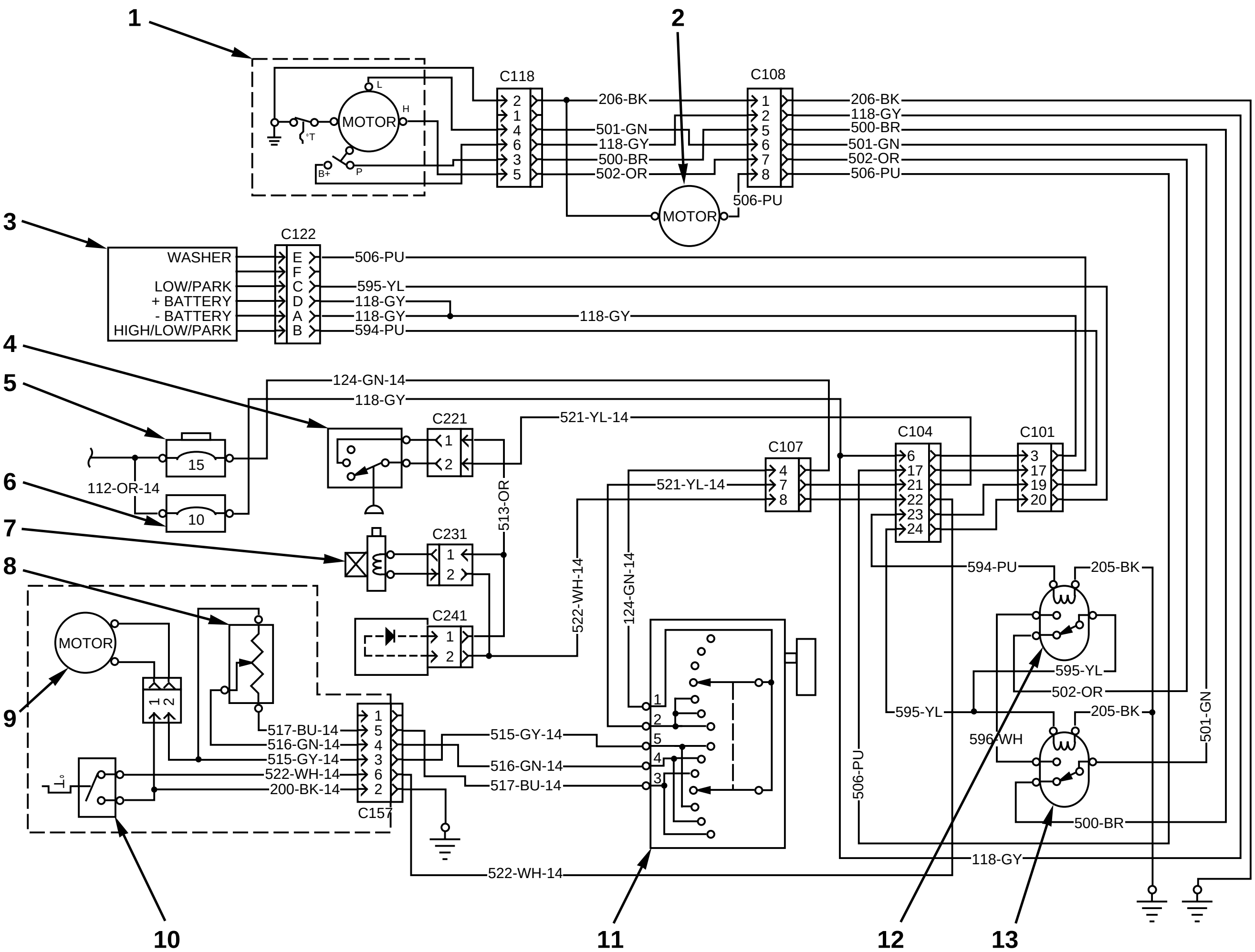
With steering relay (23) closed, current from auxiliary circuit breaker (22) flows through the relay and to steering solenoid (19). The current energizes the solenoid, enabling the C-turn steering logic.

Current flowing from steering relay (23) also reaches the coil of backup relay (24). The coil energizes and the backup relay closes. Power available to the backup relay from contact 4 of horn on/off switch (6) now flows through backup alarm (20), causing the alarm to sound.

Suspension System Charge

Power from auxiliary circuit breaker (22) is available to charge switch (16). When the charge switch is in the CHARGE position, the switch is closed and current flows to charge solenoid (15). The charge solenoid energizes, allowing the hydraulic system to charge the suspension cylinders.

Blower, Air Conditioning, and Washer and Wiper Circuit



Blower, Air Conditioning, and Washer and Wiper Circuit.
(1) Wiper motor. (2) Washer motor. (3) Wiper switch. (4) Air conditioner pressure switch. (5) Air conditioner blower motor circuit breaker. (6) Washer/wiper circuit breaker. (7) Air conditioner clutch solenoid. (8) Blower resistor. (9) Blower motor. (10) Thermostat switch. (11) Blower switch. (12) Wiper relay 1. (13) Wiper relay 2.

The blower, air conditioning, and washer and wiper circuit controls operation of the air conditioning, heater, and windshield washer and wiper. The major components in the system are: wiper motor (1), washer motor (2), wiper switch (3), air-conditioning pressure switch (4), air-conditioning blower motor circuit breaker (5), washer/wiper circuit breaker (6), air-conditioning clutch solenoid (7), blower resistor (8), blower motor (9), thermostat switch (10), blower switch (11), wiper relay (12), and wiper relay (13).

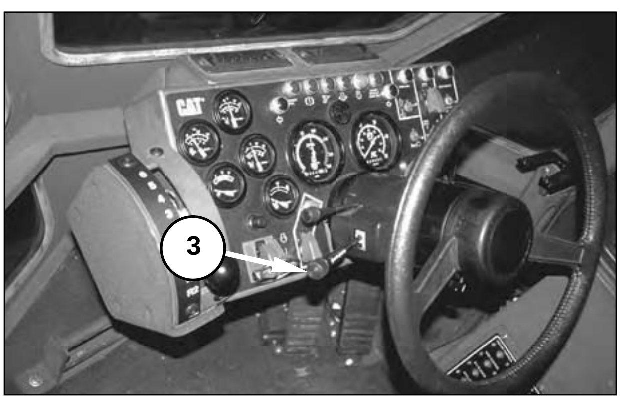
Component Location

Front of Machine.
(1) Wiper motor.

Wiper motor (1) is at the base of the wiper. The motor is inside the cab, under the instrument panel.

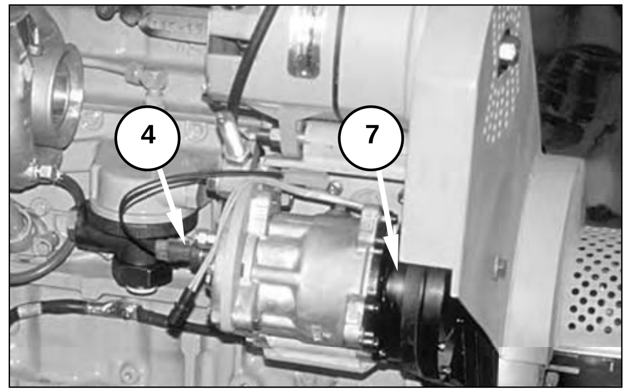
Operator's Compartment, Right Rear Corner.
(2) Washer motor.

Washer motor (2) is near the washer fluid reservoir.



Left Side of Steering Column.
(3) Wiper switch.

Wiper switch (3) is on the end of the turn signal lever. The switch controls the two speeds of the wiper and activates the washer. Rotating the end of the turn signal lever activates the wiper. Depressing the end of the turn signal lever (towards the steering column) activates the washer.



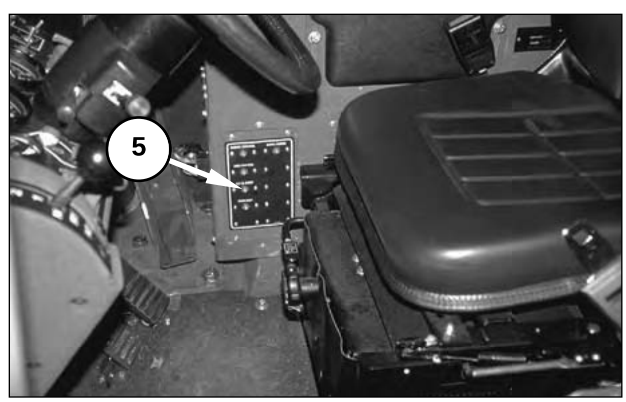
Right Side of Engine.
(4) Air conditioner pressure switch. (7) Air conditioner clutch solenoid.

Air conditioner pressure switch (4) is attached to the compressor, on the right side of the engine. The switch contains three positions: two open (off) and one closed (on). The switch is open when pressure in the system is below 170 ± 55 kPa (25 ± 8 psi), closed when the pressure in the system is between 275 kPa (40 psi) and 1750 ± 200 kPa (254 ± 30 psi), and open when the pressure in the system is above 2800 ± 140 kPa (406 ± 20 psi).

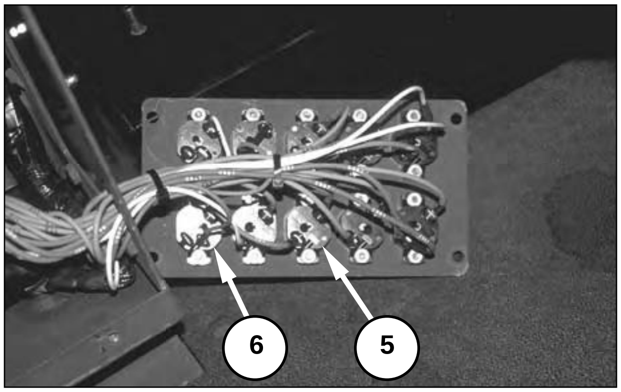
As pressure in the system increases from approximately 170 kPa (25 psi) to 275 kPa (40 psi), the switch remains open. As pressure in the system decreases from approximately 275 kPa (40 psi) to 170 kPa (25 psi), the switch remains closed.

As pressure in the system increases from approximately 1750 kPa (254 psi) to 2800 kPa (406 psi), the switch remains closed. As pressure in the system decreases from approximately 2800 kPa (406 psi) to 1750 kPa (254 psi), the switch remains open.

Air conditioner clutch solenoid (7) activates the air-conditioning compressor based on the position of air-conditioning pressure switch (4) and the position of thermostat switch (10, shown on next page).



Front Circuit Breaker Panel.
(5) Air conditioner blower motor circuit breaker.

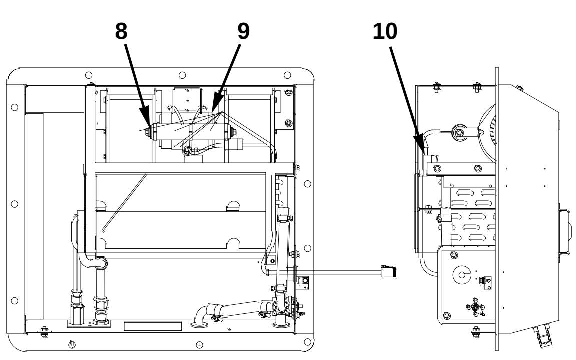


Front Circuit Breaker Panel, Back Side.
(5) Air conditioner blower motor circuit breaker.
(6) Washer/wiper circuit breaker.

Air conditioner blower motor circuit breaker (5) is in the panel at the base of the console to the right of the operator's seat. The air-conditioning blower motor circuit breaker is rated at 15 amps.

Washer and wiper circuit breaker (6) is attached to the back side of the panel. The washer and wiper circuit breaker is self-resetting and rated at 10 amps.

Air-Conditioning Unit, Under Operator's Seat.

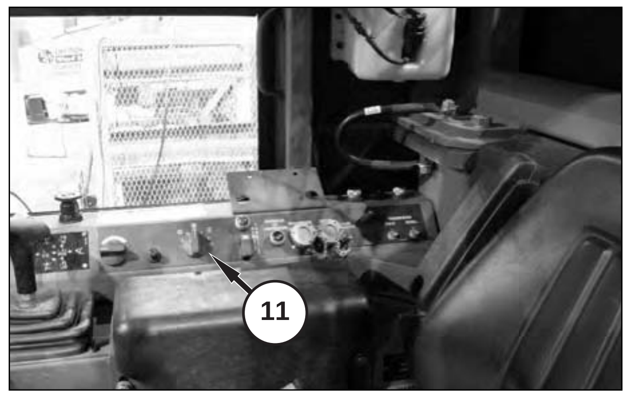


View of Air-Conditioning Unit.
(8) Blower resistor. (9) Blower motor. (10) Thermostat switch.

Blower resistor (8), blower motor (9), and thermostat switch (10) are located under the operator's seat.

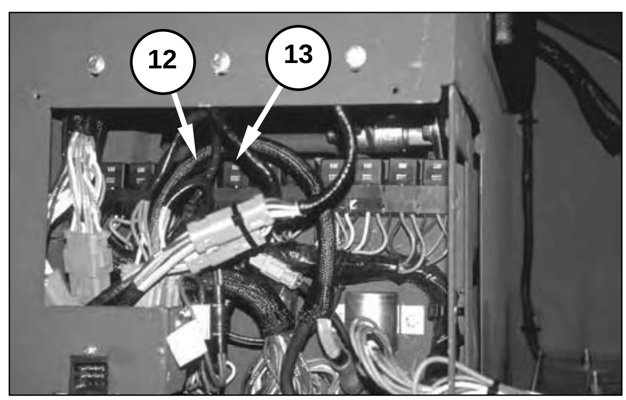
Blower resistor (8) controls the speed of the blower motor by decreasing the voltage available at blower motor (9). The voltage drop across the resistor depends on the position of blower switch (11). The resistor provides a maximum of two voltage drops, giving a total of three blower speeds.

Thermostat switch (10) prevents the condensation formed on the evaporator coil from freezing by monitoring the temperature of the air flowing through the evaporator coil. If the air temperature through the evaporator coil falls below -1.1°C (30°F), the thermostat switch opens, interrupting the electrical signal which energizes the compressor clutch solenoid. When the temperature of the air flowing through the evaporator coil raises to 2.2°C (36°F), the thermostat switch closes, allowing the compressor to operate. The thermostat switch is not adjustable.



Console to Right of Operator's Seat.
(11) Blower switch.

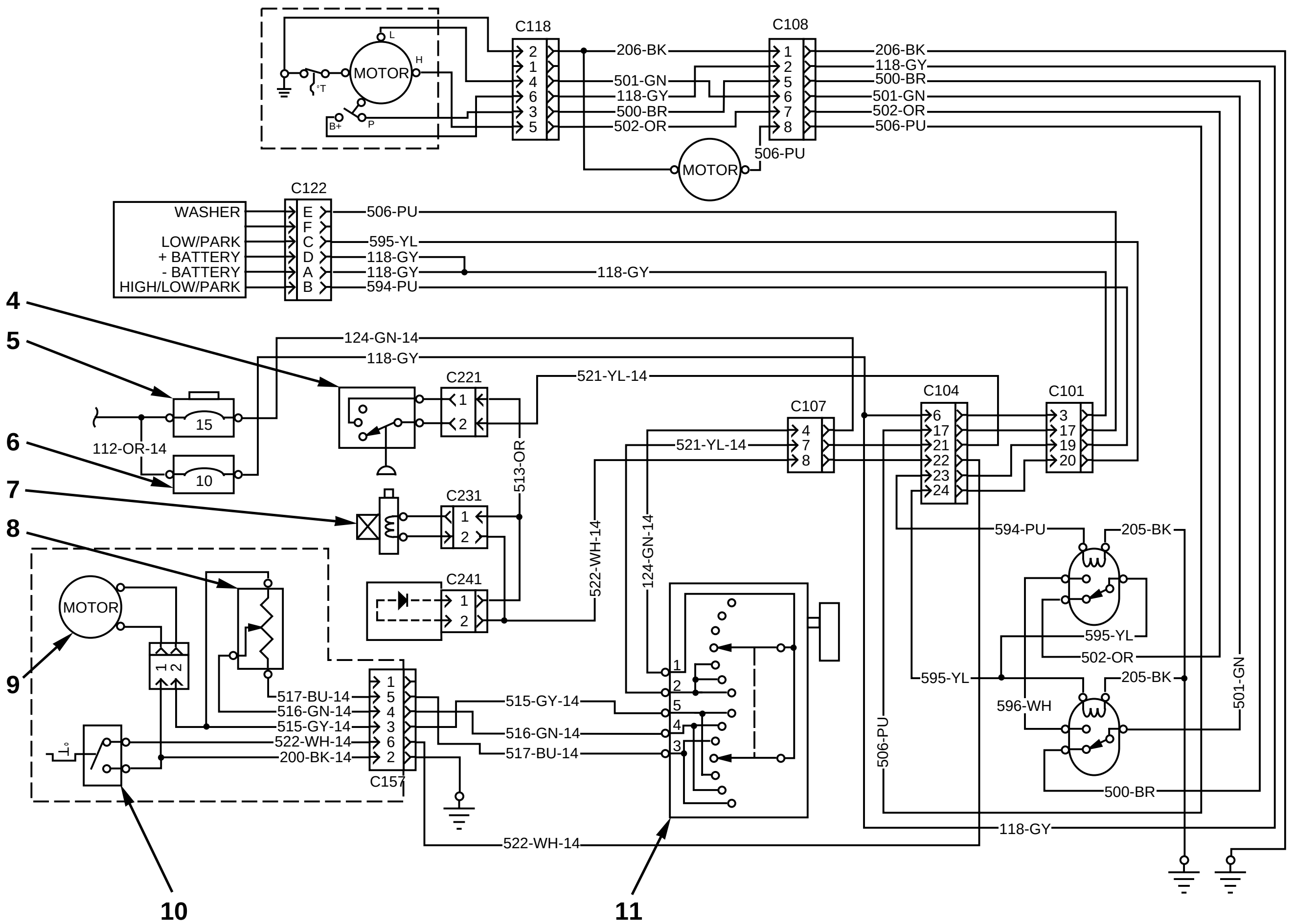
Blower switch (11) is on the console to the right of the operator's seat. The blower switch controls the blower for the heat and air conditioning. The blower has three speeds. Moving the switch to the right activates the heater, while moving the switch to the left activates the air conditioning.



Behind Right Console Circuit Breaker Panel.
(12) Wiper relay. (13) Wiper relay.

Wiper relay (12) and wiper relay (13) are in the relay bank behind the right console circuit breaker panel.

Circuit Operation



Blower, Air Conditioning, and Washer and Wiper Circuit.
(4) Air conditioner pressure switch. (5) Air conditioner blower motor circuit breaker. (6) Washer/wiper circuit breaker. (7) Air conditioner clutch solenoid. (8) Blower resistor. (9) Blower motor. (10) Thermostat switch. (11) Blower switch.

When the start switch is in the ON position, power is available at air-conditioning blower motor circuit breaker (5) and washer and wiper circuit breaker (6).

Blower and Air Conditioning

If air-conditioning blower motor circuit breaker (5) is closed, power is available at contact 1 of blower switch (11). Contacts 3, 4, and 5 of the blower switch determine the fan speed (low, medium, and high, respectively) for both air conditioning and heating. Contact 2 of the blower is live only when the air conditioning is in use.

Moving blower switch (11) to any of the air-conditioning positions conducts current from contact 1 to contacts 2 and 5 of the blower switch. Power from contact 2 is available at contact 2 of air-conditioning pressure switch (4). The air-conditioning pressure switch measures pressure in the air-conditioning system.

Air conditioner pressure switch (4) is closed while pressure in the system is increasing between 275 and 2800 kPa (40 and 405 psi). The air-conditioning pressure switch is also closed while the pressure is decreasing between 1750 and 170 kPa (254 and 25 psi). The air-conditioning pressure switch is open while the pressure is increasing between 0 and 275 kPa (0 and 40 psi), when the pressure is above 2800 kPa (405 psi), while the pressure is decreasing to 1750 kPa (254 psi), and when the pressure is less than 170 kPa (25 psi).

If air-conditioning pressure switch (4) is closed, current flows out contact 1 of the switch and to contact 1 of air-conditioning clutch solenoid (7). The ground avenue for the air-conditioning clutch solenoid is through thermostat switch (10).

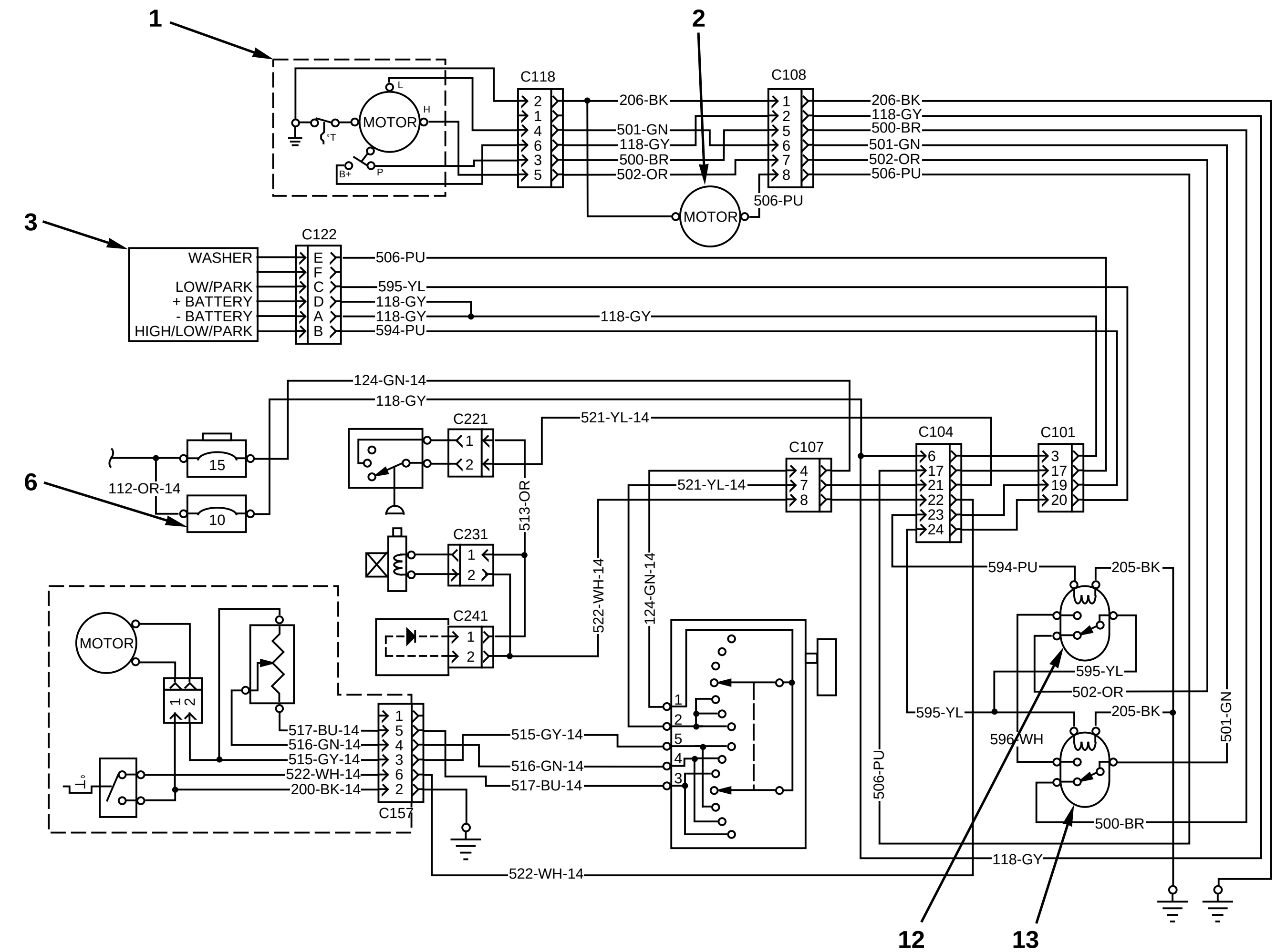
When the temperature of the air flowing through the evaporator coil is 2.2°C (36°F) or more, thermostat switch (4) closes, providing the ground path to energize air-conditioning clutch solenoid (7). Energizing the air-conditioning clutch solenoid activates the air-conditioning compressor. When the temperature is -1.1°C (30°F) or less, the thermostat switch opens, breaking the ground path from the air-conditioning clutch solenoid and disengaging the air-conditioning compressor.

When blower switch (11) is in the HIGH, AIR CONDITIONING position, power from contact 5 of the blower switch is available at contact 2 of blower motor (9). Current is conducted through the blower motor, causing the motor to produce maximum air flow.

When blower switch (11) is in the MEDIUM position, current flows from contact 1 to contact 4 of the blower switch. Power from contact 4 is available at the center post of blower resistor (8). The resistor causes a voltage drop, so a lower voltage reaches contact 2 of blower motor (9). The reduced voltage at contact 2 causes the blower motor to turn more slowly and produce less air flow than when the blower switch was in the HIGH position.

When blower switch (11) is in the LOW position, current flows from contact 1 to contact 3 of the blower switch. Power from contact 3 is available at the first post of blower resistor (8). The resistor causes a voltage drop, so a lower voltage reaches contact 2 of blower motor (9). The reduced voltage at contact 2 causes the blower motor to turn more slowly and produce less air flow than when the blower switch was in the MEDIUM position.

Washer and Wiper



Blower, Air Conditioning, and Washer and Wiper Circuit.
(1) Wiper motor. (2) Washer motor. (3) Wiper switch. (6) Washer/wiper circuit breaker. (12) Wiper relay. (13) Wiper relay.

If washer and wiper circuit breaker (6) is closed, power is available at contacts A and D of wiper switch (3). Contact A provides power to operate washer motor (2), and contact D provides power to operate wiper motor (1).

Wiper switch (3) controls four conditions: PARK, LOW, HIGH, and WASH. When the wiper switch is in PARK, power available at contacts A and D is not conducted though the switch. When the wiper switch is in the LOW position, power at contact D is available at contacts B and C.

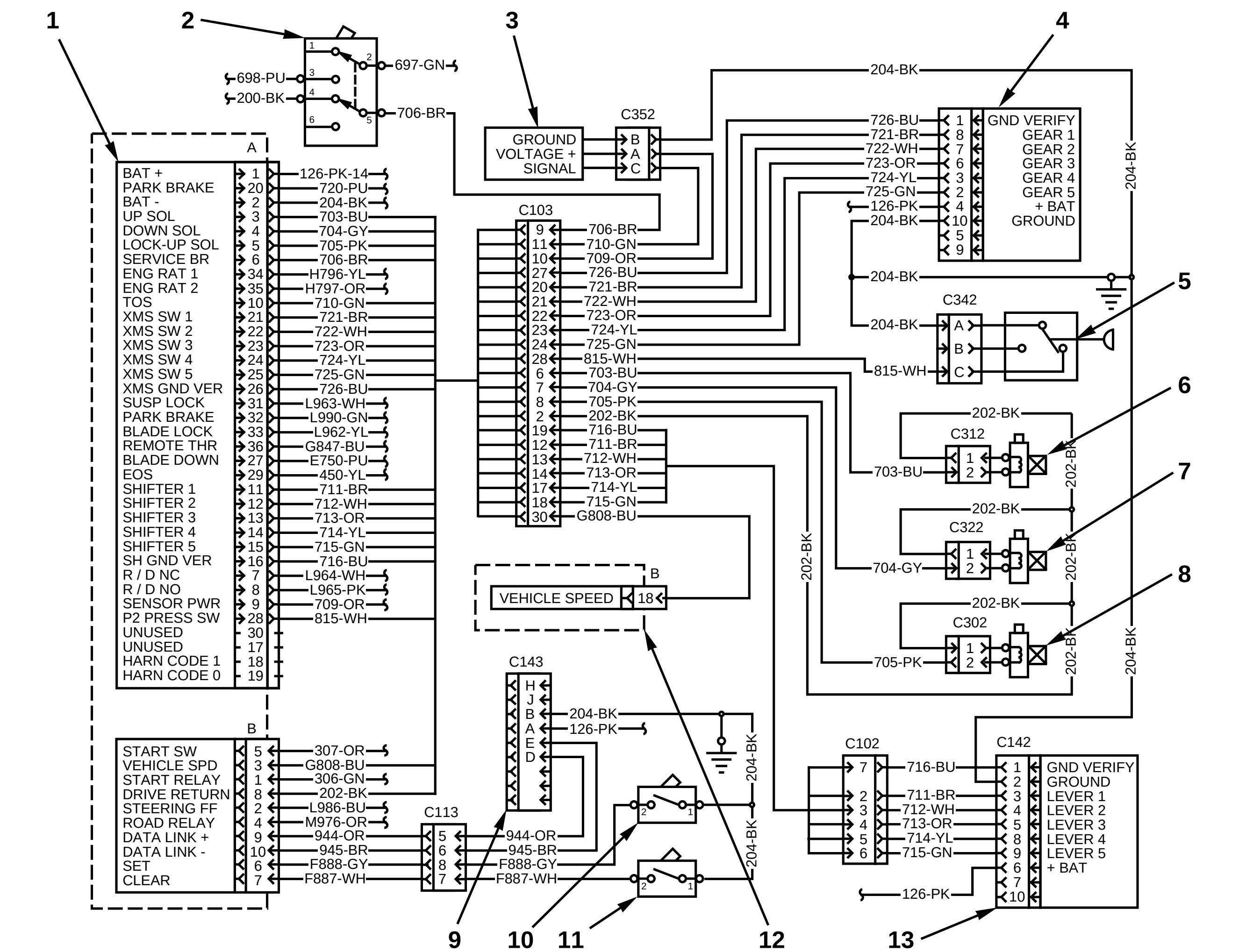
Current flows from contact B of wiper switch (3) to the coil in wiper relay (12). Current simultaneously flows from contact C of the wiper switch to contact 30 of wiper relay (12) and to the coil in wiper relay (13). Both wiper relays close.

Current is conducted across wiper relay (12) and to contact 87 of wiper relay (13). Current flows across wiper relay (13) to the L-terminal of wiper motor (1), causing the motor to operate at low speed.

When wiper switch (3) is in the HIGH position, power at contact D is available only at contact C. Current flows from contact C of the wiper switch to contact 30 of wiper relay (12) and the coil in wiper relay (13). At wiper relay (12), current flows from contact 30 to contact 87a and then flows to the H-terminal of wiper motor (1). This causes the wiper motor to operate at high speed.

When wiper switch (3) is in the WASH position, power at contact A is available at contact E. Current flows from contact E to washer motor (2), causing the motor to turn. The washer motor will continue to turn as long as the wiper switch is held in the WASH position.

Transmission Control Circuit



Transmission Control Circuit.

(1) EPTC II. (2) Service brake switch. (3) Transmission speed sensor. (4) Transmission gear switch. (5) P2 pressure switch. (6) Upshift solenoid. (7) Downshift solenoid. (8) Lockup solenoid. (9) Diagnostic plug. (10) Transmission diagnostic check switch. (11) Transmission diagnostic scroll switch. (12) ECM. (13) Shift lever switch.

EPTC II (1) controls many of the functions on the machine. The EPTC II has two connectors: one 36-pin connector and one 10-pin connector. The following list specifies the function of each terminal on the EPTC II. Where applicable, other sections of this manual have been referenced.

- Terminal A-1 is the power input. The power input comes from the EPTC II circuit breaker. Refer to “Systems Operation, Power Distribution Circuit” in this module.

- Terminal A-2 is the machine frame ground line. Refer to “Systems Operation, Power Distribution Circuit” in this module.

- Terminal A-3 sends an output signal to upshift solenoid (6). EPTC II (1) generates an output signal from A-3 when the transmission needs to shift up one gear.

- Terminal A-4 sends an output signal to downshift solenoid (7). EPTC II (1) generates an output signal from A-4 when the transmission needs to shift down one gear.

- Terminal A-5 sends an output signal to lockup solenoid (8). An output signal from A-5 energizes the lockup solenoid, causing the transmission to operate in direct drive.

- Terminal A-6 is the ground verify input of the service brake switch (2). The ground path is through contacts 5 and 4 of the service brake switch. For additional information, refer to “Systems Operation, Lighting Circuit” in this module.

- Terminal A-7 is an operating mode input. The line goes to contact 1 of the self-deploy/earthmoving switch. A ground signal at terminal A-7 of EPTC II (1) (across contact 1 and contact 2 of the self-deploy/earthmoving switch) confirms the SELF-DEPLOY mode. For additional information, refer to “Systems Operation, Self-Deploy/Earthmoving Circuit” in this module.

- Terminal A-8 is an operating mode input. The line goes to contact 3 of the self-deploy/earthmoving switch. A ground signal at terminal A-8 of EPTC II (1) (across contact 3 and contact 2 of the self-deploy/earthmoving switch) confirms the EARTHMOVING mode. For additional information, refer to “Self-Deploy/Earthmoving Circuit” in this module.

- Terminal A-9 is the transmission speed sensor power supply. The line provides power to contact A of transmission speed sensor (3).

- Terminal A-10 is the transmission output speed input. The line comes from contact C of transmission speed sensor (3).

- Terminal A-11 is an input from shift lever switch (13). EPTC II (1) monitors terminals A-11 through A-15 to determine the position of the transmission control lever.

- Terminal A-12 is an input from shift lever switch (13). EPTC II (1) monitors terminals A-11 through A-15 to determine the position of the transmission control lever.

- Terminal A-13 is an input from shift lever switch (13). EPTC II (1) monitors terminals A-11 through A-15 to determine the position of the transmission control lever.

- Terminal A-14 is an input from shift lever switch (13). EPTC II (1) monitors terminals A-11 through A-15 to determine the position of the transmission control lever.

- Terminal A-15 is an input from shift lever switch (13). EPTC II (1) monitors terminals A-11 through A-15 to determine the position of the transmission control lever.

- Terminal A-16 is the ground verify input from shift lever switch (13). This signal confirms that the shift lever switch is connected to EPTC II (1).

- Terminal A-17 is not used.

- Terminal A-18 is not used.

- Terminal A-19 is not used.

- Terminal A-20 is the parking brake switch ground verify input. The line goes to contact 3 of the parking brake switch. A ground signal at terminal A-20 of EPTC II (1) confirms that the parking brake switch is in the OFF position. For additional information, refer to “Systems Operation, Start, Charge, Stop Circuit” in this module.

- Terminal A-21 is an input from transmission gear switch (4). EPTC II (1) monitors terminals A-22 through A-25 to determine which transmission gear is currently engaged.

- Terminal A-22 is an input from transmission gear switch (4). EPTC II (1) monitors terminals A-22 through A-25 to determine which transmission gear is currently engaged.

- Terminal A-23 is an input from transmission gear switch (4). EPTC II (1) monitors terminals A-22 through A-25 to determine which transmission gear is currently engaged.

- Terminal A-24 is an input from transmission gear switch (4). EPTC II (1) monitors terminals A-22 through A-25 to determine which transmission gear is currently engaged.

- Terminal A-25 is an input from transmission gear switch (4). EPTC II (1) monitors terminals A-22 through A-25 to determine which transmission gear is currently engaged.

- Terminal A-26 is the ground verify input from transmission gear switch (4). This signal confirms that the transmission gear switch is connected to EPTC II (1).

- Terminal A-27 is the blade position input. The line goes to contact 6 of the blade position switch. An open circuit at terminal A-27 of EPTC II (1) confirms that the blade is not in the fully RAISED position or that the self-deploy/earthmoving switch is in the EARTHMOVING position. For additional information, refer to “Systems Operation, Self-Deploy/Earthmoving Circuit” in this module.

- Terminal A-28 is the input from P2 pressure switch (5). A completed circuit at terminal A-28 indicates that a shift is in process. This prompts EPTC II (1) to disengage the lockup clutch.

- Terminal A-29 is the engine speed input. The input is from terminal B-17 of ECM (12). For additional information, refer to “Systems Operation, Gauges and Auxiliary Circuit” in this module.

- Terminal A-30 is not used.

- Terminal A-31 is the suspension lock solenoid output. The output (ground) signal goes to terminal 5 of the number-2 solenoid driver. The solenoid driver locks the suspension. For additional information, refer to “Systems Operation, Self-Deploy/Earthmoving Circuit” in this module.

- Terminal A-32 is the park brake solenoid output. The output (ground) signal goes to terminal 4 of the number-2 solenoid driver. The solenoid driver energizes the park brake relay to release the brake. For additional information, refer to “Systems Operation, Start, Charge, and Stop Circuit” in this module.

- Terminal A-33 is the blade lock solenoid output. The output (ground) signal goes to terminal 5 of the number-1 solenoid driver. The solenoid driver energizes the blade lock solenoid to prevent the blade LOWER function from working while the machine is in the SELF-DEPLOY mode. For additional information, refer to “Systems Operation, Self-Deploy/Earthmoving Circuit” in this module.

- Terminal A-34 is the low-horsepower output signal to terminal B-38 of ECM (12). EPTC II (1) generates an output signal from terminal A-34 when the machine is in EARTHMOVING mode, and when the machine is in SELF-DEPLOY mode and the transmission is below THIRD FORWARD. For additional information, refer to “Systems Operation, Self-Deploy/Earthmoving Circuit” in this module.

- Terminal A-35 is the high-horsepower output signal to terminal B-8 of ECM (12). EPTC II (1) generates an output signal from terminal A-35 when the machine is in SELF-DEPLOY mode and the transmission is above SECOND FORWARD. For additional information, refer to “Systems Operation, Self-Deploy/Earthmoving Circuit” in this module.

- Terminal A-36 is the remote throttle input. The line goes to contact 2 of the remote throttle switch. A ground signal at terminal A-36 of EPTC II (1) confirms that the remote throttle switch is in the OFF position. For additional information, refer to “Systems Operation, Remote Throttle Circuit” in this module.

- Terminals A-37 through A-40 are not used.

- Terminal B-1 is the output to the start relay. EPTC II (1) sends an output signal to the start relay coil when the start switch is in the START position and the engine speed is less than 200 rpm. For additional information, refer to “Systems Operation, Start, Charge, and Stop Circuit” in this module.

- Terminal B-2 is the backup alarm output. EPTC II (1) sends an output signal to the coil in the steering relay when the transmission is in REVERSE. The steering relay controls the backup relay and the steering solenoid. For additional information, refer to “Systems Operation, Gauges and Auxiliary Circuit” in this module.

- Terminal B-3 is the transmission output speed output. EPTC II (1) interprets the input signal at terminal A-10 and generates an output signal from terminal B-3. The EPTC II sends the output signal from terminal B-3 to terminal B-18 of ECM (12). The ECM uses this signal to calculate vehicle speed. For additional information, refer to “Gauges and Auxiliary Circuit” and “ECM Circuit” in the “Systems Operation” section of this module.

- Terminal B-4 is the roading relay output. The output (ground) signal goes to terminal 4 of the number-1 solenoid driver. The solenoid driver energizes the roading relay to illuminate the self-deploy lamp. For additional information, refer to “Systems Operation, Self-Deploy/Earthmoving Circuit” in this module.

- Terminal B-5 is the engine start switch input. The input comes from contact 1 of the engine start switch. Power at terminal B-5 confirms that the engine start switch is in the ON position. For additional information, refer to “Systems Operation, Start, Charge, and Stop Circuit” in this module.

- Terminal B-6 is the input from transmission diagnostic check switch (10). EPTC II (1) translates input to terminals B-6 and B-7 into an LED display.

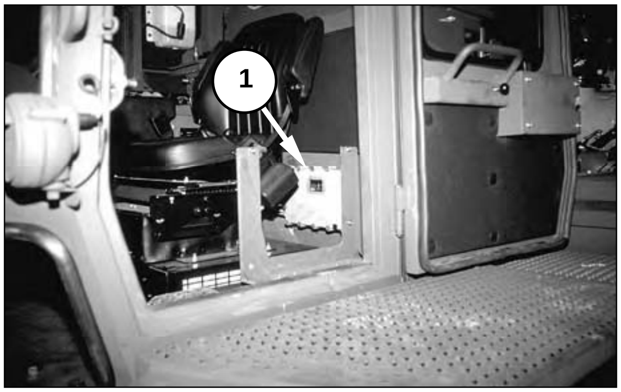
- Terminal B-7 is the input from transmission diagnostic scroll switch (11). EPTC II (1) translates input to terminals B-6 and B-7 into an LED display.

- Terminal B-8 is the common ground from upshift solenoid (6), downshift solenoid (7), and lockup solenoid (8).

- Terminal B-9 is a data link line from EPTC II (1) to transmission diagnostic plug (9).

- Terminal B-10 is a data link line from EPTC II (1) to transmission diagnostic plug (9).

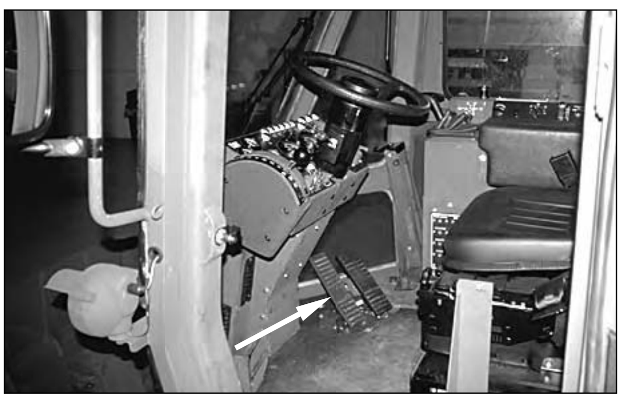
Component Location



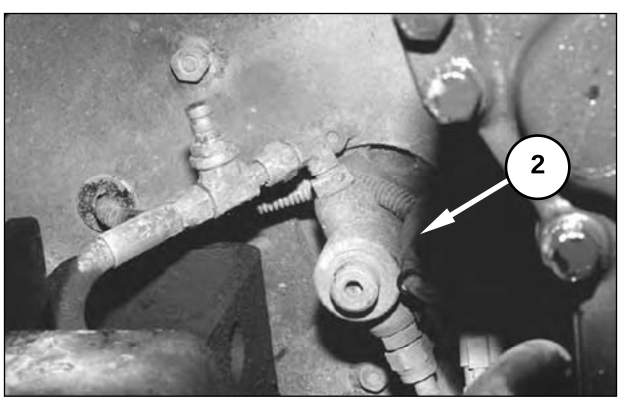
Inside Cab, Back Wall, Cover Removed.
(1) EPTC II.

EPTC II (1) is on the back, inside wall of the cab.The face of the EPTC II contains an LED which displays diagnostic information.

NOTE: For additional information about the EPTC II diagnostic mode, refer to *System Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electronic Programmable Transmission Control (EPTC II).*



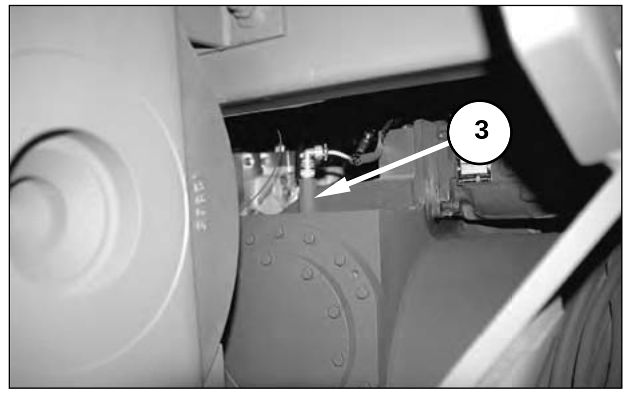
Inside Cab (Brake Pedal [Arrow] Shown for Location Reference).



Front of Machine, Under Cab, Attached to Brake Pedal.
(2) Service brake switch.

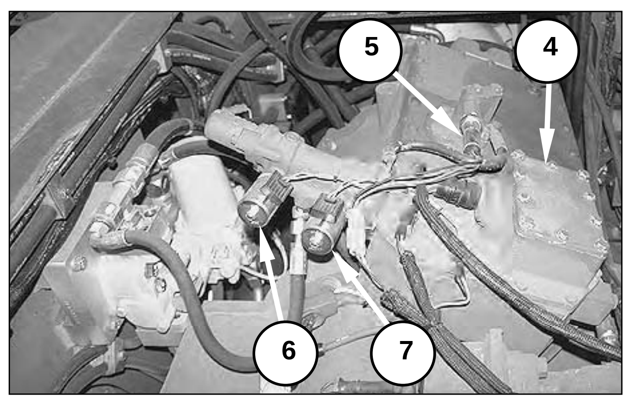
Service brake switch (2) is under the brake pedal. The service brake switch serves two functions: the switch confirms the status of the brakes (ENGAGED or RELEASED) to EPTC II (1) and illuminates the brake lamps when the brake pedal is depressed. The EPTC II will not shift the transmission out of NEUTRAL unless the service brake is engaged.

NOTE: For more information about the brake lamps, refer to “Systems Operation, Lighting Circuit” in this module.



Rear of Machine, in Front of Winch.
(3) Transmission speed sensor.

Transmission speed sensor (3) is at the rear of the machine, in front of the winch, on top of the differential steer housing. The EPTC II uses the transmission speed sensor to determine when to shift the transmission.



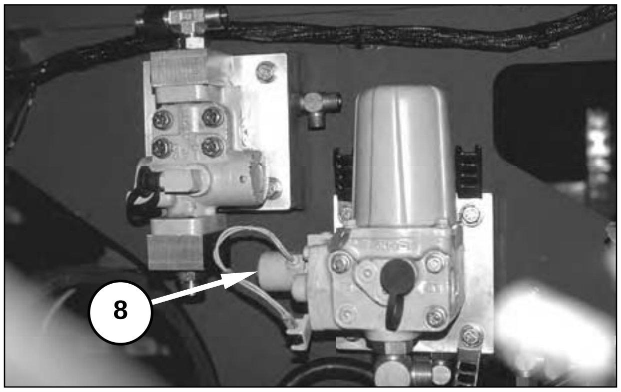
Transmission.
(4) Transmission gear switch. (5) P2 pressure switch. (6) Upshift solenoid. (7) Downshift solenoid.

Transmission gear switch (4) is mechanically connected to the transmission housing. The EPTC II uses the transmission gear switch to determine which gear is currently engaged. The transmission gear switch contains 10 contacts.

EPTC II (1) uses upshift solenoid (6) and downshift solenoid (7) to shift the transmission. These solenoids control the oil flow to the rotary actuator in the transmission control group.

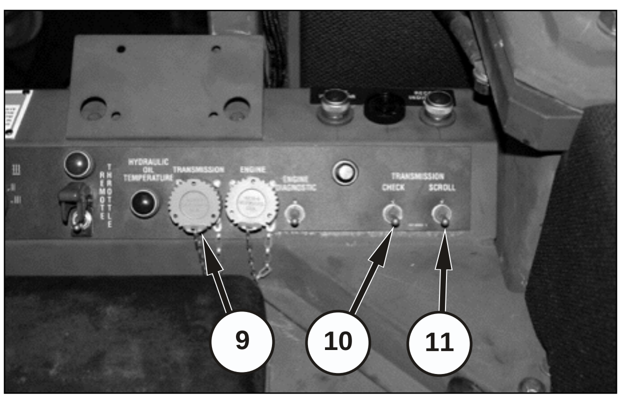
P2 pressure switch (5) monitors the oil pressure in the directional clutch. The EPTC II uses the input from the P2 pressure switch to determine when to disengage the lockup clutch during shifting of the transmission.

P2 pressure switch (5) is closed when P2 pressure is below 1100 ± 75 kPa (160 ± 11 psi). The P2 pressure switch opens when P2 pressure reaches approximately 1400 kPa (200 psi).



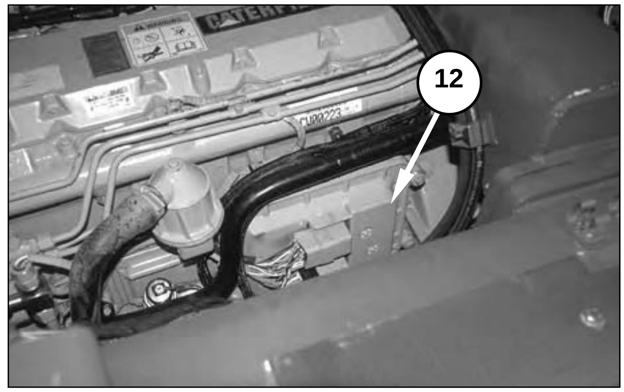
Left Side of Machine, Inside of Frame.
(8) Lockup solenoid.

Lockup solenoid (8) is located on the left side of the machine, on the inside of the frame. Energizing the lockup solenoid enables the machine to operate in direct drive. When the lockup solenoid is not energized, the machine operates in torque converter drive. EPTC II (1) controls the lockup solenoid.



Console to Right of Operator's Seat.
(9) Transmission diagnostic plug. (10) Transmission diagnostic check switch. (11) Transmission diagnostic scroll switch.

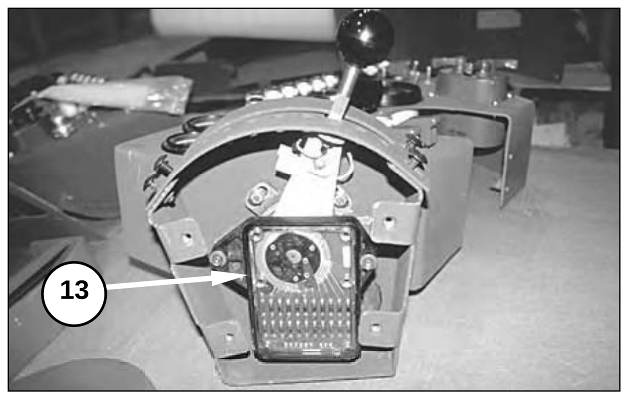
Transmission diagnostic plug (9), transmission diagnostic check switch (10), and transmission diagnostic scroll switch (11) are on the console to the right of the operator. The transmission diagnostic check switch and the transmission diagnostic scroll switch are normally open.



Left Side of Engine.
(12) ECM.

ECM (12) receives the vehicle speed input signal from EPTC II (1).

NOTE: For more information about the ECM, refer to "Gauges and Auxiliary Circuit, Circuit Operation" and "ECM Circuit" in the "Systems Operation" section of this module.

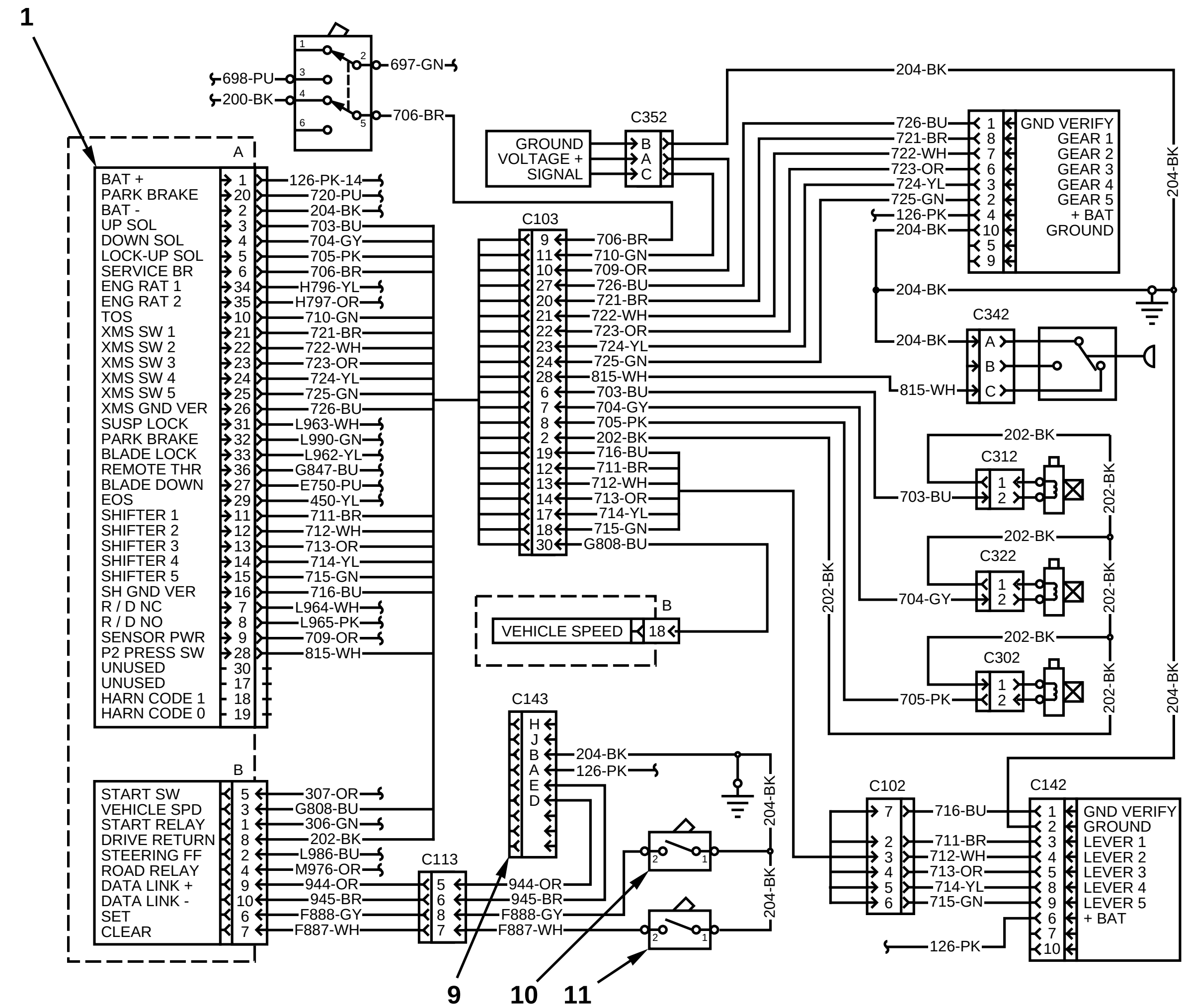


Shift Console, Left of Instrument Panel.
(13) Shift lever switch.

Shift lever switch (13) is mechanically connected to the transmission control lever. The EPTC II uses the shift lever to determine the position of the transmission control lever. The shift lever contains 10 contacts.

Circuit Operation

Diagnostic Circuit



Transmission Control Circuit.
(1) EPTC II. (9) Transmission diagnostic plug. (10) Transmission diagnostic check switch. (11) Transmission diagnostic scroll switch.

Transmission diagnostic plug (9) receives power from the EPTC II circuit breaker at contact A. Refer to “Systems Operation, Power Distribution” in this module.Contact B of the transmission diagnostic plug is ground.

Terminal B-9 of EPTC II (1) is connected to contact D of transmission diagnostic plug (9). Terminal B-10 of the EPTC II is connected to contact E of the transmission diagnostic plug. These connections provide a data transfer point between the EPTC II and service tools.

Power from terminal B-6 of EPTC II (1) is available at transmission diagnostic check switch (10). In the OFF position, the transmission diagnostic check switch is open and the circuit from terminal B-6 to ground is not complete. In the ON position, the transmission diagnostic check switch is closed and the EPTC II reads the completed circuit at terminal B-6.

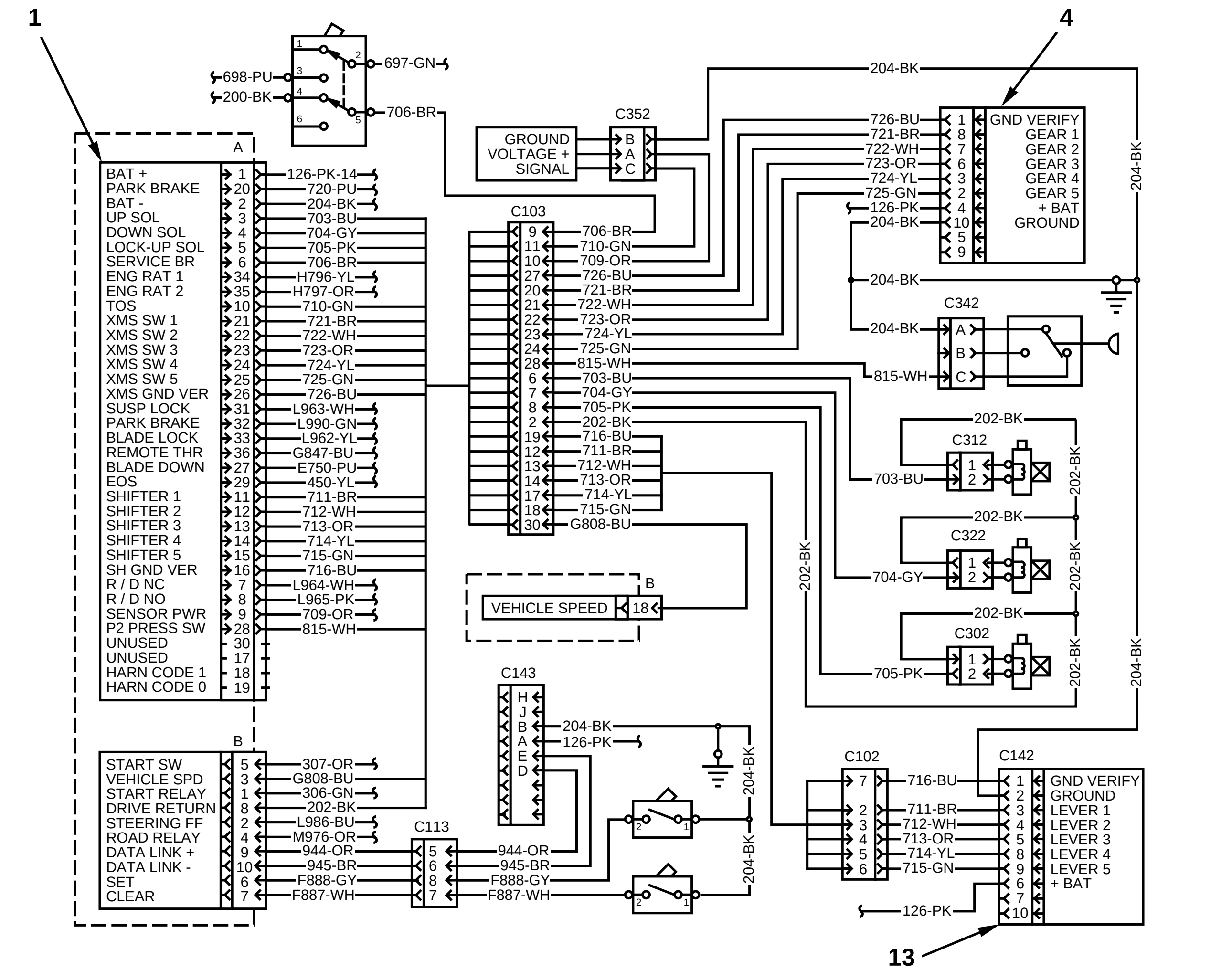
Power from terminal B-7 of EPTC II (1) is available at transmission diagnostic scroll switch (11). In the OFF position, the transmission diagnostic scroll switch is open and the circuit from terminal B-7 to ground is not complete. In the ON position, the transmission diagnostic scroll switch is closed and the EPTC II reads the completed circuit at terminal B-7.

EPTC II (1) enters the transmission diagnostic mode when terminals B-6 and B-7 are grounded at the same time. (Transmission diagnostic check switch (10) and transmission diagnostic scroll switch (11) must be simultaneously held in the ON position.) In the transmission diagnostic mode, fault information is displayed on the LED on the face of the EPTC II.

While in the diagnostic mode, completing the circuit at terminal B-6 of EPTC II (1) by moving transmission diagnostic check switch (10) to the ON position displays the next fault present in the system on the LED. To clear the currently displayed fault, the circuit at terminal B-7 must be completed by moving transmission diagnostic scroll switch (11) to the ON position.

NOTE: For more information about the diagnostic mode, refer to *Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electronic Programmable Transmission Control (EPTC II)*.

Transmission Gear Switch and Shift Lever Switch Operation



Transmission Control Circuit.
(1) EPTC II. (4) Transmission gear switch. (13) Shift lever switch.

NOTE: For additional information about transmission gear switch (4) and shift lever switch (13), refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electronic Programmable Transmission Control (EPTC II),* "Systems Operation, Component Description, Switches."

Contacts 1, 3, 4, 5, 8, and 9 of shift lever switch (13) provide input to EPTC II (1) through terminals A-16, A-11, A-12, A-13, A-14, and A-15, respectively. Contact 2 of the shift lever is the ground line which is connected to terminal B-8 of the EPTC II. Power from the EPTC II circuit breaker is available at contact 6 of the shift lever but is not used. Contact 7 of the shift lever is blank and serves as a reference position. Contact 10 is not used.

EPTC II (1) interprets the input from shift lever switch (13) to determine the current position of the transmission control lever. The EPTC II requires three input signals to determine the transmission control lever position. The first input, from contact 1 of the shift lever switch to terminal A-16 of the EPTC II, is the ground verify signal.

The origin of the second and third input signals depends on the position of the transmission control lever in the operator's station. In addition to the ground verify signal, two contacts of shift lever switch (13) are grounded for each transmission control lever position. EPTC II interprets the ground input signals from the shift lever switch to determine the transmission control lever position.

The contacts of the shift lever switch which are grounded for each gear are as follows:

Transmission Control Lever Position	Grounded Contacts of Shift Lever Switch
Sixth Forward	8 and 9
Fifth Forward	5 and 9
Fourth Forward	4 and 9
Third Forward	3 and 9
Second Forward	5 and 8
First Forward	4 and 8
Neutral	3 and 8
First Reverse	4 and 5
Second Reverse	3 and 5

When shift lever switch (13) is in the SIXTH FORWARD position, contacts 8 and 9 transmit a ground signal to terminals A-14 and A-15 of EPTC II (1). The EPTC II uses these ground signals to confirm that the shift lever switch is in the SIXTH FORWARD position.

When shift lever switch (13) is in the FIFTH FORWARD position, contacts 5 and 9 transmit a ground signal to terminals A-12 and A-15 of EPTC II (1). The EPTC II uses these ground signals to confirm that the shift lever switch is in the FIFTH FORWARD position.

NOTE: EPTC II (1) interprets the input signals for the remaining transmission control lever positions in a similar manner. For additional information about shift lever switch (13), refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electronic Programmable Transmission Control (EPTC II),* “Systems Operation, Component Description, Switches.”

Contacts 1, 2, 3, 6, 7, and 8 of transmission gear switch (4) provide input to EPTC II (1) through terminals A-20, A-25, A-24, A-23, A-22, and A-21, respectively. Contact 10 of the transmission gear switch is the ground line and is connected to terminal B-8 of the EPTC II. Power from the EPTC II circuit breaker is available at contact 4 of the transmission gear switch. Contact 5 of the transmission gear switch is blank and serves as a reference position. Contact 9 is not used.

The EPTC II (1) uses six input signals from transmission gear switch (4) to determine which of the transmission gears is currently engaged. For each gear, the transmission gear switch transmits a ground verify signal from contact 1 to terminal A-26 of the EPTC II. This signal is constantly transmitted to confirm that the transmission gear switch is connected to the EPTC II.

The remaining five input signals depend on which gear is currently engaged. Two of the five contacts transmit a 0.5-volt signal while the other three transmit a 5.0-volt signal.

The following shows the two contacts which transmit the lower voltage signal for each gear:

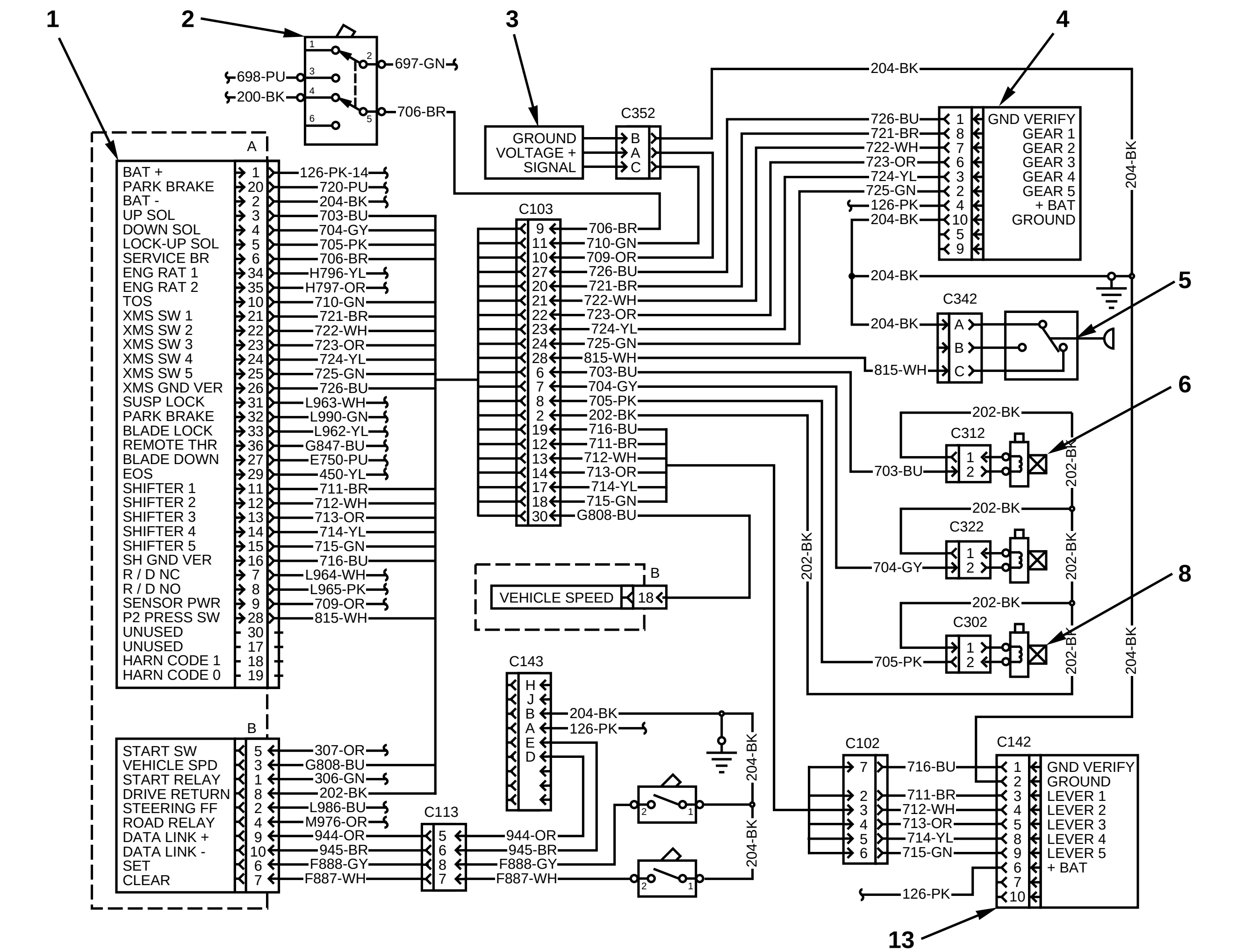
Transmission Gear Currently Engaged	Low Voltage Contacts
Neutral	2 and 3
Second Reverse	2 and 7
First Reverse	2 and 6
First Forward	2 and 8
Second Forward	3 and 6
Third Forward	3 and 7
Fourth Forward	3 and 8
Fifth Forward	7 and 7
Sixth Forward	6 and 8

When the transmission is in NEUTRAL, transmission gear switch (4) transmits a 0.5-volt signal from contacts 2 and 3 to terminals A-25 and A-24 of EPTC II (1). The transmission gear switch simultaneously transmits a 5.0-volt signal from contacts 6, 7, and 8 to terminals A-23, A-22, and A-21 of the EPTC II. This confirms that the transmission is in NEUTRAL.

When the transmission is in SECOND REVERSE, transmission gear switch (4) transmits a 0.5-volt signal from contacts 2 and 7 to terminals A-25 and A-22 of EPTC II (1). The transmission gear switch simultaneously transmits a 5.0-volt signal from contacts 3, 6, and 8 to terminals A-24, A-23, and A-21 of the EPTC II. This confirms that the transmission is in SECOND REVERSE.

NOTE: EPTC II (1) controls the remaining gears in a similar manner. For additional information about transmission gear switch (4), refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electronic Programmable Transmission Control (EPTC II),* “Systems Operation, Component Description, Switches.”

Manual Shifting, NEUTRAL to FIRST FORWARD



Transmission Control Circuit.
(1) EPTC II. (2) Service brake switch. (3) Transmission speed sensor. (4) Transmission gear switch. (5) P2 pressure switch. (6) Upshift solenoid. (8) Lockup solenoid. (13) Shift lever switch.

NOTE: While in the EARTHMOVING mode, EPTC II (1) forces the operator to manually shift, limiting the transmission to the REVERSE gears and FIRST, SECOND, and THIRD FORWARD. For more information about the EARTHMOVING mode, refer to “Systems Operation, Self-Deploy/Earthmoving Circuit” in this module.

When the transmission control lever is in the NEUTRAL position, terminals A-11, A-14, and A-16 of EPTC II (1) receive the ground verify signals from contacts 3, 8, and 1 of shift lever switch (13). This input to the EPTC II verifies that the shift lever switch is in the NEUTRAL position.

When the transmission is in NEUTRAL, transmission gear switch (4) transmits a 0.5-volt signal from contacts 2 and 3 to terminals A-25 and A-24 of EPTC II (1). The EPTC II confirms that the transmission gear switch position matches the position of the transmission control lever.

The ground path for terminal A-6 of EPTC II (1) is through contact 5 of service brake switch (2). The service brake switch provides a path to ground (across contacts 4 and 5) when the service brakes are released. The ground signal at terminal A-6 confirms to the EPTC II that the service brakes are released.

Engaging the service brakes opens contacts 4 and 5 of service brake switch (2), causing EPTC II (1) to lose the ground signal. The lack of ground confirms to the EPTC II that the service brakes are engaged. The EPTC II will only shift the machine out of NEUTRAL if the service brake is engaged.

Moving the transmission control lever from NEUTRAL to FIRST FORWARD causes shift lever switch (13) to transmit ground signals from contacts 4 and 8 to terminals A-12 and A-14 of EPTC II (1). From this input, the EPTC II determines that the shift lever switch is in the FIRST FORWARD position. However, the input signals from transmission gear switch (4) indicate that the transmission is still in NEUTRAL. Since the input signals do not match, the EPTC II determines that the transmission needs to be shifted.

To shift from NEUTRAL to FIRST FORWARD, EPTC II (1) directs current from terminal A-3 to energize upshift solenoid (6). Energizing the upshift solenoid causes the transmission to shift.

After upshift solenoid (6) causes the transmission to shift, transmission gear switch (4) transmits a 0.5-volt signal from contacts 2 and 8 to terminals A-25 and A-21 of EPTC II (1). The EPTC II confirms that the transmission is currently in FIRST FORWARD.

Since the input from transmission gear switch (4) matches the input from shift lever switch (13), EPTC II (1) confirms that the gear currently engaged matches the position of the transmission control lever. The EPTC II discontinues the signal from terminal A-3 to upshift solenoid (6).

In the SELF-DEPLOY mode with the transmission in FIRST FORWARD, the machine begins in torque converter drive. After the transmission output speed increases to the direct drive speed, EPTC II (1) energizes lockup solenoid (8) to initiate direct drive. The EPTC II monitors the transmission output speed through transmission speed sensor (3).

Contact A of transmission speed sensor (3) receives power from terminal A-9 of EPTC II (1). Contact B of the transmission speed sensor is the ground and is connected to terminal B-8 of the EPTC II. Contact C of the transmission speed sensor transmits the speed input to terminal A-10 of the EPTC II. The frequency of the speed input signal from contact C of the transmission speed sensor is proportional to the speed of the transmission output shaft.

When the transmission output shaft speed reaches the specified point, EPTC II (1) energizes lockup solenoid (8) by directing current from terminal A-5 to the coil of the lockup solenoid. The lockup solenoid energizes, engaging the lockup clutch and initiating direct drive.

NOTE: For shift point information, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electronic Programmable Transmission Control (EPTC II),* “Testing and Adjusting, Shift Point Specifications.”

NOTE: In the EARTHMOVING mode, the machine will only operate in torque converter drive. In the SELF-DEPLOY mode, the transmission operates in torque converter drive while the transmission is in NEUTRAL, FIRST REVERSE, and SECOND REVERSE. In SELF-DEPLOY FIRST FORWARD, SECOND FORWARD and THIRD FORWARD, the machine operates in torque converter drive while the transmission output speed is low, and in direct drive when transmission output speed is high.

Manual Shifting, FIRST FORWARD to SECOND FORWARD

NOTE: The machine will only shift into SECOND FORWARD while in the SELF-DEPLOY mode if the shift lever switch is placed in the SECOND FORWARD position.

When the transmission control lever is in the FIRST FORWARD position, terminals A-12 and A-14 of EPTC II (1) receive ground verify signals from contacts 4 and 8 of shift lever switch (13). This input to the EPTC II verifies that the shift lever switch is in the FIRST FORWARD position.

When the transmission is in FIRST FORWARD, transmission gear switch (6) transmits a 0.5-volt signal from contacts 2 and 8 to terminals A-25 and A-21 of EPTC II (1). The EPTC II confirms that the transmission gear currently engaged matches the position of the transmission control lever.

Moving the transmission control lever from FIRST FORWARD to SECOND FORWARD causes shift lever switch (13) to transmit ground signals from contacts 5 and 8 to terminals A-13 and A-14 of EPTC II (1). From this input, the EPTC II determines that the shift lever switch is in the SECOND FORWARD position. However, the input signals from transmission gear switch (4) indicate that the transmission is still in FIRST FORWARD. Since the input signals do not match, the EPTC II determines that the transmission needs to be shifted.

EPTC II (1) initiates the shift by directing current from terminal A-3 to energize upshift solenoid (6). Energizing the upshift solenoid directs oil flow to the rotary actuator of the transmission hydraulic control group. The oil flow moves the rotary actuator, causing the transmission control valve to begin the shift.

As the shift progresses, P2 pressure switch (5) detects a decrease in P2 pressure. When P2 pressure decreases to 1100 ± 75 kPa (160 ± 11 psi), contacts A and C of the P2 pressure switch close, sending a ground signal to terminal A-28 of EPTC II (1).

A ground signal at terminal A-28 prompts EPTC II (1) to discontinue the signal from terminal A-5 to the coil of lockup solenoid (8). This releases the lockup clutch, returning the machine to torque converter drive.

As the shift progresses further, P2 pressure switch (5) detects the increased P2 pressure. When the P2 pressure increases to approximately 1400 kPa (200 psi), contacts A and C of the P2 pressure switch open, thereby opening the circuit to terminal A-28 of EPTC II (1).

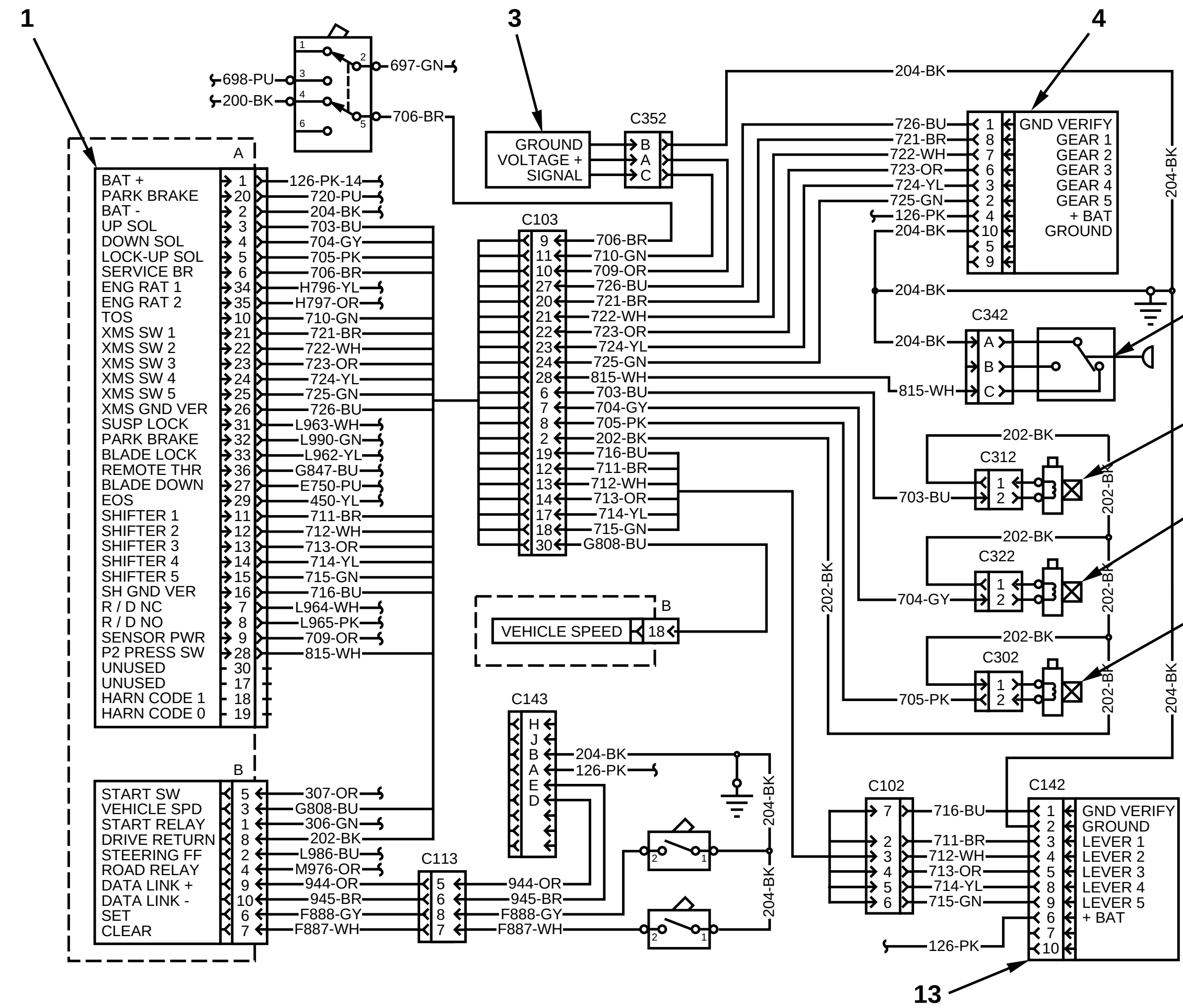
After the shift is complete, transmission gear switch (4) transmits a 0.5-volt signal from contacts 3 and 6 to terminals A-24 and A-23 of EPTC II (1). The EPTC II compares this input to the input from shift lever switch (13) and confirms that the transmission gear currently engaged matches the position of the transmission control lever.

With the ground signal at terminal A-28 of EPTC II (1) no longer present, when the transmission output speed reaches the set point, the EPTC II directs current from terminal A-5 to the coil of lockup solenoid (8). The lockup solenoid energizes, engaging the lockup clutch and initiating direct drive when the machine is in the SELF-DEPLOY mode.

NOTE: For shift point information, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electronic Programmable Transmission Control (EPTC II),* “Testing and Adjusting, Shift Point Specifications.”

NOTE: Shifting between other gears works in a similar manner. However, EPTC II (1) will not allow a downshift if the transmission output speed is too great for the gear chosen. The downshift will not occur until the transmission output speed decreases to a level which will not damage the transmission.

Automatic Shifting, FIRST FORWARD to Top Gear Selected



Transcription Control Circuit.

(1) EPTC II. (3) Transmission speed sensor. (4) Transmission gear switch. (5) P2 pressure switch. (6) Upshift solenoid. (7) Downshift solenoid. (8) Lockup solenoid. (13) Shift lever switch.

While in the SELF-DEPLOY mode, EPTC II (1) automatically shifts the transmission between FIRST FORWARD and the highest gear selected.

NOTE: During automatic shifting (SELF-DEPLOY mode), the transmission skips SECOND FORWARD. The only way to operate the machine in SECOND FORWARD while in the SELF-DEPLOY mode is to place the transmission control lever in the SECOND FORWARD position.

During an automatic shift, the shifting mechanism is the same as during a manual shift. The difference between manual and automatic shifting lies in what prompts the shift to initiate.

During manual shifting, the operator must initiate the shift by moving the transmission control lever from one gear to another. During automatic shifting, EPTC II (1) monitors input signals from shift lever switch (13), transmission gear switch (4), and transmission speed sensor (3) to determine when to shift the transmission. If the transmission speed dictates a downshift, the EPTC II will initiate the downshift.

Moving the transmission control lever from NEUTRAL to a FORWARD gear (SECOND FORWARD or higher), with the machine in the SELF-DEPLOY mode, begins the auto-shift sequence. EPTC II (1) determines when a shift is necessary by comparing input signals from shift lever switch (13) and transmission gear switch (4). The EPTC II directs current from terminal A-3 to energize upshift solenoid (6).

NOTE: For more information about the SELF-DEPLOY mode, refer to “Systems Operation, Self-Deploy/Earthmoving Mode” in this module. For details about how shift lever switch (13) and transmission gear switch (4) interact with EPTC II (1), refer to “Switch Operation” in this section.

After the shift from NEUTRAL to FIRST FORWARD is complete, terminal A-10 of EPTC II (1) monitors the input signal from contact C of transmission speed sensor (3). When the transmission output speed reaches the direct drive setting, terminal A-5 of the EPTC II sends current to energize lockup solenoid (8) and engage the lockup clutch.

When transmission speed sensor (3) indicates that the transmission output speed has reached the upshift setting, the following will happen:

- Terminal A-3 of EPTC II (1) energizes upshift solenoid (6) and causes the rotary actuator to shift the transmission.
- P2 pressure decreases, closing contacts A and C of P2 pressure switch (5).
- Terminal A-28 of EPTC II (1) receives a ground signal from P2 pressure switch (5).
- EPTC II (1) discontinues the signal from terminal A-5 to the coil of lockup solenoid (8), changing the machine from direct to torque converter drive.
- The transmission completes the shift into the next higher gear.
- P2 pressure increases, causing contacts A and C of P2 pressure switch (5) to open.
- Terminal A-5 of EPTC II (1) directs current to energize lockup solenoid (8).

After completing the shift, EPTC II (1) compares the input from shift lever switch (13) to the input from transmission gear switch (4). If the input signals indicate that the transmission is in the same gear as the transmission control lever, the EPTC II will not shift to a higher gear. If the transmission is in a lower gear than the transmission control lever, the EPTC II will shift the transmission to the next higher gear when transmission speed sensor (3) indicates that the transmission output speed has reached the upshift setting.

The shifting process continues until transmission gear switch (4) indicates that the transmission is in the same gear as the shift lever switch (13) indicates.

NOTE: EPTC II (1) will shift one gear beyond the position of the transmission control lever to prevent engine overspeed.

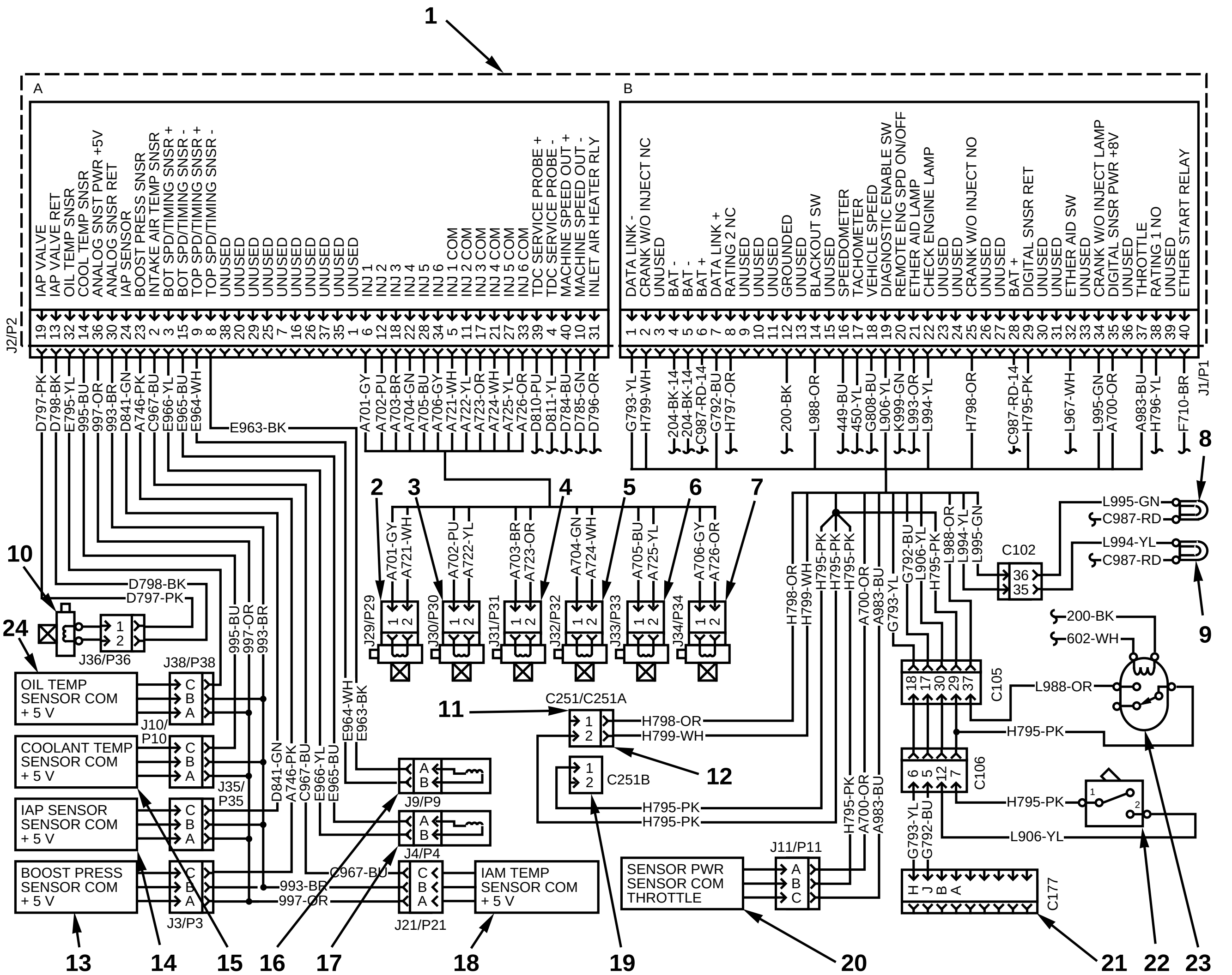
Down Shifting

During the automatic shifting process, if transmission speed sensor (3) indicates to terminal A-10 of EPTC II (1) that the transmission output speed has decreased to the downshift setting, the EPTC II initiates a downshift.

A downshift follows the same process as an upshift except instead of directing current to upshift solenoid (6), EPTC II (1) transfers power from terminal A-4 to the coil of downshift solenoid (7). The EPTC II will downshift to FIRST FORWARD, one gear at a time, if the conditions dictate.

NOTE: A downshift can be initiated by moving the transmission control lever to a gear which is lower than the currently engaged gear. However, EPTC II (1) will not allow a downshift if doing so will damage the machine.

ECM Circuit



ECM Circuit Schematic.

(1) ECM. (2) Number-1 fuel injection solenoid. (3) Number-2 fuel injection solenoid. (4) Number-3 fuel injection solenoid. (5) Number-4 fuel injection solenoid. (6). Number-5 fuel injection solenoid. (7) Number-6 fuel injection solenoid. (8) Crank-without-inject lamp. (9) Check engine lamp. (10) Injection actuation pressure solenoid. (11) Connector C251A. (12) Crank-without-inject plug C251. (13) Boost pressure sensor. (14) Injection actuation pressure sensor. (15) Coolant temperature sensor. (16) Top speed/timing sensor. (17) Bottom speed/timing sensor. (18) Intake air temperature sensor. (19) Connector C251B. (20) Throttle position sensor. (21) Diagnostic plug. (22) Diagnostic enable switch. (23) Blackout switch relay. (24) Engine oil temperature sensor.

ECM (1) electronically controls the engine and various other components of the machine. The ECM circuit contains sensors to “see” conditions throughout the system, software to “evaluate” input from the sensors, and solenoid/unit injectors to “act” to control the engine. The system software, inside the ECM, is called the “Personality Module.” The software stores the operating maps that define horsepower, torque curves, rpm, and other operating parameters. These maps provide the logic necessary for the ECM to operate the engine at the proper setting for the current conditions.

NOTE: For additional information, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine*.

Components of the ECM circuit are: ECM (1), number-1 fuel injection solenoid (2), number-2 fuel injection solenoid (3), number-3 fuel injection solenoid (4), number-4 fuel injection solenoid (5), number-5 fuel injection solenoid (6), number-6 fuel injection solenoid (7), crank-without-inject lamp (8), check engine lamp (9), injection actuation pressure solenoid (10), connector (11), crank-without-inject plug (12), boost pressure sensor (13), injection actuation pressure sensor (14), coolant temperature sensor (15), top speed/timing sensor (16), bottom speed/timing sensor (17), intake air temperature sensor (18), connector (19), throttle position sensor (20), diagnostic plug (21), diagnostic enable switch (22), blackout switch relay (23), and oil temperature sensor (24).

NOTE: The function of other components which provide input to or receive output from the ECM are discussed in the previous sections of this module.

The ECM has two 40-pin connectors. Each terminal on both connectors has a separate function, as described below.

- Terminal A-1 is not used.
- Terminal A-2 receives the input signal from contact C of intake air temperature sensor (18). ECM (1) uses this signal as one input to help determine fuel injection timing and quantity. The ECM also uses this signal as one input to help determine when to send an output signal from contact A-31 to the start-aid relay and from contact B-21 to the start-aid lamp. For additional information, refer to, "Systems Operation, Start, Charge, and Stop Circuit" in this module.
- Terminal A-3 provides power to bottom speed/timing sensor (17). ECM (1) uses this terminal to obtain one of the inputs needed to determine engine speed and the top center position of the number-1 cylinder.
- Terminal A-4 is for use by Caterpillar service technicians.
- Terminal A-5 is the common line for the number-1 fuel injection solenoid (2). This terminal acts as the ground for the number-1 fuel injection solenoid.
- Terminal A-6 provides power to the number-1 fuel injection solenoid (2). ECM (1) uses input signals from intake air temperature sensor (refer to terminal A-2), boost pressure sensor (refer to terminal A-23), bottom and top speed/timing sensors (refer to terminals A-3 and A-9), and throttle position sensor (refer to terminal B-37) to determine the amount of fuel to inject and when to energize the number-1 fuel injection solenoid.
- Terminal A-7 is not used.
- Terminal A-8 is the negative line from top speed/timing sensor (16).
- Terminal A-9 provides power to bottom speed/timing sensor (17). ECM (1) uses this terminal to obtain one of the inputs needed to determine engine speed and the top center position of the number-1 cylinder.
- Terminal A-10 is for use by Caterpillar service technicians.
- Terminal A-11 is the common line for the number-2 fuel injection solenoid (3). This terminal acts as the ground for the number-2 fuel injection solenoid.
- Terminal A-12 provides power to number-2 fuel injection solenoid (3). ECM (1) uses input signals from the intake air temperature sensor (refer to terminal A-2), boost pressure sensor (refer to terminal A-23), bottom and top speed/timing sensors (refer to terminals A-3 and A-9), and throttle position sensor (refer to terminal B-37) to determine the amount of fuel to inject and when to energize the number-2 fuel injection solenoid.
- Terminal A-13 is the return line from injection actuation pressure solenoid (10). The positive line to the injection actuation pressure solenoid is connected at terminal A-19.
- Terminal A-14 receives the input signal from contact C of coolant temperature sensor (15). ECM (1) uses the signal to monitor engine coolant temperature and record high engine coolant temperatures.
- Terminal A-15 is the negative line from bottom speed/timing sensor (17).
- Terminal A-16 is not used.
- Terminal A-17 is the common line for number-3 fuel injection solenoid (4). This terminal acts as the ground for the number-3 injection solenoid.
- Terminal A-18 provides power to number-3 fuel injection solenoid (4). ECM (1) uses input signals from the intake air temperature sensor (refer to terminal A-2), boost pressure sensor (refer to terminal A-23), bottom and top speed/timing sensors (refer to terminals A-3 and A-9), and throttle position sensor (refer to terminal B-37) to determine the amount of fuel to inject and when to energize the number-3 fuel injection solenoid.

- Terminal A-19 provides power to injector actuation pressure solenoid (10). ECM (1) completes the circuit from the injector actuation pressure solenoid at terminal A-13. The ECM energizes this solenoid to control oil pressure in the high pressure oil manifold. If terminals B-2 and B-25 indicate that the crank-without-inject switch is in the ON position, the ECM will not provide power to the injection actuation pressure solenoid.

- Terminal A-20 is not used.

- Terminal A-21 is the common line for number-4 fuel injection solenoid (5). This terminal acts as the ground for the number-4 fuel injection solenoid.

- Terminal A-22 provides power to number-4 fuel injection solenoid. ECM (1) uses input signals from the intake air temperature sensor (refer to terminal A-2), boost pressure sensor (refer to terminal A-23), bottom and top speed/timing sensors (refer to terminals A-3 and A-9), and throttle position sensor (refer to terminal B-37) to determine the amount of fuel to inject and when to energize the number-4 fuel injection solenoid.

- Terminal A-23 receives the input signal from contact C of boost pressure sensor (13). ECM (1) uses this signal as one input to determine fuel injection timing and quantity.

- Terminal A-24 receives the input signal from contact C of injection actuation pressure sensor (14). ECM (1) uses this signal to monitor the oil pressure in the high pressure oil manifold.

- Terminal A-25 is not used.

- Terminal A-26 is not used.

- Terminal A-27 is the common line for number-5 fuel injection solenoid (6). This terminal acts as the ground for the number-5 fuel injection solenoid.

- Terminal A-28 provides power to number-5 fuel injection solenoid. ECM (1) uses input signals from the intake air temperature sensor (refer to terminal A-2), boost pressure sensor (refer to terminal A-23), bottom and top speed/timing sensors (refer to terminals A-3 and A-9), and throttle position sensor (refer to terminal B-37) to determine the amount of fuel to inject and when to energize the number-5 fuel injection solenoid.

- Terminal A-29 is not used.

- Terminal A-30 is the common line from coolant temperature sensor (15), injection actuation pressure sensor (14), boost pressure sensor (13), intake air temperature sensor (18), and oil temperature sensor (24). For additional information about the coolant temperature sensor and the intake air temperature sensor, refer to “Systems Operation, Start, Charge, and Stop Circuit” in this module.

- Terminal A-31 provides the ground for the coil in the inlet air heater relay. ECM (1) uses inputs from the oil temperature sensor (refer to terminal A-32) and intake air temperature sensor (refer to terminal A-14) to determine when to allow the coil in the relay to energize in order to activate the intake air heater.

- Terminal A-32 receives the input signal from contact C of engine oil temperature sensor (24). ECM (1) uses this signal to determine when to initiate the start-aid function. For additional information, refer to “Systems Operation, Start, Charge, and Stop Circuit” in this module.

- Terminal A-33 is the common line for number-6 fuel injection solenoid (7). This terminal acts as the ground for the number-6 fuel injection solenoid.

- Terminal A-34 provides power to number-6 fuel injection solenoid (7). ECM (1) uses input signals from the intake air temperature sensor (refer to terminal A-2), boost pressure sensor (refer to terminal A-23), bottom and top speed/timing sensors (refer to terminals A-3 and A-9), and throttle position sensor (refer to terminal B-37) to determine when to energize the number-6 fuel injection solenoid and the amount of fuel to inject.

- Terminal A-35 is not used.

- Terminal A-36 provides power to coolant temperature sensor (15), injection actuation pressure sensor (14), boost pressure sensor (13), intake air temperature sensor (18), and oil temperature sensor (24). For additional information about the coolant temperature sensor and the intake air temperature sensor, refer to “Systems Operation, Start, Charge, and Stop Circuit” in this module.

- Terminals A-37 is not used.

- Terminal A-38 is not used.

- Terminal A-39 is for use by Caterpillar service technicians.

- Terminal A-40 is for use by Caterpillar service technicians.

- Terminal B-1 provides a data link line between ECM (1) and diagnostic plug (21).
- Terminal B-2 connects to the normally closed line from the crank-without-inject connectors (11), (12), and (19). A completed circuit between terminals B-2 and B-29 tells ECM (1) to operate the engine normally.
- Terminal B-3 receives power from the ECM circuit breaker. The power delivered to terminal B-3 is not used.
- Terminal B-4 is a ground line.
- Terminal B-5 is a ground line.
- Terminal B-6 is not used.
- Terminal B-7 provides a data link line between ECM (1) and diagnostic plug (21).
- Terminal B-8 receives the high horsepower input signal from terminal A-35 of the EPTC II. The EPTC II sends the signal when the machine is in SELF-DEPLOY mode and the transmission is above THIRD FORWARD. A completed circuit at terminal B-8 prompts ECM (1) to operate the engine following the high-horsepower fuel map. For additional information, refer to “Transmission Control Circuit” and/or “Self-Deploy/Earthmoving Circuit” in the “Systems Operation” section of this module.
- Terminal B-9 is not used.
- Terminal B-10 is not used.
- Terminal B-11 is not used.
- Terminal B-12 is a ground line for the vehicle speed input at terminal B-18.
- Terminal B-13 is not used.
- Terminal B-14 is the input from blackout switch relay (23). When a grounded circuit exists between terminals B-14 and B-29, ECM (1) enables the start-aid lamp (refer to terminal B-21), check engine lamp (9) (refer to terminal B-22), and the crank-without-inject lamp (refer to terminal B-34) to illuminate.
- Terminal B-15 is not used.
- Terminal B-16 transmits the output signal to drive the speedometer. ECM (1) uses the input at terminal B-18 to determine vehicle speed.
- Terminal B-17 transmits the engine output speed signal to terminal A-29 of the EPTC II and to the sender terminal of the tachometer. For more information, refer to “Systems Operation, Gauges and Auxiliary Circuit” in this module.
- Terminal B-18 receives the transmission output speed signal from terminal B-3 of the EPTC II. ECM (1) uses this input to calculate vehicle speed. For more information, refer to “Systems Operation, Gauges and Auxiliary Circuit” in this module.
- Terminal B-19 is connected to terminal B-29 through diagnostic enable switch (22). A complete circuit between terminal B-19 and terminal B-29 prompts ECM (1) to display the diagnostic flash codes on check engine lamp (9) (refer to terminal B-22).
- Terminal B-20 is the remote throttle switch input. A completed circuit between terminals B-20 and B-29 confirms to ECM (1) that the remote throttle switch is in the ON position. For more information, refer to “Systems Operation, Remote Throttle Circuit” in this module.
- Terminal B-21 is the start-aid lamp driver. When conditions are right, ECM (1) sends power to illuminate the start-aid lamp (refer to terminals A-2, A-14, and B-14). For more information, refer to “Systems Operation, Start, Charge, Stop Circuit” in this module.
- Terminal B-22 is the check engine lamp driver. When conditions are right, ECM (1) grounds terminal B-22 to illuminate check engine lamp (9) (refer to terminal B-14).
- Terminal B-23 is not used.
- Terminal B-24 is not used.
- Terminal B-25 is the return line from the crank-without-inject connector (12). This terminal is normally open. A completed circuit between terminals B-25 and B-29 tells ECM (1) to disable the fuel injectors and illuminate crank-without-inject lamp (8) (refer to terminals B-2 and B-34).
- Terminal B-26 is not used.
- Terminal B-27 is not used.
- Terminal B-28 is the power supply for ECM (1). Refer to “Systems Operation, Power Distribution Circuit” in this module.

- Terminal B-29 is the return line for the crank-without-inject connector (refer to terminals B-2 and B-25), blackout switch relay (refer to terminal B-14), diagnostic enable switch (refer to terminal B-19), remote throttle switch (refer to terminal B-20), start-aid lamp (refer to terminal B-21), start-aid switch (refer to terminal B-32), and throttle position sensor (refer to terminals B-35 and B-37).

- Terminal B-30 is not used.

- Terminal B-31 is not used.

- Terminal B-32 supplies power to enable the start-aid switch. When the circuit between terminal B-32 and B-29 is complete and conditions are right, the ECM initiates the start-aid function (refer to terminals A-2 and A-14). For additional information, refer to “Systems Operation, Start, Charge, and Stop Circuit” in this module.

- Terminal B-33 is not used.

- Terminal B-34 is the crank-without-inject lamp driver. When conditions are right, ECM (1) grounds terminal B-34 to illuminate crank-without-inject lamp (8) (refer to terminals B-2 and B-25).

- Terminal B-35 provides 8 volts of power to terminal A of throttle position sensor (20) (refer to terminals B-29 and B-37).

- Terminal B-36 is not used.

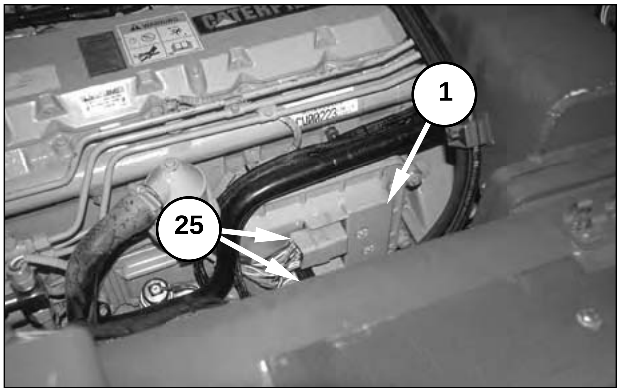
- Terminal B-37 receives the pulse width modulated output signal from the throttle (refer to terminals B-29 and B-35).

- Terminal B-38 receives the low horsepower input signal from terminal A-34 of the EPTC II. The EPTC II sends the signal when the machine is in the EARTHMOVING mode or the SELF-DEPLOY mode when the transmission is below THIRD FORWARD. A completed circuit at terminal B-38 prompts the ECM to operate the engine following the low horsepower fuel map. For additional information, refer to “Transmission Control Circuit” and/or “Self-Deploy/Earthmoving Circuit” in the “Systems Operation” section of this module.

- Terminal B-39 is not used.

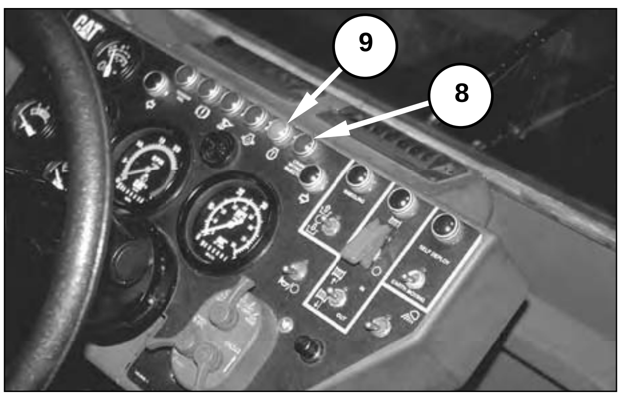
- Terminal B-40 provides the power to energize the start-aid relay when conditions are right (refer to terminals A-2, A-14, and B-32). For additional information, refer to “Systems Operation, Start, Charge, and Stop Circuit” in this module.

Component Location



Left Side of Engine.
(1) ECM. (25) ECM connectors.

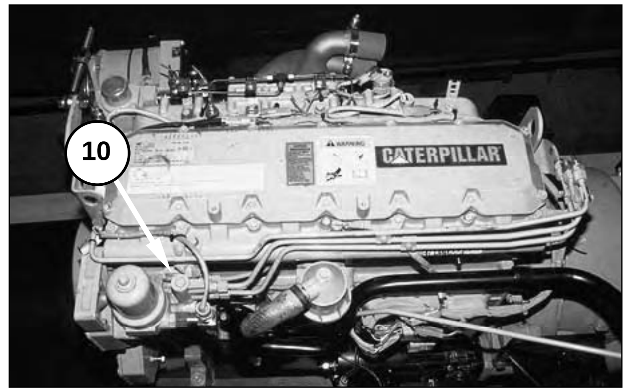
ECM (1) electronically controls the operation of the engine and various other components on the machine. The ECM has two 40-pin connectors (25). The A-terminals of the ECM are in the top connector (J2/P2), and the B-terminals of the ECM are in the bottom connector (J1/P1).



Instrument Panel.
(8) Crank-without-inject lamp. (9) Check engine lamp.

Crank-without-inject lamp (8) and check engine lamp (9) are on the instrument panel. ECM (1) controls operation of these lamps.

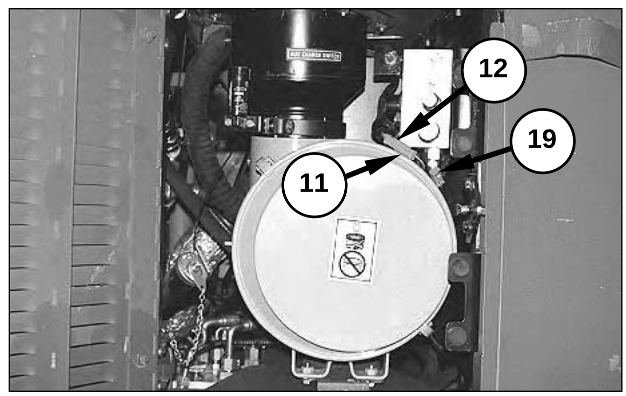
NOTE: The blackout switch must be in the SERVICE DRIVE or STOP LIGHT position for the lamps to function. For additional information about the positions of the blackout switch, refer to “Systems Operation, Lighting Circuit” in this module.



Left Side of Engine, Engine Removed From Machine.
(10) Injection actuation pressure solenoid.

Injection actuation pressure solenoid (10) is located on the left side of the engine. ECM (1) uses the injection actuation pressure solenoid to control the pressure in the high pressure oil manifold.

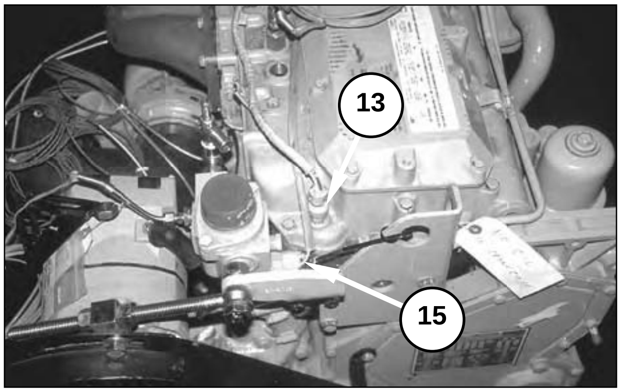
NOTE: Engine harness connector J36/P36 connects injection actuation pressure solenoid (10) to the engine harness.



Left Side of Machine, Back Wall of Air Cleaner Compartment.
(11) Connector. (12) Crank-without-inject plug. (19) Connector.

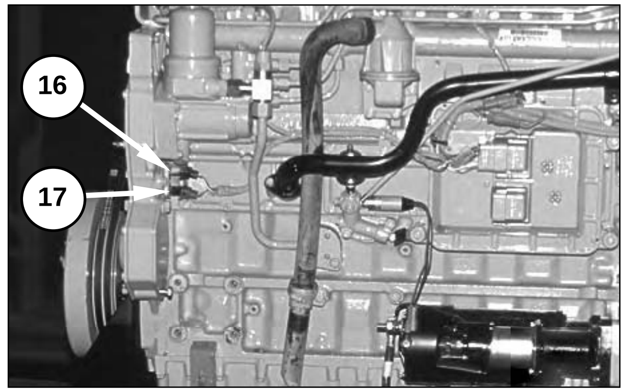
Crank-without-inject plug (12) is near the back wall of the air cleaner compartment. To use the crank-without-inject function, the crank-without-inject plug must be unplugged from connector (11) and plugged into connector (19).

NOTE: Connector (11) is engine harness connector C251A; crank-without-inject plug (12) is engine harness plug C251; and connector (19) is engine harness connector C251B.



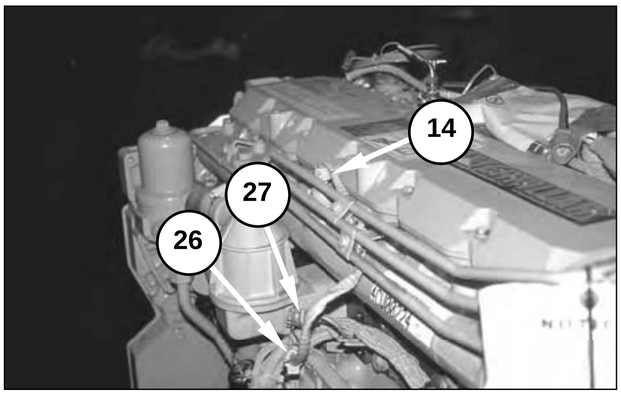
Front of Engine, Engine Removed From Machine.
(13) Boost pressure sensor. (15) Coolant temperature sensor.

Boost pressure sensor (13) monitors the air pressure in the intake manifold. Coolant temperature sensor (15) monitors the temperature of the engine coolant.



Left Side of Engine, Engine Removed From Machine.
(16) Top speed/timing sensor. (17) Bottom speed/timing sensor.

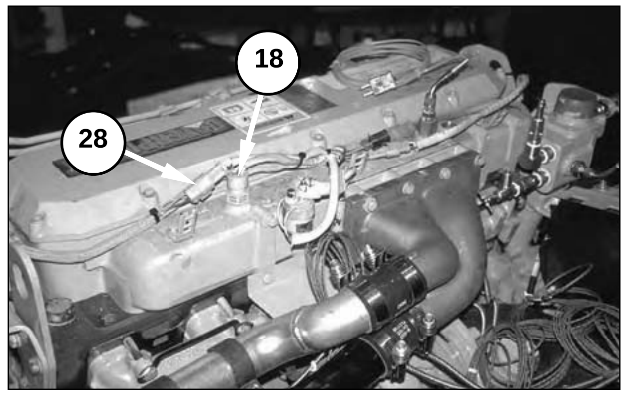
ECM (1) uses the top and bottom speed/timing sensors (16 and 17) to establish the position of the number-1 cylinder, as well as the speed of the engine.



Left Side of Engine, Engine Removed From Machine.
(14) Injection actuation pressure sensor. (26) Engine harness connector J35/P35. (27) Engine harness connector J24/P24.

Injection actuation pressure sensor (14) measures the oil pressure in the high pressure oil manifold.

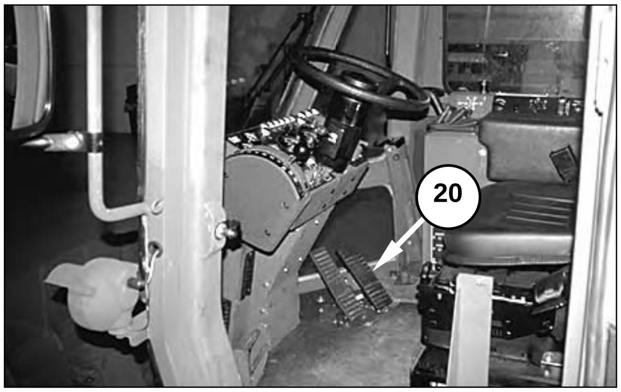
NOTE: Engine harness connector J35/P35 (26) connects the engine harness to injection actuation pressure sensor (14). Engine harness connector J24/P24 (27) is also visible.



RIght Side of Engine, Engine Removed From Machine.
(18) Intake air temperature sensor. (28) Engine harness connector J21/P21.

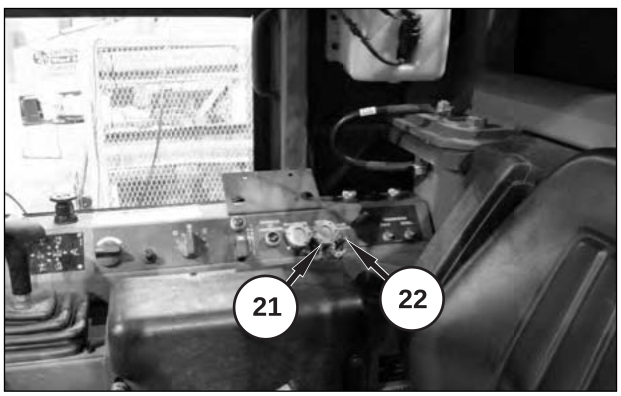
Intake air temperature sensor (18) monitors the temperature of the intake air.

NOTE: Engine harness connector J21/P21 (28) is located near intake air temperature sensor (18).



Inside Cab, Front Floor.
(20) Throttle position sensor (not shown, attached to throttle control pedal).

Throttle position sensor (20) is connected to the throttle control pedal. The throttle position sensor provides a pulse width modulated signal to ECM (1) to indicate the throttle control pedal position. The ECM uses the input signal (along with other signals) to determine the speed at which the engine should operate.

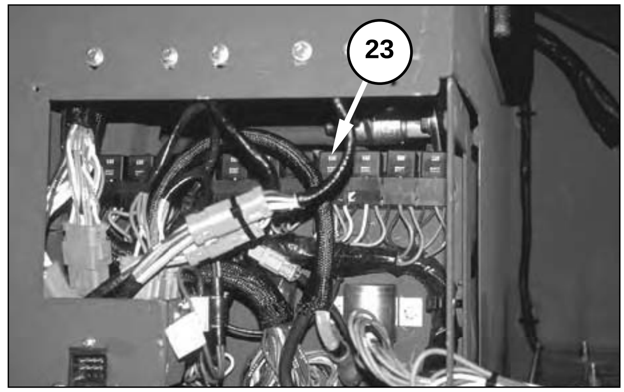


Console, Right of Operator Seat.
(21) Diagnostic plug. (22) Diagnostic enable switch.

Diagnostic plug (21) and diagnostic enable switch (22) are on the console to the right of the operator. The diagnostic plug provides a data transfer point between ECM (1) and service tools.

In the ON position, diagnostic enable switch (22) signals ECM (1) to enter the engine diagnostic mode and display the engine diagnostic flash codes on the check engine lamp.

NOTE: Unless the blackout switch is in the SERVICE DRIVE or STOP LIGHT position, ECM (1) will not illuminate check engine lamp (9), regardless of the position of diagnostic enable switch (22). For additional information about the positions of the blackout switch, refer to “Systems Operation, Lighting Circuit” in this module.

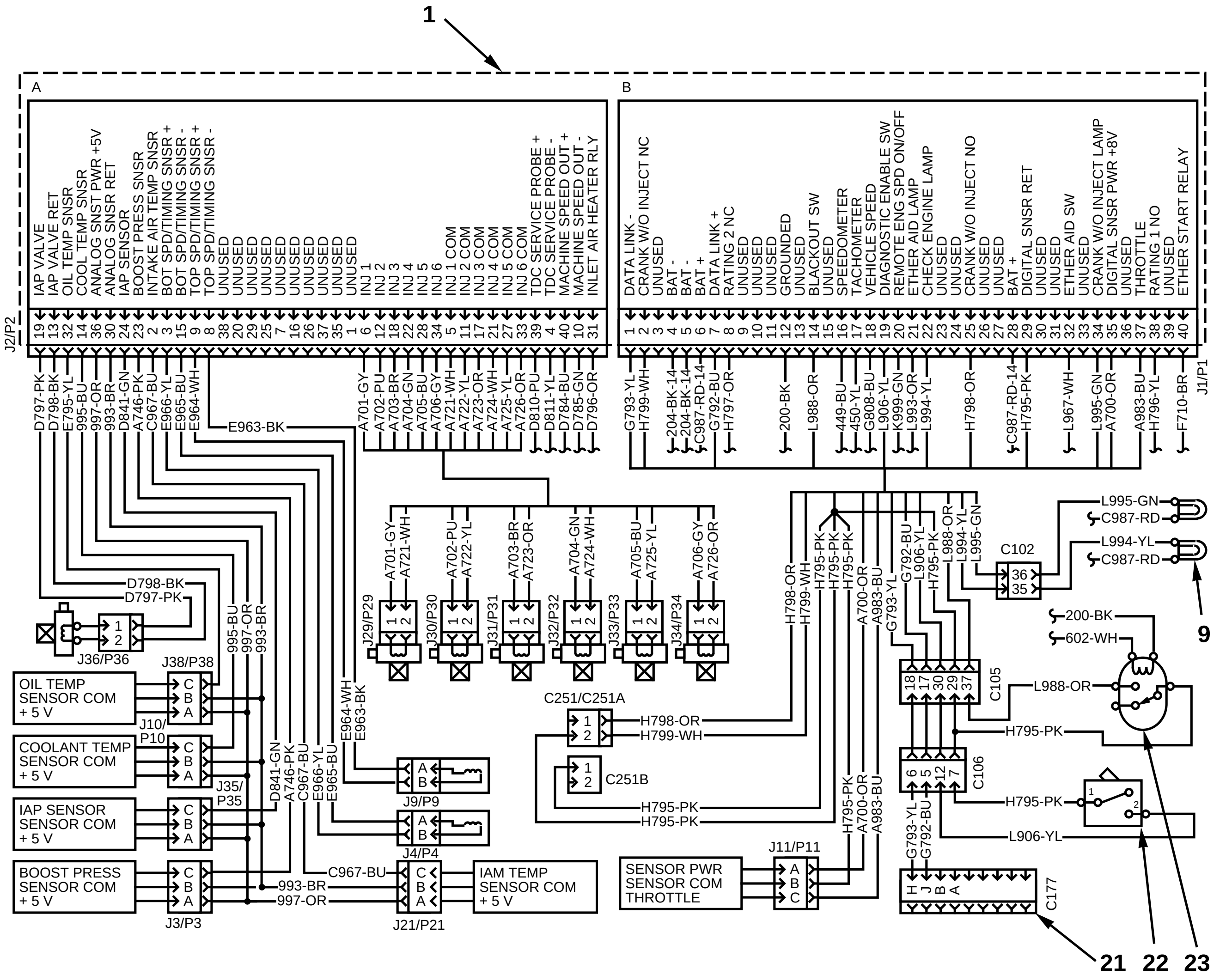


Right Console, Front View, Cover Removed.
(23) Blackout switch relay.

Blackout switch relay (23) is behind the front circuit breaker panel. The blackout switch relay confirms the position of the blackout switch to ECM (1). The blackout switch relay is closed when the blackout switch is in the SERVICE DRIVE or STOP LIGHT position. The relay is open when the blackout switch is in all other positions.

Circuit Operation

Diagnostic Mode



ECM Circuit Schematic.
(1) ECM. (9) Check engine lamp. (21) Diagnostic plug. (22) Diagnostic enable switch. (23) Blackout switch relay.

Terminal B-1 of ECM (1) is connected to contact H of diagnostic plug (21). Terminal B-7 of the ECM is connected to contact J of the diagnostic plug. These connections provide a data transfer point between the ECM and service tools.

Power from terminal B-19 of ECM (1) is available at contact 2 of diagnostic enable switch (22). Contact 1 of the diagnostic enable switch is connected to ground at terminal B-29 of the ECM. In the OFF position, contacts 1 and 2 of the engine diagnostic enable switch are open. The ECM does not receive a ground signal at terminal B-19, and so does not enable the engine diagnostic mode.

Moving diagnostic enable switch (22) to the ON position closes contacts 2 and 1 of the switch, completing the circuit between terminals B-19 and B-29 of ECM (1). With this input, the ECM enters the engine diagnostic mode. However, before the ECM will display the flash codes on check engine lamp (9), the ECM must determine the position of the blackout switch.

If the blackout switch is not in the SERVICE DRIVE or STOP LIGHT position, ECM (1) will not illuminate check engine lamp (9). The ECM uses the blackout switch relay (23) to confirm the position of the blackout switch.

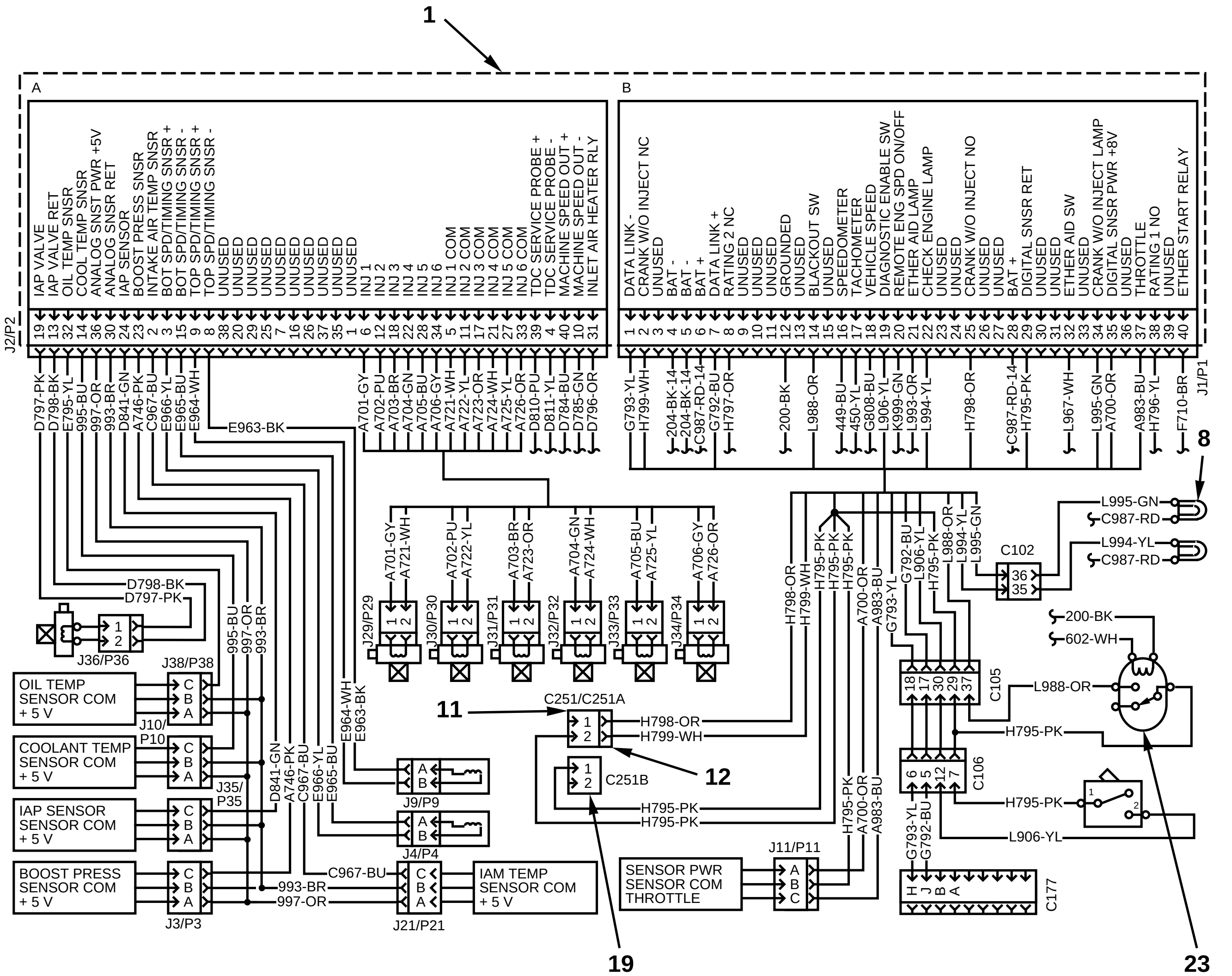
NOTE: For additional information about positions of the blackout switch, refer to “Systems Operation, Lighting Circuit” in this module.

When the blackout switch is in the SERVICE DRIVE or STOP LIGHT position, the blackout relay closes and power transfers to the horn/dome circuit breaker (refer to “Systems Operation, Lighting Circuit” in this module). Power from the horn/dome circuit breaker energizes the coil in blackout switch relay (23). The blackout switch relay closes, completing a circuit between terminals B-14 and B-29 of ECM (1).

After ECM (1) interprets a closed circuit across blackout switch relay (23), the ECM displays the engine diagnostic flash codes on check engine lamp (9) by providing a ground at terminal B-22 for power from the start-aid circuit breaker to flow through the check engine lamp.

NOTE: For additional information about the engine diagnostic flash codes, refer to “Testing and Adjusting, Troubleshooting, Engine Diagnostic Flash Codes” in this module.

Crank-Without-Inject Mode



ECM Circuit Schematic.
(1) ECM. (8) Crank-without-inject lamp. (11) Connector C251A. (12) Crank-without-inject plug C251. (19) Connector C251B. (23) Blackout switch relay.

Crank-without-inject plug (12) can be attached to two different connectors (11 and 19). When the crank-without-inject plug is attached to connector (11), current from terminal B-2 of ECM (1) flows across contact 2 of the connector and to ground at terminal B-29 of the ECM. The ECM reads the completed circuit and interprets this state as normal. The injectors remain active and the engine operates normally.

Plugging crank-without-inject plug (12) into connector (19) breaks the ground circuit between terminals B-2 and B-29 of ECM (1) and establishes a ground circuit between terminals B-25 and B-29. A completed circuit at terminal B-25 prompts the ECM to switch to the crank-without-inject mode.

NOTE: ECM (1) will disable the crank-without-inject mode if either a complete or an open circuit is simultaneously read at terminals B-2 and B-14 for more than one second.

In the crank-without-inject mode, ECM (1) disables the fuel injectors to allow the starter to turn the engine without injecting fuel into the cylinders. The completed circuit at terminal B-25 also causes the ECM to determine if conditions are right to illuminate crank-without-inject lamp (8). Before the ECM will illuminate the crank-without-inject lamp, the ECM must determine the position of the blackout switch.

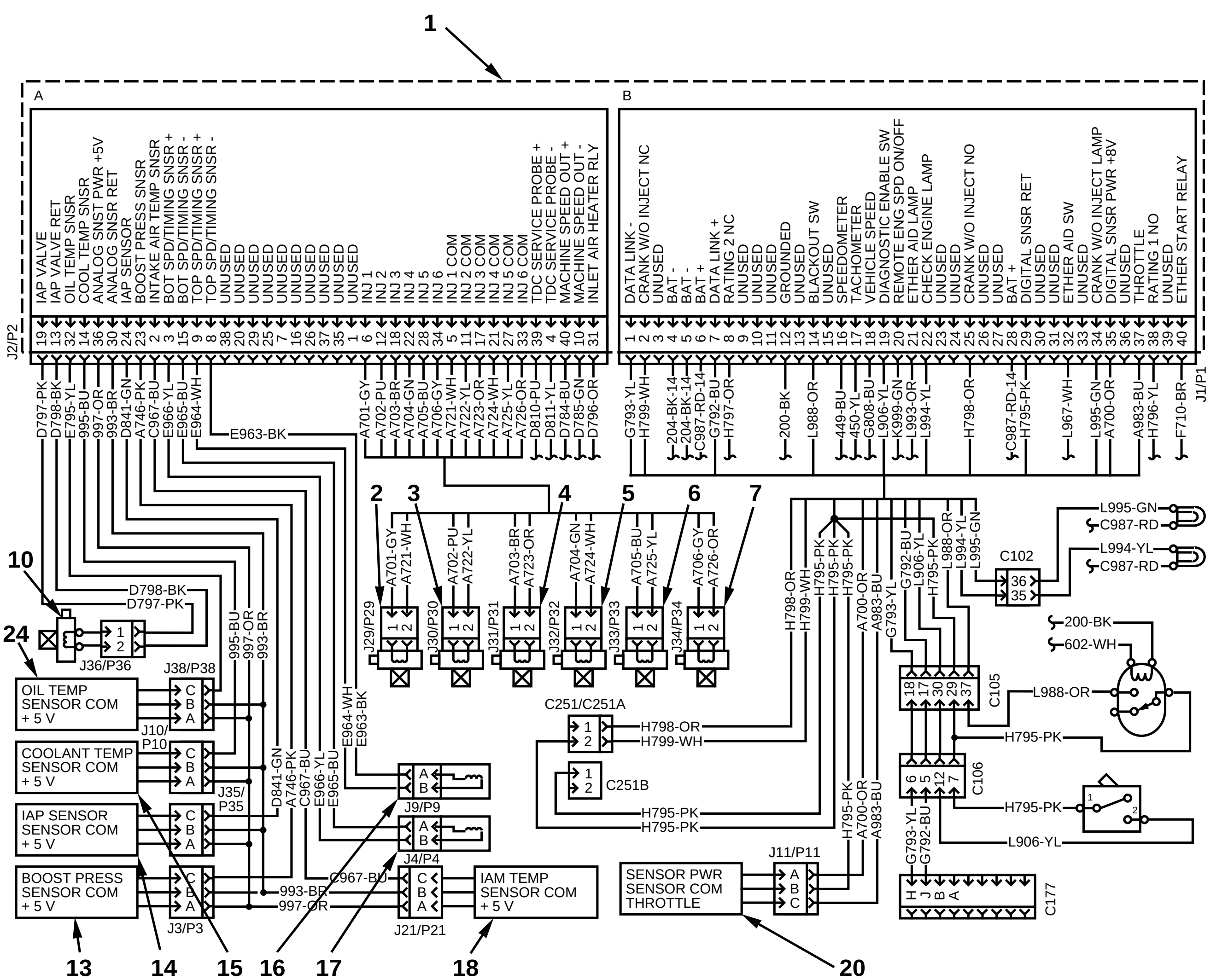
If the blackout switch is not in the SERVICE DRIVE or STOP LIGHT position, ECM (1) will not illuminate the crank-without-inject lamp (8). The ECM uses blackout switch relay (23) to confirm the position of the blackout switch.

NOTE: For additional information about positions of the blackout switch, refer to "Systems Operation, Lighting Circuit" in this module.

When the blackout switch is in the SERVICE DRIVE or STOP LIGHT position, the blackout relay closes and power transfers to the horn/dome circuit breaker (refer to "Systems Operation, Lighting Circuit" in this module). Power from the horn/dome circuit breaker energizes the coil in blackout switch relay (23). The blackout switch relay closes, completing a circuit between terminals B-14 and B-29 of ECM (1).

After ECM (1) interprets a closed circuit across blackout switch relay (23), the ECM illuminates crank-without-inject lamp (8) by providing a ground at terminal B-34 for power from the start-aid circuit breaker to flow through the crank-without-inject lamp.

Electronic Engine Control



ECM Circuit Schematic.

(1) ECM. (2) Number-1 fuel injection solenoid. (3) Number-2 fuel injection solenoid. (4) Number-3 fuel injection solenoid. (5) Number-4 fuel injection solenoid. (6). Number-5 fuel injection solenoid. (7) Number-6 fuel injection solenoid. (10) Injection actuation pressure solenoid. (13) Boost pressure sensor. (14) Injection actuation pressure sensor. (15) Coolant temperature sensor. (16) Top speed/timing sensor. (17) Bottom speed/timing sensor. (18) Intake air temperature sensor. (20) Throttle position sensor. (24) Engine oil temperature sensor.

Terminal B-28 of ECM (1) receives power from the ECM circuit breaker when the start switch is in the ON or START position.

NOTE: For additional information, refer to “Systems Operation, Power Distribution Circuit” in this module.

Terminal A-36 of ECM (1) distributes power to contact A of several sensors: boost pressure sensor (13); injection actuation pressure sensor (14); coolant temperature sensor (15); intake air temperature sensor (18), and engine oil temperature sensor (24). Terminal A-30 of the ECM provides the ground path from contact B of each sensor. Contact C of each sensor provides a voltage input signal to the ECM.

Terminal B-35 of ECM (1) distributes power to contact A of throttle position sensor (20). Terminal B-29 of the ECM provides the ground path from contact B of the throttle position sensor. Contact C of the sensor provides a pulse width modulated input signal to terminal B-37 of the ECM.

Coolant temperature sensor (15) monitors the temperature of the engine coolant. Terminal C of the coolant temperature sensor generates an analog voltage output signal of between 0.2 to 4.37 volts, based on temperatures ranging from -40 to +120°C (-40 to +248°F). Terminal A-14 of ECM (1) reads the voltage signal from the coolant temperature sensor and converts the voltage value to a temperature value.

Engine oil temperature sensor (24) monitors the temperature of the engine oil. This sensor acts as one of three inputs to the engine control logic (see also, intake air temperature sensor [18] and throttle position sensor [20]).

NOTE: The engine control logic determines the desired fuel position based on the currently active operating mode and throttle position. The desired fuel position is one of three input signals transferred to the electronic governor. The “electronic governor” is fuel control logic which is programmed into the ECM software. For additional information about operating modes, refer to “Systems Operation, Start, Charge, and Stop Circuit” in this module.

Intake air temperature sensor (18) monitors the temperature of the intake air. Terminal C of the intake air temperature sensor generates an analog voltage output signal of between 0.5005 to 4.463 volts, based on temperatures ranging from -40 to +120°C (-40 to +248°F). Terminal A-2 of ECM (1) reads the voltage signal from the intake air temperature sensor and converts the voltage value to a temperature value.

Intake air temperature sensor (18) acts as one of three inputs to the engine control logic (see also, oil temperature sensor [24] and throttle position sensor [20]). The intake air temperature sensor also acts as one of three inputs to the fuel ratio control (FRC) map logic (see also, boost pressure sensor [13] and top and bottom speed/timing sensors [16 and 17]).

NOTE: The FRC map logic determines the FRC fuel position. The FRC fuel position is one of three input signals transferred to the electronic governor.

Throttle position sensor (20) monitors the position of the throttle control pedal. Terminal C of the throttle position sensor generates a pulse width modulated signal of between 483 to 654 Hz. The signal frequency depends on the degree of travel of the throttle control pedal. The throttle position sensor acts as one of three inputs to the engine control logic (see also, engine oil temperature sensor [24] and intake air temperature sensor [18]).

Boost pressure sensor (13) monitors the air pressure in the inlet manifold. Terminal C of the boost pressure sensor generates an analog voltage output signal of between 0 to 5.0 volts, based on pressures ranging from 20.3 to 338.7 kPa (2.9 to 49 psi). Terminal A-23 of ECM (1) reads the voltage signal from the boost pressure sensor and converts the voltage value to a pressure value. The boost pressure sensor acts as one of three inputs to the FRC map logic (see also, intake air temperature sensor [18] and top and bottom speed/timing sensors [16 and 17]).

Terminal A-9 of ECM (1) sends power to contact B of top speed/timing sensor (16). Contact A of the sensor is connected to terminal A-8 of the ECM. As the engine operates, the top speed/timing sensor generates a series of pulses as teeth on the back of the camshaft gear pass the sensor. All but one of the teeth are evenly spaced. When the tooth which is not evenly spaced passes the sensor, the ECM establishes the position of the number-1 cylinder as well as the speed of the engine.

NOTE: Bottom speed/timing sensor (17) operates the same as top speed/timing sensor (16). Terminal A-3 of ECM (1) sends power to contact B of the bottom speed/timing sensor. Contact A of the sensor is connected to terminal A-15 of the ECM.

Top and bottom speed/timing sensors (16 and 17) act as one of three inputs to the FRC map logic (see also, boost pressure sensor [13] and intake air temperature sensor [18]). The top and bottom speed/timing sensors also act as one of two inputs to the torque map logic (refer to “Systems Operation, Self-Deploy/Earthmoving Circuit” in this module) and one of three inputs to the fuel injection control logic (injection actuation pressure sensor [14] and the electronic governor are the other two).

NOTE: The torque map logic determines the rated fuel position. The rated fuel position is one of the three input signals transferred to the electronic governor. When the electronic governor receives the desired fuel position, the FRC fuel position, and the rated fuel position, the electronic governor analyzes the input signals to determine the actual fuel position. The electronic governor then transfers the actual fuel position to the fuel injection control logic.

Injection actuation pressure sensor (14) measures the oil pressure in the high pressure oil manifold. Terminal C of the injection actuation pressure sensor generates an analog voltage output signal of between 0 and 5.0 volts, based on pressures ranging from 418 to 33,148 kPa (21 to 4805 psi). Terminal A-24 of ECM (1) reads the voltage signal from the injection actuation sensor and converts the voltage value to a pressure value. The injection actuation pressure sensor acts as one of three inputs to the fuel injection control logic (see also, electronic governor and top and bottom speed/timing sensors [16 and 17]).

The fuel injection control logic analyzes the fuel position, engine speed, position of the number-1 cylinder, and injection actuation pressure to determine the required fuel injection pressure and the proper fuel injection timing.

The fuel injection control logic prompts ECM (1) to generate an output signal from terminal A-19 to injection actuation pressure solenoid (10). The injection actuation pressure solenoid is grounded through terminal A-13 of the ECM. The magnitude of the output signal from terminal A-19 depends on the current fuel requirements of the engine.

Injection actuation pressure solenoid (10) controls oil pressure in the high pressure oil manifold. Pressures range from 5000 to 23 000 kPa (725 to 3335 psi). The oil pressure in the high pressure oil manifold is available at each fuel injection nozzle.

The fuel injection control logic determines when to activate the fuel injection solenoids. Number-1 fuel injection solenoid (2) is fired first, number-5 solenoid (6) is fired second, number-3 solenoid (4) is fired third, number-6 solenoid (7) is fired fourth, number-2 solenoid (3) is fired fifth, and number-4 solenoid (5) is fired last.

To activate number-1 fuel injection solenoid (2), ECM (1) directs a 110-volt DC electrical pulse from terminal A-6 to the number-1 fuel injection solenoid. The ECM grounds the number-1 fuel injection solenoid at terminal A-5. The fuel injection control logic determines the length and timing of the electrical pulse. Energizing the injection solenoid allows oil in the high pressure oil manifold to depress the fuel injector plunger, which then injects fuel into the number-1 cylinder.

The remaining fuel injection solenoids operate in the same manner as number-1 fuel injection solenoid (2). The following are the power and ground ECM terminals for the remaining fuel injection solenoids:

Injector Solenoid #	ECM Power Terminal	ECM Ground Terminal
2	A-12	A-11
3	A-18	A-17
4	A-22	A-21
5	A-28	A-27
6	A-34	A-33

Testing and Adjusting

Troubleshooting

Troubleshooting can be difficult. This section gives a list of possible electrical problems. Non-electrical failures can often cause the same problems and symptoms as electrical failures. The probable causes listed relate only to the electrical system. Refer to other modules in this service manual for non-electrical troubleshooting procedures.

NOTE: The problem list given here does not address many problems with the EPTC II or ECM. For troubleshooting tips for the EPTC II, refer to *Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electronic Programmable Transmission Control (EPTC II).* For troubleshooting tips for the ECM, refer to “Testing and Adjusting, Troubleshooting, Engine Diagnostic Flash Codes” in this section.

This list of problems, causes, and corrections will only indicate where a possible problem can be, and what repairs are needed. Normally, additional repair work may be needed beyond the recommendations in the list. To repair a problem, refer to the cause and correction listed on the pages that follow.

Remember, a problem is not normally caused only by one part, but by the relation of one part to other parts. This list is only a guide and cannot give all possible problems and corrections. Service personnel must find the problem and its source, then make the necessary repairs.

Troubleshooting Problem List

Troubleshooting Problems

Problem 1: Starter Will Not Crank Engine and Power Does Not Reach Any Electrical Components

Possible Cause(s):

- Wiring between frame ground and circuit breaker power buss bar contains short or open circuit
- Batteries not delivering sufficient voltage

1. Wiring between frame ground and circuit breaker power buss bar contains short or open circuit:

a. Ensure that the electrical disconnect switch is in the ON position.

b. Check the battery terminals for corrosion and proper connection.

c. Test the electrical disconnect switch for proper operation. Refer to “Testing and Adjusting, Testing, Switch Test” in this module.

2. Batteries not delivering sufficient voltage:

a. Determine if the batteries are able to maintain the proper charge level. Refer to “Testing and Adjusting, Testing, Battery Open Circuit Voltage Test” in this module.

b. If the batteries test within specifications, determine if the alternator is functioning properly.

c. If the problem recurs, analyze the circuit for a short to ground (parasitic load).

Problem 2: Power Is Available to Some Machine Electrical Components but Starter Does Not Crank Engine

Possible Cause(s):

- Batteries not delivering sufficient voltage
- Main power circuit breaker tripped (open)
- Main power relay failed open
- Start relay failed open
- Start switch circuit breaker tripped (open), or start switch failed
- EPTC II circuit breaker tripped (open)
- Starter failed

- EPTC II faulty or transmission gear switch faulty
- Wiring between start switch and starter contains short or open

1. Batteries not delivering sufficient voltage:

a. Check the battery terminals for corrosion and a proper connection.

b. If the needle on the voltmeter in the instrument panel lies in the first green zone while the engine is OFF and the start switch in the ON position, the batteries are fully charged. The starter may be faulty.

c. If the needle lies in the first red zone while the engine is not running and the start switch in the ON position, charge the batteries.

d. If the problem recurs, determine if the batteries are able to maintain the proper charge level. Refer to “Testing and Adjusting, Testing, Battery Open Circuit Voltage Test” in this module.

e. If the batteries test within specifications, determine if the alternator is functioning properly. Refer to “Specifications, Other Components, Alternator” in this module.

f. If the problem recurs, analyze the circuit for a short to ground (parasitic load).

2. Main power circuit breaker tripped (open):

If the coil in the main power relay energizes when the start switch is moved to the ON or START positions, but neither the ECM nor the EPTC II receives power, and the lamp test function does not operate, reset the main power circuit breaker. Refer to “Systems Operation, Start, Charge, and Stop Circuit” in this module.

3. Main power relay failed open:

If the coil in the main power relay does not energize when the start switch is moved to the ON or START position, neither the ECM nor the EPTC receives power, and the lamp test does not function, check the main power relay for failure. Refer to “Testing and Adjusting, Testing, Relay Test” in this module.

4. Start relay failed open:

If power is available to the ECM and EPTC II and the lamp test functions properly with the start switch in the ON or START position, check the start relay for failure. Refer to “Testing and Adjusting, Testing, Relay Test” in this module.

5. Start switch circuit breaker tripped (open), or start switch failed:

a. If power is not available to the ECM and EPTC II, the lamp test will not function with the start switch in the ON position, the coil in the start relay will not energize with the start switch in the START position, and the coil in the main power relay will not energize with the start switch in ON or START, reset the start switch circuit breaker.

b. If resetting the start switch circuit breaker does not solve the problem, test contacts 1 and 2 of the start switch with the start switch in the START position. Also test contacts 4 and 5 of the start switch with the start switch in the START and the ON positions. Refer to “Testing and Adjusting, Testing, Switch Test” in this module.

6. EPTC II circuit breaker tripped (open):

If the EPTC II is not receiving power, the start relay does not engage when the start switch is in the START position, the lamp test functions properly when the start switch is in the START position, and the coil in the main power relay energizes with the start switch in the ON position, reset the EPTC II circuit breaker.

7. Starter failed:

If all other electrical components function normally but the engine does not crank, test the starter for proper operation. Refer to “Testing and Adjusting, Testing, Starter Tests, On-machine Starter Diagnosis Procedure” or “Testing and Adjusting, Testing, Starter Tests, Off-machine No Load Test” and “Testing and Adjusting. Testing, Starter Tests, Brush Length Checks” in this module.

8. EPTC II faulty or transmission gear switch faulty:

For EPTC II troubleshooting procedures, refer to *Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electronic Programmable Transmission Control (EPTC II)*.

9. Wiring between start switch and starter contains short or open:

Other symptoms of this problem may depend on the location of the short or open. If the problem is not solved by any other step, test the wiring harnesses between the starter and start switch for a short or an open. Refer to *Schematic, Deployable Universal Combat Earthmover (DEUCE), Electrical Schematic.*

Problem 3: Engine Cranks Slowly

Possible Cause(s):

- Batteries not delivering sufficient voltage
- Faulty starter

1. Batteries not delivering sufficient voltage:

a. Check the battery terminals for corrosion and a proper connection.

b. If the needle on the voltmeter in the instrument panel lies in the first green zone while the engine is OFF and the start switch in the ON position, the batteries are fully charged. The starter may be faulty.

c. If the needle lies in the first red zone while the engine is not running and the start switch in the ON position, charge the batteries.

d. If the problem recurs, determine if the batteries are able to maintain the proper charge level. Refer to “Testing and Adjusting, Testing, Battery Open Circuit Voltage Test” in this module.

e. If the batteries test within specifications, determine if the alternator is functioning properly. Refer to “Specifications, Other Components, Alternator” in this module.

f. If the problem recurs, analyze the circuit for a short to ground (parasitic load).

2. Faulty starter:

If the batteries function within specifications, test the starter for proper operation. Refer to “Testing and Adjusting, Testing, Starter Tests, On-machine Starter Diagnosis Procedure” or “Testing and Adjusting, Testing, Starter Tests, Off-machine No Load Test” and “Testing and Adjusting. Testing, Starter Tests, Brush Length Checks” in this module.

Problem 4: Engine Cranks But Will Not Start (Crankshaft Turns Freely)

Possible Cause(s):

- Crank-without-inject connector plugged into wrong receptacle
- ECM circuit contains faulty component(s) or ECM faulty
- Faulty starter

1. Crank-without-inject connector plugged into wrong receptacle:

If the crank-without-inject lamp is illuminated, examine the position of the crank-without-inject connector. Refer to “Systems Operation, ECM Circuit” in this module.

2. ECM circuit contains faulty component(s) or ECM faulty:

For ECM troubleshooting procedures, refer to “Testing and Adjusting, Troubleshooting, Engine Diagnostic Flash Codes” in this section.

3. Faulty starter:

Refer to “Testing and Adjusting, Testing, Starter Tests, On-machine Starter Diagnosis Procedure” or “Testing and Adjusting, Testing, Starter Tests, Off-machine No Load Test” and “Testing and Adjusting. Testing, Starter Tests, Brush Length Checks” in this module.

Problem 5: Engine Constantly Remains at 2400 RPM and Transmission Will Not Shift

Possible Cause(s):

- Remote throttle switch failed in ON position
- Faulty ECM

1. Remote throttle switch failed in ON position:

a. Ensure that the remote throttle switch is in the OFF position.

b. If the problem persists, test contacts 10 and 11 of the remote throttle switch. With the remote throttle switch in the ON position, contacts 10 and 11 should be closed. With the switch in the OFF position, contacts 10 and 11 should be open. Refer to “Testing and Adjusting, Testing, Switch Test” in this module.

2. Faulty ECM

A completed circuit must exist between terminals B-20 and B-29 of the ECM only when the remote throttle switch is in the ON position. For ECM troubleshooting procedures, refer to “Testing and Adjusting, Troubleshooting, Engine Diagnostic Flash Codes” in this section.

Problem 6: Remote Throttle Function Does Not Operate

Possible Cause(s):

- Parking brake not engaged
- Remote throttle switch failed in OFF position
- Faulty ECM

1. Parking brake not engaged:

a. Engage parking brake.

2. Remote throttle switch failed in OFF position:

a. Move the remote throttle switch to the ON position.

b. If the problem persists, test contacts 10 and 11 of the remote throttle switch. With the remote throttle switch in the ON position, contacts 10 and 11 should be closed. With the switch in the OFF position, contacts 10 and 11 should be open. Refer to "Testing and Adjusting, Testing, Switch Test" in this module.

3. Faulty ECM:

A completed circuit must exist between terminals B-20 and B-29 of the ECM when the remote throttle switch is in the ON position. For ECM troubleshooting procedures, refer to "Testing and Adjusting, Troubleshooting, Engine Diagnostic Flash Codes" in this section.

Problem 7: Transmission Will Not Shift out of NEUTRAL and Park Brake Will Not Release

Possible Cause(s):

- Jumper wires at connector C130 open
- Contacts 2 and 3 of remote throttle switch open with remote throttle switch in OFF position
- Circuit from terminal A-36 of EPTC II to ground contains open
- Faulty EPTC II

1. Jumper wires at connector C130 open:

NOTE: Terminal A-36 of the EPTC II should receive a ground signal when contacts 2 and 3 of the remote throttle switch are closed.

a. Examine the LED on the EPTC II with the remote throttle switch in the OFF position. Determine if the remote throttle indicator is illuminated. For a description of this procedure, refer to *Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electronic Programmable Transmission Control (EPTC II)*.

b. If the remote throttle indicator is not illuminated, check the connection of the jumper wires at connector C130. Contacts 1 and 2 should be connected, and contacts 5 and 6 should be connected.

NOTE: Connector C130 is located under the cab, on the inside of the right machine frame.

2. Contacts 2 and 3 of remote throttle switch open with remote throttle switch in OFF position:

If the remote throttle indicator is not illuminated and the jumper wires at connector C130 are connected properly, then test contacts 2 and 3 of the remote throttle switch. When the remote throttle switch is in the OFF position, contacts 2 and 3 should be closed. When the remote throttle switch is in the ON position, contacts 2 and 3 should be open. Refer to "Testing and Adjusting, Testing, Switch Test" in this module.

3. Circuit from terminal A-36 of EPTC II to ground contains open:

a. Test continuity of the G847-BU wire between terminal A-36 of the EPTC II and contacts 1 and 5 of connector C130. Refer to "Systems Operation, Remote Throttle Circuit" in this module.

b. Test continuity of the L960-YL wire between contacts 2 and 6 of contact C130 and contact 2 of the remote throttle switch.

4. Faulty EPTC II:

For EPTC II troubleshooting procedures, refer to *Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electronic Programmable Transmission Control (EPTC II)*.

Problem 8: Transmission Will Not Upshift

Possible Cause(s):

- Faulty upshift solenoid
- Faulty transmission gear switch
- Faulty shift lever switch

- Faulty transmission speed sensor

- Faulty EPTC II

1. Faulty upshift solenoid:

a. Perform “CID 707 Procedure, Up Solenoid,” found in *Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electronic Programmable Transmission Control (EPTC II),* “Testing and Adjusting, Detected Fault Troubleshooting.” Repair the wiring fault, if necessary.

b. If “CID 707 Procedure, Up Solenoid” indicates that the upshift solenoid may be the cause of the fault, refer to “Testing and Adjusting, Testing, Solenoid Test” in this module.

2. Faulty transmission gear switch:

Perform “CID 700 Procedure, Transmission Gear Switch,” found in *Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electronic Programmable Transmission Control (EPTC II),* “Testing and Adjusting, Detected Fault Troubleshooting.” Replace the switch or repair the wiring fault, if necessary.

3. Faulty shift lever switch:

Perform “CID 702 Procedure, Shift Lever Switch,” found in *Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electronic Programmable Transmission Control (EPTC II),* “Testing and Adjusting, Detected Fault Troubleshooting.” Replace the switch or repair the wiring fault, if necessary.

4. Faulty transmission speed sensor:

Perform “CID 701, Transmission Output Speed Sensor,” found in *Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electronic Programmable Transmission Control (EPTC II),* “Testing and Adjusting, Detected Fault Troubleshooting.” Replace the sensor or repair the wiring fault, if necessary.

5. Faulty EPTC II

For EPTC II troubleshooting procedures, refer to *Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electronic Programmable Transmission Control (EPTC II)*.

Problem 9: Transmission Will Not Downshift

Possible Cause(s):

- Faulty downshift solenoid
- Faulty transmission gear switch
- Faulty shift lever switch
- Faulty transmission speed sensor
- Faulty EPTC II

1. Faulty downshift solenoid:

a. Perform “CID 708 Procedure, Down Solenoid,” found in *Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electronic Programmable Transmission Control (EPTC II),* “Testing and Adjusting, Detected Fault Troubleshooting.” Repair the wiring fault, if necessary.

b. If “CID 708 Procedure, Down Solenoid” indicates that the downshift solenoid may be the cause of the fault, refer to “Testing and Adjusting, Testing, Solenoid Test” in this module.

2. Faulty transmission gear switch:

Perform “CID 700 Procedure, Transmission Gear Switch,” found in *Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electronic Programmable Transmission Control (EPTC II),* “Testing and Adjusting, Detected Fault Troubleshooting.” Replace the switch or repair the wiring fault, if necessary.

3. Faulty shift lever switch:

Perform “CID 702 Procedure, Shift Lever Switch,” found in *Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electronic Programmable Transmission Control (EPTC II),* “Testing and Adjusting, Detected Fault Troubleshooting.” Replace the switch or repair the wiring fault, if necessary.

4. Faulty transmission speed sensor

Perform “CID 701 Procedure, Transmission Output Speed Sensor,” found in *Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electronic Programmable Transmission Control (EPTC II),* “Testing and Adjusting, Detected Fault Troubleshooting.” Replace the sensor or repair the wiring fault, if necessary.

5. Faulty EPTC II

For EPTC II troubleshooting procedures, refer to *Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electronic Programmable Transmission Control (EPTC II)*.

Problem 10: Transmission Will Not Shift Above THIRD FORWARD and/or Machine Will Not Shift Automatically While in SELF-DEPLOY Mode

Possible Cause(s):

- Terminal A-7 of EPTC II does not receive ground signal, or terminal A-8 of EPTC II does receive ground signal when self-deploy/earthmoving switch is in SELF-DEPLOY position
- Terminal A-27 of EPTC II does not receive ground signal when blade position switch in BLADE RAISED position and self-deploy/earthmoving switch in SELF-DEPLOY position
- Circuit from terminal A-7 of EPTC II to ground contains open with self-deploy/earthmoving switch in SELF-DEPLOY position
- Circuit between terminal A-8 of EPTC II and self-deploy/earthmoving switch contains short to ground
- Circuit between terminal A-27 of EPTC II and ground contains open when blade position switch in BLADE RAISED position and self-deploy/earthmoving switch in SELF-DEPLOY position
- Faulty EPTC II

1. Terminal A-7 of EPTC II does not receive ground signal, or terminal A-8 of EPTC II does receive ground signal when self-deploy/earthmoving switch is in SELF-DEPLOY position:

NOTE: Terminal A-7 of the EPTC II should receive a ground signal when the self-deploy/earthmoving switch is in the SELF-DEPLOY position. Terminal A-8 should receive a ground signal when the self-deploy/earthmoving switch is in the EARTHMOVING position.

a. Examine the LED on the EPTC II with the self-deploy/earthmoving switch in the SELF-DEPLOY position. Determine if the self-deploy/earthmoving switch indicator is illuminated. For a description of this procedure, refer to *Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electronic Programmable Transmission Control (EPTC II)*.

b. If the self-deploy/earthmoving switch indicator is not illuminated, test contacts 1 and 2 of the self-deploy/earthmoving switch. When the self-deploy/earthmoving switch is in the SELF-DEPLOY position, the contacts should be closed. When the self-deploy/earthmoving switch is in the EARTHMOVING position, the contacts should be open. Refer to “Testing and Adjusting, Testing, Switch Test” in this module.

c. Next, test contacts 2 and 3 of the self-deploy/earthmoving switch. When the self-deploy/earthmoving switch is in the EARTHMOVING position, the contacts should be closed. When the self-deploy/earthmoving switch is in the self-deploy position, the contacts should be open. Refer to “Testing and Adjusting, Testing, Switch Test” in this module.

d. If the results in either Step b or Step c indicate a fault, the self-deploy/earthmoving switch should be replaced.

2. Terminal A-27 of EPTC II does not receive ground signal when blade position switch in BLADE RAISED position and self-deploy/earthmoving switch in SELF-DEPLOY position:

a. Examine the LED on the EPTC II with the blade position switch in the BLADE RAISED position and the self-deploy/earthmoving switch in the SELF-DEPLOY position. Determine if the blade lock switch indicator is illuminated. For a description of this procedure, refer to *Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electronic Programmable Transmission Control (EPTC II)*.

b. If the blade lock switch indicator is illuminated, test contacts 5 and 6 of the blade position switch. When the blade position switch is in the BLADE RAISED position, the contacts should be closed. When the blade position switch is in the BLADE LOWERED position, the contacts should be open. Refer to “Testing and Adjusting, Testing, Switch Test” in this module. If necessary, replace the switch.

c. If the blade position switch is functioning properly, then test contacts 4 and 5 of the self-deploy/earthmoving switch. When the self-deploy/earthmoving switch is in the SELF-DEPLOY position, the contacts should be closed. When the self-deploy/earthmoving switch is in the EARTHMOVING position, the contacts should be open. Refer to “Testing and Adjusting, Testing, Switch Test” in this module. If necessary, replace the switch.

3. Circuit from terminal A-7 of EPTC II to ground contains open with self-deploy/earthmoving switch in SELF-DEPLOY position:

Test the continuity of the L964-WH wire between terminal A-7 of the EPTC II and contacts 1 and 2 of the self-deploy/earthmoving switch.

4. Circuit between terminal A-8 of EPTC II and self-deploy/earthmoving switch contains short to ground:

Test the continuity of the L965-PK wire between terminal A-8 of the EPTC II and contacts 2 and 3 of the self-deploy/earthmoving switch.

5. Circuit between terminal A-27 of EPTC II and ground contains open when blade position switch in BLADE RAISED position and self-deploy/earthmoving switch in SELF-DEPLOY position:

a. Test the continuity of the E750-PU wire between terminal A-27 of the EPTC II and contacts 6 and 5 of the blade position switch.

b. Test the continuity of the H787-GN wire between contact 5 of the blade position switch and contact 4 of the self-deploy/earthmoving switch.

6. The EPTC II is faulty.

For EPTC II troubleshooting procedures, refer to *Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electronic Programmable Transmission Control (EPTC II)*.

Problem 11: Park Brake Will Not Engage

Probable Cause(s):

- Park brake switch failed in OFF position
- Faulty EPTC II

1. Park brake switch failed in OFF position:

NOTE: This situation will only occur when the park brake switch fails in the OFF position while the engine is running. When the park brake switch fails while the engine is running and the engine is stopped, the engine will not restart.

2. Faulty EPTC II:

For EPTC II troubleshooting procedures, refer to *Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electronic Programmable Transmission Control (EPTC II)*.

Problem 12: Park Brake Will Not Release

Probable Cause(s):

- Faulty park brake switch

Faulty park brake switch:

Test contacts 1 and 2 of the park brake switch. With the park brake in the OFF position, contacts 1 and 2 are open. With the park brake in the ON position, contacts 1 and 2 are closed. Refer to “Testing and Adjusting, Testing, Switch Test” in this module.

Problem 13: Machine Steers Opposite Direction Than Expected While Traveling in REVERSE

Possible Cause(s):

- Auxiliary circuit breaker tripped (open)
- Steering relay failed open
- Steering solenoid not energizing or stuck open
- Circuit between terminal B-2 of EPTC II and steering relay contains an open
- Circuit between auxiliary circuit breaker and steering solenoid contains an open
- Faulty EPTC II

1. Auxiliary circuit breaker tripped (open):

NOTE: If the auxiliary circuit breaker is tripped, the voltmeter, tachometer, and winch will not function.

Reset the auxiliary circuit breaker.

2. Steering relay failed open:

a. In an appropriate location, move the transmission control lever to a REVERSE gear. If the backup alarm works, the steering relay has not failed open. (Refer to Step 3.)

b. If the backup alarm does not work, check the steering relay. Refer to "Testing and Adjusting, Testing, Relay Test" in this module. If the steering relay is not faulty, go to Step 4.

3. Steering solenoid not energizing or stuck open:

a. If the backup alarm works, test the steering solenoid. Refer to "Testing and Adjusting, Testing, Solenoid Test" in this module.

b. If the steering solenoid does not contain a fault, test the circuit between the auxiliary circuit breaker and the steering solenoid. (Refer to Step 5.)

4. Circuit between terminal B-2 of EPTC II and steering relay contains an open:

If the backup alarm does not work but the steering relay is not faulty, check the L986-BU wire between terminal B-2 of the EPTC II and the coil in the steering relay.

5. Circuit between auxiliary circuit breaker and steering solenoid contains an open:

If the steering solenoid is not faulty, check the F881-OR wire from the steering relay to the steering solenoid.

6. Faulty EPTC II:

For EPTC II troubleshooting procedures, refer to *Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electronic Programmable Transmission Control (EPTC II)*.

Problem 14: Backup Alarm Does Not Work (REVERSE Steering Functions Properly)

Possible Cause(s):

- Horn/dome circuit breaker tripped (open)
- Horn enable switch failed in OFF position
- Faulty backup relay
- Faulty backup alarm
- Circuit between horn/dome circuit breaker and backup alarm contains an open or short

1. Horn/dome circuit breaker tripped (open):

NOTE: If the horn/dome circuit breaker is tripped, the machine horn and the dome lamp will not function.

Reset the horn/dome circuit breaker.

2. Horn enable switch failed in OFF position:

Test contacts 4 and 5 of the horn enable switch. With the horn enable switch in the ON position, the contacts should be closed. With the horn enable switch in the OFF position, the contacts should be open. Refer to "Testing and Adjusting, Testing, Switch Test" in this module.

3. Faulty backup relay:

Test the backup relay. Refer to "Testing and Adjusting, Testing, Relay Test" in this module.

4. Faulty backup alarm:

Test the backup alarm.

5. Circuit between horn/dome circuit breaker and backup alarm contains an open or short:

a. Check the 602-WH wire between the horn/dome circuit breaker and contact 5 of the horn enable switch.

NOTE: If this circuit contains a fault, the machine horn will not function.

b. Check the 817-WH wire between contact 4 of the horn enable switch and the backup alarm relay.

c. Check the 321-BR wire between the backup relay and the backup alarm.

Problem 15: Machine Horn Does Not Work

Possible Cause(s):

- Horn/dome circuit breaker tripped (open)
- Horn enable switch failed in OFF position
- Faulty horn relay
- Faulty turn/hazard/horn switch
- Faulty machine horn
- Circuit between horn/dome circuit breaker and horn contains an open or short
- Circuit between horn relay and turn/hazard/horn switch contains an open or short

1. Horn/dome circuit breaker tripped (open):

NOTE: If the horn/dome circuit breaker is tripped, the backup alarm and the dome lamp will not function.

Reset the horn/dome circuit breaker.

2. Horn enable switch failed in OFF position:

Test contacts 1 and 2 of the horn enable switch. With the horn enable switch in the ON position, the contacts should be closed. With the horn enable switch in the OFF position, the contacts should be open. Refer to “Testing and Adjusting, Testing, Switch Test” in this module.

3. Faulty horn relay:

Test the horn relay. Refer to “Testing and Adjusting, Testing, Relay Test” in this module.

4. Faulty turn/hazard/horn switch:

Test contact G of the turn/hazard/horn switch. With the horn button in the ON position, contact G should be grounded.

5. Faulty machine horn:

Test the horn.

6. Circuit between horn/dome circuit breaker and horn contains an open or short:

a. Check the 602-WH wire between the horn/dome circuit breaker and contact 2 of the horn on/off switch.

NOTE: If this circuit contains a fault, the backup alarm will not function.

b. Check the H791-GN wire between contact 1 of the horn on/off switch and the horn relay.

c. Check the 114-GN wire between the horn relay and the machine horn.

7. Circuit between horn relay and turn/hazard/horn switch contains an open or short:

Check the 320-OR wire between contact G of the turn/hazard/horn switch and the horn relay.

Problem 16: Blade Will Not Lower

Possible Causes:

- Contacts 5 and 6 of blade position switch failed closed
- Contacts 1 and 2 of self-deploy/earthmoving switch failed in SELF-DEPLOY position
- Faulty number-1 solenoid driver
- Faulty blade lock solenoid
- Circuit from terminal A-7 of EPTC II to ground contains open with self-deploy/earthmoving switch in SELF-DEPLOY position
- Circuit between terminal A-8 of EPTC II and self-deploy/earthmoving switch contains short to ground
- Circuit between terminal A-27 of EPTC II and ground contains open when blade position switch in BLADE RAISED position, and self-deploy/earthmoving switch in SELF-DEPLOY position

- Circuit between terminal A-33 and contact 5 of number-1 solenoid driver contains short or open
- Circuit from contact 3 of number-1 solenoid driver and blade lock solenoid contains short or open
- Faulty EPTC II

1. Contacts 5 and 6 of blade position switch failed closed:

a. Examine the LED on the EPTC II with the blade position switch in the BLADE RAISED position and the self-deploy/earthmoving switch in the SELF-DEPLOY position. Determine if the blade lock switch indicator is illuminated. For a description of this procedure, refer to S*ystems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electronic Programmable Transmission Control (EPTC II)*.

b. If the blade lock switch indicator is illuminated, test contacts 5 and 6 of the blade position switch. When the blade position switch is in the BLADE RAISED position, the contacts should be closed. When the blade position switch is in the BLADE LOWERED position, the contacts should be open. Refer to “Testing and Adjusting, Testing, Switch Test” in this module. If necessary, replace the switch.

2. Contacts 1 and 2 of self-deploy/earthmoving switch failed in SELF-DEPLOY position:

If the blade position switch is functioning properly, then test contacts 1 and 2 of the self-deploy/earthmoving switch. When the self-deploy/earthmoving switch is in the SELF-DEPLOY position, the contacts should be closed. When the self-deploy/earthmoving switch is in the EARTHMOVING position, the contacts should be open. Refer to “Testing and Adjusting, Testing, Switch Test” in this module. If necessary, replace the switch.

3. Faulty number-1 solenoid driver:

If the blade lock switch indicator, the blade position switch, and the self-deploy/earthmoving switch function properly but the blade will not lower, test the number-1 solenoid driver.

4. Faulty blade lock solenoid:

If the blade lock switch indicator, the blade position switch, the self-deploy/earthmoving switch, and the number-1 solenoid driver function properly but the blade will not lower, test the blade lock solenoid. Refer to “Testing and Adjusting, Testing, Solenoid Test” in this module.

5. Circuit from terminal A-7 of EPTC II to ground contains open with self-deploy/earthmoving switch in SELF-DEPLOY position:

Test the continuity of the L964-WH wire between terminal A-7 of the EPTC II and contacts 1 and 2 of the self-deploy/earthmoving switch.

6. Circuit between terminal A-8 of EPTC II and self-deploy/earthmoving switch contains short to ground:

Test the continuity of the L965-PK wire between terminal A-8 of the EPTC II and contacts 2 and 3 of the self-deploy/earthmoving switch.

7. Circuit between terminal A-27 of EPTC II and ground contains open when blade position switch in BLADE RAISED position and self-deploy/earthmoving switch in SELF-DEPLOY position:

a. Test the continuity of the E750-PU wire between terminal A-27 of the EPTC II and contacts 6 and 5 of the blade position switch.

b. Test the continuity of the H787-GN wire between contact 5 of the blade position switch and contact 4 of the self-deploy/earthmoving switch.

8. Circuit between terminal A-33 and contact 5 of number-1 solenoid driver contains short or open:

Test the L962-YL wire between terminal A-33 of the EPTC II and contact 5 of the number-1 solenoid driver.

9. Circuit from contact 3 of number-1 solenoid driver and blade lock solenoid contains short or open:

Test the F884-BU wire between contact 3 of the solenoid driver and the blade lock solenoid.

10. Faulty EPTC II:

For EPTC II troubleshooting procedures, refer to *Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electronic Programmable Transmission Control (EPTC II)*.

Problem 17: Self-Deploy Lamp Will Not Illuminate

Possible Cause(s):

- Self-deploy lamp burned out
- Faulty roading relay
- Faulty turn/flasher circuit breaker
- Faulty number-1 solenoid driver
- Faulty self-deploy/earthmoving switch or blade down switch
- Circuit between terminal B-4 and roading relay contains fault
- Circuit between turn/flasher circuit breaker and roading relay contains fault
- Faulty EPTC II

1. Self-deploy lamp burned out:

NOTE: In this case, the self-deploy lamp does not illuminate at any time.

Check the self-deploy lamp. If necessary, replace the lamp.

2. Faulty roading relay:

NOTE: In this case, the self-deploy lamp illuminates during the lamp test but does not illuminate when the self-deploy/earthmoving switch is in the SELF-DEPLOY position.

Check the roading relay. Refer to “Testing and Adjusting, Testing, Relay Test” in this module.

3. Faulty turn/flasher circuit breaker:

NOTE: In this case, the kneeling lamp, winch lamp, turn signals, and blade down alarm will not function.

Check the continuity across the turn/flasher circuit breaker. Replace the circuit breaker if the contacts show an open.

4. Faulty number-1 solenoid driver:

a. If the self-deploy lamp, roading relay, and turn/flasher breaker are not faulty, check the number-1 solenoid driver.

b. When in the self-deploy mode, terminal 4 of the solenoid driver should be grounded and terminal 6 should send power to the coil in the roading relay.

5. Faulty self-deploy/earthmoving switch or blade down switch:

Refer to “Problem 10, Transmission Will Not Shift Above THIRD FORWARD and/or Machine Will Not Shift Automatically While in SELF-DEPLOY Mode” and “Problem 16, Blade Will Not LOWER,” in this section, to determine if either the self-deploy/earthmoving switch or the blade down switch is faulty.

6. Circuit between terminal B-4 of EPTC II and roading relay contains fault:

a. Check the M976-OR wire from terminal B-4 of the EPTC II to terminal 4 of the number-1 solenoid driver.

b. Check the C904-GN wire between terminal 4 of the number-1 solenoid driver and the coil of the roading relay.

7. Circuit between turn/flasher circuit breaker and roading relay contains fault:

a. Check the 692-YL wire between the turn/flasher circuit breaker and the self-deploy lamp.

b. Check the H780-BU wire between the self-deploy lamp and the roading relay.

8. Faulty EPTC II:

For EPTC II troubleshooting procedures, refer to *Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electronic Programmable Transmission Control (EPTC II)*.

Problem 18: Suspension Will Not Lock in EARTHMOVING

Possible Cause(s):

- Faulty self-deploy/earthmoving switch
- Faulty number-2 solenoid driver
- Faulty suspension lock solenoid
- Circuit between terminal A-31 of EPTC II and terminal 5 of number-2 solenoid driver contains fault

- Circuit between terminal 3 of number-2 solenoid driver and one (or more) suspension lock solenoid(s) contains fault

- Faulty EPTC II

1. Faulty self-deploy/earthmoving switch:

Refer to “Problem 10, Transmission Will Not Shift Above THIRD FORWARD and/or Machine Will Not Shift Automatically While in SELF-DEPLOY Mode”in this section to determine if the self-deploy/earthmoving switch is faulty.

2. Faulty number-2 solenoid driver:

a. If the self-deploy/earthmoving switch is not faulty, check the number-2 solenoid driver.

b. When traveling FORWARD in the EARTHMOVING mode, terminal 5 of the number-2 solenoid driver should be grounded and terminal 3 should send power to the suspension lock solenoids.

3. Faulty suspension lock solenoid:

Test each of the four suspension lock solenoids. Refer to “Testing and Adjusting, Testing, Solenoid Test” in this module.

4. Circuit between terminal A-31 of EPTC II and terminal 5 of number-2 solenoid driver contains fault:

Check the L963-WH wire between terminal A-31 of the EPTC II and terminal 5 of the number-2 solenoid driver.

5. Circuit between terminal 3 of number-2 solenoid driver and one (or more) suspension lock solenoid(s) contains fault:

Check the F883-WH wire between terminal 3 of the number-2 solenoid driver and each of the suspension lock solenoids.

6. Faulty EPTC II:

For EPTC II troubleshooting procedures, refer to *Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electronic Programmable Transmission Control (EPTC II)*.

Problem 19: All (Or Some) Warning Lamps Do Not Function During Lamp Test

Possible Cause(s):

- Malfunctioning lamp burned out

- Horn/dome circuit breaker, warning lights circuit breaker, and/or turn/flasher circuit breaker tripped (open)

- Faulty blackout relay

- Faulty blackout switch

- Faulty lamp test relay

- One or more diode in diode block failed

- One or more circuits contain faults

1. Malfunctioning lamp burned out:

Check the malfunctioning lamp. If necessary, replace the lamp.

2. Horn/dome circuit breaker, warning lights circuit breaker, and/or turn/flasher circuit breaker tripped (open):

NOTE: If none of the lamps work during the lamp test, the circuit breakers are not the likely cause of the problem.

a. If the remote throttle lamp does not function, check the horn/dome circuit breaker.

b. If the park brake, engine oil pressure, blade down, brake fail, and the tension fail lamps do not function, check the warning lights circuit breaker.

c. If the blade down alarm and the winch, self-deploy and kneeling lamps do not function, check the turn/flasher circuit breaker.

3. Faulty blackout relay:

If the blade down alarm and the remote throttle, winch, self-deploy and kneeling lamps do not function, check the blackout relay. Refer to “Testing and Adjusting, Testing, Relay Test” in this module.

4. Faulty blackout switch:

a. If the blade down alarm and the remote throttle, winch, self-deploy and kneeling lamps do not function but the blackout relay is not faulty, check the blackout switch. Refer to “Systems Operation, Lighting Circuit” in this module, for operation of the blackout switch.

b. Test contacts F and J of the blackout switch. When in the STOP LIGHT or SERVICE DRIVE position, contacts F and J of the blackout switch should be closed. Contacts F and J should be open in all other positions.

5. Faulty lamp test relay:

NOTE: When the lamp test relay is faulty, none of the warning lamps will illuminate during a lamp test but all lamps function during normal operation (unless the system contains another fault).

Test the lamp test relay. Refer to “Testing and Adjusting, Testing, Relay Test” in this module.

6. One or more diodes in diode block failed:

Test the diode which corresponds to the non-functioning lamp. Refer to “Testing and Adjusting, Testing, Diode Test” in this module. The following gives the diode block contacts associated with each lamp.

Diode Block 1 Contact	Associated Lamp
2	Tension fail
3	Brake fail
4	Blade down
5	Park brake
6	Kneeling
7	Self-deploy
10	Winch

Diode Block 2 Contact	Associated Lamp
4	Hydraulic oil temperature
6	Remote throttle
7	Engine oil pressure

7. One or more circuits contain faults:

a. Check the wires between the circuit breakers and the lamps and then the lamps to the diode block. Refer to “Systems Operation, Lamp Test Circuit, Circuit Operation” in this module to determine which wires to test.

b. Check the wires between the blackout switch and the blackout relay and then between the blackout relay and the horn/dome and turn/flasher circuit breakers. Refer to “Systems Operation, Lamp Test Circuit, Circuit Operation” in this module to determine which wires to test.

Problem 20: Check Engine and/or Crank-without-Inject Indicator Lamps Do Not Function

Possible Cause(s):

- Malfunctioning lamp burned out
- Horn/dome circuit breaker tripped (open)
- Faulty blackout switch relay
- Faulty blackout relay
- Faulty blackout switch
- Faulty engine diagnostic enable switch
- Fault in one or more circuit
- Faulty ECM

1. Malfunctioning lamp burned out:

Check the malfunctioning lamp. If necessary, replace the lamp.

2. Horn/dome circuit breaker tripped (open):

NOTE: If the horn/dome circuit breaker is tripped, the backup alarm and the dome lamp will not function.

Check the horn/dome circuit breaker.

3. Faulty blackout switch relay:

Check the blackout switch relay. If the relay failed in the open position, neither the remote throttle lamp nor the check engine lamp will function. If the relay failed closed, the lamps will work regardless of the position of the blackout switch. Refer to “Testing and Adjusting, Testing, Relay Test” in this module.

4. Faulty blackout relay:

If the blade down alarm and the winch, self-deploy and kneeling lamps also do not function, check the blackout relay. Refer to “Testing and Adjusting, Testing, Relay Test” in this module.

5. Faulty blackout switch:

NOTE: The blackout switch must be in the STOP LIGHT or SERVICE DRIVE position for the remote throttle and/or the check engine lamps to function.

a. If the blade down alarm and the winch, self-deploy and kneeling lamps also do not function but the blackout relay is not faulty, check the blackout switch. Refer to “Systems Operation, Lighting Circuit” in this module, for operation of the blackout switch.

b. Test contacts F and J of the blackout switch. When in the STOP LIGHT or SERVICE DRIVE position, contacts F and J of the blackout switch should be closed. Contacts F and J should be open in all other positions.

6. Faulty engine diagnostic enable switch:

a. Check the engine diagnostic enable switch. Move the switch to the ON position. Contacts 1 and 2 of the switch should be closed.

b. Move the switch to the OFF position. Contacts 1 and 2 of the switch should be open. Refer to “Testing and Adjusting, Testing, Switch Test” in this module.

7. Fault in one or more circuit:

a. Check the 602-WH wire between the horn/dome circuit breaker and the blackout switch relay.

b. Check the L988-OR wire between terminal 14 of the ECM and the blackout switch relay.

c. Check the H795-PK wire between the blackout switch relay and terminal B-29 of the ECM, and between engine diagnostic enable switch and terminal B-29 of the ECM.

d. Check the C987-RD wire between the ECM circuit breaker and the check engine and crank-without-inject lamps.

e. Check the L994-YL wire between the check engine lamp and terminal B-22 of the ECM, and check the L995-GN wire between the crank-without-inject lamp and terminal B-34 of the ECM.

8. Faulty ECM:

For ECM troubleshooting procedures, refer to “Engine Diagnostic Flash Codes” in this section.

Problem 21: Winch Does Not Function

Possible Cause(s):

- Auxiliary circuit breaker tripped
- Winch enable switch failed open
- Faulty winch control switch
- Faulty coil in winch solenoid
- Circuit between auxiliary circuit breaker and winch-in and/or winch-out coils of the winch solenoid contains fault

1. Auxiliary circuit breaker tripped:

NOTE: If the auxiliary circuit breaker is tripped, the voltmeter and tachometer will not work and REVERSE steering will not function properly.

a. Reset the auxiliary circuit breaker.

b. Test the continuity between the posts of the auxiliary circuit breaker. If necessary, replace the circuit breaker.

2. Winch enable switch failed open:

a. Test contacts 4 and 5 of the winch enable switch in the ON position. Contacts 4 and 5 of the switch should be closed. Refer to “Testing and Adjusting, Testing, Switch Test” in this module.

b. Test contacts 4 and 5 of the winch enable switch in the OFF position. Contacts 4 and 5 of the switch should be open. Refer to “Testing and Adjusting, Testing, Switch Test” in this module.

3. Faulty winch control switch:

a. Test contacts 1, 2, and 3 of the winch control switch in the HOLD position. Contacts 1 and 2 and contacts 2 and 3 should be open. Refer to “Testing and Adjusting, Testing, Switch Test” in this module.

b. Test contacts 1, 2 and 3 of the winch control switch in the IN position. Contacts 1 and 2 should be closed and contacts 2 and 3 should be open. Refer to “Testing and Adjusting, Testing, Switch Test” in this module.

c. Test contacts 1, 2, and 3 of the winch control switch in the OUT position. Contacts 1 and 2 should be open and contacts 2 and 3 should be closed. Refer to “Testing and Adjusting, Testing, Switch Test” in this module.

4. Faulty coil in winch solenoid:

a. Test the coil resistance across contacts 1 and 2 of the winch solenoid. Refer to “Testing and Adjusting, Testing, Solenoid Test” in this module.

b. Test the coil resistance across contacts 3 and 4 of the winch solenoid. Refer to “Testing and Adjusting, Testing, Solenoid Test” in this module.

5. Circuit between auxiliary circuit breaker and winch-in and/or winch-out coils of the winch solenoid contains fault:

a. Test the H788-WH wire between the auxiliary circuit breaker and contact 5 of the winch enable switch.

b. Test the G728-YL wire between contact 4 of the winch enable switch and contact 2 of the winch control switch.

c. Test the F868-OR wire between contact 3 of the winch control switch and contact 3 of the winch solenoid.

d. Test the F869-PK wire between contact 1 of the winch control switch and contact 1 of the winch solenoid.

Problem 22: Windshield Wiper Does Not Work

Possible Cause(s):

- Faulty washer/wiper circuit breaker
- Faulty wiper relay
- Faulty wiper switch
- Faulty wiper motor
- Faulty circuit wiring

1. Faulty washer/wiper circuit breaker:

Test the continuity between the posts of the washer/wiper circuit breaker. If necessary, replace the circuit breaker.

2. Faulty wiper relay:

When the wiper switch is in the LOW position, the coil of wiper relay 1 and wiper relay 2 should be energized. If the number-1 relay coil does not energize with the wiper switch in the LOW position, the wipers will operate on high speed only. If the number-2 relay coil does not energize with the wiper switch in the LOW position, the wipers will not operate. Refer to “Testing and Adjusting, Testing, Relay Test” in this module.

3. Faulty wiper switch:

a. Test the wiper switch contacts. Refer to “Testing and Adjusting, Testing, Switch Test” in this module.

b. With the wiper switch in the PARK position, all of the contacts are open.

c. With the wiper switch in the LOW position, contacts B and D are closed and contacts C and D are closed.

d. With the wiper switch in the HIGH position, contacts C and D are closed.

e. With the wiper switch in the WASH position, contacts A and E are closed.

4. Faulty circuit wiring:

a. Test the 118-GY wire between the washer/wiper circuit breaker and contacts A and D of the wiper switch. Also test the 118-GY wire to the B+ terminal of the wiper motor.

b. Test the 594-GY wire between contact B of the wiper switch and the coil of wiper relay 1.

c. Test the 595-YL wire between contact C of the wiper switch and wiper relay 1 and the coil of wiper relay 2.

d. Test the 502-OR wire between wiper relay 1 and terminal H of the wiper motor.

e. Test the 501-GN wire between wiper relay 2 and terminal L of the wiper motor.

5. Faulty wiper motor

If the wiper switch, relays, and/or circuits do not contain a fault, the wiper motor may be the cause of the problem.

Problem 23: Blower Does Not Work

Possible Cause(s):

- Air conditioner blower motor circuit breaker tripped (open)
- Faulty blower switch
- Faulty blower resistor
- Faulty circuit wiring
- Faulty blower motor

1 Air conditioner blower motor circuit breaker tripped (open):

a. Reset the blower motor circuit breaker.

b. Test the continuity between the posts of the blower motor circuit breaker. If necessary, replace the circuit breaker.

2. Faulty blower switch:

a. Test the blower switch contacts in the air conditioning and the heating positions. Refer to "Testing and Adjusting, Testing, Switch Test" in this module.

b. With the blower switch in the OFF position, none of the contacts should be closed.

c. With the blower switch in the LOW position, contacts 1 and 3 are closed.

d. With the blower switch in the MEDIUM position, contacts 1 and 4 are closed.

e. With the blower switch in the HIGH position, contacts 1 and 5 are closed.

3. Faulty blower resistor:

a. Test the resistance between the end posts of the blower resistor. Replace the resistor if the reading is out of specification.

b. Test the resistance between the middle and the end post of the blower resistor. Replace the resistor if the reading is out of specification.

4. Faulty circuit wiring:

a. Test the 124-GN-14 wire from the air-conditioning blower motor circuit breaker to contact 1 of the blower switch.

b. Test the 515-GY-14 wire between contact 5 of the blower switch and contact 2 of the blower motor.

c. Test the 516-GN-14 wire between contact 4 of the blower switch and the center post of the blower resistor.

d. Test the 517-BU-14 wire between contact 3 of the blower switch and the first post of the blower resistor.

5. Faulty blower motor:

a. If the circuit breaker, blower switch, resistor, and wiring do not contain a fault, the blower motor may be the cause of the problem.

Problem 24: Machine Will Not Kneel and/or Kneeling Lamp Will Not Illuminate

Possible Cause(s):

- Auxiliary circuit breaker tripped (open)
- Faulty turn/flasher circuit breaker
- Kneeling lamp burned out
- Faulty kneeling limit switch
- Faulty kneeling switch
- Faulty kneeling solenoid
- Fault circuit wiring

1. Auxiliary circuit breaker tripped (open):

NOTE: If the auxiliary circuit breaker is tripped, the machine will not kneel, the voltmeter and tachometer will not work, and REVERSE steering will not function properly.

a. Reset the auxiliary circuit breaker.

b. Test the continuity between the posts of the auxiliary circuit breaker. If necessary, replace the circuit breaker.

2. Faulty turn/flasher circuit breaker:

NOTE: In this case, the kneel lamp, winch lamp, turn signals, and blade down alarm will not function but the machine will kneel.

Check the continuity across the turn/flasher circuit breaker. Replace the circuit breaker if the contacts show an open.

3. Kneeling lamp is burned out:

Check the lamp.

4. Faulty kneeling limit switch

NOTE: A faulty kneeling limit switch will prevent the kneeling lamp from illuminating.

a. Test the kneeling limit switch. Refer to "Testing and Adjusting, Testing, Switch Test" in this module.

b. With the kneeling limit switch in the KNEEL position, contacts 1 and 2 are closed. With the kneeling limit switch in the RAISED position, contacts 1 and 2 are open.

c. With the kneeling limit switch in the KNEEL position, contacts 5 and 6 are closed. With the kneeling limit switch in the RAISED position, contacts 5 and 6 are open.

d. If either Step b or c indicates a fault, replace the kneeling limit switch. However, the kneeling limit switch is not the cause of the problem unless both Step b and Step c indicate a fault.

5. Faulty kneeling switch:

a. Test the kneeling switch. Refer to “Testing and Adjusting, Testing, Switch Test” in this module.

b. With the kneeling switch in the HOLD position, none of the contacts should be closed.

c. With the kneeling switch in the LOWER position, contacts 1 and 2 should be closed.

d. With the kneeling switch in the RAISE position, contacts 2 and 3 should be closed.

6. Faulty kneeling solenoid:

a. Test the coil resistance between contacts 1 and 2 of the kneeling solenoid. Refer to “testing and Adjusting, Testing, Solenoid Test” in this module.

b. Test the coil resistance between contacts 3 and 4 of the kneeling solenoid. Refer to “Testing and Adjusting, Testing, Solenoid Test” in this module.

7. Faulty circuit wiring:

a. If the kneeling lamp alone will not function, test the 692-YL wire between the turn/flasher circuit breaker and the kneeling lamp. Then, test the H779-GN wire between the kneeling lamp and contacts 2 and 6 of the kneeling limit switch.

b. If the machine will not LOWER or RAISE, test the H788-WH wire between the auxiliary circuit breaker and contact 2 of the kneeling switch. Then, test the F886-PK wire between contact 1 of the kneeling switch and contact 3 of the kneeling solenoid. Finally, test the F885-PU wire between contact 3 of the kneeling switch and contact 1 of the kneeling solenoid.

Problem 25: Service Brake Lights Do Not Function

Possible Cause(s):

- Burned out light
- Faulty service brake switch
- Faulty blackout switch
- Faulty circuit wiring

1. Burned out light:

Replace the faulty light.

2. Faulty service brake switch:

Test contacts 2 and 3 of the service brake switch. When the service brakes are ENGAGED, the contacts should be closed. When the service brakes are RELEASED, the contacts should be open. Refer to “Testing and Adjusting, Testing, Switch Test” in this module. If necessary, replace the switch.

3. Faulty blackout switch:

a. Test contacts A and F of the blackout switch. With the blackout switch in the OFF position, the contacts should be open. With the blackout switch in the BLACKOUT DRIVE, BLACKOUT MARKER, SERVICE DRIVE, or STOP LIGHT position, the contacts should be closed. Refer to “testing and Adjusting, Testing, Switch Test” in this module.

b. Test contacts K and N of the blackout switch. With the blackout switch in the OFF, SERVICE DRIVE, or STOP LIGHT position, the contacts should be open. With the blackout switch in the BLACKOUT DRIVE or BLACKOUT MARKER position, the contacts should be closed. Refer to “Testing and Adjusting, Testing, Switch Test” in this module.

c. Test contacts K and C of the blackout switch. With the blackout switch in the OFF, BLACKOUT DRIVE or BLACKOUT MARKER position, the contacts should be open. With the blackout switch in the SERVICE DRIVE, or STOP LIGHT position, the contacts should be closed. Refer to “testing and Adjusting, Testing, Switch Test” in this module.

4. Faulty circuit wiring:

a. Check the 697-GN wire from contact A of the blackout switch to contact 2 of the service brake switch.

b. Test the 698-PU wire from contact 3 of the service brake switch to contact K of the blackout switch.

c. Test the 8627-PK wire from contact N of the blackout switch to the blackout brake lamps.

d. Test the 604-OR wire from contact C of the blackout switch to the stop lamps.

Problem 26: Some or All Lights Do Not Function

Possible Cause(s):

- Burned out light

- Faulty blackout switch
- Faulty circuit wiring

1. Burned out light:

Replace the faulty light.

2. Faulty blackout switch:

a. With the blackout switch in the OFF position, none of the contacts are closed.

b. With the blackout switch in the BLACKOUT DRIVE position, contacts F and D, F and E, F and A, and K and N are closed. Refer to “Testing and Adjusting, Testing, Switch Test” in this module.

c. With the blackout switch in the BLACKOUT MARKER position, contacts F and E, F and A, and K and N are closed. Refer to “Testing and Adjusting, Testing, Switch Test” in this module.

d. With the blackout switch in the STOP LIGHT position, contacts F and A, F and J, and K and C are closed. Refer to “Testing and Adjusting, Testing, Switch Test” in this module.

e. With the blackout switch in the SERVICE DRIVE/OFF position, contacts F and A, F and J, F and H, F and M, and K and C are closed. Refer to “Testing and Adjusting, Testing, Switch Test” in this module.

f. With the blackout switch in the SERVICE DRIVE/PARK position, contacts F and A, F and J, F and H, F and L, K and C are closed. Refer to “Testing and Adjusting, Testing, Switch Test” in this module.

g. With the blackout switch in the SERVICE DRIVE/PANEL DIM position, contacts F and A, F and J, F and H, F and M, F and L, and K and C are closed. Refer to “Testing and Adjusting, Testing, Switch Test” in this module.

h. With the blackout switch in the SERVICE DRIVE/PANEL BRIGHT position, contacts F and A, F and J, F and H, F and M, F and B, and K and C are closed. Refer to “Testing and Adjusting, Testing, Switch Test” in this module.

3. Faulty circuit wiring:

a. If none of the lamps work, test the 112-OR wire from the main power relay to contact F of the blackout switch.

b. If some lamps work and some do not, test the circuit between the blackout switch and the faulty lamp. Refer to “Systems Operation, Lighting Circuit, Circuit Operation” in this module, for the wire numbers.

Engine Diagnostic Flash Codes

Interpreting Engine Diagnostic Flash Codes

The following chart lists each engine diagnostic flash code, the effect the associated error will have on engine performance, and the page number to refer to for troubleshooting procedures.

NOTE: An alternate method of troubleshooting is using the SPORT/ET. Refer to *Electronic Troublshooting, Deployable Universal Combat Earthmover (DEUCE), Appendix D: 3100 HEUI DEUCE Engine*, " P-2.0 Programming Parameters, Connecting Electronic Technician (ET)," in this manual.

ENGINE DIAGNOSTIC FLASH CODE/ENGINE PERFORMANCE RELATIONSHIP–3100 HEUI DEUCE ENGINE					
Diagnostic Flash Codes	EFFECT ON ENGINE PERFORMANCE				
	Engine Misfire	Low Power	Engine Speed Reduced	Engine Shutdown	Refer to Page
12 – Crank-Without-Inject Fault					12-152
15 – Injection Actuation Pressure Sensor Fault	✔	✔			12-153
17 – Injection Actuation Pressure Fault	✔	✔			12-155
18 – Injection Actuation Pressure Driver Fault	✔			✔	12-156
21 – Sensor Supply Voltage Fault[1]	✔	✔			12-158
25 – Boost Pressure Sensor Fault[1]		✔			12-153
26 – Rating Select Input Fault		✔	✔		12-160
27 – Coolant Temperature Sensor Fault[1]					12-153
28 – Throttle Sensor Calibration Fault			✔		12-162
31 – Loss of Vehicle Speed Signal			✔		12-163
32 – Throttle Position Sensor Fault			✔		12-162
34 – Engine RPM Signal Fault					12-164
37 – Oil Temperature Sensor Open or Short Circuit[1]					12-153
38 – Inlet Manifold Temperature Sensor Fault[1]	✔				12-153
39 – Injection Actuation Pressure System Fault	✔	✔		✔	12-158
42 – Timing Sensor Calibration Fault					12-166
49 – Intake Air Heater Fault[1]					12-166
51 – Low/Intermittent Power to ECM	✔			✔	12-166
55 – No Detected Faults					12-167
59 – Incorrect Engine Software				✔	12-167
72 – Cylinder 1 or 2 Fault	✔	✔			12-168
73 – Cylinder 3 or 4 Fault	✔	✔			12-168
74 – Cylinder 5 or 6 Fault	✔	✔			12-168
88 – Ether Start Relay Fault	✔				12-168
89 – Start-Aid Lamp Fault					12-169
91 – Crank-Without-Inject Lamp Fault					12-170

[1] **These diagnostic flash codes may only affect the system under specific environmental conditions, such as engine start-up at cold temperature and cold weather operation at high altitude.**

Connector Checks

NOTE: Perform the following procedure to check engine harness connectors. The troubleshooting procedure for each engine diagnostic flash code specifies which connectors should be checked.

1. Check connections:

a. Move the start switch to OFF, and ensure that the connector is properly locked and not damaged. If the connector is not locked or is damaged, go to Step b. If the two halves of the connector are locked together and the connector is not damaged, go to Step 2.

NOTE: The connector bolt on the ECM connector should be tightened to a torque of 2.25 N•m (20 lb in).

b. Repair or replace the component or harness piece, and go to Step c.

c. Move the start switch to ON (engine not running), and check the engine diagnostic flash codes. If the diagnostic flash code is still present, move the start switch to OFF, and go to Step 2. If the diagnostic flash code is not present, stop here.

2. Perform pull-test on each socket/pin/wire:

a. Using 44.5 N (10 lb) of force, attempt to pull the wires from the pins and/or the pins from the sockets. If all wires are secure, go to Step 3. If any wire is not secure, go to Step b.

b. Secure the loose wire to a new pin and/or the loose pin in the corresponding socket, and go to Step c.

NOTE: Do not solder a loose wire to a pin. Use a 1U-5084 Crimping Tool to secure a pin to a wire.

c. Move the start switch to ON (engine not running), and check the engine diagnostic flash codes. If the diagnostic flash code is still present, move the start switch to OFF, and go to Step 3. If the diagnostic flash code is not present, stop here.

3. Check wires for insulation nicks or abrasion:

a. Inspect each wire for signs of abrasion, nicks, or cuts, and check each harness clamp for proper clamping. If no defect is found, go to Step 4. If a defect is found, go to Step b.

NOTE: Look for exposed points where the insulation may be rubbing against metal. Pull the harness sleeves away from the wires under the harness clamps to check for flattened wires.

b. Replace the damaged wire or harness piece, and go to Step c.

c. Move the start switch to ON (engine not running), and check the engine diagnostic flash codes. If the diagnostic flash code is still present, move the start switch to OFF, and go to Step 4. If the diagnostic flash code is not present, stop here.

4. Check connectors for moisture or corrosion:

a. Inspect the connector seals and sealing plugs for damage. If a seal or sealing plug is damaged or missing, go to Step b. If no damage is found, go to Step c.

b. Replace the damaged seal or missing sealing plug, and go to Step c.

c. Inspect the wiring at the connector. If the wiring makes a sharp bend out of the connector, or if all the wires are pulled towards the center of the connector within approximately 1 cm (0.4 in) from the end of the connector, go to Step d. If wire routing is acceptable, go to Step e.

d. Reroute the wires, and go to Step e.

e. Inspect the inside of each half of the connector for moisture or corrosion. If moisture or corrosion is found, go to Step f. If no moisture or corrosion is found, go to Step 5.

f. Identify and repair the avenue of moisture entry and go to Step g.

g. Clean the pins, sockets, and the inside of the connector with denatured alcohol and a cotton swab or soft brush. Go to Step h.

h. Move the start switch to ON (engine not running), and check the engine diagnostic flash codes. If the diagnostic flash code is still present, move the start switch to OFF, and go to Step 5. If the diagnostic flash code is not present, stop here.

5. Inspect connector pins and sockets:

a. Inspect the connector pins and sockets for damage and/or proper placement. If a fault is found, go to Step b. If no faults are found, go to Step d.

b. Replace the parts or harness piece, and go to Step c.

c. Move the start switch to ON (engine not running), and check the engine diagnostic flash codes. If the diagnostic flash code is still present, move the start switch to OFF, and go to Step d. If the diagnostic flash code is not present, stop here.

d. Insert a new pin into each socket, and check the grip the socket exerts on the pin. If each socket adequately grips the new pin, go to Step f. If any socket does not adequately grip the new pin, go to Step e.

e. Replace the connector or harness piece, and go to Step e.

f. Insert each pin on the joining side of the connector into a new socket, and check the grip between the pin and the new socket. If the grip is adequate, go to Step h. If the grip is not adequate, go to Step g.

g. Replace the connector or harness piece, and go to Step h.

h. Move the start switch to ON (engine not running), and check the engine diagnostic flash codes. If the diagnostic flash code is not present, stop here. If the diagnostic flash code is still present, attempt a different test; the connector is not the cause of the fault in the system.

Diagnostic Flash Code 12: Crank-Without-Inject Fault

1. Check for other active engine diagnostic flash codes:

a. Check for engine diagnostic flash code 91. If the code is present, go to Step b. If the code is not present, go to Step 2.

b. Troubleshoot engine diagnostic flash code 91. For the troubleshooting procedure, refer to “Engine Diagnostic Flash Codes, Diagnostic Flash Code 91: Crank-Without-Inject Lamp Fault” in this section. Go to Step c.

c. Check for engine diagnostic flash code 12. If the code is present, go to Step 2. If the code is not present, stop here.

2. Inspect ECM connector (J1/P1) and crank-without-inject connectors (C251A-B/C251):

Troubleshoot the ECM and crank-without-inject connectors. If the connectors are the cause of the problem, stop here. If the connectors are not the cause of the problem, go to Step 3.

NOTE: For the connector troubleshooting procedure, refer to “Engine Diagnostic Flash Codes, Connector Checks” in this section. The wire numbers, connectors, and socket numbers to check are:

Wire Number	Connector	Socket Number
H799-WH	P1	2
H798-OR	P1	25
H795-PK	P1	29
H798-OR	C251	1
H799-WH	C251	2
H795-PK	C251A	1
H795-PK	C251B	2

3. Check crank-without-inject input status:

a. Connect C251 to C251A, and move the blackout switch to the SERVICE DRIVE or STOP LIGHT position. Then move the start switch to the ON position (engine not running), and observe the crank-without-inject indicator. If the indicator is illuminated, go to Step 4. If the indicator is not illuminated, go to Step b.

b. Move the start switch to the OFF position, and connect C251 to C251B. Then move the start switch to the ON position (engine not running), and observe the crank-without-inject indicator. If the indicator is illuminated, go to Step c. If the indicator is not illuminated, move the start switch to the OFF position and go to Step 4.

c. The crank-without-inject connectors are functioning properly. The problem may have been caused by an intermittent fault. Operate the machine. If the fault recurs, attempt to troubleshoot the problem again.

4. Check ECM input circuit:

a. Install a breakout tee between ECM connectors J1 and P1. Go to Step b.

b. Fabricate a jumper wire with Deutsch pins on both ends. Make the jumper wire approximately 100 mm (4 in) long. Go to Step c.

c. Remove the H799-WH wire from socket 2 and the H798-OR wire from socket 25 of the P1 connector. Go to Step d.

d. Insert one end of the jumper wire into socket 2 of the P1 connector and the other end of the jumper wire into socket 29 of the breakout tee. Go to Step e.

e. Move the start switch to the ON position (engine not running), and observe the crank-without-inject indicator. If the indicator is illuminated, go to Step h. If the indicator is not illuminated, move the start switch to the OFF position and go to Step f.

f. Remove the jumper wire from socket 2 of the P1 connector, and insert the jumper wire into socket 25 of the P1 connector. Go to Step g.

g. Move the start switch to the ON position (engine not running), and observe the crank-without-inject indicator. If the indicator is illuminated, go to Step 5. If the indicator is not illuminated, move the start switch to the OFF position, and go to Step h.

h. Temporarily connect another ECM to the engine and repeat Steps 4d through 4g of this procedure. If the crank-without-inject indicator functions properly, replace the original ECM. If the crank-without-inject indicator does not function properly, return the machine to the normal condition, and go back to Step 1.

NOTE: Only perform Step h if the replacement ECM has been programmed specifically for this machine. If a replacement ECM is not available, use an electronic service tool to troubleshoot the problem. Refer to *Electronic Troubleshooting, Deployable Universal Combat Earthmover (DEUCE), Appendix D: 3100 HEUI DEUCE Engine*.

5. Check harness wiring between ECM and connectors C251A, C251B, and C251:

a. Move the start switch to OFF, remove the breakout tee, and reinsert the H799-WH wire into socket 2 and the H798-OR wire into socket 25 of the P1 connector. Go to Step b.

b. Disconnect connector C251 from C251B, connect one end of the jumper wire to socket 2 of connector C251 and the other end of the jumper cable to engine ground. Go to Step c.

NOTE: Use the jumper wire fabricated in Step 4.

c. Use a 6V-7070 Digital Multimeter (or equivalent) to confirm the ground connection. Go to Step d.

d. Move the start switch to ON (engine not running) and check the engine diagnostic flash codes. If diagnostic flash code 12 is present, go to Step e. If diagnostic flash code 12 is not present, go to Step f.

e. Either the H799-WH wire contains an open or the H798-OR wire contains a short to ground between connector P42 and the ECM. Move the start switch to OFF, and replace the faulty wire or harness piece. Go to Step f.

f. Move the start switch to OFF, remove the jumper wire from socket 2 of connector P42, and insert the jumper wire into socket 1 of connector P42. Go to Step g.

g. Use a 6V-7070 Digital Multimeter (or equivalent) to confirm the ground connection. Go to Step h.

h. Move the start switch to ON (engine not running), observe the crank-without-inject indicator, and check the engine diagnostic flash codes. If the crank-without-inject indicator is not illuminated and the diagnostic flash code 12 is still present, go to Step i. If the crank-without-inject indicator is illuminated and diagnostic flash code 12 is not present, go to Step j.

i. The H798-OR wire contains an open between connector P42 and the ECM. Move the start switch to OFF, and replace the faulty wire or harness piece. Go to Step k.

j. The H795-PK wire contains an open between connector C251A or C251B and the ECM. Move the start switch to OFF, and replace the faulty wire or harness piece. Go to Step k.

k. Remove the jumper wire from socket 1 of connector C251, plug connector C251 into connector C251A, and check the engine diagnostic flash codes. If a diagnostic flash code is not present, stop here. If a diagnostic flash code is still present, go to Step 1.

Diagnostic Flash Code 15: Injection Actuation Pressure Sensor Fault; Diagnostic Flash Code 25: Boost Pressure Sensor Fault; Diagnostic Flash Code 27: Coolant Temperature Sensor Fault; Diagnostic Flash Code 37: Oil Temperature Sensor Open Circuit or Short Circuit; Diagnostic Flash Code 38: Inlet Manifold Temperature Sensor Fault

1. Check for other active engine diagnostic flash codes:

a. If engine diagnostic flash code 21 is present, go to Step b. If engine diagnostic flash code 21 is not present, go to Step 2.

b. Troubleshoot engine diagnostic flash code 21. For the troubleshooting procedure, refer to “Engine Diagnostic Flash Codes, Diagnostic Flash Code 21: Sensor Supply Voltage Fault” in this section. Go to Step c.

c. Check the engine diagnostic flash codes. If one of the engine diagnostic flash codes (15, 25, 27, 37, or 38) is still present, go to Step 2. If none of the engine diagnostic flash codes is present, stop here.

2. Inspect ECM connector (J2/P2), injection actuation pressure sensor connector (J35/P35), boost pressure sensor connector (J3/P3), coolant temperature sensor connector (J10/P10), oil temperature sensor connector (J38/P38), and inlet manifold temperature sensor connector (J21/P21):

Troubleshoot the ECM and sensor connectors. If the connectors are the cause of the problem, stop here. If the connectors are not the cause of the problem, go to Step 3.

NOTE: For the connector troubleshooting procedure, refer to “Engine Diagnostic Flash Codes, Connector Checks” in this module. The wire numbers, connectors, and socket numbers to check are:

Wire Number	Connector	Socket Number
C967-BU	P2	2
995-BU	P2	14
A746-PK	P2	23
D841-GN	P2	24
993-BR	P2	30
E795-YL	P2	32
997-OR	P2	36
997-OR	J35	A
993-BR	J35	B
D841-GN	J35	C
997-OR	J3	A
993-BR	J3	B
A746-PK	J3	C
997-OR	J10	A
993-BR	J10	B
995-BU	J10	C
997-OR	J38	A
993-BR	J38	B
E795-YL	J38	C
997-OR	J21	A
993-BR	J21	B
C967-BU	J21	C

3. Test sensor:

a. Move the start switch to OFF, disconnect the suspected sensor, and connect a new sensor to the wiring harness. Go to Step b.

NOTE: The new sensor need not be installed on the engine to perform Step b.

b. Move the start switch to ON (engine not running), wait for a minimum of 15 seconds, and check the engine diagnostic flash codes. If the engine diagnostic flash code for the sensor being tested is still present, go to Step d. If the engine diagnostic flash code for the sensor being tested is no longer present, go to Step c.

c. Move the start switch to OFF, and replace the original sensor with the new sensor. Stop here.

d. Move the start switch to OFF, and disconnect the new sensor. Go to Step 4.

4. Measure sensor supply voltage:

a. Connect a three-pin breakout tee between the sensor and the engine harness. Go to Step b.

b. Move the start switch to ON (engine not running). Go to Step c.

c. Use a 6V-7070 Digital Multimeter (or equivalent) to measure the DC voltage from pin A to pin B of the breakout tee. If the voltage is 5.0 ± 0.5 volts, go to Step d. If the voltage is not 5.0 ± 0.5 volts, go to Step e.

d. Move the start switch to OFF, disconnect the three-pin breakout tee from the engine harness, and reconnect the sensor to the engine harness. Go to Step 5.

e. Move the start switch to OFF, disconnect the three-pin breakout tee from the engine harness, and reconnect the sensor to the engine harness. Go to Step 1.

5. Check ECM:

a. Disconnect ECM connector J2/P2. Go to Step b.

b. Move the start switch to ON (engine not running), wait for a minimum of 15 seconds, and check the engine diagnostic flash codes. If the engine diagnostic flash code for the sensor being tested is still present, move the start switch to OFF, and go to Step 6. If the engine diagnostic flash code for the sensor being tested is no longer present, go to Step c.

NOTE: Additional engine diagnostic flash codes will appear in this step. Concentrate only on the engine diagnostic flash code for the sensor being tested.

c. Move the start switch to OFF, temporarily connect another ECM to the engine, and check the engine diagnostic flash codes. If the engine diagnostic flash codes disappear, go to Step d. If the engine diagnostic flash codes remain the same as before, go to Step e.

NOTE: Only perform Step c if the replacement ECM has been programmed specifically for this machine. If a replacement ECM is not available, use an electronic service tool to troubleshoot the problem. Refer to *Electronic Troubleshooting, Deployable Universal Combat Earthmover (DEUCE), Appendix D: 3100 HEUI DEUCE Engine*.

d. Move the start switch to OFF, and replace the original ECM. Stop here.

e. Move the start switch to OFF, disconnect the replacement ECM, and reconnect connector J1/P1 of the ECM. Go to Step 6.

6. Check wiring harness:

a. Disconnect the suspected sensor. Go to Step b.

b. Remove the sensor signal wire from ECM connector P2. Go to Step c.

NOTE: The following are the sensor signal wire numbers and the socket numbers of ECM connector P2 for each sensor.

Wire	Socket	Sensor
C967-BU	2	Inlet Manifold Temperature
995-BU	14	Coolant Temperature
A746-PK	23	Boost Pressure
D841-GN	24	Injection Actuation Pressure
993-BR	30	Oil Temperature

c. Remove the sensor signal wire from socket C of the connector of the suspected sensor. Go to Step d.

NOTE: Refer to Step 2 for connector numbers for each sensor.

d. Fabricate a bypass wire long enough to reach between the engine harness and the suspected sensor. Go to Step e.

NOTE: To test a temperature sensor, the bypass wire should have a socket on both ends. To test a pressure sensor, the bypass wire should have a socket on one end and a pin on the other end.

e. Insert one end of the bypass wire into the socket on ECM connector P2 for the sensor being tested and the other end into socket C of the sensor being tested. Go to Step f.

f. Connect ECM connectors P2 and J2, and connect the engine harness to the sensor being tested. Go to Step g.

g. Move the start switch to ON, wait for a minimum of 15 seconds, and check the engine diagnostic flash codes. If the engine diagnostic flash code for the sensor being tested is still present, move the start switch to OFF, and go to Step 1. If engine diagnostic flash code for the sensor being tested is no longer present, move the start switch to OFF, and go to Step h.

h. Test the continuity of the associated wires in the engine harness. Replace faulty wires or the harness piece. Go to Step i.

i. Enter the diagnostic mode and check for the engine diagnostic flash code. If the engine diagnostic flash code is still present, go to Step 1. If the engine diagnostic flash code is not present, stop here.

Diagnostic Flash Code 17: Injection Actuation Pressure Fault

1. Check for other active engine diagnostic flash codes:

a. Move the start switch to ON (engine not running), and enter the diagnostic mode. If engine diagnostic flash code 17 is the only code present, go to Step 2.

If engine diagnostic flash codes 17 and 19 are the only codes present, go to Step b.

If engine diagnostic flash codes 17 and 19 are present with engine diagnostic flash codes 15 and/or 18, go to Step c.

b. Troubleshoot engine diagnostic flash code 19. For the troubleshooting procedure, refer to “Engine Diagnostic Flash Codes, Diagnostic Flash Code 19: Injection Actuation Pressure System Fault” in this section. Go to Step d.

c. Troubleshoot engine diagnostic flash codes 15 and/or 18 first. For the troubleshooting procedure for engine diagnostic flash code 15, refer to “Engine Diagnostic Flash Codes, Diagnostic Flash Code 15: Injection Actuation Pressure Sensor Fault” in this module. For the troubleshooting procedure for engine diagnostic flash code 18, refer to “Engine Diagnostic Flash Codes, Diagnostic Flash Code 18: Injection Actuation Pressure Driver Fault” in this module. Go to Step d.

d. Check the engine diagnostic flash codes. If engine diagnostic flash codes 17 and 19 are the only codes present, go to Step b. If engine diagnostic flash code 17 is the only code present, go to Step 2. If none of the listed engine diagnostic flash codes is present, stop here.

2. Attempt to start engine:

a. Move the start switch to OFF, and disconnect the injection actuation pressure sensor at connector J35/P35. Go to Step b.

b. Move the start switch to START. If the engine starts, release the start switch, move the start switch to OFF, and go to Step 3. If the engine does not start, release the start switch, and go to Step c.

c. Reconnect the injection actuation pressure sensor, and inspect the crank-without-inject connectors. Connector P42 should be plugged into connector C251A. If C251 and C251A are connected, go to Step e. If C251 and C251A are not connected, go to Step d.

d. Plug connector C251 into connector C251A. Go back to Step b.

e. Check the engine oil level. If the dipstick registers full, go to Step g. If the engine oil level is low, go to Step f.

f. Add the proper grade of oil to the engine crankcase. Go back to Step b.

g. Check the fuel level and fuel quality. If the machine is out of fuel or if the fuel quality is poor, go to Step h. If the machine is not out of fuel, go to Step k.

h. Add the proper grade of fuel, and use the fuel priming pump to prime the fuel system. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Testing and Adjusting, Fuel System, Fuel Priming Procedure." Go back to Step b.

i. Determine if the high pressure oil system on the engine has recently been worked on (lines opened). If the high pressure oil system has been worked on, go to Step j. If the high pressure oil system has not been worked on, go to Step k.

j. Hold the start switch in the START position for thirty seconds, then release the start switch. Allow the starter to cool for thirty seconds. Repeat this procedure up to five times. If the engine starts during any of the five attempts, go to Step 3. If the engine does not start, use an electronic service tool to troubleshoot the problem. Refer to *Electronic Troubleshooting, Deployable Universal Combat Earthmover (DEUCE), Appendix D: 3100 HEUI DEUCE Engine*.

3. Inspect injection actuation pressure sensor connectors (J35/P35) and ECM connectors (J2/P2):

Troubleshoot the injection actuation pressure and ECM connectors. If the connectors are the cause of the problem, stop here. If the connectors are not the cause of the problem, go to Step 4.

NOTE: For the connector troubleshooting procedure, refer to "Engine Diagnostic Flash Codes, Connector Checks" in this module. The wire numbers, connectors, and socket numbers to check are:

Wire Number	Connector	Socket Number
D841-GN	P2	24
993-BR	P2	30
997-OR	P2	36
997-OR	J35	A
993-BR	J35	B
D841-GN	J35	C

4. Measure sensor supply voltage:

a. Move the start switch to OFF and disconnect the injection actuation pressure sensor at connector J35/P35. Go to Step b.

b. Connect a three-pin breakout tee to connector J35. Go to Step c.

c. Move the start switch to ON (engine not running), and use a 6V-7070 Digital Multimeter (or equivalent) to measure the voltage from pin A to pin B of the breakout tee. If the voltage is 5.0 ± 0.5 volts, go to Step d. If the voltage is not 5.0 ± 0.5 volts, go to Step e.

d. Remove the three-pin breakout tee from connector J35, and plug connector J35 into connector P35. Further troubleshooting of this problem requires the use of an electronic service tool. Refer to *Electronic Troubleshooting, Deployable Universal Combat Earthmover (DEUCE), Appendix D: 3100 HEUI DEUCE Engine*.

e. Move the start switch to OFF, disconnect the three-pin breakout tee from connector J35, and plug connector J35 into connector connector P35. Go to Step f.

f. Troubleshoot the sensor supply problem. For the troubleshooting procedure, refer to "Engine Diagnostic Flash Codes, Diagnostic Flash Code 21: Sensor Supply Voltage Fault" in this section. If that procedure does not resolve the problem, go to Step g.

g. Further troubleshooting of this problem requires the use of an electronic service tool. Refer to *Electronic Troubleshooting, Deployable Universal Combat Earthmover (DEUCE), Appendix D: 3100 HEUI DEUCE Engine*.

Diagnostic Flash Code 18: Injection Actuation Pressure Driver Fault

1. Check for other active engine diagnostic flash codes:

a. Move the start switch to ON (engine not running), and enter the diagnostic mode. If engine diagnostic flash code 19 is present, go to Step b. If engine diagnostic flash code 19 is not present, go to Step 2.

b. Troubleshoot engine diagnostic flash code 19. For the troubleshooting procedure, refer to “Engine Diagnostic Flash Codes, Diagnostic Flash Code 19: Injection Actuation Pressure System Fault” in this section. Go to Step c.

c. Check the engine diagnostic flash codes. If engine diagnostic flash code 18 is present but engine diagnostic flash code 19 is not, go to Step 2. If engine diagnostic flash code 19 is the still present, use an electronic service tool to troubleshoot the problem. Refer to *Electronic Troubleshooting, Deployable Universal Combat Earthmover (DEUCE), Appendix D: 3100 HEUI DEUCE Engine*.

2. Inspect injection actuation pressure control valve connectors (J36/P36) and ECM connectors (J2/P2):

Troubleshoot the injection actuation pressure control valve and ECM connectors. If the connectors are the cause of the problem, stop here. If the connectors are not the cause of the problem, go to Step 3.

NOTE: For the connector troubleshooting procedure, refer to “Engine Diagnostic Flash Codes, Connector Checks” in this section. The wire numbers, connectors, and socket numbers to check are:

Wire Number	Connector	Socket Number
D798-BK	P2	13
D797-PK	P2	19
D797-PK	P36	A
D798-BK	P36	B

3. Measure resistance through injection actuation pressure solenoid:

a. Move the start switch to OFF, and disconnect injection pressure control valve connector J36 from connector P36. Go to Step b.

b. Connect a 122-8842 Injector Actuation Pressure Control Valve Connector to connector J36. Go to Step c.

c. Use a 6V-7070 Digital Multimeter to measure the resistance between the two pins of the injector actuation pressure control valve connector section. Go to Step d.

d. Confirm the resistance measured in Step c by reversing the leads of the multimeter and measuring the resistance again. If the resistance measured is 10.0 ± 6.0 ohms, go to Step e. If the resistance measured is greater than 16.0 ohms, go to Step f.

e. Reconnect the injection actuation pressure control valve connectors J36 and P36. Go to Step 4.

f. Replace the injection actuation pressure control valve, and check the engine diagnostic system for flash code 18. If flash code 18 is not present, stop here. If flash code 18 remains present, go to Step 4.

4. Measure resistance of injection actuation pressure solenoid through engine harness:

a. Disconnect the ECM connectors J2 and P2. Go to Step b.

b. Use a 6V-7070 Digital Multimeter to measure the resistance between pins 13 and 19 of the P2 connector. Go to Step c.

c. Confirm the resistance measured in Step c by reversing the leads of the multimeter and measuring the resistance again. If the resistance measured in this step is within 2.0 ohms of the resistance measured in Step 3d, go to Step d. If the resistance measured in this step is not within 2.0 ohms of the resistance measured in Step 3d, go to Step f.

d. Use a 6V-7070 Digital Multimeter (or equivalent) to measure the resistance between pin 13 of connector P2 and pins 7, 8, 14, 20, 23 and 24 of connector P2. If each resistance measurement is greater than 10 000 ohms, go to Step e. If any of the resistance measurements is less than 10 000 ohms, go to Step f.

e. Use a 6V-7070 Digital Multimeter (or equivalent) to measure the resistance between pin 19 of connector P2 and pins 7, 8, 14, 20, 23 and 24 of connector P2. If each resistance measurement is greater than 10 000 ohms, go to Step 5. If any of the resistance measurements is less than 10 000 ohms, go to Step f.

f. Replace the injection actuation pressure control valve harness. Go to Step g.

g. Move the start switch to ON (engine not running), and enter the diagnostic mode. If engine diagnostic flash code 18 is not present, stop here. If engine diagnostic flash code 18 is still present, go to Step h.

h. Further troubleshooting of this problem requires the use of an electronic service tool. Refer to *Electronic Troubleshooting, Deployable Universal Combat Earthmover (DEUCE), Appendix D: 3100 HEUI DEUCE Engine*.

Diagnostic Flash Code 19: Injection Actuation Pressure System Fault

NOTE: Diagnostic flash code 19 indicates the presence of a mechanical problem in the high pressure oil system.

1. Check oil and fuel:

a. Check the engine oil level. If the dipstick registers full, go to Step c. If the engine oil level is low, go to Step b.

b. Add the proper grade of oil to the engine crankcase. Go to Step c.

c. Check the fuel level. If the machine is out of fuel, go to Step d. If the machine is not out of fuel, go to Step e.

d. Add the proper grade of fuel, and use the fuel priming pump to prime the fuel system. Go to Step f.

e. Determine if the high pressure oil system on the engine has recently been worked on (lines opened). If the high pressure oil system has been worked on, go to Step f. If the high pressure oil system has not been worked on, go to Step i.

f. Hold the start switch in the START position for thirty seconds, then release the start switch. Allow the starter to cool for thirty seconds. Repeat this step up to five times. If the engine starts during any of the five attempts, go to Step g. If the engine does not start, go to step i.

g. Operate the engine at 1500 rpm for several minutes. Go to Step h.

h. Check the engine diagnostic flash codes. If engine diagnostic flash code 19 is present, go to Step i. If engine diagnostic flash code 19 is not present, stop here.

i. Further troubleshooting of this problem requires the use of an electronic service tool. Refer to *Electronic Troubleshooting, Deployable Universal Combat Earthmover (DEUCE), Appendix D: 3100 HEUI DEUCE Engine*.

Diagnostic Flash Code 21: Sensor Supply Voltage Fault

1. Inspect throttle position sensor connectors (J11/P11), injection actuation pressure sensor connector (J35/P35), boost pressure sensor connector (J3/P3), coolant temperature sensor connector (J10/P10), oil temperature sensor connector (J38/P38), and inlet manifold temperature sensor connector (J21/P21), and ECM connectors (J1/P1 and J2/P2):

Troubleshoot the sensor connectors and ECM connectors. If the connectors are the cause of the problem, stop here. If the connectors are not the cause of the problem, go to Step 2.

NOTE: For the connector troubleshooting procedure, refer to “Engine Diagnostic Flash Codes, Connector Checks” in this section. The wire numbers, connectors, and socket numbers to check are:

Wire Number	Connector	Socket Number
H795-PK	P1	29
A700-OR	P1	35
A983-BU	P1	37
C967-BU	P2	2
995-BU	P2	14
A746-PK	P2	23
D841-GN	P2	24
993-BR	P2	30
E795-YL	P2	32
997-OR	P2	36
997-OR	J35	A
993-BR	J35	B
D841-GN	J35	C
997-OR	J3	A
993-BR	J3	B
A746-PK	J3	C
997-OR	J10	A
993-BR	J10	B
995-BU	J10	C
997-OR	J38	A
993-BR	J38	B
E795-YL	J38	C
997-OR	J21	A
993-BR	J21	B
C967-BU	J21	C

2. Measure sensor supply voltage:

NOTE: Check one sensor at a time. Supply voltage to the throttle position sensor should be 8.0 ± 0.5 volts. Supply voltage to all other sensors should be 5.0 ± 0.5 volts.

a. Connect a three-pin breakout tee between the sensor and the engine harness. Go to Step b.

b. Move the start switch to ON (engine not running). Go to Step c.

c. Use a 6V-7070 Digital Multimeter (or equivalent) to measure the DC voltage from pin A to pin B of the breakout tee. Make note of the voltage reading.

d. Move the start switch to OFF, disconnect the three-pin breakout tee from the engine harness, and reconnect the sensor to the engine harness. Go back to Step a and test the next sensor. After all of the sensors have been tested, go to Step e.

e. If all voltage readings were within the specified range, go to Step 4. If any voltage reading falls outside the specified range, go to Step 3.

3. Check ECM:

a. Disconnect the H795-PK wire from pin 29, the A700-OR wire from pin 35, and the A783-BU wire from pin 37 of ECM connector P1. Disconnect the remaining sensor connectors J35/P35, J3/P3, J10/P10, J38/P38, and J21/P21. Go to Step b.

b. Move the start switch to ON (engine not running), wait for a minimum of 15 seconds, and check the engine diagnostic flash codes. If engine diagnostic flash code 21 is still present, move the start switch to OFF, and go to Step c. If engine diagnostic flash code 21 is no longer present, go to Step 4.

NOTE: Additional engine diagnostic flash codes will appear in this step. Concentrate only on engine diagnostic flash code 21.

c. Use a 6V-7070 Digital Multimeter (or equivalent) to measure the voltage between pin 6 and pin 5 and between pin 4 and pin 28 of ECM connector P1. If the voltage readings are 24.5 ± 2.5 volts, go to Step d. If either voltage reading is not in the specified range go to Step g.

d. Move the start switch to OFF, temporarily connect another ECM to the engine, and check the engine diagnostic flash codes. If engine diagnostic flash code 21 is no longer present, go to Step e. If engine diagnostic flash code 21 remains active, go to Step f.

NOTE: Only perform Step d if the replacement ECM has been programmed specifically for this machine. If a replacement ECM is not available, use an electronic service tool to troubleshoot the problem. Refer to *Electronic Troubleshooting, Deployable Universal Combat Earthmover (DEUCE), Appendix D: 3100 HEUI DEUCE Engine*.

e. Move the start switch to OFF, and replace the original ECM. Stop here.

f. Move the start switch to OFF, disconnect the replacement ECM, reconnect the original ECM and reconnect all sensors. Further troubleshooting of this problem requires the use of an electronic service tool. Refer to *Electronic Troubleshooting, Deployable Universal Combat Earthmover (DEUCE), Appendix D: 3100 HEUI DEUCE Engine*.

g. Test the alternator. If the alternator is functioning properly, use an electronic service tool to troubleshoot the problem. Refer to *Electronic Troubleshooting, Deployable Universal Combat Earthmover (DEUCE), Appendix D: 3100 HEUI DEUCE Engine*.

4. Test sensors:

a. Move the start switch to OFF, reconnect the H795-PK wire to pin 29, the A700-OR wire to pin 35, and the A983-BU wire to pin 37 of ECM connector P1. Go to Step b.

b. Move the start switch to ON (engine not running), wait for a minimum of 15 seconds, and check the engine diagnostic flash codes. If engine diagnostic flash code 21 is present, move the start switch to OFF, and go to Step d. If engine diagnostic flash code 21 is not present, go to Step c.

c. Move the start switch to OFF and reconnect another sensor. Go back to Step b.

NOTE: If engine diagnostic flash code 21 is not active after every sensor has been reconnected, the problem is no longer present. Continue to monitor the machine in the future.

d. Connect a new sensor to the engine harness. Go to Step e.

NOTE: The new sensor need not be installed on the engine.

e. Move the start switch to ON (engine not running), wait a minimum of 15 seconds, and recheck the engine diagnostic flash codes. If engine diagnostic flash code 21 is not present, go to Step f. If engine diagnostic flash code 21 is present, go to Step g.

f. Move the start switch to OFF, replace the faulty sensor, and go back to Step c.

g. If working with the throttle position sensor, go to Step h. If working with one of the other sensors, go to Step j.

h. Move the start switch to OFF, disconnect throttle position sensor connector J11/P11, and the H795-PK wire from pin 29, the A700-OR wire from pin 35, and the A983-BU wire from pin 37 of ECM connector P1. Go to Step i.

i. Use a 6V-7070 Digital Multimeter (or equivalent) to measure the resistance from the A700-OR wire to the H795-PK wire and to the A983-BU wire. If the resistance in either of these measurements is less than 20 Ohms, go to Step l. If the resistance in both of these measurements is greater than 20 Ohms, go to Step m.

NOTE: Move the harness around while checking the resistance to test for intermittent short circuits.

j. Move the start switch to OFF, disconnect the new sensor from the engine harness and disconnect ECM connector J2/P2. Go to Step k.

k. Use a 6V-7070 Digital Multimeter (or equivalent) to measure the resistance from pin A to pin B and from pin A to pin C of the sensor connector. If the resistance in either of these measurements is less than 20 Ohms, go to Step l. If the resistance in both of these measurements is greater than 20 Ohms, go to Step m.

NOTE: Move the harness around while checking the resistance, to test for intermittent short circuits.

l. The engine harness contains a short circuit. Move the start switch to OFF, replace the engine harness, reconnect the sensor currently being tested, and go back to Step b.

m. The problem is not apparent at this time. Move the start switch to OFF, reconnect the ECM, and go to Step c.

NOTE: Do not reconnect the sensor which was tested in Step i or k until after troubleshooting all remaining sensors. If engine diagnostic flash code 21 is present, use an electronic service tool to troubleshoot the problem. Refer to *Electronic Troubleshooting, Deployable Universal Combat Earthmover (DEUCE), Appendix D: 3100 HEUI DEUCE Engine*.

Diagnostic Flash Code 26: Rating Select Input Fault

1. Inspect EPTC II connector C123 (40-pin), harness connectors C103 and C102, and ECM connectors (J1/P1):

Troubleshoot connectors. If the connectors are the cause of the problem, stop here. If the connectors are not the cause of the problem, go to Step 2.

NOTE: For the connector troubleshooting procedure, refer to “Engine Diagnostic Flash Codes, Connector Checks” in this section. The wire numbers, connectors, and socket numbers to check are:

Wire Number	Connector	Socket Number
H797-OR	P1	8
H796-YL	P1	38
L964-WH	C102	31
L965-PK	C102	32
H796-YL	C103	32
H797-OR	C103	33
L964-WH	C103	36
L965-PK	C103	37
L964-WH	C123	7
L965-PK	C123	8
H796-YL	C123	34
H797-OR	C123	35

2. Check EPTC II status:

a. Determine if the EPTC II is registering a CID 589 fault. For EPTC II troubleshooting procedures, refer to *Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electronic Programmable Transmission Control (EPTC II),* “Testing and Adjusting, Initial Troubleshooting Procedure.” If CID 589 is present, go to Step b. If CID 589 is not present go to Step 3.

b. Determine the cause of CID 589. For troubleshooting procedure for a CID 589 fault, refer to *Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electronic Programmable Transmission Control (EPTC II),* “Testing and Adjusting, Troubleshooting Procedures.” Go to Step c.

c. Move the start switch to ON (engine not running), and check the engine diagnostic flash codes. If engine diagnostic flash code 26 is still present, go to Step 3. If engine diagnostic flash code 26 is not present, stop here.

3. Check ECM input circuit:

a. Move the start switch to OFF, and install a 40-pin breakout tee between ECM connectors J1 and P1. Go to Step b.

b. Fabricate a jumper wire with Deutsch pins on both ends. Make the jumper wire approximately 100 mm (4 in) long. Go to Step c.

c. Remove the H797-OR wire from socket 8 and the H796-YL wire from socket 38 of the P1 connector. Go to Step d.

d. Insert one end of the jumper wire into socket 8 of the P1 connector and the other end of the jumper wire into socket 29 of the breakout tee. Go to Step e.

e. Move the start switch to the ON position (engine not running), and check the engine diagnostic flash codes. If engine diagnostic flash code 26 is present, go to Step h. If engine diagnostic flash code 26 is not present, go to Step f.

f. Move the start switch to OFF, remove the jumper wire from socket 8 of the P1 connector, and insert the jumper wire into socket 38 of the P1 connector. Go to Step g.

g. Move the start switch to ON (engine not running), check the engine diagnostic flash codes. If engine diagnostic flash code 26 is present, go to Step h. If engine diagnostic flash code 26 is not present, go to Step j.

h. Move the start switch to OFF, temporarily connect another ECM to the engine, and repeat Steps d through g of this procedure. If engine diagnostic flash code 26 is not present in Steps e or g, go to Step i. If engine diagnostic flash code 26 is present in Step e or in Step g, use an electronic service tool to troubleshoot the problem. Refer to *Electronic Troubleshooting, Deployable Universal Combat Earthmover (DEUCE), Appendix D: 3100 HEUI DEUCE Engine*.

NOTE: Only perform Step h if the replacement ECM has been programmed specifically for this machine. If a replacement ECM is not available, use an electronic service tool to troubleshoot the problem. Refer to *Electronic Troubleshooting, Deployable Universal Combat Earthmover (DEUCE), Appendix D: 3100 HEUI DEUCE Engine*.

i. Move the start switch to OFF, and replace the original ECM. Stop here.

j. Move the start switch to OFF, remove the jumper wire from socket 38 of the P1 connector, and remove the breakout tee. Go to Step 4.

4. Check wiring harness between EPTC II and ECM:

a. Fabricate two bypass wires long enough to reach from EPTC II connector C123 to ECM connector P1. Go to Step b.

b. Move the start switch to OFF, and remove the H796-YL wire from socket 34 and the H797-OR wire from socket 35 of EPTC II connector C123. Go to Step c.

c. Insert one end of one of the bypass wires into socket 34 of EPTC II connector C123 and the other end of the wire into socket 38 of ECM connector P1. Go to Step d.

d. Insert one end of the other bypass wire into socket 35 of EPTC II connector C123 and the other end of the wire into socket 8 of ECM connector P1. Go to Step e.

e. Reconnect ECM connector P1 to J1. Go to Step f.

f. Move the start switch to ON, and check the engine diagnostic flash codes. If engine diagnostic flash code 26 is present, go to Step o. If engine diagnostic flash code 26 is not present, go to Step g.

g. Move the start switch to OFF, and remove the bypass wires from sockets 8 and 38 of ECM connector P1. Go to Step h.

h. Insert the H797-OR wire into socket 8 and the H796-YL wire into socket 38 of ECM connector P1. Go to Step i.

i. Remove the H797-OR wire from socket 32 and the H796-YL wire from socket 33 of connector C103. Go to Step j.

j. Insert the bypass wire which has one end connected to socket 34 of EPTC II connector C123 into socket 32 of connector C103. Go to Step k.

k. Insert the bypass wire which has one end connected to socket 35 of EPTC II connector C123 into socket 33 of connector C103. Go to Step l.

l. Move the start switch to ON, and check the engine diagnostic flash codes. If engine diagnostic flash code 26 is not present, go to Step m. If engine diagnostic flash code 26 is present, go to Step n.

m. The wires between connector C103 and EPTC II connector C123 contain a fault. Replace the faulty wires. Stop here.

n. The wires between connector C103 and ECM connector P1 contain a fault. Replace the faulty wires, remove the bypass wires from connector C103 and EPTC II connector C123, and replace the H796-YL and H797-OR wires into their respective sockets. Stop here.

o. Reconnect all wires, and use an electronic service tool to troubleshoot the problem. Refer to *Electronic Troubleshooting, Deployable Universal Combat Earthmover (DEUCE), Appendix D: 3100 HEUI DEUCE Engine*.

Diagnostic Flash Code 28: Throttle Sensor Calibration Fault; Diagnostic Flash Code 32: Throttle Position Sensor Fault

1. Check for other active engine diagnostic flash codes:

a. If engine diagnostic flash code 21 is present, go to Step b. If engine diagnostic flash code 21 is not present, go to Step 2.

b. Troubleshoot engine diagnostic flash code 21. For the troubleshooting procedure for engine diagnostic flash code 21, refer to “Engine Diagnostic Flash Codes, Diagnostic Flash Code 21: Sensor Supply Voltage Fault” in this section. Go to Step c.

c. Check the engine diagnostic flash codes. If engine diagnostic flash code 28 or 32 is still present, go to Step 2. If engine diagnostic flash code 28 or 32 is not present, stop here.

2. Inspect throttle position sensor connectors (J11/P11) and ECM connectors (J1/P1):

a. Troubleshoot the throttle position sensor and ECM connectors. If the connectors are the cause of the problem, stop here. If the connectors are not the cause of the problem, go to Step 3.

NOTE: For the connector troubleshooting procedure, refer to “Engine Diagnostic Flash Codes, Connector Checks” in this section. The wire numbers, connectors, and socket numbers to check are:

Wire Number	Connector	Socket Number
H795-PK	P1	29
A700-OR	P1	35
A983-BU	P1	37
A700-OR	P11	A
H795-PK	P11	B
A983-BU	P11	C

3. Check throttle position sensor duty cycle at sensor:

NOTE: The remaining steps in this procedure require use of an instrument which is capable of determining pulse width modulated duty cycle. Some multimeters have this capability. If such an instrument is not available, contact the nearest Caterpillar dealer for assistance.

a. Move the start switch to OFF, and remove the A983-BU wire from pin C of connector P11. Go to Step b.

b. Install a three-pin breakout tee between throttle position sensor connectors J11 and P11, and move the start switch to ON. Go to Step c.

c. Measure the duty cycle between pin B and pin C of the breakout tee. If the duty cycle is 16.0 ± 6.0%, go to Step d. If the duty cycle is not 16.0 ± 6.0%, go to Step e.

d. Measure the duty cycle while depressing the accelerator pedal to the high idle stop. If the duty cycle steadily increased to 82.5 ± 7.5%, go to Step f. If the duty cycle did not increase to 82.5 ± 7.5% with the accelerator pedal against the high idle stop, go to Step e.

e. Move the start switch to OFF, and reinsert the A983-BU wire into pin C of connector P11. Go to Step 4.

f. Move the start switch to OFF, remove the breakout tee from between connectors J11 and P11, reinsert the A983-BU wire into pin C of connector P11, and reconnect connectors J11 and P11. Go to Step 5.

4. Check accelerator pedal assembly:

a. Remove the throttle position sensor from the accelerator pedal. Go to Step b.

b. Measure the duty cycle between pin B and pin C of the breakout tee. If the duty cycle is 10% or less, go to Step c. If the duty cycle is greater than 10%, go to Step e.

c. Using a screwdriver, advance the dial to the maximum position. If the duty cycle is 90% or greater, go to Step d. If the duty cycle is less than 90%, go to Step e.

d. Move the start switch to OFF, replace the accelerator pedal assembly, remove the breakout tee from between connectors J11 and P11, and connect connectors J11 and P11. Stop here.

e. Inspect the accelerator pedal to ensure that the pedal assembly is not causing damage to the throttle position sensor. If the accelerator pedal is causing damage to the throttle position sensor, go to Step f. If the accelerator pedal is not causing damage to the throttle position sensor, go to Step g.

f. Replace the accelerator pedal assembly. Go to Step g.

g. Move the start switch to OFF, replace the throttle position sensor, and remount the throttle position sensor on the accelerator pedal assembly. Stop here.

5. Check throttle position sensor duty cycle at ECM:

a. Remove the A983-BU wire from socket 37 of connector P1. Go to Step b.

b. Install a 40-pin breakout tee between ECM connectors J1 and P1, and move the start switch to ON. Go to Step c.

c. Measure the duty cycle between pin 29 and pin 37 of the breakout tee. If the duty cycle is 16.0 ± 6.0%, go to Step d. If the duty cycle is not 16.0 ± 6.0%, go to Step e.

d. Measure the duty cycle while depressing the accelerator pedal to the high idle stop. If the duty cycle steadily increased to 82.5 ± 7.5%, go to Step f. If the duty cycle did not increase to 82.5 ± 7.5% with the accelerator pedal against the high idle stop, go to Step e.

e. The wiring between the throttle position sensor and the ECM contains a fault. Move the start switch to OFF, and go to Step 6.

f. Move the start switch to OFF, and temporarily connect another ECM to the engine. Go to Step g.

NOTE: Only perform Step f if the replacement ECM has been programmed specifically for this machine. If a replacement ECM is not available, use an electronic service tool to troubleshoot the problem. Refer to *Electronic Troubleshooting, Deployable Universal Combat Earthmover (DEUCE), Appendix D: 3100 HEUI DEUCE Engine*.

g. Measure the duty cycle between pin 29 and pin 37 of the breakout tee. If the duty cycle is 16.0 ± 6.0%, go to Step h. If the duty cycle is not 16.0 ± 6.0%, go to Step k.

h. Measure the duty cycle while depressing the accelerator pedal to the high idle stop. If the duty cycle steadily increased to 82.5 ± 7.5%, go to Step i. If the duty cycle did not increase to 82.5 ± 7.5% with the accelerator pedal against the high idle stop, go to Step j.

i. Replace the original ECM. Stop here.

j. Use an electronic service tool to troubleshoot the problem. Refer to *Electronic Troubleshooting, Deployable Universal Combat Earthmover (DEUCE), Appendix D: 3100 HEUI DEUCE Engine*.

6. Check wiring:

a. Move the start switch to OFF, remove the 40-pin breakout tee from between ECM connectors J1 and P1, and reconnect ECM connectors J1 and P1. Go to step b.

b. Remove the A983-BU wire from pin C of throttle position sensor connector P11. Go to Step c.

c. Fabricate a bypass wire long enough to reach from connector P11 to ECM connector J1. Go to Step d.

d. Insert one end of the bypass wire into pin C of connector P11 and the other end of the bypass wire into pin 37 of ECM connector P1. Go to Step e.

e. Move the start switch to ON, and check the diagnostic flash codes. If engine diagnostic flash code 28 or 32 is present, go to Step g. If neither engine diagnostic flash code 28 nor 32 is present, go to Step f.

f. Permanently install the bypass wire. Stop here.

g. Use an electronic service tool to troubleshoot the problem. Refer to *Electronic Troubleshooting, Deployable Universal Combat Earthmover (DEUCE), Appendix D: 3100 HEUI DEUCE Engine*.

Diagnostic Flash Code 31: Loss of Vehicle Speed Signal

1. Inspect EPTC II connectors (C123 and C133), vehicle speed connectors (J24/P24), TOS sensor connectors (C352), harness connectors (C101 and C103), and ECM connectors (J1/P1 and J2/P2):

a. Troubleshoot the connectors. If the connectors are the cause of the problem, stop here. If the connectors are not the cause of the problem, go to Step 2.

NOTE: For the connector troubleshooting procedure, refer to “Engine Diagnostic Flash Codes, Connector Checks” in this section. The wire numbers, connectors, and socket numbers to check are:

Wire Number	Connector	Socket Number
709-OR	C123	9
710-GN	C123	10
G808-BU	C133	3
D784-BU	J24	1
D785-GN	J24	2
D810-PU	P24	1
D811-YL	P24	2
709-OR	C352	A
204-BK	C352	B
710-GN	C352	C
449-BU	C101	15
709-OR	C103	10
710-GN	C103	11
G808-BU	C103	30
200-BK	P1	12
449-BU	P1	16
G808-BU	P1	18
D811-YL	P2	4
D785-GN	P2	10
D810-PU	P2	39
D784-BU	P2	40

2. Check EPTC II status:

a. Determine if the EPTC II is registering a CID 701 fault. For EPTC II troubleshooting procedures, refer to *Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electronic Programmable Transmission Control (EPTC II),* “Testing and Adjusting, Initial Troubleshooting Procedure.” If CID 701 is present, go to Step b. If CID 701 is not present go to Step 3.

b. Determine the cause of CID 701. For troubleshooting procedure for a CID 701 fault, refer to *Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electronic Programmable Transmission Control (EPTC II),* “Testing and Adjusting, Troubleshooting Procedures.” Go to Step 3.

3. Check engine diagnostic flash codes:

a. Move the start switch to ON (engine not running), and check the engine diagnostic flash codes. If any engine diagnostic flash codes are present, troubleshoot those codes before continuing. If no engine diagnostic flash codes are present, go to Step b.

b. Start the machine, and check the engine diagnostic flash codes. If engine diagnostic flash code 31 is present, go to Step c. If engine diagnostic flash code 31 is not present, go to Step d.

c. Check the fuel pressure. Resolve any problems, and go back to Step a.

d. Monitor the check engine lamp while driving the machine. If the check engine lamp does not illuminate during operation, go to Step e. If the check engine lamp illuminates during operation, go to Step f.

e. The problem is no longer present. Continue to monitor the check engine lamp while operating the machine.

f. Further troubleshooting of this problem requires the use of an electronic service tool. Refer to *Electronic Troubleshooting, Deployable Universal Combat Earthmover (DEUCE), Appendix D: 3100 HEUI DEUCE Engine*.

Diagnostic Flash Code 34: Engine RPM Signal Fault

NOTE: The ECM will not register engine diagnostic flash code 34 until the machine has operated with the fault for at least 10 hours.

1. Inspect top engine speed/timing sensor connectors (J9/P9), bottom engine speed/timing sensor connectors (J4/P4), and ECM connectors (J2/P2):

Troubleshoot the connectors. If the connectors are the cause of the problem, stop here. If the connectors are not the cause of the problem, go to Step 2.

NOTE: For the connector troubleshooting procedure, refer to “Engine Diagnostic Flash Codes, Connector Checks” in this section. The wire numbers, connectors, and socket numbers to check are:

Wire Number	Connector	Socket Number
E966-YL	P2	3
E963-BK	P2	8
E964-WH	P2	9
E965-BU	P2	15
E965-BU	P4	A
E966-YL	P4	B
E963-BK	P9	A
E964-WH	P9	B

2. Check sensor and bracket installation:

a. Inspect the top and bottom engine speed/timing sensors. If the flange of the sensor is not flush against the engine, go to Step b. If the sensors are installed correctly, go to Step 3.

b. Reinstall the incorrectly installed sensors. If the sensors cannot be properly reinstalled, go to Step c. If the sensors can be properly reinstalled, go to Step d.

c. Replace both sensors. Go to Step d.

NOTE: The sensors must be replaced as a pair. Do not replace only one sensor, and do not exchange the top and bottom speed/timing sensors.

d. Check the engine diagnostic flash codes after operating the machine for at least 10 hours. If engine diagnostic flash code 34 is present, go to Step 3. If engine diagnostic flash code 34 is not present, stop here.

3. Measure sensor resistance through engine harness:

a. Move the start switch to OFF, and disconnect ECM connector J2/P2. Go to Step b.

b. Use a 6V-7070 Digital Multimeter (or equivalent) to measure the resistance between pin 9 and pin 8 of ECM connector P2. If the resistance measures 152.5 ± 77.5 ohms, go to Step c. If the resistance is not in the specified range, go to Step 4.

c. Use a 6V-7070 Digital Multimeter (or equivalent) to measure the resistance between pin 3 and pin 15 of ECM connector P2. If the resistance measures 1200 ± 600 ohms, go to Step 5. If the resistance is not in the specified range, go to Step 4.

4. Measure sensor resistance at sensor:

a. Disconnect the top and bottom speed/timing sensors from the engine harness. Go to Step b.

b. Connect a 122-8840 Engine Speed Timing Sensors Harness Section to the top and bottom speed/timing sensors. Go to Step c.

NOTE: If a 122-8840 Engine Speed Timing Sensors Harness Section is not available, the sensors may need to be removed from the engine.

c. Use a 6V-7070 Digital Multimeter (or equivalent) to measure the resistance from the white wire (pin B of connector J9) to the black wire (pin A of connector J9) of the 122-8840 Engine Speed Timing Sensors Harness Section. If the resistance is 152.5 ± 77.5 ohms, go to Step d. If the resistance is not in the specified range, go to Step e.

d. Use a 6V-7070 Digital Multimeter (or equivalent) to measure the resistance from the yellow wire (pin B of connector J4) to the blue wire (pin A of connector J4) of the 122-8840 Engine Speed Timing Sensors Harness Section. If the resistance is 1200 ± 600 ohms, go to Step 5. If the resistance is not in the specified range, go to Step e.

e. Obtain a new pair of speed/timing sensors, and perform Steps b through d on the new sensors. If the resistance measurements are within the specified range, go to Step f. If the resistance measurements are not in the specified range, go to Step h.

f. Replace the original speed/timing sensors with the new speed/timing sensors, and reconnect ECM connector J2/P2. Go to Step g.

g. Check the engine diagnostic flash codes after operating the machine for at least 10 hours. If engine diagnostic flash code 34 is present, go to Step 5. If engine diagnostic flash code 34 is not present, stop here.

h. Check that the multimeter is functioning and the 122-8840 Engine Speed Timing Sensors Harness Section is connected properly. Go back to Step e.

5. Check wiring between ECM and top and bottom speed/timing sensors:

a. If not already done, connect a 122-8840 Engine Speed Timing Sensors Harness Section to the top and bottom speed/timing sensors. Go to Step b.

b. Remove the E966-YL wire from pin 3, the E963-BK wire from pin 8, the E964-WH wire from pin 9, and the E965-BU wire from pin 15 of ECM connector P2. Go to Step c.

c. Connect the yellow wire from the 122-8840 Engine Speed Timing Sensors Harness Section to pin 3 of ECM connector P2, the black wire to pin 8, the white wire to pin 9, and the blue wire to pin 15. Go to Step d.

d. Reconnect ECM connectors J2 and P2. Go to Step e.

e. Check the engine diagnostic flash codes after operating the machine for at least 10 hours. If engine diagnostic flash code 34 is present, go to Step f. If engine diagnostic flash code 34 is not present, go to Step g.

f. Confirm that the 122-8840 Engine Speed Timing Sensors Harness Section was connected properly. If the harness was connected properly, go to Step 6. If the harness was not connected properly, go back to Step c.

g. Permanently install the 122-8840 Engine Speed Timing Sensors Harness Section to the engine. Stop here.

6. Check ECM:

NOTE: Only perform Step 6 if the replacement ECM has been programmed specifically for this machine. If a replacement ECM is not available, use an electronic service tool to troubleshoot the problem. Refer to *Electronic Troubleshooting, Deployable Universal Combat Earthmover (DEUCE), Appendix D: 3100 HEUI DEUCE Engine*.

a. Move the start switch to OFF, and temporarily connect another ECM to the engine. Go to Step b.

b. Check the engine diagnostic flash codes after operating the machine for at least 10 hours. If engine diagnostic flash code 34 is present, go to Step c. If engine diagnostic flash code 34 is not present, go to Step d.

c. Reconnect the original ECM, replace the original top and bottom speed/timing sensors, and check the engine diagnostic flash codes after operating the machine for at least 10 hours. If engine diagnostic flash code 34 is present, use an electronic service tool to troubleshoot the problem. Refer to *Electronic Troubleshooting, Deployable Universal Combat Earthmover (DEUCE), Appendix D: 3100 HEUI DEUCE Engine*. If engine diagnostic flash code 34 is not present, stop here.

d. Replace the original ECM. Stop here.

Diagnostic Flash Code 42: Timing Sensor Calibration Fault

1. Troubleshooting of this problem requires the use of an electronic service tool. Refer to *Electronic Troubleshooting, Deployable Universal Combat Earthmover (DEUCE), Appendix D: 3100 HEUI DEUCE Engine*.

Diagnostic Flash Code 49: Intake Air Heater Fault

1. Inspect the intake air heater relay connectors (J37/P37), intake air heater relay terminals, intake air heater terminals, and ECM connectors (J1/P1 and J2/P2):

Troubleshoot the connectors. If the connectors are the cause of the problem, stop here. If the connectors are not the cause of the problem, go to Step 2.

NOTE: For the connector troubleshooting procedure, refer to “Engine Diagnostic Flash Codes, Connector Checks” in this section. The wire numbers, connectors, and socket numbers to check are:

Wire Number	Connector	Socket Number
C987-RD	P1	6
D796-OR	P2	31
C987-RD	P37	1
D796-OR	P37	2
F793-RD	Relay	–
160-PU	Relay	–
160-PU	Heater	–

2. Troubleshooting of this problem requires the use of an electronic service tool. Refer to *Electronic Troubleshooting, Deployable Universal Combat Earthmover (DEUCE), Appendix D: 3100 HEUI DEUCE Engine*.

Diagnostic Flash Code 51: Low/Intermittent Power to ECM

1. Inspect ECM connectors (J1/P1):

Troubleshoot the connectors. If the connectors are the cause of the problem, stop here. If the connectors are not the cause of the problem, go to Step 2.

NOTE: For the connector troubleshooting procedure, refer to “Engine Diagnostic Flash Codes, Connector Checks” in this section. The wire numbers, connectors, and socket numbers to check are:

Wire Number	Connector	Socket Number
204-BK	P1	4
204-BK	P1	5
C987-RD	P1	6
C987-RD	P1	28

2. Check battery voltage at ECM:

a. Move the start switch to OFF, and disconnect ECM connector J1/P1. Go to Step b.

b. Install a 40-pin breakout tee between connector J1 and connector P1. Go to Step c.

c. Move the start switch to ON (engine not running), and measure the voltage between pin 5 and pin 6 of the breakout tee. If the voltage is 25.0 ± 3.0 volts, go to Step d. If voltage is present but not in the specified range, go to Step 3. If no voltage is present, go to Step e.

d. Measure the voltage between pin 4 and pin 28 of the breakout tee. If the voltage is 25.0 ± 3.0 volts, go to Step 4. If voltage is present but not in the specified range, go to Step 3. If no voltage is present, go to Step e.

e. Correct the power supply problem. For troubleshooting procedures, refer to “Troubleshooting, General Troubleshooting Problem List” in this section. Go to Step f.

f. Move the start switch to ON (engine not running), and check the engine diagnostic flash codes. If engine diagnostic flash code 51 is present, go back to Step c. If engine diagnostic flash code 51 is not present, go to Step g.

g. Move the start switch to OFF, remove the 40-pin breakout tee, and reconnect ECM connectors J1 and P1. Go to Step h.

h. Move the start switch to ON (engine not running), and check the engine diagnostic flash codes. If engine diagnostic flash code 51 is present, go back to Step a. If engine diagnostic flash code 51 is not present, stop here.

3. Check batteries:

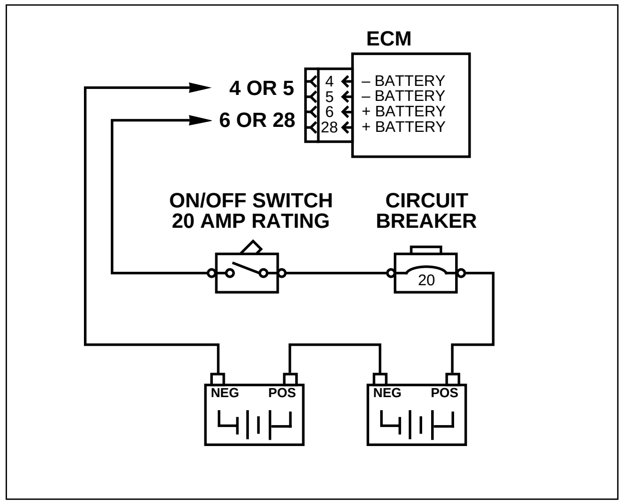
a. Measure the open circuit voltage of the batteries. For the procedure, refer to “Testing and Adjusting, Testing, Battery Open Circuit Voltage Test” in this module. If the batteries pass the test, go to Step 4. If the batteries do not pass the test, go to Step b.

b. Move the start switch to ON (engine not running), and check the engine diagnostic flash codes. If engine diagnostic flash code 51 is present, go to Step 4. If engine diagnostic flash code 51 is not present, stop here.

4. Check machine wiring harness:

a. Move start switch to OFF, and install a bypass circuit as shown below.

NOTE: Use 14-gauge wire with Deutsch pins on the end which will connect to the ECM, a 20-amp circuit breaker, and an ON/OFF switch with a 20 amp rating. Attach the battery ends of the bypass circuit directly to the machine batteries, and install the ON/OFF switch in the cab.



b. Move the ON/OFF switch in the bypass circuit to ON, and move the start switch to ON (engine not running). Go to Step c.

c. Check the engine diagnostic flash codes. If engine diagnostic flash code 51 is not present, go to Step d. If engine diagnostic flash code 51 is present, go to Step f.

d. The ECM power supply contains a fault. Check the 112-OR wire between the blackout relay and the ECM circuit breaker, the C987-RD-14 wire between the ECM circuit breaker and pins 6 and 28 of ECM connector P1, and the 204-BK-14 wire between pins 4 and 5 of ECM connector P1 and ground for an open circuit. Go to Step e.

e. Replace the damaged wire or harness piece, restore the machine wiring to the original condition, and check the engine diagnostic flash codes. If engine diagnostic flash code 51 is not present, stop here. If engine diagnostic flash code 51 is present, go to Step f.

f. Move the start switch to OFF, the ON/OFF switch to OFF, restore all wiring to the original condition, and use an electronic service tool to troubleshoot the problem. Refer to *Electronic Troubleshooting, Deployable Universal Combat Earthmover (DEUCE), Appendix D: 3100 HEUI DEUCE Engine*.

Diagnostic Flash Code 55: No Detected Faults

NOTE: Diagnostic flash code 55 indicates that the ECM is not detecting any active faults. Return the machine to normal operation.

Diagnostic Flash Code 59: Incorrect Engine Software

1. Inspect ECM connectors (J1/P1 and J2/P2):

Troubleshoot the connectors. For the connector troubleshooting procedure, refer to “Engine Diagnostic Flash Codes, Connector Checks” in this section. If the connectors are the cause of the problem, stop here. If the connectors are not the cause of the problem, go to Step 2.

2. Further troubleshooting of this engine diagnostic flash code requires the use of an electronic service tool. Refer to *Electronic Troubleshooting, Deployable Universal Combat Earthmover (DEUCE), Appendix D: 3100 HEUI DEUCE Engine*.

Diagnostic Flash Code 72: Cylinder 1 or 2 Fault, Diagnostic Flash Code 73: Cylinder 3 or 4 Fault, Diagnostic Flash Code 74: Cylinder 5 or 6 Fault

1. Inspect ECM connectors (J2/P2), and injector connectors (J29/P29, J30/P30, J31/P31, J32/P32, J33/P33, and J34/P34):

Troubleshoot the connectors. If the connectors are the cause of the problem, stop here. If the connectors are not the cause of the problem, go to Step 2.

NOTE: For the connector troubleshooting procedure, refer to “Engine Diagnostic Flash Codes, Connector Checks” in this section. The wire numbers, connectors, and socket numbers to check are:

Wire Number	Connector	Socket Number
A721-WH	P2	5
A701-GY	P2	6
A722-YL	P2	11
A702-PU	P2	12
A723-OR	P2	17
A703-BR	P2	18
A724-WH	P2	21
A704-GN	P2	22
A725-YL	P2	27
A705-BU	P2	28
A726-OR	P2	33
A706-GY	P2	34
A701-GY	P29	A
A721-WH	P29	B
A702-PU	P30	A
A722-YL	P30	B
A703-BR	P31	A
A723-OR	P31	B
A704-GN	P32	A
A724-WH	P32	B
A705-BU	P33	A
A725-YL	P33	B
A706-GY	P34	A
A726-OR	P34	B

2. Further troubleshooting of these engine diagnostic flash codes requires the use of an electronic service tool. Refer to *Electronic Troubleshooting, Deployable Universal Combat Earthmover (DEUCE), Appendix D: 3100 HEUI DEUCE Engine*.

Diagnostic Flash Code 88: Start-Aid Relay Fault

1. Inspect ECM connectors (J1/P1), start-aid solenoid connectors (J40/P40), harness connectors (C102 and C404):

Troubleshoot the connectors. If the connectors are the cause of the problem, stop here. If the connectors are not the cause of the problem, go to Step 2.

NOTE: For the connector troubleshooting procedure, refer to “Engine Diagnostic Flash Codes, Connector Checks” in this section. The wire numbers, connectors, and socket numbers to check are:

Wire Number	Connector	Socket Number
H795-PK	P1	29
L967-WH	P1	32
F710-BR	P1	40
317-YL	P40	1
200-BK	P40	2
H795-PK	C102	30
L967-WH	C102	33
317-YL	C404	10
F710-BR	C404	11

2. Measure start-aid relay resistance through harness:

a. Move the start switch to OFF, and disconnect ECM connectors J1 and P1. Go to Step b.

b. Use a 6V-7070 Digital Multimeter (or equivalent) to measure the resistance between socket 40 and engine ground. If the resistance is 360 ± 180 ohms, go to Step i. If the resistance is not in the specified range, go to Step c.

c. Test the start-aid relay. For relay testing procedures, refer to “Testing and Adjusting, Testing, Relay Test” in this module. If the relay was faulty, go to Step h. If the relay is not faulty, go to Step d.

d. Test the 710-BR wire for an open or short between pin 40 of ECM connector P1 and pin 11 of harness connector C404. If an open or short is found, go to Step e. If no fault is found, go to Step f.

e. Replace the faulty wire or harness piece and go to Step f.

f. Test the 710-BR wire for an open or short between pin 11 of harness connector C404 and terminal 86 of the start-aid relay. If an open or short is found, go to Step g. If no fault is found, go to Step i.

g. Replace the faulty wire or harness piece, and go to Step i.

h. Replace the faulty relay, and go to Step i.

i. Reconnect ECM connectors J1 and P1 and go to Step j.

j. Move the start switch to ON (engine not running), and check the engine diagnostic flash codes. If engine diagnostic flash code 88 is present, go to Step 3. If engine diagnostic flash code 88 is not present, stop here.

3. Test start-aid circuit:

NOTE: This step should only be performed when there is not an ether canister installed on the machine.

a. Move the start switch to OFF, connect a 40-pin breakout tee between ECM connectors J1 and P1, and disconnect start-aid solenoid connectors J40 and P40. Go to Step b.

b. Fabricate a jumper wire with Deutsch pins on both ends. Make the jumper wire approximately 100 mm (4 in) long. Go to Step c.

c. Insert one end of the jumper wire into pin 40 of the breakout tee and the other end into pin 6. Go to Step d.

d. Connect start-aid solenoid connectors J40 and P40. If the start-aid solenoid engages (clicks), go to to Step e. If the start-aid solenoid does not engage, go to Step g.

NOTE: Do not leave the start-aid solenoid connectors plugged together for more than a few seconds.

e. Move the start switch to OFF, disconnect the 40-pin breakout tee, and reconnect ECM connectors J1 and P1 and start-aid solenoid connectors J40 and P40. Go to Step f.

f. Move the start switch to ON (engine not running), and check the engine diagnostic flash codes. If engine diagnostic flash code 88 is present, use an electronic service tool to troubleshoot the problem. Refer to *Electronic Troubleshooting, Deployable Universal Combat Earthmover (DEUCE), Appendix D: 3100 HEUI DEUCE Engine*. If engine diagnostic flash code 88 is not present, stop here.

g. Move the start switch to OFF, disconnect the 40-pin breakout tee, and reconnect ECM connectors J1 and P1. Go to Step 4.

4. Test start-aid solenoid:

a. Perform a solenoid test. For the solenoid test procedure, refer to “Testing and Adjusting, Testing, Solenoid Test” in this module. If the solenoid is faulty, go to Step b. If the solenoid is not faulty, go to Step c.

b. Move the start switch to OFF, and replace the faulty solenoid. Go to Step d.

c. Move the start switch to OFF, and replace the faulty wire or harness piece between the start-aid solenoid and the start-aid relay. Go to Step d.

d. Move the start switch to ON (engine not running), and check the engine diagnostic flash codes. If engine diagnostic flash code 88 is present, use an electronic service tool to troubleshoot the problem. Refer to *Electronic Troubleshooting, Deployable Universal Combat Earthmover (DEUCE), Appendix D: 3100 HEUI DEUCE Engine*. If engine diagnostic flash code 88 is not present, stop here.

Diagnostic Flash Code 89: Start-Aid Lamp Fault

1. Inspect ECM connectors (J1/P1), harness connectors (C101 and C102):

Troubleshoot the connectors. If the connectors are the cause of the problem, stop here. If the connectors are not the cause of the problem, go to Step 2.

NOTE: For the connector troubleshooting procedure, refer to “Engine Diagnostic Flash Codes, Connector Checks” in this section. The wire numbers, connectors, and socket numbers to check are:

Wire Number	Connector	Socket Number
L993-OR	P1	21
H795-PK	P1	29
H795-PK	C102	30
L993-OR	C102	34

2. Test lamp circuit:

a. Check the start-aid lamp. If the lamp is burned out, replace the lamp. If the lamp is not burned out, go to Step b.

b. Move the start switch to OFF, and connect a 40-pin breakout tee between ECM connectors J1 and P1. Go to Step c.

c. Fabricate a jumper wire with Deutsch pins on both ends. Make the jumper wire approximately 100 mm (4 in) long. Go to Step d.

d. Insert one end of the jumper wire into socket 5 and the other end of the jumper wire to socket 21 of the breakout tee. Go to Step e.

e. Move the start switch to ON (engine not running). If the start-aid lamp illuminates, go to Step 4. If the start-aid lamp does not illuminate, go to Step f.

f. The start-aid lamp is burned out or the wiring between the ECM and the start-aid lamp contains an open or short. Move the start switch to OFF, and repair the fault. Go to Step g.

g. Move the start switch to ON (engine not running), and check the engine diagnostic flash codes. If engine diagnostic flash code 89 is present, go to Step 4. If engine diagnostic flash code 89 is not present, stop here.

3. Check ECM:

NOTE: Only perform Step 4 if the replacement ECM has been programmed specifically for this machine. If a replacement ECM is not available, use an electronic service tool to troubleshoot the problem. Refer to *Electronic Troubleshooting, Deployable Universal Combat Earthmover (DEUCE), Appendix D: 3100 HEUI DEUCE Engine*.

a. Temporarily connect another ECM to the engine, and check the engine diagnostic flash codes. If engine diagnostic flash code 89 is no longer present, go to Step b. If engine diagnostic flash code 89 remains active, go to Step c.

b. Move the start switch to OFF, and replace the original ECM. Stop here.

c. Move the start switch to OFF, disconnect the replacement ECM, remove the 40-pin breakout tee, reconnect the original ECM, and use an electronic service tool to troubleshoot the problem. Refer to *Electronic Troubleshooting, Deployable Universal Combat Earthmover (DEUCE), Appendix D: 3100 HEUI DEUCE Engine*.

Diagnostic Flash Code 91: Crank-Without-Inject Lamp Fault

1. Inspect ECM connectors (J1/P1), harness connectors (C101 and C102):

Troubleshoot the connectors. If the connectors are the cause of the problem, stop here. If the connectors are not the cause of the problem, go to Step 2.

NOTE: For the connector troubleshooting procedure, refer to “Engine Diagnostic Flash Codes, Connector Checks” in this section. The wire numbers, connectors, and socket numbers to check are:

Wire Number	Connector	Socket Number
L995-GN	P1	34
C987-RD	C101	10
L995-GN	C102	36

2. Test lamp circuit:

a. Check the crank-without-inject lamp. If the lamp is burned out, replace the lamp. If the lamp is not burned out, go to Step b.

b. Move the start switch to OFF, and connect a 40-pin breakout tee between ECM connectors J1 and P1. Go to Step c.

c. Fabricate a jumper wire with Deutsch pins on both ends. Make the jumper wire approximately 100 mm (4 in) long. Go to Step d.

d. Insert one end of the jumper wire into socket 34 and the other end of the jumper wire to socket 6 of the breakout tee. Go to Step e.

e. Move the start switch to ON (engine not running). If the crank-without-inject lamp illuminates, go to Step 4. If the crank-without-inject lamp does not illuminate, go to Step f.

f. The crank-without-inject lamp is burned out or the wiring between the ECM and the crank-without-inject lamp contains an open or short. Move the start switch to OFF, and repair the fault. Go to Step g.

g. Move the start switch to ON (engine not running), and check the engine diagnostic flash codes. If engine diagnostic flash code 91 is present, go to Step 4. If engine diagnostic flash code 91 is not present, stop here.

4. Check ECM:

NOTE: Only perform Step 4 if the replacement ECM has been programmed specifically for this machine. If a replacement ECM is not available, use an electronic service tool to troubleshoot the problem. Refer to *Electronic Troubleshooting, Deployable Universal Combat Earthmover (DEUCE), Appendix D: 3100 HEUI DEUCE Engine*.

a. Temporarily connect another ECM to the engine, and check the engine diagnostic flash codes. If engine diagnostic flash code 91 is no longer present, go to Step b. If engine diagnostic flash code 91 remains active, go to Step c.

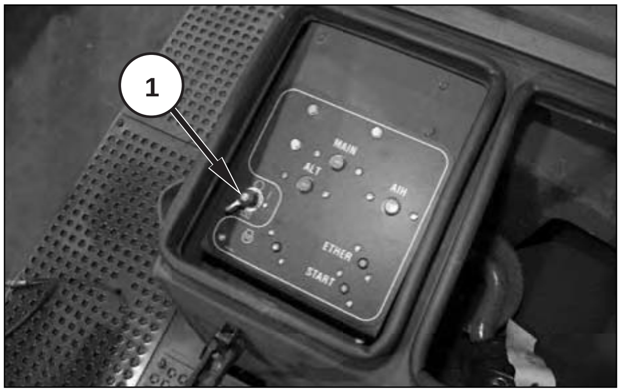
b. Move the start switch to OFF, and replace the original ECM. Stop here.

c. Move the start switch to OFF, disconnect the replacement ECM, remove the 40-pin breakout tee, reconnect the original ECM, and use an electronic service tool to troubleshoot the problem. Refer to *Electronic Troubleshooting, Deployable Universal Combat Earthmover (DEUCE), Appendix D: 3100 HEUI DEUCE Engine*.

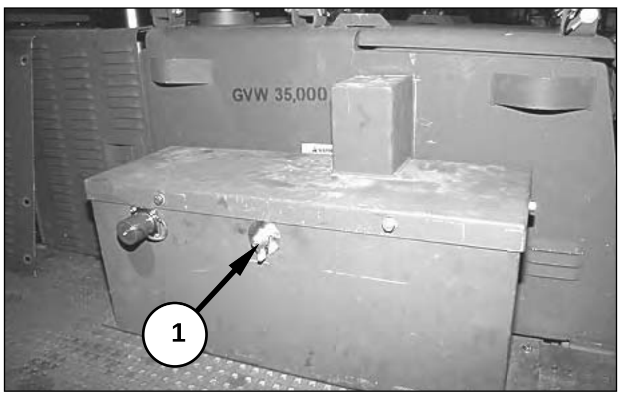
Testing

Battery Open Circuit Voltage Test

NOTE: A 6V-7070 Digital Multimeter (or equivalent) is necessary to perform this test.

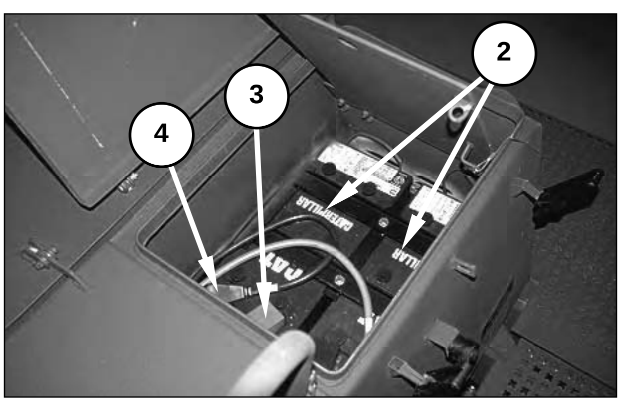


Rear Circuit Breaker Panel.
(1) Electrical disconnect switch.

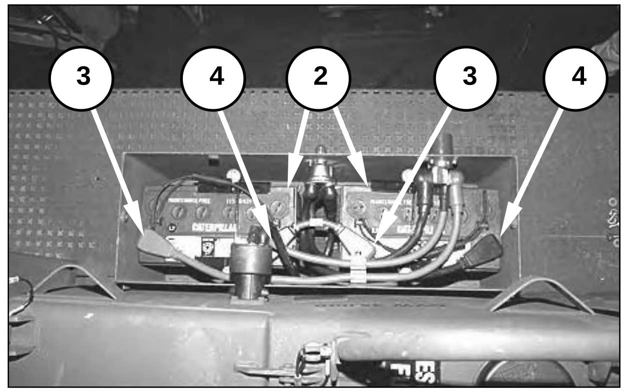


Left Side of Machine, Optional Arctic Battery Box.
(1) Optional arctic battery disconnect switch.

1. Move electrical disconnect switches (1) to the OFF position.



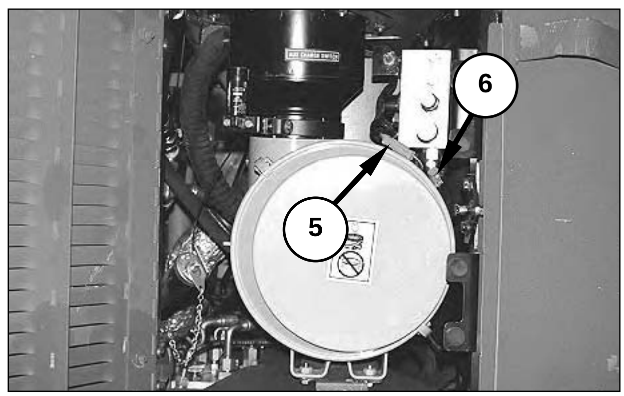
Battery Compartment, Rear of Machine.
(2) Batteries. (3) Positive terminal. (4) Negative terminal.



Optional Arctic Battery Box.
(2) Batteries. (3) Positive terminal. (4) Negative terminal.

2. Working on one battery (2) at a time, touch the positive probe of the digital multimeter to positive terminal (3) of the battery. Touch the negative probe to negative terminal (4).

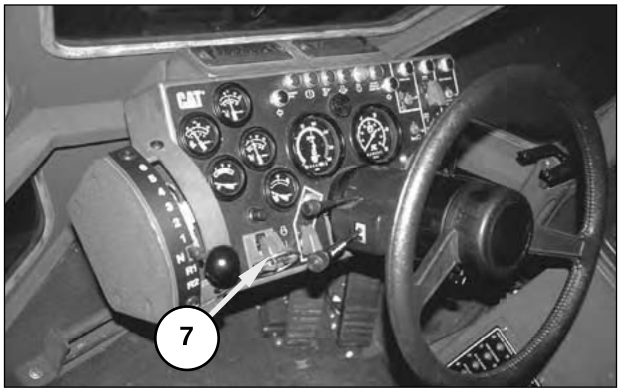
3. If the voltage reading is less than 12.00 volts, charge the battery and repeat Steps 1 and 2. If the voltage reading is 12.00 volts or greater, proceed to Step 4.



Left Side of Machine, Back Wall of Air Cleaner Compartment.
(5) Crank-without-inject plug. (6) Connector.

4. Remove crank-without-inject plug (5) from connector C251A, and connect the plug to connector C251B (6).

5. Move electrical disconnect switch (1) to the ON position.



Instrument Panel.
(7) Start switch.

6. Move start switch (7) to the START position and crank the engine for 5 seconds.

7. Move electrical disconnect switch (1) to the OFF position.

8. Remove crank-without-inject plug (5) from receptacle (6) and connect the plug to the original receptacle.

9. Allow five minutes to elapse after performing Step 6. Then, repeat Step 2.

10. If the voltage reading is less than 12.40 volts, charge the battery and perform a load test.

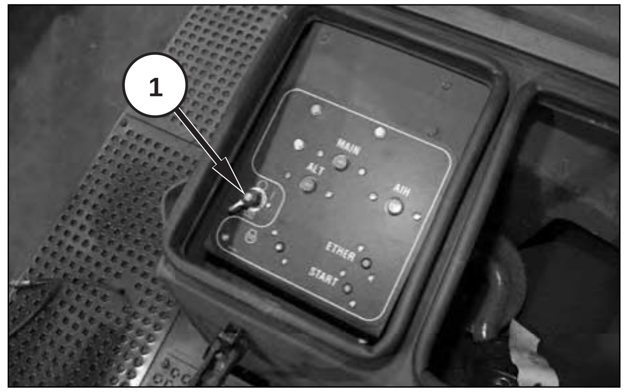
NOTE: For the load test procedure, refer to the instructions which are provided with the battery load tester.

Diode Test

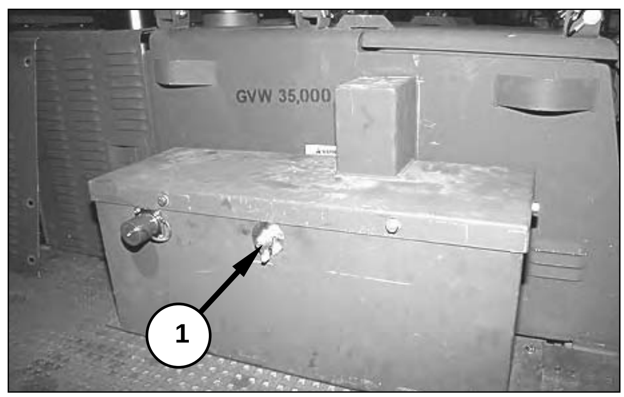
NOTE: A 6V-7070 Digital Multimeter (or equivalent) is necessary to perform this test.

1. Connect the red test lead to the V-Ω input connector and the black test lead to the COM input connector of the digital multimeter.

2. Set the function/range switch to the diode test position.

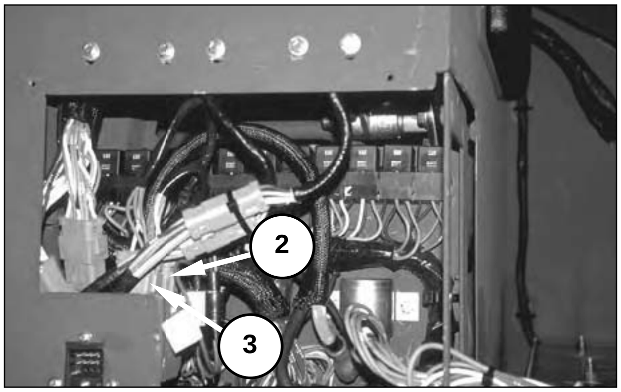


Circuit Breaker Panel, Rear of Machine.
(1) Electrical disconnect switch.



Left Side of Machine, Optional Arctic Battery Box.
(1) Optional arctic battery disconnect switch.

3. Move electrical disconnect switches (1) to the OFF position.



Inside Right Console, Behind Circuit Breaker Panel.
(2) Diode block. (3) Diode block.

4. Touch the black lead of the digital multimeter to contact 1 (wire C420-YL) of diode block (2 or 3) and the red lead to the contact of the desired lamp (refer to “Testing and Adjusting, Troubleshooting, Troubleshooting Problems, Problem 19, Step 6” in this module for the diode block connections). With a properly functioning diode, the multimeter should display 600 to 900 mV. If OL is displayed, go to step 6.

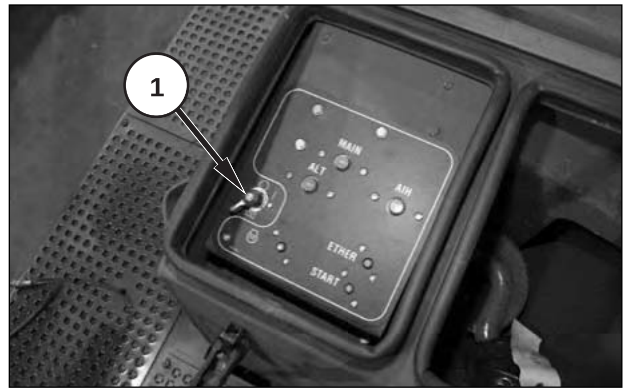
5. Measure the same diode with the red and black leads in the opposite positions. If the multimeter again displays a low voltage reading (less than 1 volt), the junction is internally shorted or shunted by a resistance of less than 500 ohms.

6. If the multimeter reading displays OL, measure the same diode with the red and black leads in the opposite positions. If the multimeter reading displays OL in both positions, then the junction is open.

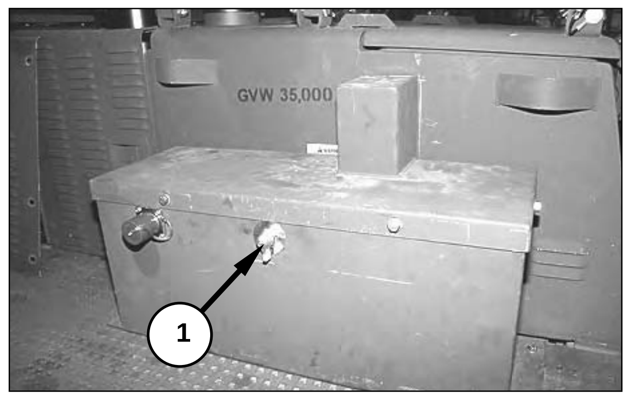
Relay Test

NOTE: A 6V-7070 Digital Multimeter (or equivalent) is necessary to perform this test.

Coil Resistance

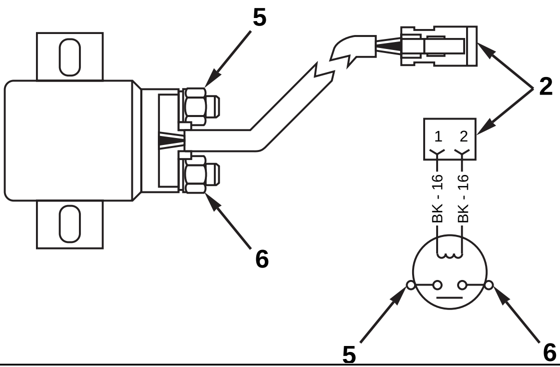


Circuit Breaker Panel, Rear of Machine.
(1) Electrical disconnect switch.

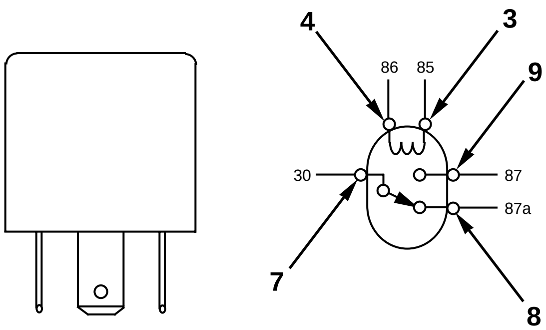


Left Side of Machine, Optional Arctic Battery Box.
(1) Optional arctic battery disconnect switch.

1. Move electrical disconnect switches (1) to the OFF position.



Typical Relay.
(2) Relay connector. (5) Contact. (6) Contact.



Typical Relay.
(3) Relay coil connection 85. (4) Relay coil connection 86.
(7) Contact 30. (8) Contact 87a. (9) Contact 87.

2. Disconnect the relay and measure the resistance between contact 1 of relay connector (2) and contact 2 of the relay connector. If the resistance measurement is not within specifications, the relay is faulty.

-OR-

Disconnect the relay and measure the resistance between relay coil connection 85 (3) and relay coil connection 86 (4). If the resistance measurement is not within specifications, the relay is faulty.

NOTE: Refer to “Specifications, Relays” in this module for the relay coil resistance specifications.

Gate Test

3. Measure the resistance across contact (5) and contact (6). The multimeter should display OL when the relay coil is not energized and the gate is open. If the multimeter displays a resistance of less than 5.0 ohms, the relay gate is closed and the relay is faulty.

-OR-

Measure the resistance across contact 30 (7) and contact 87a (8). The multimeter should display a resistance of less than 5.0 ohms when the relay coil is not energized. If the multimeter displays OL, the relay is faulty.

4. Reconnect the relay and move electrical disconnect switch (1) to the ON position.

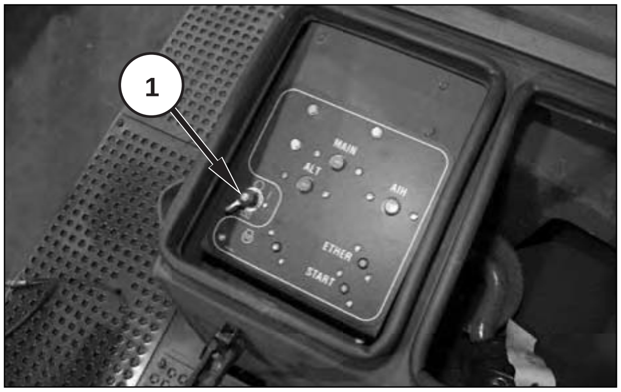
5. Provide power to the relay coil and measure the voltage drop across contact (5) and contact (6). The voltage drop should be 0 volts. If the multimeter reads a voltage drop, the relay is faulty.

-OR-

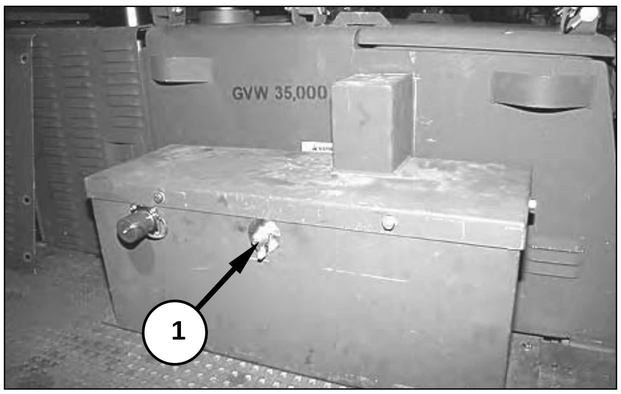
Provide power to the relay coil and measure the voltage drop across contact 30 (7) and contact 87 (9). The voltage drop should be 0 volts. If the multimeter reads a voltage drop, the relay is faulty.

Solenoid Test

NOTE: A 6V-7070 Digital Multimeter (or equivalent) is necessary to perform this test.

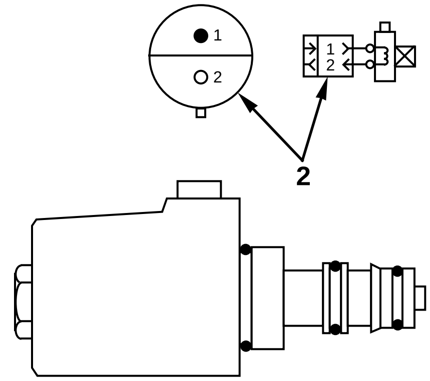


Circuit Breaker Panel, Rear of Machine.
(1) Electrical disconnect switch.



Left Side of Machine, Optional Arctic Battery Box.
(1) Optional arctic battery disconnect switch.

1. Move electrical disconnect switches (1) to the OFF position.



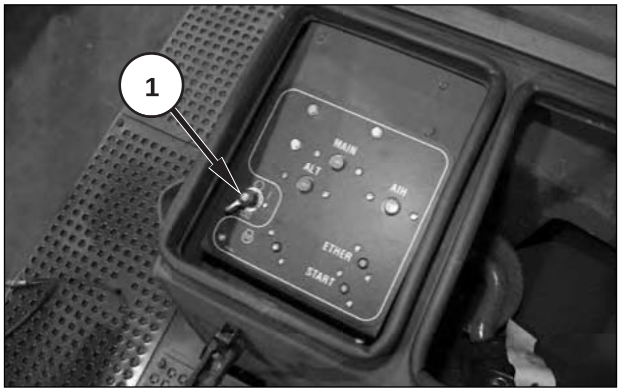
Typical Solenoid.
(2) Connector.

2. Disconnect the solenoid and measure the resistance across contacts 1 and 2 of solenoid connector (2). If the resistance measurement is not within specifications, the solenoid is faulty.

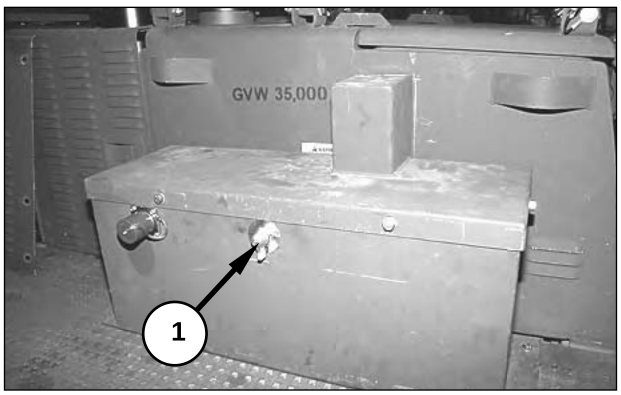
NOTE: Refer to “Specifications, Solenoids” in this module for the solenoid coil resistance specifications.

Switch Test

NOTE: A 6V-7070 Digital Multimeter (or equivalent) is necessary to perform this test.

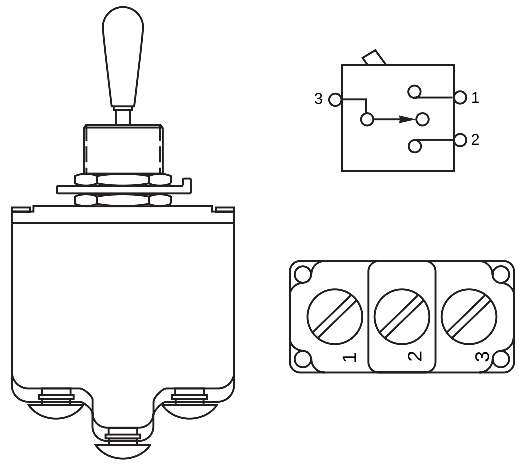


Circuit Breaker Panel, Rear of Machine.
(1) Electrical disconnect switch.



Left Side of Machine, Optional Arctic Battery Box.
(1) Optional arctic battery disconnect switch.

1. Move electrical disconnect switches (1) to the OFF position.



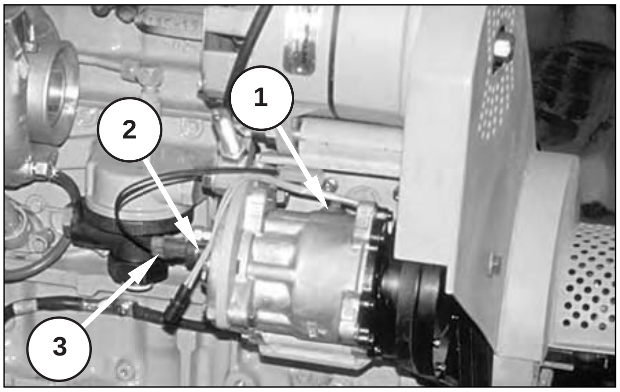
Typical Switch.

2. Determine the switch contacts to be tested.

3. Disconnect the wires from the switch, and measure the resistance across the contacts. In the closed position, the multimeter should display a low resistance reading. In the open position, the multimeter should display OL. If these readings are not obtained, the switch is faulty.

Air Conditioning High/Low Pressure Switch Test

NOTE: A 146-4080 Digital Multimeter (or equivalent) is necessary to perform this test.



Right Side of Engine.
(1) Compressor. (2) Pressure switch. (3) Connector.

1. Unplug connector (3) from pressure switch (2) located on front of the air compressor (1).

2. Place the multimeter in the ohms position, and connect the test leads to the two connector pins on the switch.

3. Measure the switch resistance.

   a. If the resistance displayed is OL (high resistance), and the system pressure is within acceptable limits, the switch is faulty. Go to Step 4.

   b. If the system is charged to above 275 kPa (39.5 psi) and below 1750 kPa (254 psi) and the multimeter displays less than 1 ohm, go to Step 5.

4. Replace the switch. Secure the switch wires with cable ties to prevent vibration damage.

5. Reconnect the pressure switch.

NOTE: The multimeter can display OL if the switch contacts are dirty. The switch contacts become dirty if the arc suppressor is no longer functioning. The multimeter will also display OL if the switch is not threaded into the air conditioning compressor.

NOTE: A test of the arc suppressors functionality should be conducted on each occurence of switch failure. Refer to “Testing and Adjusting, Testing, Diode Test,” in this module for diode testing.

Starter Tests

On-Machine Diagnosis Procedure

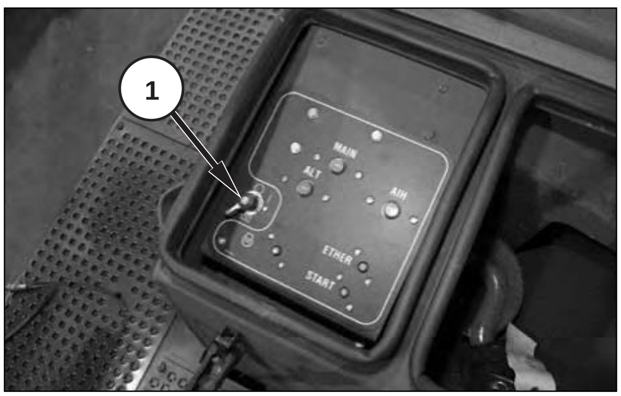
NOTE: A 6V-7070 Digital Multimeter (or equivalent) and an 8T-0900 AC/DC Clamp-on Ammeter (or equivalent) are required to perform this procedure.

NOTICE

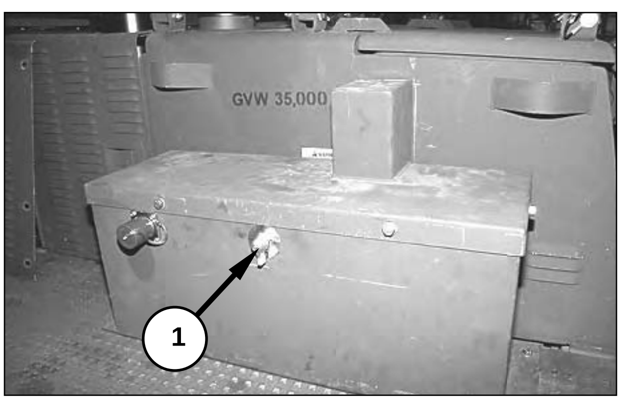
Do not operate the starting motor for more than 30 seconds at a time. After cranking for 30 seconds, the starting motor must be allowed to cool for two minutes before cranking again.

NOTE: Perform the following procedure if the starting motor will not crank or cranks very slowly.

1. Check the batteries. Refer to "Battery Open Circuit Voltage Test" in this section. If the batteries are operating within specifications, go to Step 2.

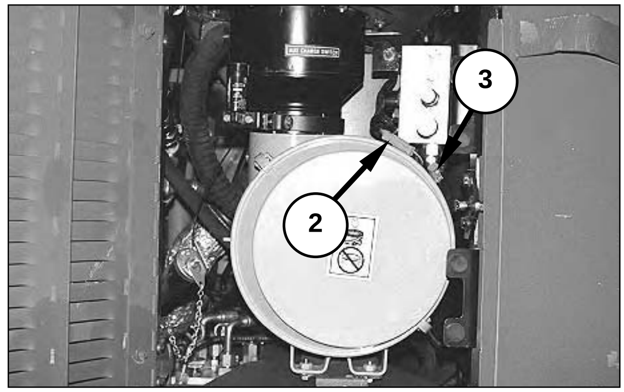


Rear Circuit Breaker Panel.
(1) Electrical disconnect switch.



Left Side of Machine, Optional Arctic Battery Box.
(1) Optional arctic battery disconnect switch.

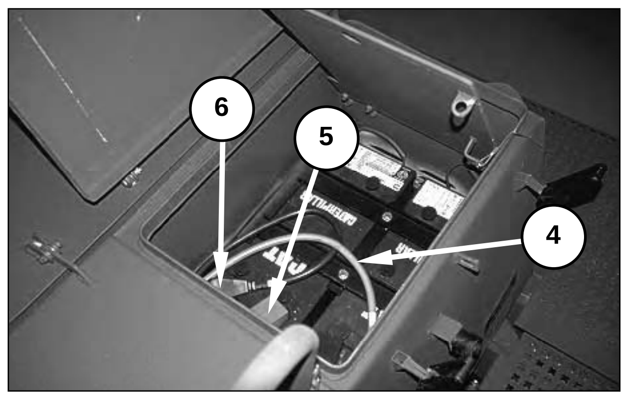
2. Move electrical disconnect switches (1) to the OFF position.



Left Side of Machine, Back Wall of Air Cleaner Compartment.
(2) Crank-without-inject plug. (3) Connector.

3. Remove crank-without-inject plug (2) from connector C251A and connect the plug to connector C251B (3).

4. Move electrical disconnect switches (1) to the ON position.

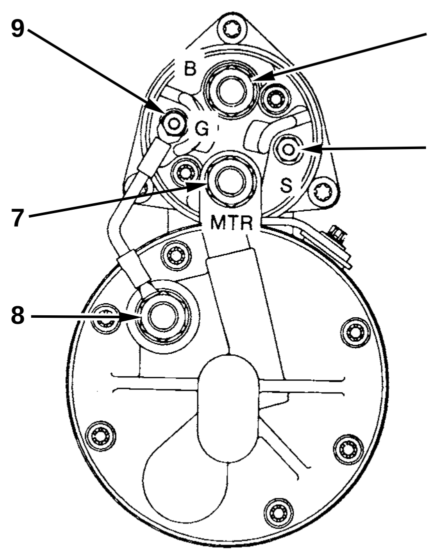


Battery Compartment, Rear of Machine.
(4) Positive battery cable. (5) Positive battery post. (6) Negative battery post.

5. Use a clamp-on ammeter to measure current flow through positive battery cable (4), between the battery and the starting motor solenoid, while attempting to crank the engine. If the current draw is greater than 750 amps at 18.0 volts, go to Step 6. If the current draw is less than or equal to 750 amps at 18.0 volts, go to Step 7.

NOTE: The current specifications are given for temperatures of 27°C (80°F) or greater. If the temperature is lower than 27°C (80°F), the current draw will be greater and the voltage will be less.

6. The starting motor is faulty. Repair or replace the starting motor. Refer to "Starter Tests" in this section, to "Specifications, Other Components, Starter" in this module, and to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* "Starter."



End View of Starter.
(7) MTR-terminal. (8) Motor ground terminal. (9) G-terminal.
(10) S-terminal. (11) B-terminal.

7. Use a digital multimeter to measure the voltage drop from MTR-terminal (7) to motor ground terminal (8) while attempting to crank the engine. If the voltage falls within the following specifications, go to Step 9. If the voltage is less than the specification, go to Step 8.

Temperature	Voltage
-23 to -7°C (-10 to 20°F)	12 to 16 volts
-7 to 10°C (20 to 50°F)	14 to 18 volts
10 to 27°C (50 to 80°F)	16 to 20 volts

8. Use a digital multimeter to measure the voltage drop from negative battery post (6) to G-terminal (9) while attempting to crank the engine. The voltage drop should equal 1.4 volts.

Measure the voltage drop across electrical disconnect switch (1) while attempting to crank the engine. The voltage drop should equal 1.0 volt.

Measure the voltage drop from positive battery post (5) to S-terminal (10) while attempting to crank the engine. The voltage drop should equal 1.0 volt.

Measure the voltage drop from MTR-terminal (7) to B-terminal (11) while attempting to crank the engine. The voltage drop should equal 0.8 volts.

If any of the voltage drops are outside the given specifications, repair or replace the faulty component. If all of the measurements are within specification, go to Step 9.

9. Turn the engine by hand to ensure that the engine components have not seized. If the engine turns freely, go to Step 10. If the engine does not turn freely, repair the engine.

NOTE: For additional information about the engine, refer to Specifications, *System Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine*.

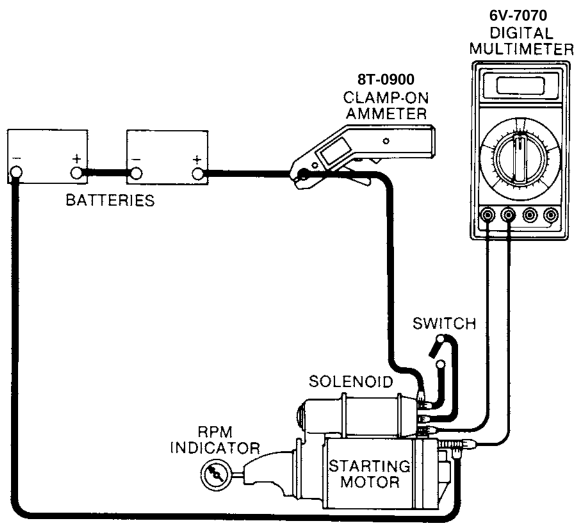
10. Determine if the stating motor cranks when the start switch is held in the START position. If the starting motor cranks, repair or replace the starting motor. Refer to “Specifications, Other Components, Starter” in this module and to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Starter.” If the starting motor does not crank the engine, go to Step 11.

11. Determine if the pinion is blocked from engaging the flywheel ring gear. If the pinion is blocked, remove the blockage. If the pinion is not blocked, test the starting motor solenoids.

NOTE: For solenoid testing procedures, refer to “Starting Motor Solenoid Tests” in this section.

Off Machine No-Load Test

NOTE: Perform this test after the starting motor has been repaired or removed from the machine. A 6V-7070 Digital Multimeter (or equivalent), an 8T-0900 AC/DC Clamp-on Ammeter (or equivalent), and an rpm indicator (or a phototachometer) are required to perform this procedure.



No Load Test Diagram

1. Connect a switch between S-terminal (10) and B-terminal (11) of the starter. Open the switch. Go to Step 2.

2. Secure the starter in a vise, and attach the rpm indicator to the starter. Go to Step 3.

3. Connect two fully charged 12 volt batteries to the starting motor, as shown. Connect the positive battery cable to B-terminal of the starter (11). Connect the negative battery cable to motor ground terminal (8). Go to Step 4.

4. Connect the red lead of the digital multimeter to MTR-terminal (7) and the black lead to motor ground terminal (8). Go to Step 5.

5. Attach the clamp-on ammeter to the positive battery cable. Go to Step 6.

6. Close the switch and observe the voltage, current, and rpm readings. The readings should indicate 67.5 ± 7.5 amps at 23.0 volts and 7643 ±1683 rpm. If the readings are within specifications, stop here. If the readings are not within specifications, go to Step 7.

7. If the voltage is low, go to Step 8. If the speed is low and the current draw is high, go to Step 9. If the starter does not operate but the current draw is high, go to Step 13. If the starter does not operate and the current draw is zero, go to Step 16. If the speed is low and the current draw is low, go to Step 20. If the speed is high and the current draw is high, go to Step 21.

8. The charge on the batteries is low. Recharge the batteries and go to Step 1.

9. Check the bushings for wear and damage, inspect the armature for bends, and check for loose field pole shoes. Repair or replace components as necessary. Refer to “Specifications, Other Components, Starter” in this module and to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Starter.” If no problems are found, go to Step 10.

10. Perform an armature short circuit test. For test procedures, refer to “Armature Short Circuit Test” in this section. Repair or replace the armature if necessary. Refer to “Specifications, Other Components, Starter” in this module and to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Starter.” If no problem is found, go to Step 11.

11. Perform an armature ground test. For test procedures, refer to “Armature Ground Test” in this section. Repair or replace the armature if necessary. Refer to “Specifications, Other Components, Starter” in this module and to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Starter.” If no problem is found, go to Step 12.

12. Perform a field winding ground test. For test procedures, refer to “Field Winding Ground Test” in this section. Repair or replace the field winding if necessary. Refer to “Specifications, Other Components, Starter” in this module and to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Starter.” If no problems are found, go to Step 1.

13. Turn the armature by hand. If the armature does not turn, go to Step 14. If the armature freely turns, go to Step 15.

14. The bushings are seized. Repair or replace all damaged components. Refer to “Specifications, Other Components, Starter” in this module and to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Starter.”

15. Perform a field winding ground test. For test procedures, refer to “Field Winding Ground Test” in this section. Repair or replace the field winding if necessary. Refer to “Specifications, Other Components, Starter” in this module and to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Starter.” If no problems is found, go to Step 1.

16. Inspect the brush springs and bushings for damage. Repair or replace components as necessary. Refer to “Specifications, Other Components, Starter” in this module and to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Starter.” If no problems are found, go to Step 17.

17. Inspect the commutator for pitting or burned bars. If pitting or burned bars are found, replace the armature. Refer to “Specifications, Other Components, Starter” in this module and to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Starter.” If no problem is found, go to Step 18.

18. Inspect the diameter of the commutator. For inspection procedures, refer to “Commutator Outside Diameter Check” in this section. Repair or replace the commutator if necessary. Refer to “Specifications, Other Components, Starter” in this module and to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Starter.” If no problem is found, go to Step19.

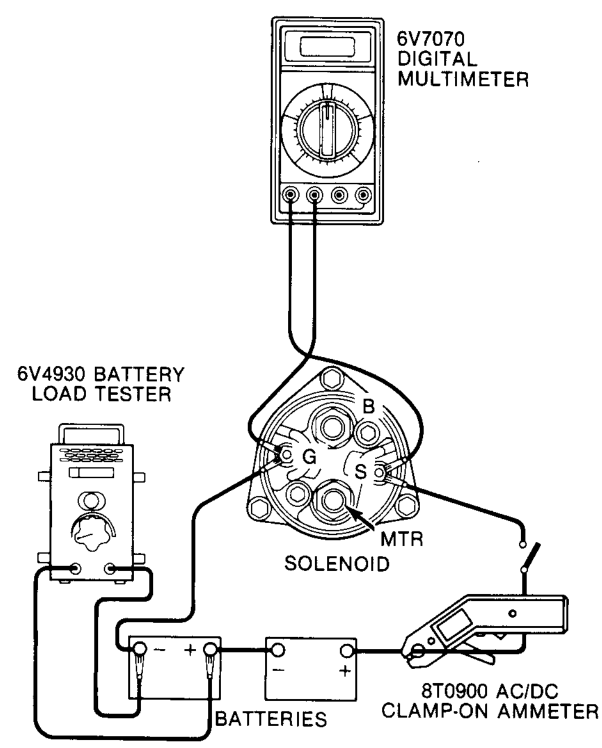
19. Test the field winding for an open. For test procedures, refer to “Field WInding Continuity Test” in this section. Repair or relace the field winding if necessary. Refer to “Specifications, Other Components, Starter” in this module and to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Starter.” If no problem is found, go to Step 1.

20. Inspect connections, leads, and commutator for dirt, damage, and loose connections. Repair or replace components if necessary. Refer to “Specifications, Other Components, Starter” in this module and to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Starter.” If no problems are found, go to Step 16.

21. Perform continuity tests on the field winding. For test procedures, refer to “Field Winding Continuity Test” in this section. Repair or replace the field winding if necessary. Refer to “Specifications, Other Components, Starter” in this module and to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine,* “Starter.” If no problem is found, go to Step 1.

Hold-in Winding Test

NOTE: A 6V-7070 Digital Multimeter (or equivalent), an 8T-0900 AC/DC Clamp-on Ammeter (or equivalent), and 4C-4911 Battery Load Tester (or equivalent) are required to perform this procedure.



Hold-in Winding Test Connections.

NOTE: If a battery load tester or a clamp-on ammeter is not available, go to Step 4.

1. Construct a circuit as shown above. Go to Step 2.

2. Close the switch, and use the battery load tester to reduce the battery supply voltage to 20 volts. Go to Step 3.

NOTICE

Do not leave the switch closed for more than 10 seconds at a time.

3. Use the clamp-on ammeter to determine the current draw. If the current draw is 14.6 amps, the hold-in winding of the solenoid is within specifications. If the current draw is not 14.6 amps, replace the solenoid.

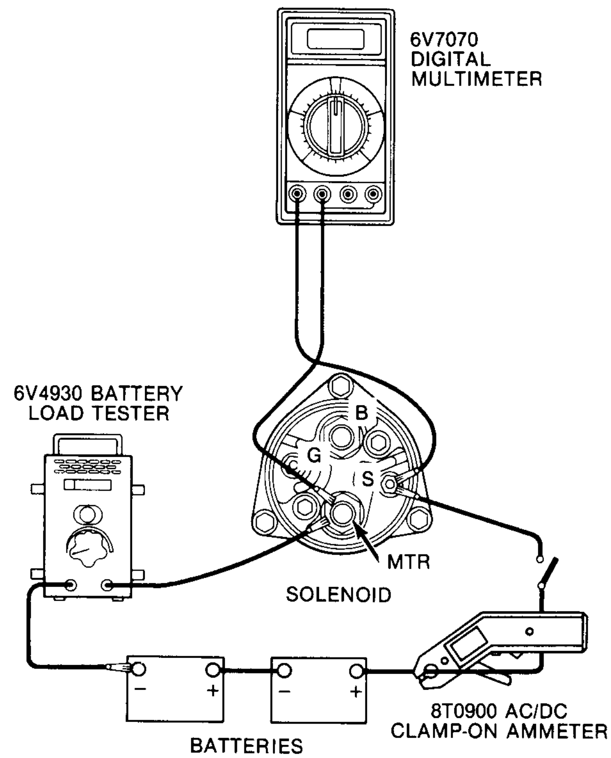
NOTE: A current draw of greater than 14.6 amps indicates that the coil contains a short. A current draw of less than 14.6 amps indicates excessive resistance in the coil.

4. Disconnect the batteries from the starter. Go to Step 5.

5. Place the multimeter on the 200 ohms resistance scale. Touch one probe to the G-terminal and the other probe to the S-terminal. Read the resistance. If the resistance is 1.57 ± 0.20 ohms, the hold-in winding of the solenoid is within specifications. If the resistance is not 1.57 ± 0.20 ohms, replace the solenoid.

Pull-in Winding Test

NOTE: A 6V-7070 Digital Multimeter (or equivalent), an 8T-0900 AC/DC Clamp-on Ammeter (or equivalent), and 6V-4930 Battery Load Tester (or equivalent) are required to perform this procedure.



Pull-in Winding Test Connections.

NOTE: If a battery load tester or a clamp-on ammeter is not available, go to Step 4.

1. Construct a circuit as shown above. Go to Step 2.

2. Close the switch, and use the battery load tester to reduce the battery supply voltage to 20 volts. Go to Step 3.

NOTICE

Do not leave the switch closed for more than 10 seconds at a time.

3. Use the clamp-on ammeter to determine the current draw. If the current draw is 56.5 ± 4.5 amps, the pull-in winding of the solenoid is within specifications. If the current draw is not 56.5 ± 4.5 amps, replace the solenoid.

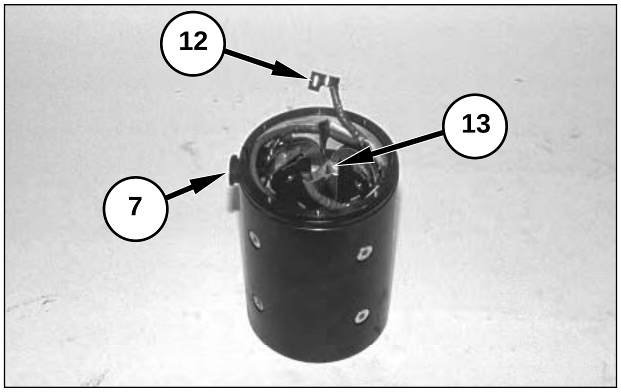
NOTE: A current draw of greater than 56.5 ± 4.5 amps indicates that the coil contains a short. A current draw of less than 56.5 ± 4.5 amps indicates excessive resistance in the coil.

4. Disconnect the batteries from the starter. Go to Step 5.

5. Place the multimeter on the 200 ohms resistance scale. Touch one probe to the S-terminal and the other probe to the MTR-terminal. Read the resistance. If the resistance is 0.46 ± 0.03 ohms, the pull-in winding of the solenoid is within specifications. If the resistance is not 0.46 ± 0.03 ohms, replace the solenoid.

Field Winding Ground Test

NOTE: A 6V-7070 Digital Multimeter (or equivalent) is required to perform this test.



Field Winding Ground Test, Starter Removed From Machine.
(7) MTR-terminal. (12) Field winding lead. (13) Field winding lead.

1. With the multimeter on the 20M ohms resistance scale, touch one of the multimeter leads to MTR-terminal (7) and the other multimeter lead to the starting motor housing. If the resistance is less than 100 000 ohms, rebuild or replace the field winding. If the resistance is greater than 100 000 ohms, go to Step 2.

2. With the multimeter on the 20M ohms resistance scale, touch one of the multimeter leads to field winding lead (12) and the other multimeter lead to the starting motor housing. If the resistance is less than 100 000 ohms, rebuild or replace the field winding. If the resistance is greater than 100 000 ohms, go to Step 3.

3. With the multimeter on the 20M ohms resistance scale, touch one of the multimeter leads to field winding lead (13) and the other multimeter lead to the starting motor housing. If the resistance is less than 100 000 ohms, rebuild or replace the field winding. If the resistance is greater than 100 000 ohms, the field winding is not grounded.

Field Winding Continuity Test

NOTE: A 6V-7070 Digital Multimeter (or equivalent) is required to perform this test.

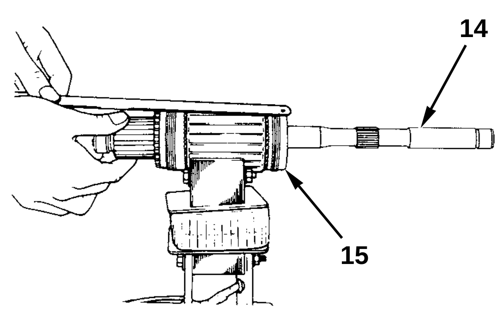
1. With the multimeter on the 200 ohms resistance scale, touch one of the multimeter leads to field winding lead (12) and the other multimeter lead to field winding terminal (13). If the resistance is greater than 0.1 ohms, rebuild or replace the field winding. If the resistance is 0.0 to 0.1 ohms, go to Step 2.

2. With the multimeter on the 200 ohms resistance scale, touch one of the multimeter leads to field winding lead (12) and the other multimeter lead to MTR-terminal (7). If the resistance is greater than 0.1 ohms, rebuild or replace the field winding. If the resistance is 0.0 to 0.1 ohms, go to Step 3.

3. With the multimeter on the 200 ohms resistance scale, touch one of the multimeter leads to to field winding lead (13) and the other multimeter lead to MTR-terminal (7). If the resistance is greater than 0.1 ohms, rebuild or replace the field winding. If the resistance is 0.0 to 0.1 ohms, the field winding does not contain an open.

Armature Short Circuit Test

NOTE: A growler tester and a hack saw blade are required to perform this procedure.



Armature Short Circuit Check.
(14) Armature. (15) Armature core.

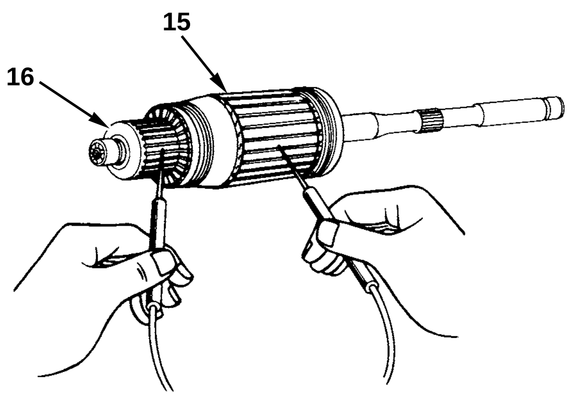
1. Place armature (14) on a growler tester. Turn the growler tester ON. Go to Step 2.

2. Slowly rotate armature (14) while holding a hack saw blade against armature core (15). If the hack saw blade vibrates or is attracted to the armature core, go to Step 2. If the hack saw blade does not vibrate and is not attracted to the armature core, the armature does not contain a short.

3. The armature core contains a short. Rebuild or replace the armature.

Armature Ground Test

NOTE: A 6V-7070 Digital Multimeter (or equivalent) is required to perform this procedure.

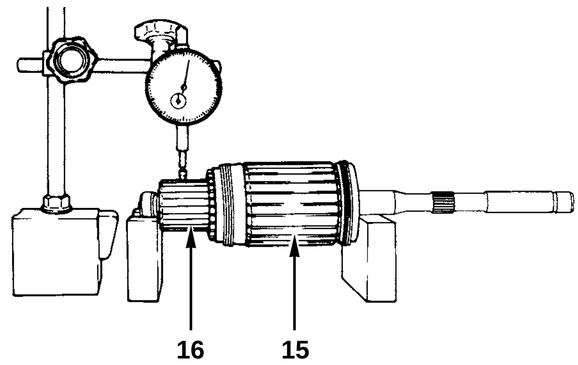


Armature Ground Test.
(15) Armature core. (16) Commutator.

1. With the multimeter on the 20M ohms resistance scale, touch one of the multimeter leads to to commutator (16) and the other multimeter lead to the armature core (15). If the resistance is less than 100 000 ohms, go to Step 2. If the resistance is greater than 100 000 ohms, the armature core is not grounded.

2. The armature core is grounded. Rebuild or replace the armature.

Armature Runout Check

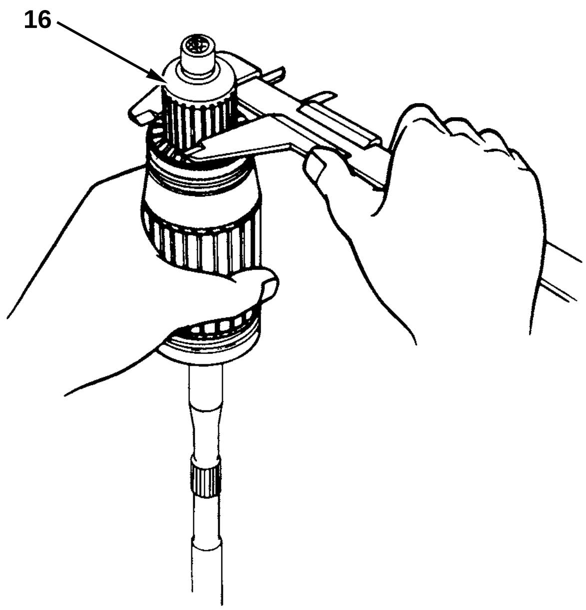


Armature Runout Check.
(15) Armature core. (16) Commutator.

1. Check the armature runout. The runout specification for armature core (15) and commutator (16) is 0.13 mm (0.005 in).

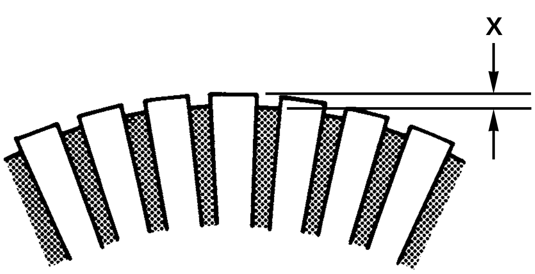
2. If the armature runout is greater than the specification, replace the armature.

Commutator Outside Diameter Check



Commutator Outside Diameter Check.
(16) Commutator

1. Measure the outside diameter of commutator (16). The diameter of a new part should be 54.0 mm (2.12 in). The minimum diameter of a commutator is 51.9 mm (2.04 in). If the diameter of the commutator is not within specifications, replace the armature.



Depth of Insulation Between Commutator Bars.
(X) Depth.

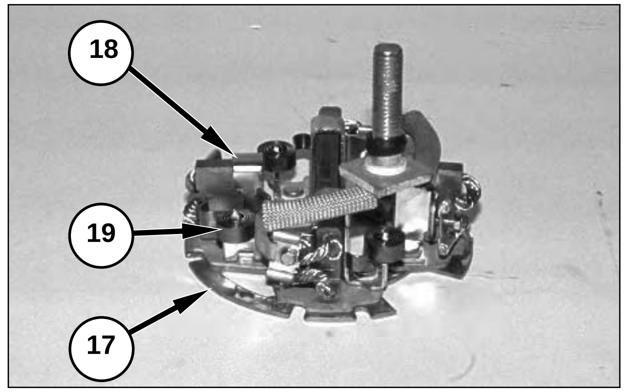
2. Measure the depth of insulation between the bars of commutator (16). The minimum depth allowed (X) is 0.64 mm (0.025 in). If the depth of insulation is less than the minimum allowed, go to Step 3.

3. Cut the insulation to the proper depth.

NOTICE

Failure to remove insulation shavings and particles will cause increased brush wear.

Brush Holder Test



Brush Holder Insulation Test.
(17) Brush holder plate. (18) Brush holder. (19) Brush spring.

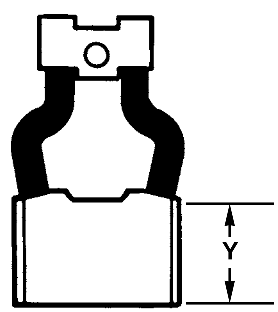
1. Inspect each brush holder spring (19) for damage or rust. Replace springs if necessary. Go to Step 2.

2. With the multimeter set on the 20M ohms resistance scale, touch one of the leads to brush holder (18) and the other lead to brush holder plate (17). If the resistance is greater than 100 000 ohms, go to Step 4. If the resistance is less than 100 000 ohms, go to Step 3.

3. The brush holder is grounded. Replace the brush holder, and go to Step 4.

4. Repeat Step 2 for each remaining brush holder.

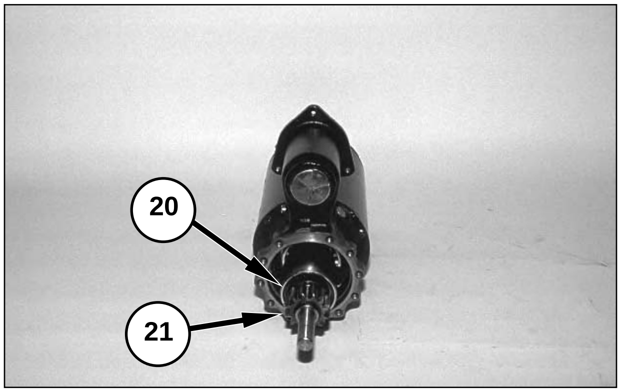
Brush Length Check



Brush Length Measurement.
(Y) Brush length.

1. Measure brush length (Y). New, the brush length should be 23.0 mm (0.91 in). The minimum brush length allowed is 10 mm (0.39 in). Replace any brush which is less than 10 mm (0.39 in) long.

Pinion Drive Check



Pinion Drive Check.
(20) Housing. (21) Pinion.

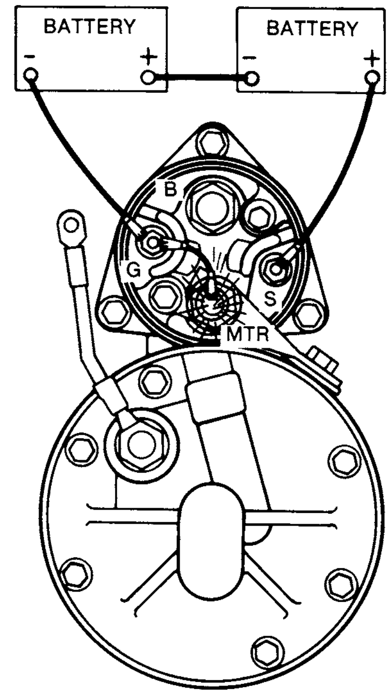
1. Inspect the overrunning clutch section of the pinion drive for damage. Replace damaged components if necessary. Go to Step 2.

2. Hold housing (20) and turn pinion (21) in the direction of operation. If a clicking noise is heard, go to Step 3. If a clicking noise is not heard, replace the pinion.

3. Hold housing (20) and attempt to turn pinion (21) in the opposite direction of operation. If the pinion is locked, go to Step 4. If the pinion turns, replace the pinion.

4. Press pinion (21) into housing (20) as far as possible, and then release the pinion. If the pinion pinion does not spring back to the original position, replace the pinion.

Pinion Clearance Adjustment



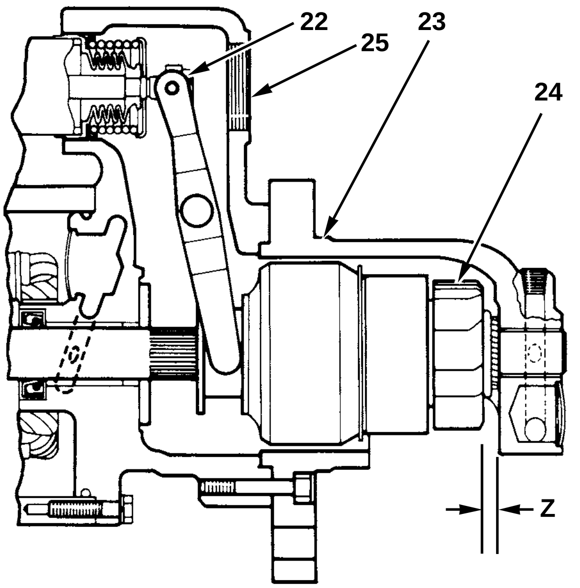
Connections for Pinion Clearance Check.

1. Disconnect the negative terminal wire from the G-terminal of the starter solenoid.

2. Connect two 12-volt batteries to the starting motor as shown. Connect one jumper cable from the battery negative post to the G-terminal of the starter solenoid. Connect another jumper cable from the battery positive post to the S-terminal of the starter solenoid.

3. Momentarily flash a third jumper cable from the G-terminal to the MTR-terminal.

NOTE: The pinion drive will shift into the cranking position and remain there until the batteries are disconnected.



Pinion Clearance Check.
(22) Pinion clearance adjustment nut. (23) Pinion drive housing. (24) Pinion. (Z) Pinion clearance.

4. Push pinion (24) into the starter to remove any free play.

5. Measure the clearance between pinion (24) and pinion drive housing (23). Pinion clearance (Z) must be 9.1 ± 0.8 mm (0.36 ±0.03 in).

6. If pinion clearance (Z) is not correct, remove plug (25) on the shift lever housing, and turn pinion clearance adjustment nut (22) clockwise to decrease pinion clearance (Z) or counterclockwise to increase pinion clearance (Z).

7. Remove the battery jumpers and install shift lever housing plug (25).

TM5-2430-200-24

Disassembly & Assembly

Deployable Universal Combat Earthmover (DEUCE)

Electrical System

PIN: 7RR00003-Up

Important Safety Information

Most accidents involving product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “WARNING” as shown below.

The meaning of this safety alert symbol is as follows:

⚠ WARNING

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning, explaining the hazard, can be either written or pictorially presented.

Operations that may cause product damage are identified by NOTICE labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are therefore not all inclusive. If a tool, procedure, work method or operating technique not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and others. You should also ensure that the product will not be damaged or made unsafe by the operation, lubrication, maintenance or repair procedures you choose.

The information, specifications, and illustrations in this publication are on the basis of information available at the time it was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service given to the product. Obtain the complete and most current information before starting any job. Caterpillar dealers have the most current information available. For a list of the most current publication form numbers available, see the Service Manual Contents Microfiche, REG1139F.

Table of Contents

WARNING

Disconnect the negative (black) battery cable before performing any component replacement on the electrical system. If the machine is equipped with the arctic battery kit, located on the left fender, the North Atlantic Treaty Organization (NATO) connector must also be disconnected from the machine before any components are replaced.

NOTE: Dielectric grease should not be used in electrical connectors on Caterpillar machines regardless of the connector family. The use of dielectric grease in connector assemblies can result in moisture and dirt contamination. Moisture and dirt contamination can lead to shorts and/or intermittent connections.

NOTE: Dielectric grease shall be restricted to use on bolted connections such as ring terminals, cable assemblies, battery posts and spark plug connections. On bolted connections, Caterpillar part number **151-1340 Dielectric Tune-Up Grease** should be used.

Arctic Battery Box

Remove and Install

NOTE: The group number related to this procedure is 152-0463.

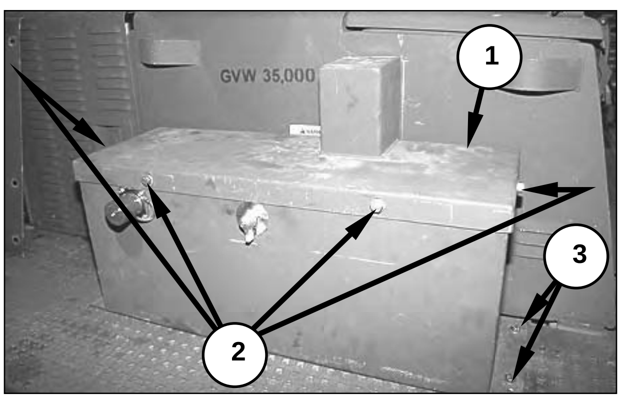
WARNING

Batteries give off flammable fumes. Prevent sparks and do not smoke around batteries. Sparks or lit smoking materials can cause battery vapors to explode.

Electrolyte is an acid which can cause severe injury if spilled on skin or in eyes. Always wear eye protection and protective clothing when working with batteries.

1. Move the start switch to the OFF position. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Monitoring Systems and Cab Features, Switches."

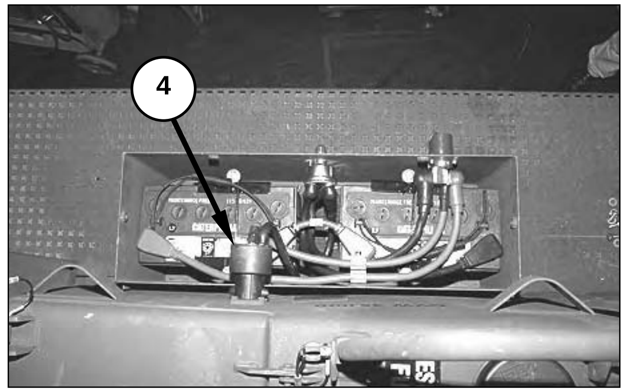
2. Turn the main disconnect switch to the OFF position. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Machine Features, Main Disconnect Switch."



3. Remove four bolts and washers (2).

4. Remove cover (1).

5. Remove bolts (3) with the washers (two from each side of the battery box).



6. Disconnect auxiliary start receptacle (4).

7. Use a suitable lifting device to remove the arctic battery box. The weight of the arctic battery box with the batteries installed is approximately **70 kg (154 lb).**

NOTE: To install the arctic battery box, reverse the removal steps.

Batteries, Arctic

Remove and Install

NOTE: The group number related to this procedure is 152-0463.

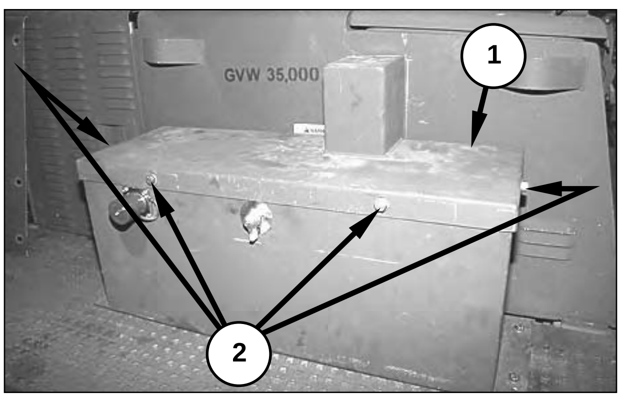
⚠ WARNING

Batteries give off flammable fumes. Prevent sparks and do not smoke around batteries. Sparks or lit smoking materials can cause battery vapors to explode.

Electrolyte is an acid which can cause severe injury if spilled on skin or in eyes. Always wear eye protection and protective clothing when working with batteries.

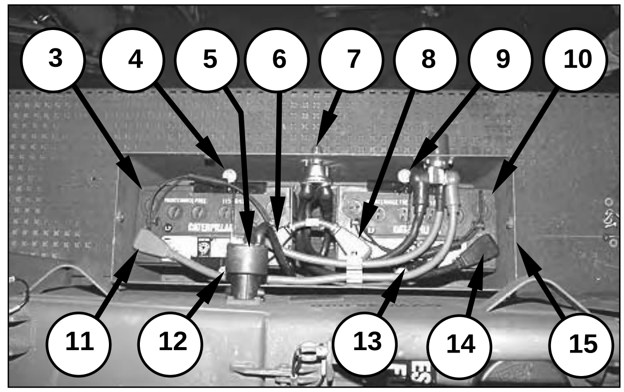
1. Move the start switch to the OFF position. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Monitoring Systems and Cab Features, Switches."

2. Turn the main disconnect switch to the OFF position. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Machine Features," "Main Disconnect Switch."



3. Remove four bolts and washers (2).

4. Remove cover (1).



5. Disconnect auxiliary start receptacle (5).

6. Lift black boot (14) and loosen the nut on the clamp on the negative battery terminal (–) on battery (10). Upon reassembly, coat the battery terminal with petroleum jelly before installing the cables, and tighten the nut to a torque of **7.2 ± 1.6 N•m (63.7 ± 14.2 lb in)**.

7. Remove the negative battery cable (black) from the negative battery terminal of battery (10), and position the cable out of the way.

8. Lift black boot (6) on the short cable, and loosen the nut on the clamp on the negative battery terminal of battery (3). Upon reassembly, coat the battery terminal with petroleum jelly before installing the cables, and tighten the nut to a torque of **7.2 ± 1.6 N•m (63.7 ± 14.2 lb in)**.

9. Remove the short cable from the negative battery terminal of battery (3).

10. Lift red boot (11) and loosen the nut on the clamp of the positive battery terminal (+) of battery (3). Upon reassembly, coat the battery terminal with petroleum jelly before installing the cables, and tighten the nut to a torque of **7.2 ± 1.6 N•m (63.7 ± 14.2 lb in)**.

11. Remove the positive battery cable (red) from the positive battery terminal of battery (3), and position the cable out of the way.

12. Lift red boot (8) on the short cable, and loosen the nut on the camp on the positive battery terminal of battery (10). Upon reassembly, coat the battery terminal with petroleum jelly before installing the cables, and tighten the nut to a torque of **7.2 ± 1.6 N•m (63.7 ± 14.2 lb in)**.

13. Remove the short cable from the positive battery terminal of battery (10), and put the short cable aside.

14. Remove bolts (4), (9), (12) and (13) with the washers, and remove the battery holders.

15. Remove the screw and lock washer from disconnect switch (7). Remove the knob, nut, and washer, and move the disconnect switch out of the way.

16. Use a suitable lifting device, and remove battery (3) and battery (10). The weight of each battery is **27 kg (59 lb)**.

NOTE: Battery (10) must be slid to the opposite end of the case before it can be removed.

17. If necessary, remove the four bolts with the washers that fasten battery box (15) to the left fender group, and remove the battery box.

NOTE: To install the batteries, reverse the removal steps.

Batteries, Main

Remove and Install

NOTE: The group number related to this procedure is 124-5842.

WARNING

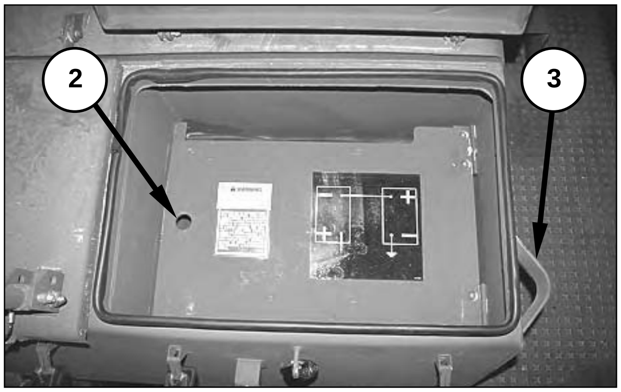
Batteries give off flammable fumes. Prevent sparks and do not smoke around batteries. Sparks or lit smoking materials can cause battery vapors to explode.

Electrolyte is an acid which can cause severe injury if spilled on skin or in eyes. Always wear eye protection and protective clothing when working with batteries.

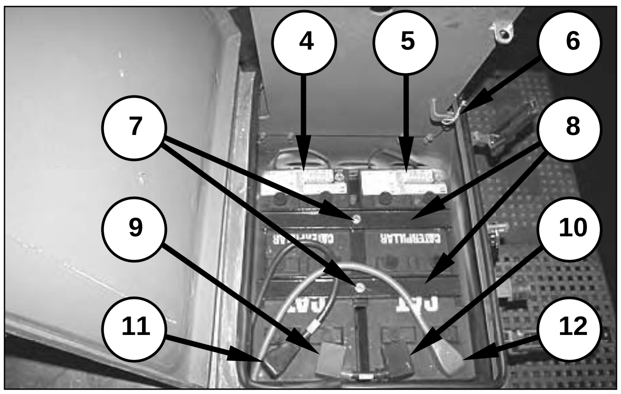
1. Move the start switch to the OFF position. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Monitoring Systems and Cab Features, Switches."

2. Turn the main disconnect switch to the OFF position. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Machine Features, Main Disconnect Switch."

3. Raise the lid to the battery and tool compartment, and remove tool tray (1).



4. Lift plate (2).



5. Hook cable (6) to strap (3) to secure plate (2) open.

6. Lift black boot (11), and loosen the nut on the clamp on the negative battery terminal (–) of battery (4). Upon reassembly, coat the battery terminal with petroleum jelly before installing the cables, and tighten the nut to a torque of **7.2 ± 1.6 N•m (63.7 ± 14.2 lb in)**.

7. Remove the negative battery cable (black) from the negative battery terminal of battery (4), and position the cable out of the way.

8. Lift black boot (10) on the short cable, and loosen the nut on the clamp of the negative battery terminal of battery (5). Upon reassembly, coat the battery terminal with petroleum jelly before installing the cables, and tighten the nut to a torque of **7.2 ± 1.6 N•m (63.7 ± 14.2 lb in)**.

9. Remove the short cable from the negative battery terminal of battery (5).

10. Lift red boot (12) and loosen the nut on the clamp on the positive battery terminal (+) of battery (5). Upon reassembly, coat the battery terminal with petroleum jelly before installing the cables, and tighten the nut to a torque of **7.2 ± 1.6 N•m (63.7 ± 14.2 lb in)**.

11. Remove the positive battery cable (red) from the positive battery terminal of battery (5), and position the cable out of the way.

12. Lift red boot (9) on the short cable, and loosen the nut on the camp on the positive battery terminal of battery (4). Upon reassembly, coat the battery terminal with petroleum jelly before installing the cables, and tighten the nut to a torque of **7.2 ± 1.6 N•m (63.7 ± 14.2 lb in)**.

13. Remove the short cable from the positive battery terminal of battery (4), and put the short cable aside.

14. Remove two bolts (7) and two washers.

15. Remove clamp assembly (8).

16. Use a suitable lifting device to remove battery (5) and battery (6). The weight of each battery is **37 kg (81 lb)**.

NOTE: To install the batteries, reverse the removal steps.

Battery Wiring Group, Arctic

Remove and Install

NOTE: The group number related to this procedure is 152-0463.

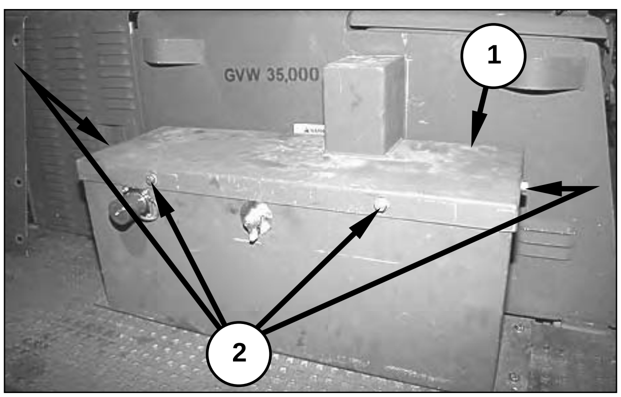
⚠ WARNING

Batteries give off flammable fumes. Prevent sparks and do not smoke around batteries. Sparks or lit smoking materials can cause battery vapors to explode.

Electrolyte is an acid which can cause severe injury if spilled on skin or in eyes. Always wear eye protection and protective clothing when working with batteries.

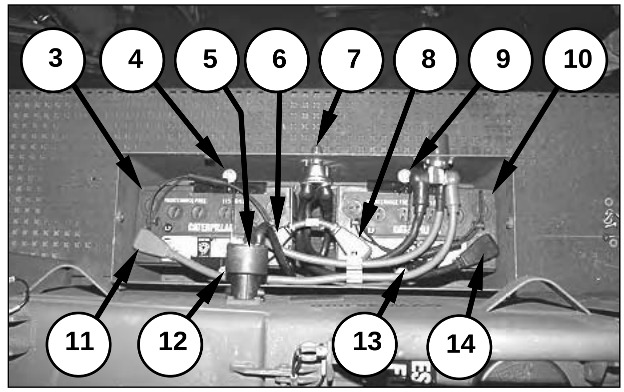
1. Move the start switch to the OFF position. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Monitoring Systems and Cab Features, Switches."

2. Turn the main disconnect switch to the OFF position. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Machine Features, Main Disconnect Switch."



3. Remove four bolts and washers (2).

4. Remove cover (1).



5. Disconnect auxiliary start receptacle (5).

6. Lift black boot (14), and loosen the nut on the clamp on the negative battery terminal (–) on battery (10). Upon reassembly, coat the battery terminal with petroleum jelly before installing the cables, and tighten the nut to a torque of **7.2 ± 1.6 N•m (63.7 ± 14.2 lb in)**.

7. Remove the negative battery cable (black) from the negative battery terminal of battery (10), and position the cable out of the way.

8. Lift black boot (6) on the short cable, and loosen the nut on the clamp on the negative battery terminal of battery (3). Upon reassembly, coat the battery terminal with petroleum jelly before installing the cables, and tighten the nut to a torque of **7.2 ± 1.6 N•m (63.7 ± 14.2 lb in)**.

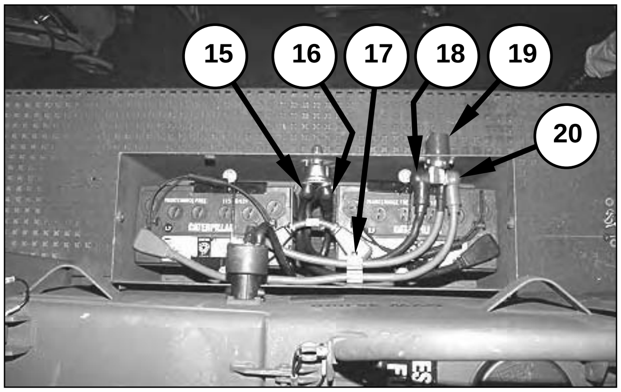
9. Remove the short cable from the negative battery terminal of battery (3).

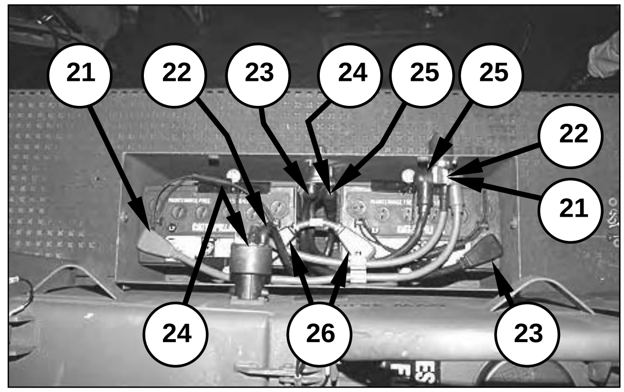
10. Lift red boot (11), and loosen the nut on the clamp on the positive battery terminal (+) of battery (3). Upon reassembly, coat the battery terminal with petroleum jelly before installing the cables, and tighten the nut to a torque of **7.2 ± 1.6 N•m (63.7 ± 14.2 lb in)**.

11. Remove the positive battery cable (red) from the positive battery terminal of battery (3), and position the cable out of the way.

12. Lift red boot (8) on the short cable, and loosen the nut on the camp on the positive battery terminal of battery (10). Upon reassembly, coat the battery terminal with petroleum jelly before installing the cables, and tighten the nut to a torque of **7.2 ± 1.6 N•m (63.7 ± 14.2 lb in)**.

13. Remove the short cable from the positive battery terminal of battery (10), and put the short cable aside.





14. Lift boot (15), and remove the nut, lock washer, and negative cable from disconnect switch (7). Upon reassembly, tighten the nut to a torque of **8 ± 2 N•m (70.8 ± 17.7 lb in)**.

15. Lift boot (16), and remove the nut, lock washer, and two negative cables from disconnect switch (7). Upon reassembly, tighten the nut to a torque of **8 ± 2 N•m (70.8 ± 17.7 lb in)**.

16. Lift boot (18), and remove the bolt, lock washer, and negative cable from auxiliary start receptacle (19).

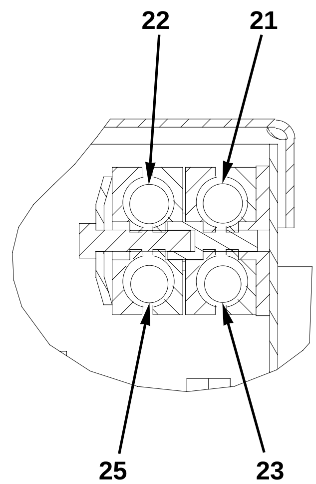
17. Lift boot (20), and remove the bolt, lock washer, and two positive cables from auxiliary start receptacle (19).

18. Remove two bolts (17) with two retainers, and two clamps.

19. Remove all wires from the arctic battery box.

NOTE: If necessary, remove bolts (4), (9), (12), and (13) with the washers and battery holders, and remove batteries (3) and (10).

NOTE: To install the arctic battery wiring group, reverse the removal steps.



NOTE: The above photo and graphic show cable connection points and routing for reference during installation. The pairs of numbers (21 through 26) in the above photo indicate two ends of a wire. The above graphic illustrates the clamp on the back wall of the battery box. Cable (22) is the positive cable, and cable (24) is the negative cable.

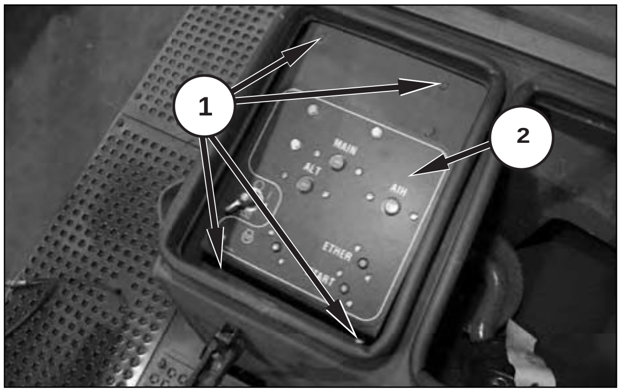
Battery Wiring Group, Main

Remove and Install

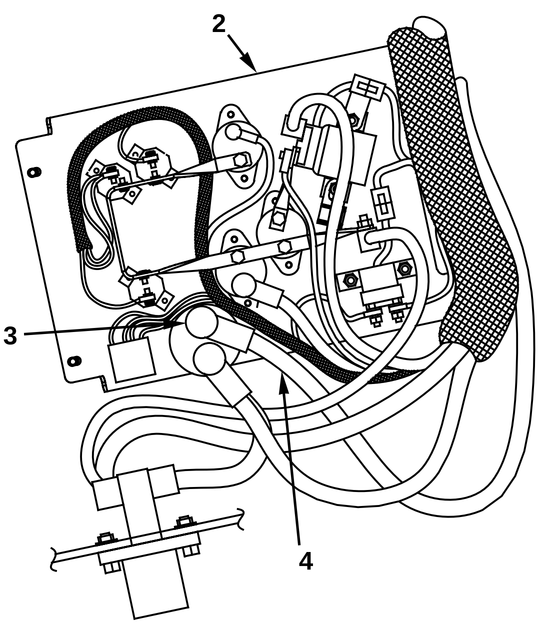
Start By:

a. Remove the main batteries.

NOTE: The group number related to this procedure is 124-5844.

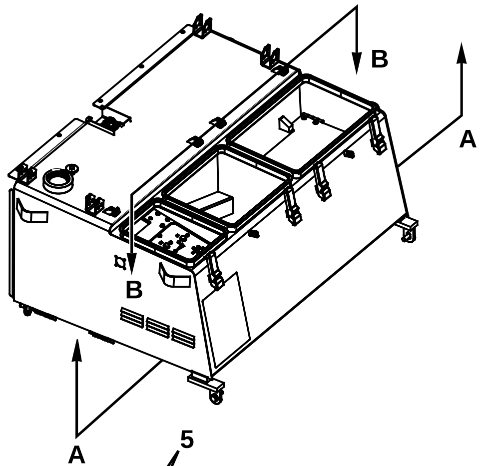


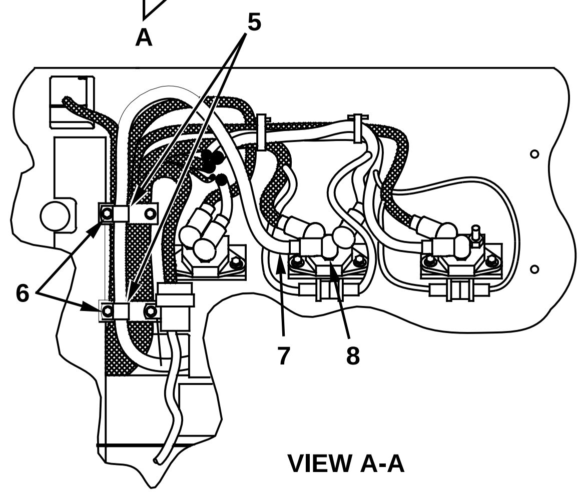
1. Remove four screws (1), and lift rear circuit breaker panel (2) out of the compartment.



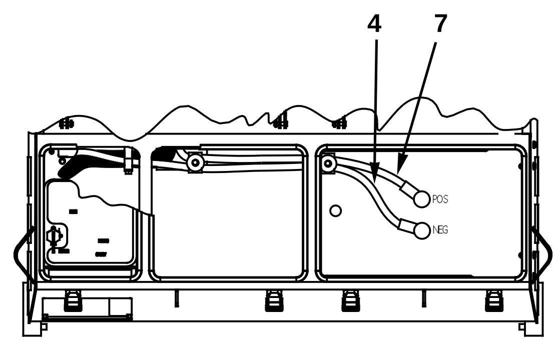
2. Lift boot (3), loosen and remove the nut, remove the lock washer, and remove negative battery cable (4) from the stud on the back of the main electrical disconnect switch. Upon reassembly, tighten the nut to a torque of **8 ± 2 N•m (70 ± 20 lb in)**.

3. Reinstall rear circuit breaker panel (2), tightening four screws (1) finger tight.





VIEW A-A



VIEW B-B

4. Lift boot (8), loosen and remove the nut, and remove the washer and positive battery cable (7) from the stud.

5. Loosen two bolts (6), and remove the washers, and clips (5).

6. Remove positive battery cable (7) and negative battery cable (4).

NOTE: To install the battery wiring group, reverse the removal steps.

End By:

a. Install the main batteries.

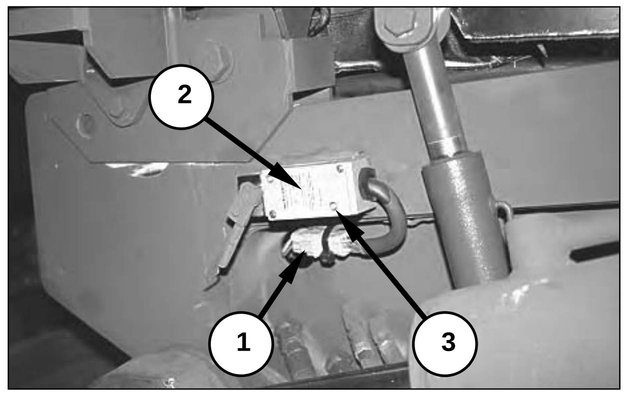
Blade Position Switch

Remove

NOTE: The group number related to this procedure is 150-1683.

1. Move the start switch to the OFF position. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Monitoring Systems and Cab Features, Switches."

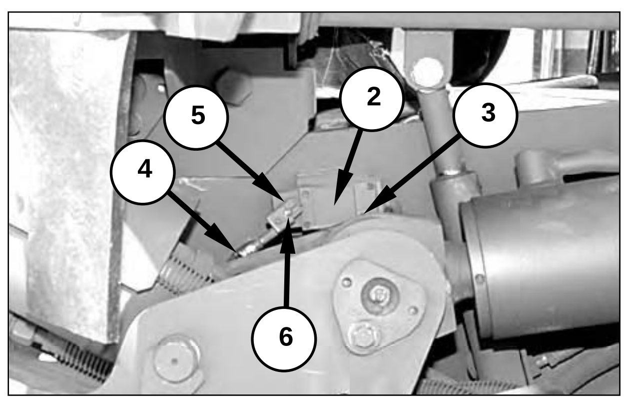
2. Turn the main disconnect switch to the OFF position. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Machine Features, Main Disconnect Switch."



3. Disconnect harness connector C140 (1).

4. Remove two bolts (3), and remove blade position switch (2).

Install



1. Install blade position switch using two bolts (3).

2. Fully raise the blade. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Equipment Controls, Blade Controls." Block the blade to prevent the blade from lowering.

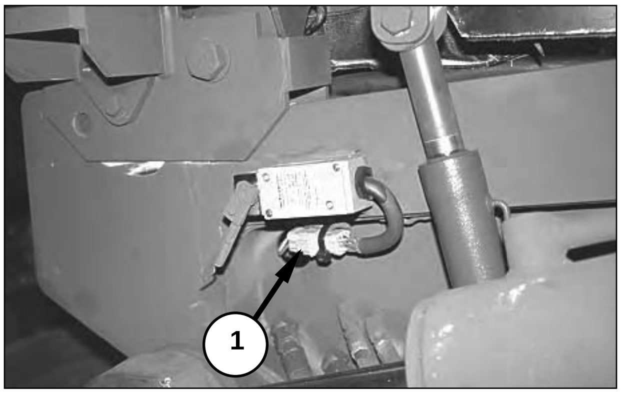
3. Place actuator arm (4) on the actuator arm shaft (6).

NOTE: New blade position switches are shipped without actuator arm (4) installed. To adjust an old switch, loosen the pinch bolt (5) and allow the actuator arm to float freely on the shaft.

4. Insert a screwdriver into the slot on actuator arm shaft (6), and turn the shaft clockwise until the switch clicks.

NOTE: The actuator arm should be resting on the C-frame.

5. Hold actuator arm shaft (6) in this position and tighten pinch bolt (5).



6. Lower the blade, and connect harness connector C140 (1).

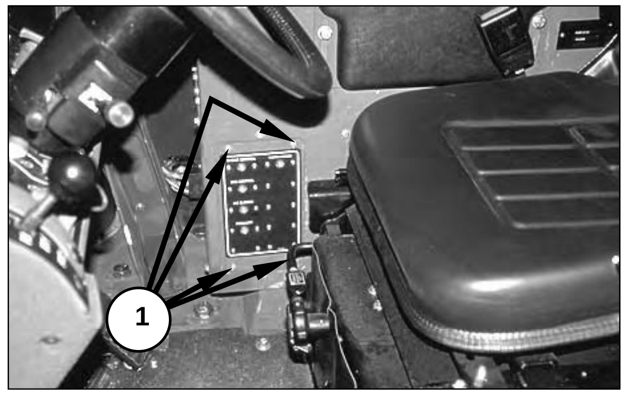
Circuit Breaker Panel, Front

Remove and Install

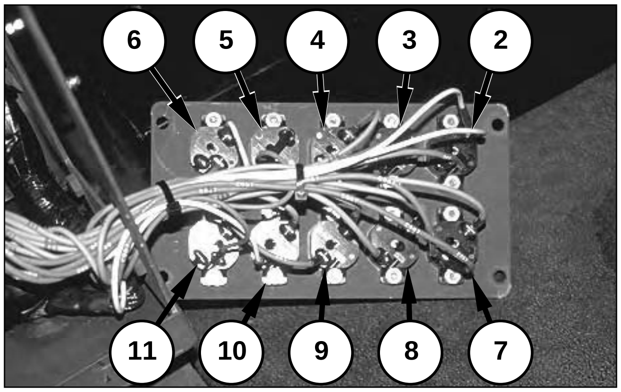
NOTE: The group number related to this procedure is 124-5857.

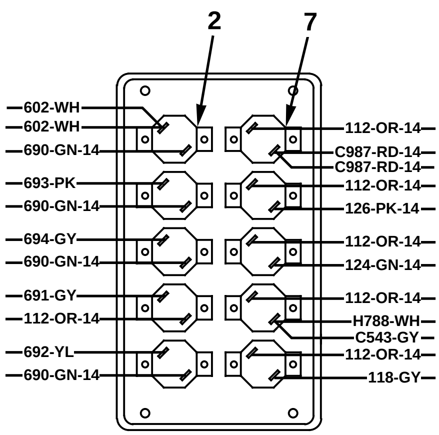
1. Move the start switch to the OFF position. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Monitoring Systems and Cab Features, Switches."

2. Turn the main disconnect switch to the OFF position. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Machine Features, Main Disconnect Switch."

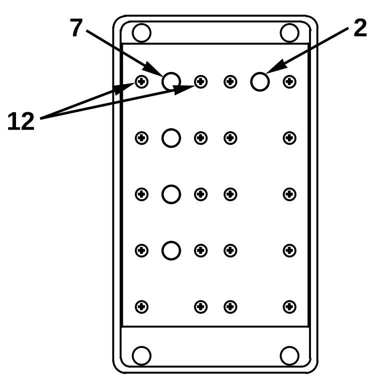


3. Remove four bolts (1) and washers.





4. Loosen two contact screws, and remove the attached wires from circuit breakers (2) through (11). Mark the wires for correct connection upon reassembly. Upon reassembly, tighten the contact screws to a torque of **1.7 ± 0.2 N•m (15 ± 1.8 lb in)**.



5. Remove individual circuit breakers by removing two screws (12) with nuts.

NOTE: Each circuit breaker is held to the panel by two screws. Circuit breakers (2) and (7) are shown for reference.

NOTE: To install the front circuit breaker panel, reverse the removal steps.

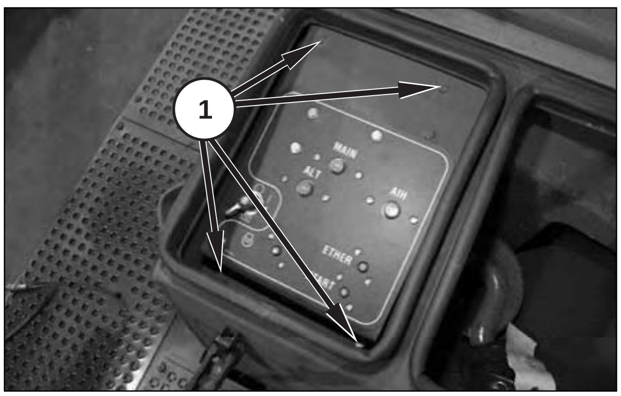
Circuit Breaker Panel, Rear

Remove and Install

NOTE: Group numbers related to this procedure include 124-5844 and 147-0720.

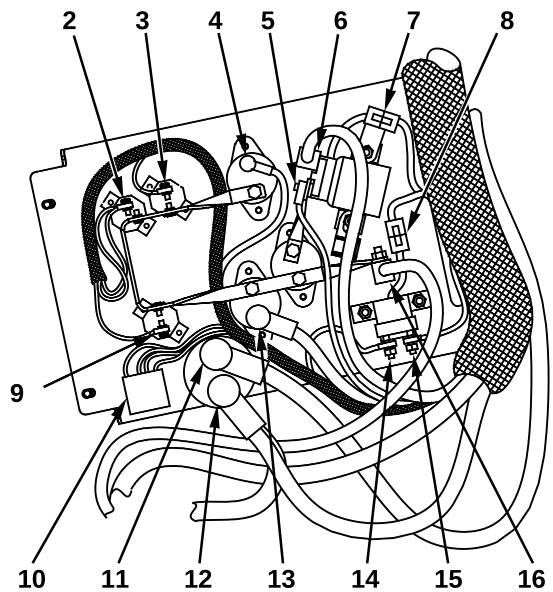
1. Move the start switch to the OFF position. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Monitoring Systems and Cab Features, Switches."

2. Turn the main disconnect switch to the OFF position. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Machine Features, Main Disconnect Switch."



3. Remove four screws (1), and lift the rear circuit breaker panel out of the compartment.

NOTE: A harness clamp that is mounted under the panel to the front right corner of the box can be removed to provide additional movement of the rear circuit breaker panel.



4. Remove contact screw (2), the lock washer, and the 105-RD wires. Mark all wires for correct connection upon reassembly. Upon reassembly, tighten the contact screw to a torque of **1.7 ± 0.2 N•m (15 ± 1.8 lb in)**.

5. Remove contact screw (3), the lock washer, and the 315-RD wire. Upon reassembly, tighten the contact screw to a torque of **1.7 ± 0.2 N•m (15 ± 1.8 lb in)**.

6. Remove contact screw (4), the lock washer, and the F793-RD-4 wire. Upon reassembly, tighten the contact screw to a torque of **1.7 ± 0.2 N•m (15 ± 1.8 lb in)**.

7. Remove nut (5), the lock washer, and the 117-RD-10 wire. Upon reassembly, tighten the nut to a torque of **5.0 ± 0.5 N•m (44 ± 4 lb in)**.

8. Remove nut (6), the lock washer, and the 112-OR-2 wire. Upon reassembly, tighten the nut to a torque of **5.0 ± 0.5 N•m (44 ± 4 lb in)**.

9. Disconnect harness connector (7) at the main power relay and connector (8) at the start relay. Mark the connectors for correct connection during reassembly.

10. Remove contact screw (9), the lock washer, and the G799-RD-10 wire. Upon reassembly, tighten the contact screw to a torque of **1.7 ± 0.2 N•m (15 ± 1.8 lb in)**.

11. Disconnect start-aid relay (10).

12. Remove nut (11), the lock washer, and the BK-00 wire. Upon reassembly, tighten the nut to a torque of **8 ± 2 N•m (70.8 ± 17.7 lb in)**.

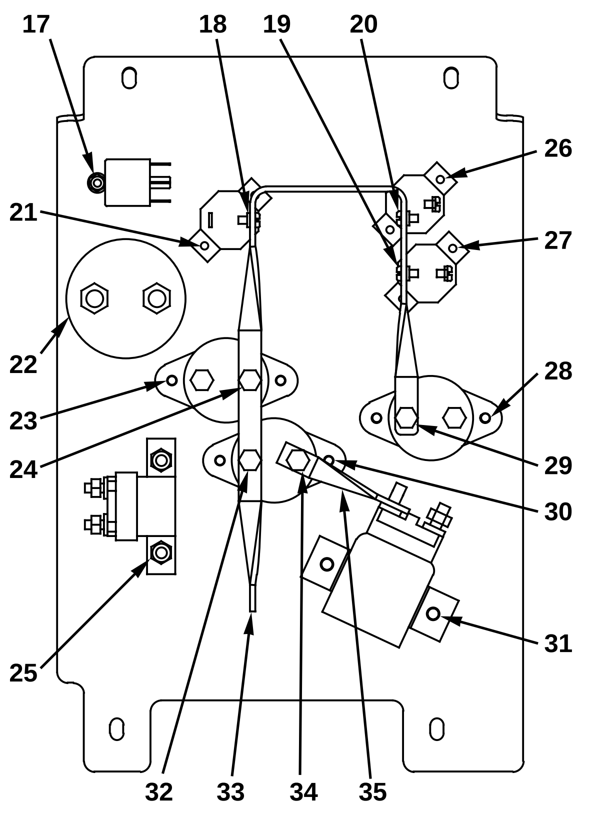
13. Remove nut (12), the lock washer, and remove the 200-BK-00 and the BK-00 wires. Upon reassembly, tighten the nut to a torque of **8 ± 2 N•m (70.8 ± 17.7 lb in)**.

14. Remove nut (13), the lock washer, and the 109-RD-2 wire. Upon reassembly, tighten nut (13) to a torque of **4.6 ± 0.4 N•m (40.7 ± 3.5 lb in)**.

15. Remove nut (14), the lock washer, and the 117-RD-10 wire. Upon reassembly, tighten the nut to a torque of **4.0 ± 0.5 N•m (35.4 ± 4 lb in)**.

16. Remove nut (15), the lock washer, and the 304-WH-10 wire. Upon reassembly, tighten the nut to a torque of **4.0 ± 0.5 N•m (35.4 ± 4 lb in)**.

17. Remove nut (16), the lock washer, and the 101-RD-2 wire.



18. Remove nuts (24), (29), (32), and (34), and remove the lock washers. Upon reassembly, tighten the nuts to a torque of **4.6 ± 0.4 N•m (40.7 ± 3.5 lb in)**.

19. Remove power buss bar (35).

20. Remove contact screws (18), (19) and (20), and remove the lock washers. Upon reassembly, tighten the contact screws to a torque of **1.7 ± 0.2 N•m (15 ± 1.8 lb in)**.

21. Remove power buss bar (33).

22. Remove nut and bolt (17), and remove the start-aid relay.

23. Remove two screws (21), and remove the engine coolant heater circuit breaker.

24. Remove the screw with the washer, knob, lock nut, and star washer on the front side of electrical disconnect switch (22), and remove the switch. Upon reassembly, tighten the lock nut to a torque of **23 ± 4 N•m (203.5 ± 35.4 lb in)**.

25. Remove two screws (23), and remove the main power circuit breaker.

26. Remove bolts (25), nuts, and four washers, and remove the start relay.

27. Remove two screws (26), and remove the start switch circuit breaker.

28. Remove two screws (27) with the washers, and remove the start-aid circuit breaker.

29. Remove two screws (28) with the washers, and remove the intake air heater circuit breaker.

30. Remove two screws (30) with the washers, and remove the alternator circuit breaker.

31. Remove bolts (31), nuts, and four washers, and remove the main power relay. Upon reassembly, tighten the screws to a torque of **5.0 ± 0.5 N•m (44 ± 4 lb in)**.

NOTE: To install the rear circuit breaker panel, reverse the removal steps.

Console Wiring Group

Remove and Install

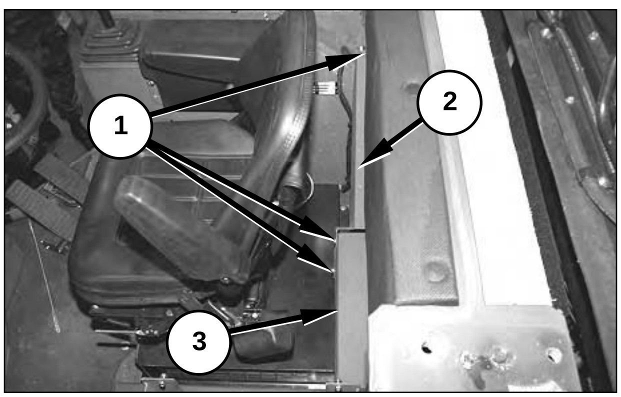
Start By:

a. Remove the cab assembly. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Machine Systems,* “Cab Assembly.”

NOTE: Group numbers related to this procedure include 124-5848, 124-5857, and 126-5842.

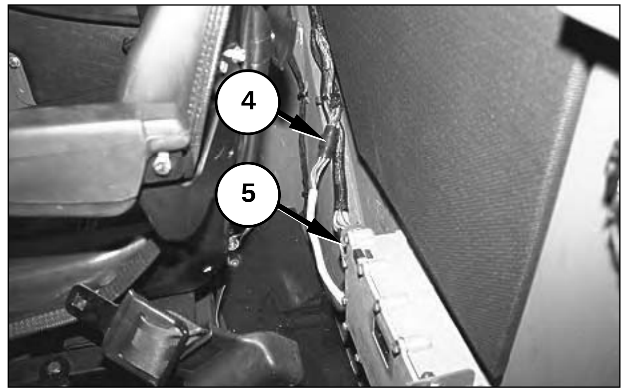
NOTE: Mark all wires and connectors which are disconnected during this procedure for identification during reassembly. During the disassembly process, cut wire ties as needed. Upon reassembly, replace all wire ties which were cut.

1. Turn the main disconnect switch to the OFF position. Refer to *Operator’s Manual, Deployable Universal Combat Earthmover (DEUCE),* “Operation Section, Machine Features, Main Disconnect Switch.”

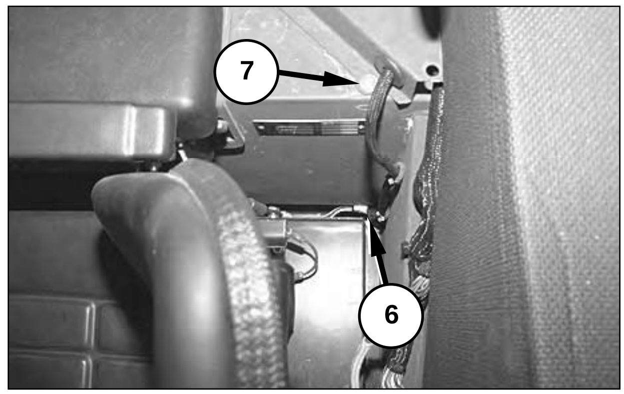


2. Remove four bolts (1) with the washers (only three shown), and remove cover (2).

3. Remove one bolt with the washer from each corner of cover (3), and remove the cover.

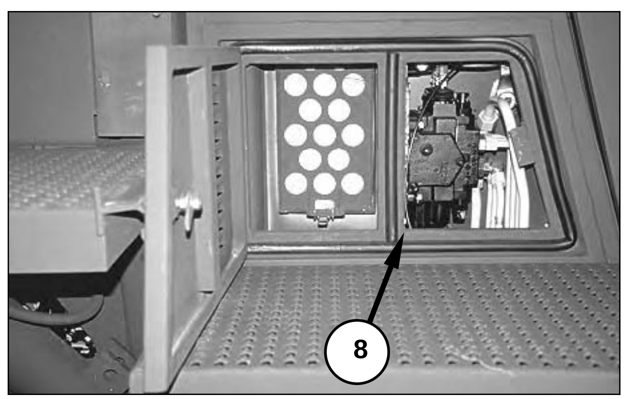


4. Disconnect EPTC II harness connectors C133 (4) and C123 (5).

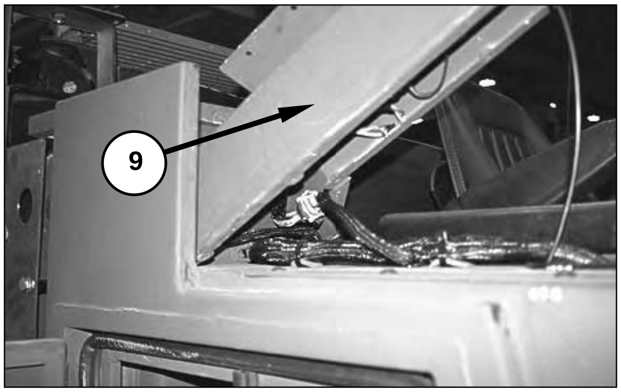


5. Disconnect air conditioning harness connector C157 (6).

6. Remove bolt (7) with the washer.

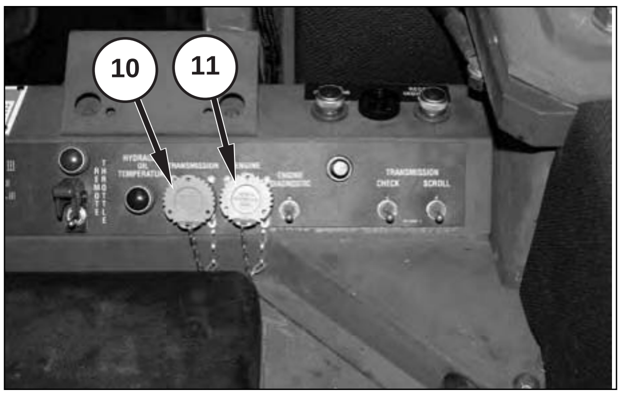


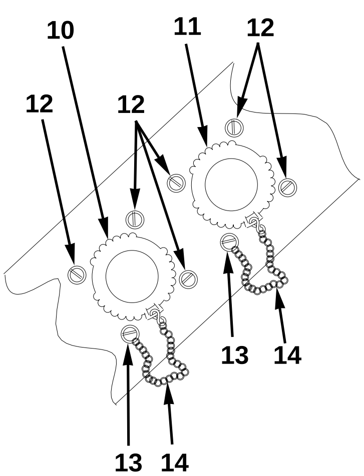
7. Open the door to hydraulic valve compartment (8) on the right side of the machine.



8. Remove six bolts with the washers, and lift top panel (9) off the console base.

NOTE: The six bolts can be reached through hydraulic valve compartment (8).

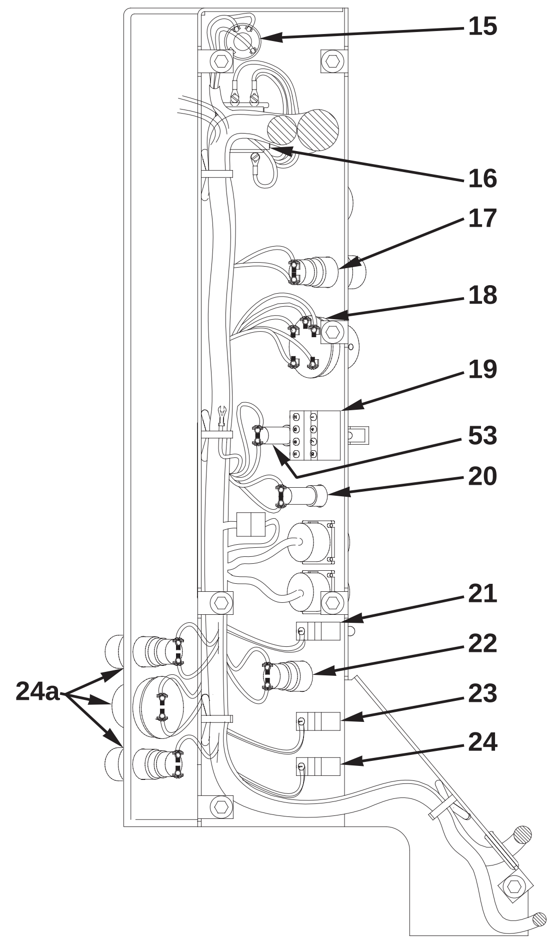




9. Remove the covers from transmission diagnostic port (10) and engine diagnostic port (11).

10. Remove six screws, washers, and nuts (12).

11. Remove two screws, washers, and nuts (13), and remove two chains (14).



12. Disconnect the following wires from engine coolant heater switch (15):

Wire Number	Wire Location
102-RD	Contact +
103-BR	Contact 31
104-YL	Contact S1

13. Disconnect the following wires from park brake switch (16):

Wire Number	Wire Location	
720-PU	Contact 3	Block 1
204-BK	Contact 4	Block 1
677-GN	Lamp	
691-GY	Lamp	
126-PK	Contact 3	Block 2
966-PK	Contact 4	Block 2

14. Disconnect the 600-BR and 204-BK wires from panel lamps (17 and 22).

15. Disconnect the following wires from air conditioner and heater switch (18):

Wire Number	Wire Location
124-GN-14	Contact 1
521-YL-14	Contact 2
517-BU-14	Contact 3
516-GN-14	Contact 4
515-GY-14	Contact 5

16. Disconnect the following wires from remote throttle switch (19):

Wire Number	Wire Location
L960-YL	Contact 2
204-BK	Contact 3
204-BK	Contact 4
K998-BU	Contact 5
K999-GN	Contact 10
H795-PK	Contact 11

17. Disconnect the 602-WH and the K998-BU wires from remote throttle lamp (20), and disconnect the K980-PK and the 691-GY wires from hydraulic oil temperature lamp (53).

18. Disconnect the following wires from engine diagnostic switch (21):

Wire Number	Wire Location
H795-PK	Contact 1
L906-YL	Contact 2

19. Disconnect the following wires from transmission check switch (23):

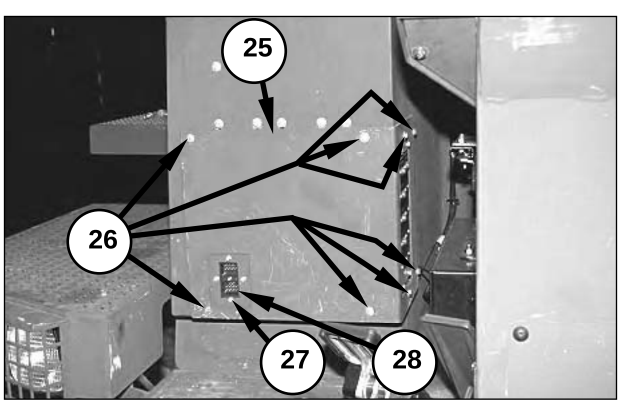
Wire Number	Wire Location
204-BK	Contact 1
F887-WH	Contact 2

20. Disconnect the following wires from transmission scroll switch (24):

Wire Number	Wire Location
204-BK	Contact 1
F888-GY	Contact 2

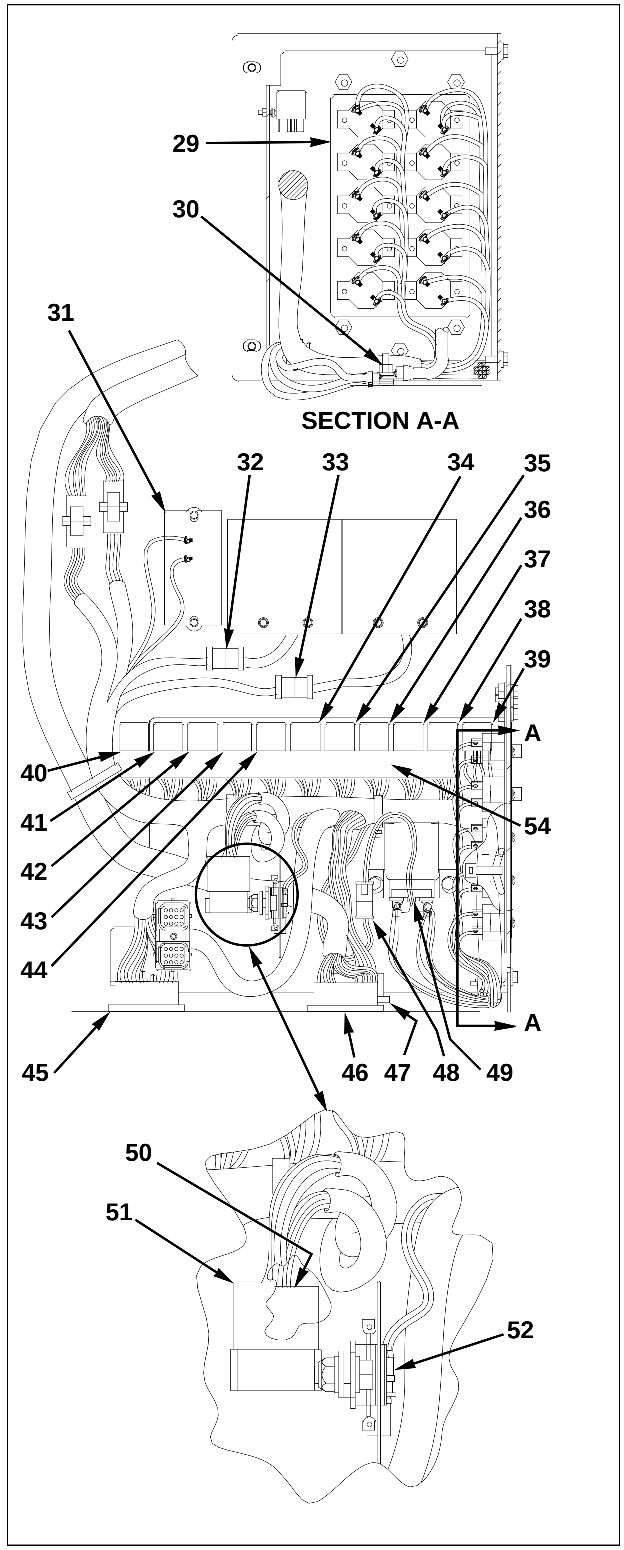
a. Disconnect the following wires from recoil alert (24a):

Wire Number	Wire Location
320-OR	Lamp
459-BU	Lamp
478-GN	Alarm
101-RD	Contact +



21. Remove eight bolts (26), and remove front cover (25).

22. Remove four bolts (27) with the washers and nuts from lighting connector C108 (28).



23. Remove front circuit breaker panel (29). Refer to "Circuit Breaker Panel, Front, Remove and Install," in this module.

24. Loosen the nut, and remove the washer and the black wires from ground stud (30).

25. Disconnect the 518-OR and the 962-YL wires from flasher (31).

26. Disconnect solenoid driver connectors C114 (32a) and C124 (33a). Mark the connectors for identification during reassembly.

27. Disconnect diode block connectors C109 (51) and C158 (50).

28. Disconnect dimmer resistor connector C134 (52).

29. Disconnect machine harness connectors C103 (46), C104 (45), and C105 (47).

30. Disconnect blackout relay connector C144 (48).

31. Disconnect four 690-GN-14 wires, seven 112-OR-14 wires, and one 112-OR-2 wire from blackout relay (49). Upon reassembly, tighten terminal nuts to a torque of **5.0 ± 0.5 N•m (44 ± 4 lb in)**.

32. Remove four nuts from relay mount (54).

NOTE: The four nuts can be reached through the door to hydraulic valve compartment (8), on the right side of the machine. The relays in the bank include: diagnostic relay (40), suspension relay (41), lamp test relay (42), wiper relay (43), wiper relay (44), steering relay (34), horn relay (35), blackout switch relay (36), backup relay (37), park brake relay (38), and roading relay (39).

33. Remove the console wiring harness through the front of the console.

NOTE: To install the console wiring group, reverse the removal steps.

End By:

a. Install the cab.

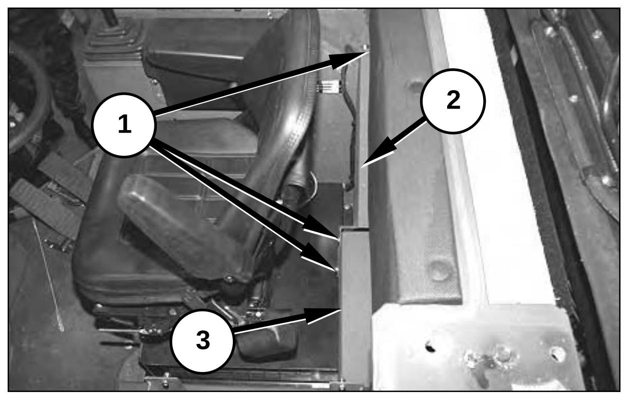
Electronic Programmable Transmission Control (EPTC II)

Remove and Install

NOTE: Group numbers related to this procedure include 141-6655, 145-0425, 151-3260.

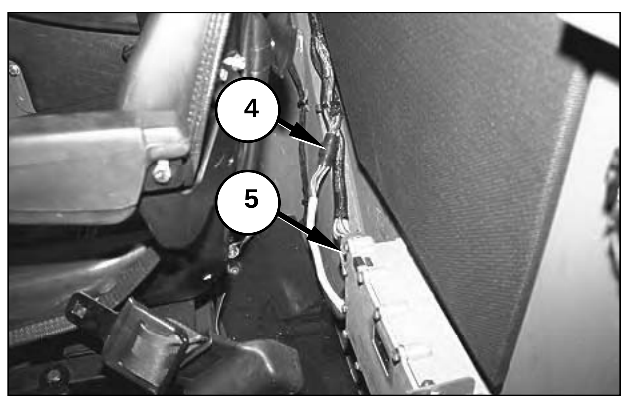
1. Move the start switch to the OFF position. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Monitoring Systems and Cab Features, Switches."

2. Turn the main disconnect switch to the OFF position. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Machine Features, Main Disconnect Switch."



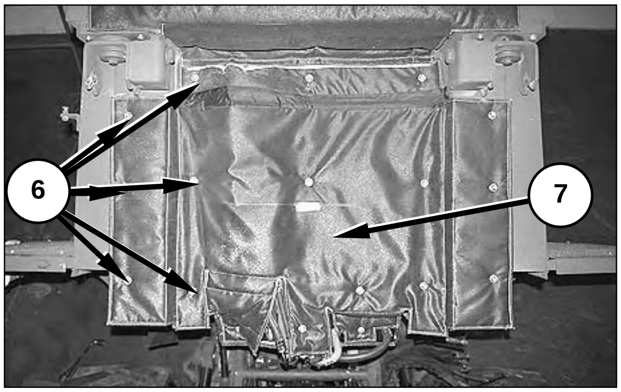
3. Remove four bolts (1) with the washers (only three shown), and remove cover (2).

4. Remove one bolt and washer from each corner of cover (3), and the remove cover.



5. Disconnect electronic programmable transmission control (EPTC II) harness connectors C133 (4) and C123 (5).

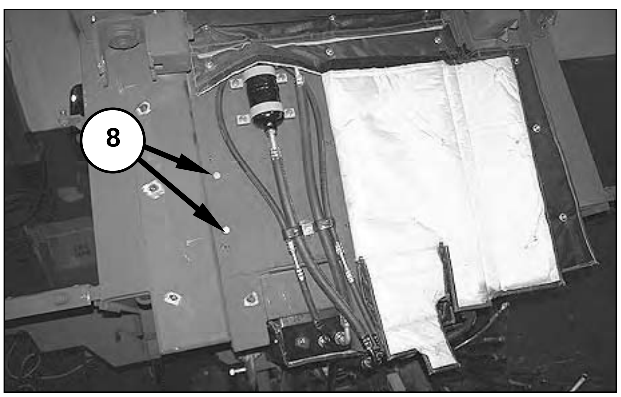
6. Raise the cab to approximately one-half of the fully raised position. Attach a hoist to the cab to support the cab in this position. The cab assembly weighs approximately **431 kg (950 lb).** Refer to "Maintenance Features, Cab Tilt" in *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* for the procedure to raise and lower the cab.



7. Remove six caps (6).

NOTE: Replace any caps (6) which are damaged in removal.

8. Roll insulation blanket (7) away from the back wall of the cab.



9. A second person must support the EPTC II unit from the inside of the cab. Remove four bolts (8) with the washers, and the EPTC II unit.

NOTE: Only two of four bolts (8) are visible in the photograph.

NOTE: To install the EPTC II, reverse the removal steps.

Electronic Control Module (ECM)

Remove and Install

NOTE: The group number related to this procedure is 122-8947.

NOTE: The electronic control module (ECM) must be calibrated after replacement. When the ECM has been replaced, have the timing calibration procedure performed by a Caterpillar dealer at the next convenient time, or the next unit level service interval, whichever comes first. The check engine light on the instrument panel will remain on until the timing calibration procedure is performed.

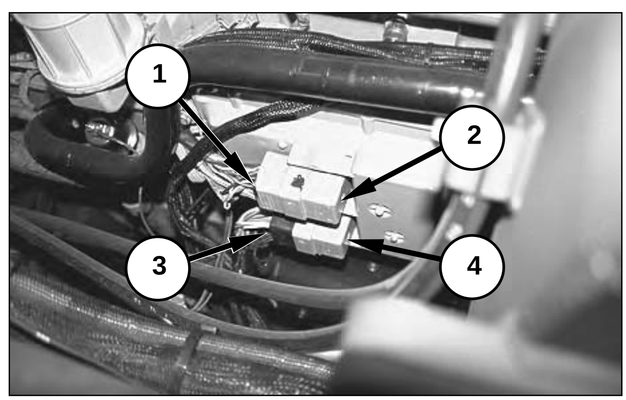
NOTICE

Operating without a calibrated ECM can cause the engine to overheat more easily than normal. Pay close attention to the gauges while operating the machine after the ECM has been replaced.

1. Move the start switch to the OFF position. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Monitoring Systems and Cab Features, Switches."

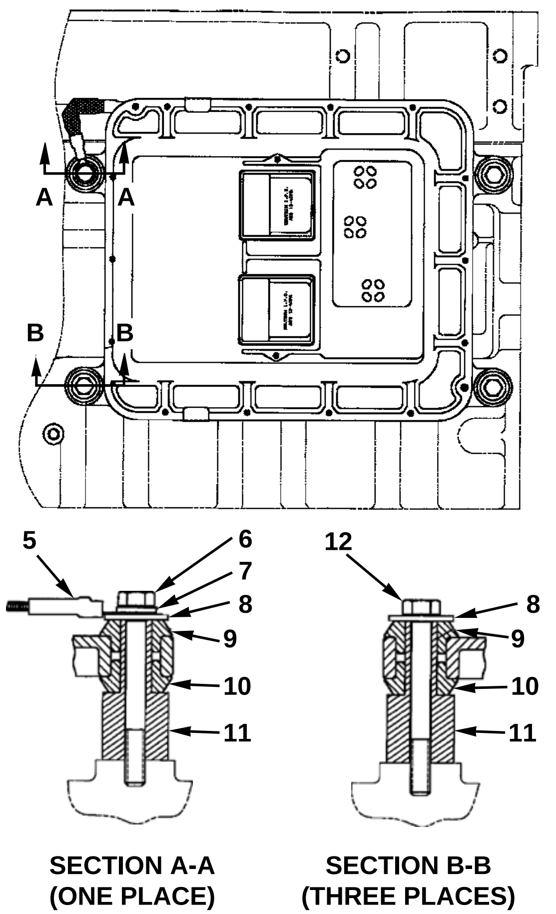
2. Turn the main disconnect switch to the OFF position. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Machine Features, Main Disconnect Switch."

3. Raise the radiator. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Features, Radiator Tilt."



4. Loosen Allen screw (2), and disconnect harness connector J1/P1 (1) from the ECM. Upon reassembly, tighten the Allen screw to a torque of **2.25 N•m (20 lb in)**.

5. Loosen Allen screw (4), and disconnect harness connector J2/P2 (3) from the ECM. Upon reassembly, tighten the Allen screw to a torque of **2.25 N•m (20 lb in)**.



6. Remove bolt (6), washer (7), ground strap (5), washer (8), and mount (9). (Refer to Section A-A.)

7. Remove three bolts (12), three washers (8), and three mounts (9). (Refer to Section B-B.)

8. Remove the ECM.

9. Remove four spacers (11) and four mounts (10).

NOTE: To install the ECM, reverse the removal steps. Have the ECM calibrated by a Caterpillar dealer at the next convenient time, or the next unit level service interval, whichever comes first.

Instrument Wiring Group

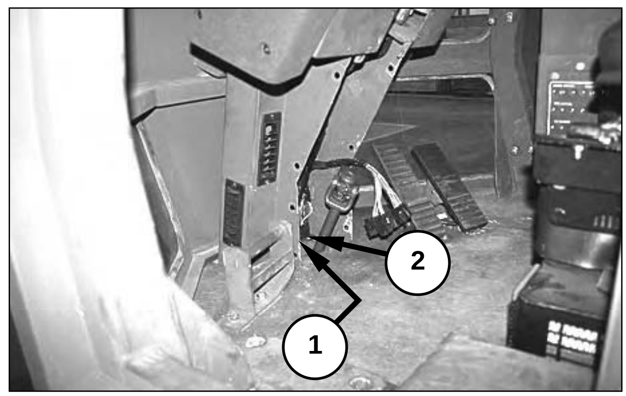
Remove and Install

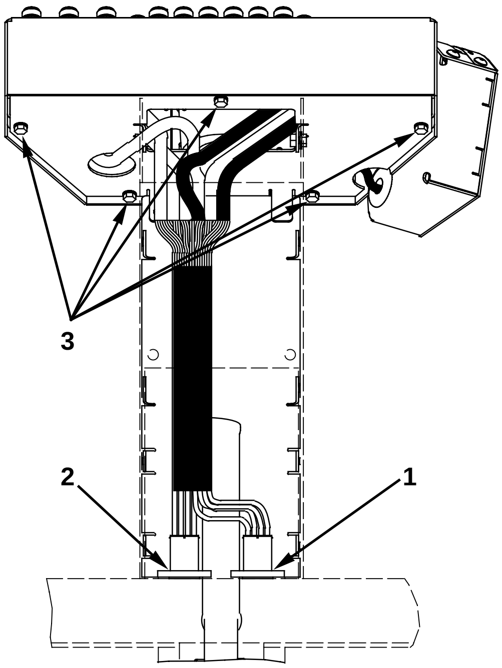
Start By:

a. Remove the steering column. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Steering Column."

NOTE: Group numbers related to this procedure include 124-5856 and 145-0075.

1. Ensure that the start switch is and main disconnect switch are in the OFF position. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Monitoring Systems and Cab Features, Switches" and "Operation Section, Machine Features, Main Disconnect Switch."

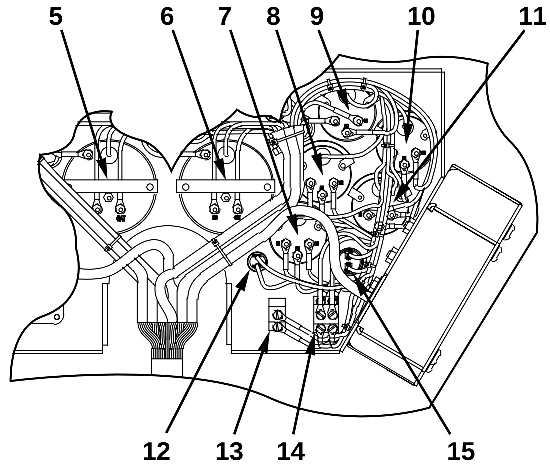




2. Disconnect harness connector C101 (1) and harness connector C102 (2).

3. Remove five bolts and washers (3), and tip the instrument panel up. Slide the front plate out of the way.

4. Disconnect blackout switch harness connector C112 (4).



NOTE: Cut harness straps as necessary when disconnecting the wires from the instrument panel components. Upon reassembly, replace the straps which were cut during disassembly.

5. Disconnect the following wires from speedometer (5):

Wire Number	Wire Location
600-BR	Gauge light
204-BK	Ground terminal
449-BU	S-terminal
H788-WH	I-terminal

Upon reassembly, tighten the terminal nuts to a torque of **0.62 ± 0.10 N•m (5.5 ± 0.9 lb in)**.

6. Disconnect the following wires from tachometer (6):

Wire Number	Wire Location
600-BR	Gauge light
H794-GY	Ground terminal
450-YL	S-terminal
H788-WH	I-terminal

Upon reassembly, tighten the terminal nuts to a torque of **0.62 ± 0.10 N•m (5.5 ± 0.9 lb in)**.

7. Disconnect the following wires from fuel level gauge (7):

Wire Number	Wire Location
600-BR	Gauge light
204-BK	Ground terminal
447-PK	S-terminal
H788-WH	I-terminal

Upon reassembly, tighten the terminal nuts to a torque of **0.85 ± 0.12 N•m (7.5 ± 1.1 lb in)**.

8. Disconnect the following wires from transmission oil temperature gauge (8):

Wire Number	Wire Location
600-BR	Gauge light
204-BK	Ground terminal
442-GY	S-terminal
H788-WH	I-terminal

Upon reassembly, tighten the terminal nuts to a torque of **0.85 ± 0.12 N•m (7.5 ± 1.1 lb in)**.

9. Disconnect the following wires from coolant temperature gauge (9):

Wire Number	Wire Location
600-BR	Gauge light
204-BK	Ground terminal
441-OR	S-terminal
H788-WH	I-terminal

Upon reassembly, tighten the terminal nuts to a torque of **0.85 ± 0.12 N•m (7.5 ± 1.1 lb in)**.

10. Disconnect the following wires from engine oil pressure gauge (10):

Wire Number	Wire Location
600-BR	Gauge light
204-BK	Ground terminal
A476-PU	S-terminal
H788-WH	I-terminal

Upon reassembly, tighten the terminal nuts to a torque of **0.85 ± 0.12 N•m (7.5 ± 1.1 lb in)**.

11. Disconnect the following wires from voltmeter (11):

Wire Number	Wire Location
600-BR	Gauge light
204-BK	Ground terminal
H788-WH	I-terminal

Upon reassembly, tighten the terminal nuts to a torque of **0.85 ± 0.12 N•m (7.5 ± 1.1 lb in)**.

12. Disconnect the 993-OR and the H795-PK wires from start-aid indicator (12).

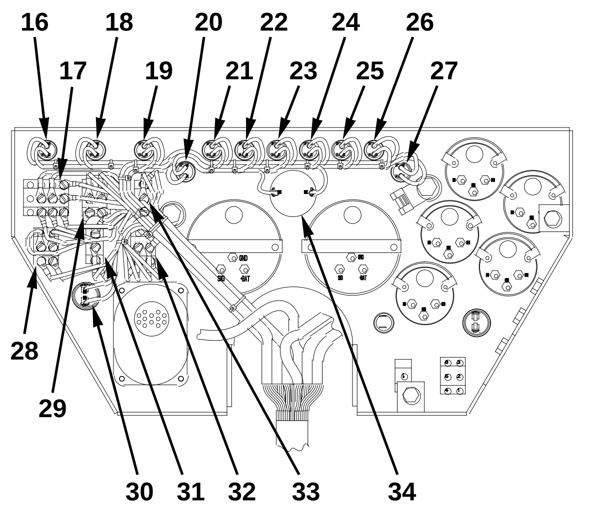
13. Disconnect the following wires from start-aid switch (13):

Wire Number	Wire Location
H795-PK	Contact 1
L967-WH	Contact 2

14. Disconnect the following wires from start switch (14):

Wire Number	Wire Location
307-OR	Contact 1
105-RD	Contact 2
128-PK	Contact 4
105-RD	Contact 5

15. Disconnect the 204-BK and the 600-BR wires from panel lamp (15).



16. Disconnect the H780-BU and the H782-BR wires from self-deploy/earthmoving indicator (16).

17. Disconnect the following wires from self-deploy/earthmoving switch (17):

Wire Number	Wire Location
L964-WH	Contact 1
206-BK	Contact 2
L965-PK	Contact 3
H787-GN	Contact 4
206-BK	Contact 5
H786-YL	Contact 7
H789-GY	Contact 8

18. Disconnect the 692-YL and the H781-PU wires from winch indicator (18).

19. Disconnect the 692-YL and the H779-GN wires from kneeling indicator (19).

20. Disconnect the 606-GY and the 204-BK wires from right turn indicator (20).

21. Disconnect the C987-RD and the L995-GN wires from crank-without-inject indicator (21).

22. Disconnect the C987-RD and the L994-YL wires from check engine indicator (22).

23. Disconnect the 691-GY and the H793-PU wires from engine oil pressure indicator (23).

24. Disconnect the H789-GY and the 691-GY wires from blade down indicator (24).

25. Disconnect the 691-GY and the H778-YL wires from low brake pressure indicator (25).

26. Disconnect the 691-GY and the H777-OR wires from tension fail indicator (26).

27. Disconnect the 204-BK and the 605-YL wires from left turn indicator (27).

28. Disconnect the following wires from work lamp switch (28):

Wire Number	Wire Location
665-BR	Contact 1
694-GY	Contact 2
666-YL	Contact 4
693-PK	Contact 5

29. Disconnect the following wires from winch enable switch (29):

Wire Number	Wire Location
206-BK	Contact 1
H781-PU	Contact 2
G728-YL	Contact 4
H788-WH	Contact 5

30. Disconnect the 204-BK and the 600-BR wires from panel lamp (30).

31. Disconnect the following wires from winch control switch (31):

Wire Number	Wire Location
F869-PK	Contact 1
G728-YL	Contact 2
F868-OR	Contact 3

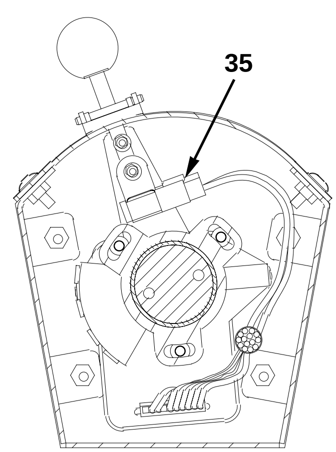
32. Disconnect the following wires from horn ON/OFF switch (32):

Wire Number	Wire Location
H791-GN	Contact 1
602-WH	Contact 2
817-WH	Contact 4
602-WH	Contact 5

33. Disconnect the following wires from kneeling switch (33):

Wire Number	Wire Location
F886-PK	Contact 1
H788-WH	Contact 2
F885-PU	Contact 3

34. Disconnect the 692-YL and the C445-BU wires from blade down alarm (34).



35. Remove the transmission control switch. Refer to "Transmission Control Switch, Remove and Install" in this module.

36. Disconnect shifter indicator harness connector F152 (35).

37. Remove the instrument group wiring harness

NOTE: Cut wire ties as necessary when removing the wiring harness. Upon reassembly, replace the wire ties which were cut.

NOTE: To install the instrument wiring group, reverse the removal steps.

End By:

a. Install the steering column.

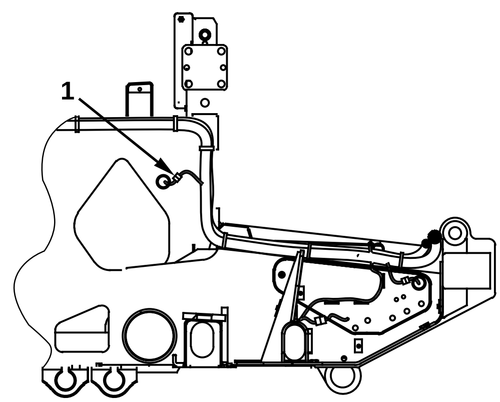
Kneeling Limit Switch

Remove and Install

NOTE: The group number related to this procedure is 150-1683.

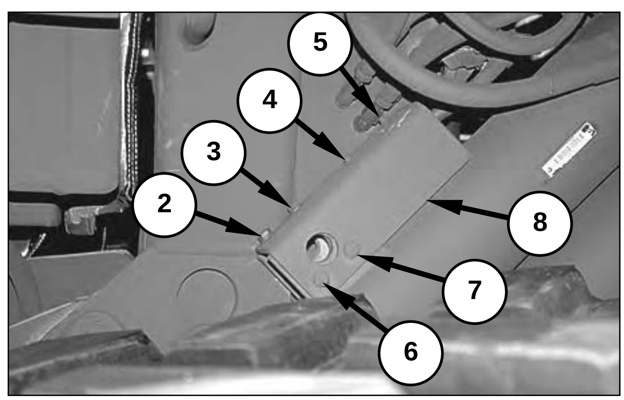
1. Move the start switch to the OFF position. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Monitoring Systems and Cab Features, Switches."

2. Turn the main disconnect switch to the OFF position. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Machine Features, Main Disconnect Switch."



LEFT FRAME – INSIDE VIEW

3. Disconnect harness connector C120 (1).



4. Remove four bolts (2), (3), (6), and (7), with the washers.

5. Remove two bolts and nuts (4) and (5) with two washers, and separate the kneeling limit switch from cover (8).

NOTE: The following steps show the procedure to install the kneeling limit switch.

NOTE: New kneeling limit switches are shipped without the actuator arm installed. Install the actuator arm on the shaft so that the centerline of the roller is approximately **31.75 mm (1.25 in)** below the top surface of the switch, and then tighten the pinch bolt. To adjust an old switch, loosen the pinch bolt and reposition the actuator arm.

6. Install the switch in cover (8) using two bolts and nuts (4) and (5) with two washers.

NOTE: Install the switch all the way to the rear of the adjustment slots. Tighten nuts (4) and (5) just tight enough to hold the switch in place but not so tight that the switch cannot be moved by hand.

7. Reconnect harness connector C120 (1).

8. Place cover (8) in position, and install four bolts (2), (3), (6), and (7), with the washers.

9. Place the machine in kneeling mode. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Machine Features, Kneeling Switch."

10. Install the kneeling lock pin, and stop the engine. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Machine Features, Kneeling Lock Pin."

11. Move the start switch to the ON position.

12. Slide the kneeling limit switch forward in the adjustment slots in cover (8) until the kneeling indicator illuminates. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Monitoring Systems and Cab Features, Indicators."

13. Remove the kneeling lock pin and raise the machine.

14. Remove four bolts (2), (3), (6), and (7), with the washers, remove cover (8), and tighten two bolts and nuts (4) and (5).

NOTE: Ensure that the position of the kneeling limit switch does not change when cover (8) is removed and/or bolts and nuts (4) and (5) are tightened.

15. Install cover (8) and tighten four bolts (2), (3), (6), and (7), with the washers.

NOTE: After the kneeling limit switch has been installed, place the machine in the kneeling mode to test the operation of the kneeling limit switch. If the kneeling indicator does not illuminate when the machine is fully lowered, the kneeling limit switch must be readjusted.

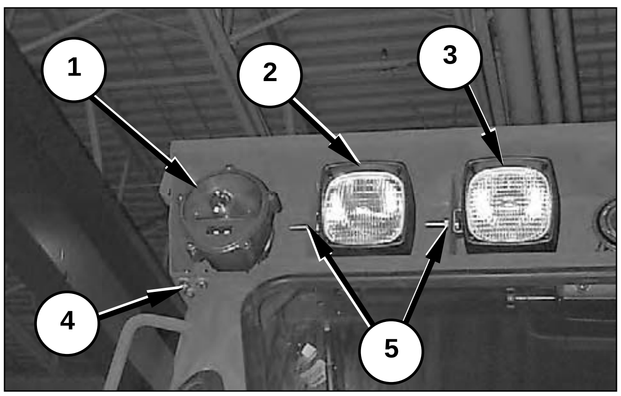
Lighting Group

Remove and Install

NOTE: The group number related to this procedure is 145-0022.

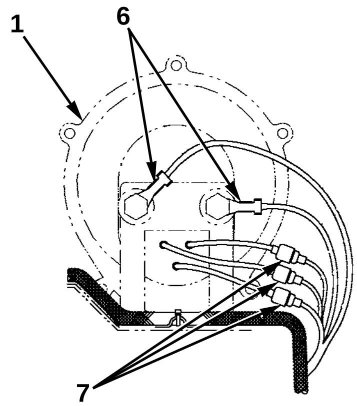
1. Move the start switch to the OFF position. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Monitoring Systems and Cab Features, Switches."

2. Turn the main disconnect switch to the OFF position. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Machine Features, Main Disconnect Switch."

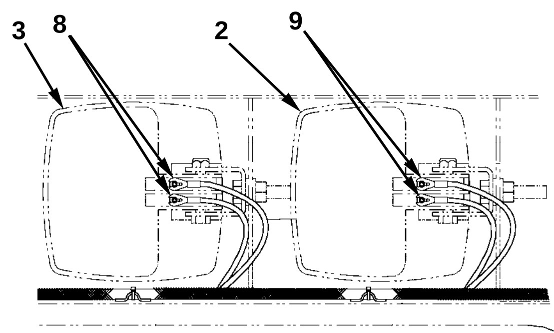


3. To remove marker lamp assembly (1) (right side shown), remove three bolts (4) with the washers, and pull marker lamp assembly (1) forward to access the terminals on the back of the light.

4. To remove head lamp (2) or work lamp (3), remove nut (5) with the washer, and pull the lamp assembly forward to access the terminals on the back of the lamp. Upon reassembly, tighten nut (5) to a torque of **25 ± 7 N•m (18.4 ± 5.2 lb ft).**

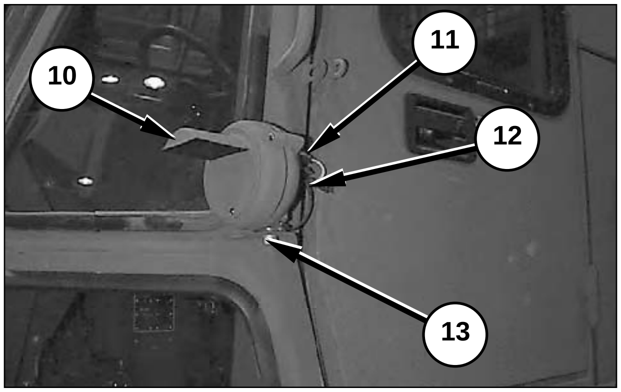


5. Disconnect two wires (6) and three connectors (7) from the back of marker lamp (1), and remove the marker lamp. Mark all wires for correct connection during reassembly.



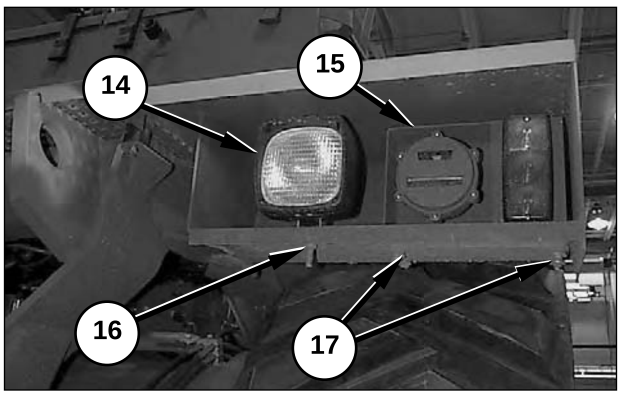
6. Remove two wires (8) and remove work lamp (3). Mark all wires for correct connection during reassembly. Upon reassembly, tighten the contact screws of wires (8) to a torque of **1.7 ± 0.25 N•m (1.3 ± 0.2 lb ft).**

7. Remove two wires (9) and remove head lamp (2). Mark all wires for correct connection during reassembly. Upon reassembly, tighten the contact screws of wires (9) to a torque of **1.7 ± 0.25 N•m (1.3 ± 0.2 lb ft).**



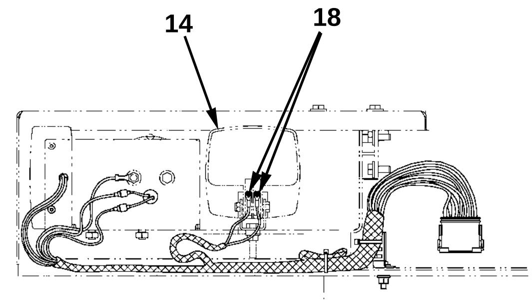
8. To remove blackout head lamp (10), disconnect wires (11) and (12).

9. Remove nut (13) with the washer, and blackout head lamp (10).

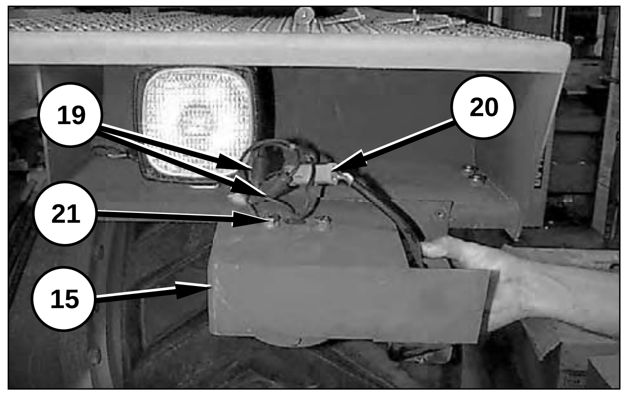


10. To remove rear work lamp (14), remove nut (16) with the washer, and pull the lamp out to access the wire terminals on the back of the lamp. Upon reassembly, tighten nut (16) to a torque of **25 ± 7 N•m (18.4 ± 5.2 lb ft).**

11. To remove rear signal lamp assembly (15), remove four bolts (17) (only two shown) with eight washers, four sleeves, and eight grommets. Upon reassembly, tighten nut (16) to a torque of **12 ± 3 N•m (108.8 ± 26.7 lb in).**



12. Disconnect two wires (18) and remove rear work lamp (14). Mark all wires for correct connection during reassembly. Upon reassembly, tighten the contact screws of wires (18) to a torque of **1.7 ± 0.25 N•m (1.3 ± 0.2 lb ft).**

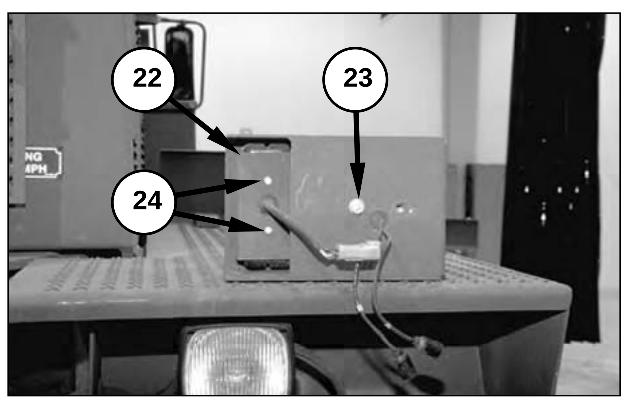


13. Disconnect two connectors (19) from the blackout tail lamp. Mark the wires for correct connection at reassembly.

14. Disconnect connector C431 (20).

15. Remove bolt (21) with the washer, and remove the ground wire.

16. Remove rear signal lamp assembly (15).



17. Remove two bolts (24) with the washers, and then remove clamp (22) and turn signal.

18. Remove bolt (23) with the washer and remove the blackout lamp.

NOTE: To install the lights in the light group, reverse the disassembly steps.

NOTE: The above text step 18, and **NOTE:** have been moved from the first column of the original document page 13-29. No chages were made to the text or the previous procedure.

Recoil Alert Switch

Remove and Install

NOTE: The group number related to this procedure is 144-7169

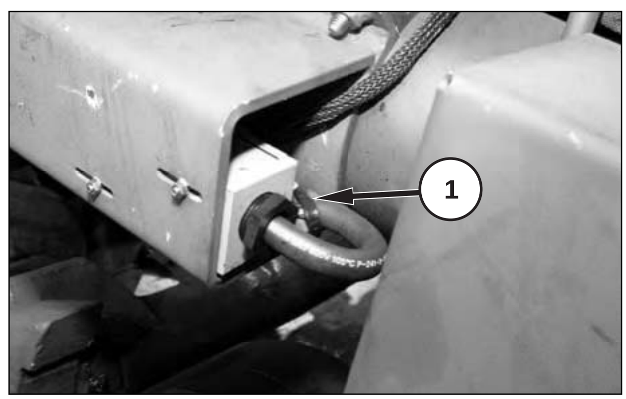
NOTE: The following procedure is for the component on the right side of the machine. The procedure for the component on the left side of the machine is the same.

Start By:

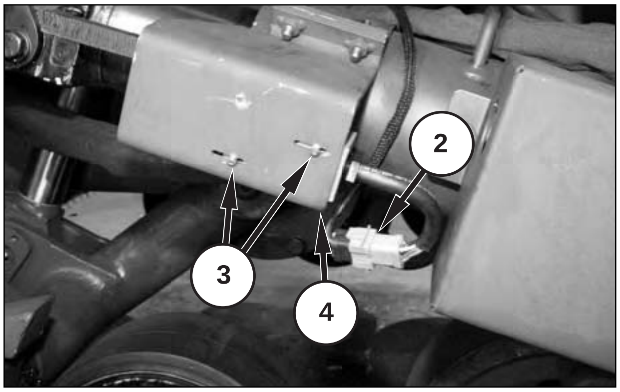
a. Ensure that the suspension system is fully charged. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage Steering and Brakes,* “Testing and Adjusting, Suspension System Procedures, Suspension Hydraulic Charging Procedure.”

1. Move the start switch to the OFF position. Refer to *Operator’s Manual, Deployable Universal Combat Earthmover (DEUCE),* “Operation Section, Monitoring Systems and Cab Features, Switches.”

2. Turn the main disconnect switch to the OFF position. Refer to *Operator’s Manual, Deployable Universal Combat Earthmover (DEUCE),* “Operation Section, Machine Features, Main Disconnect Switch.”



3. Cut wire tie (1).

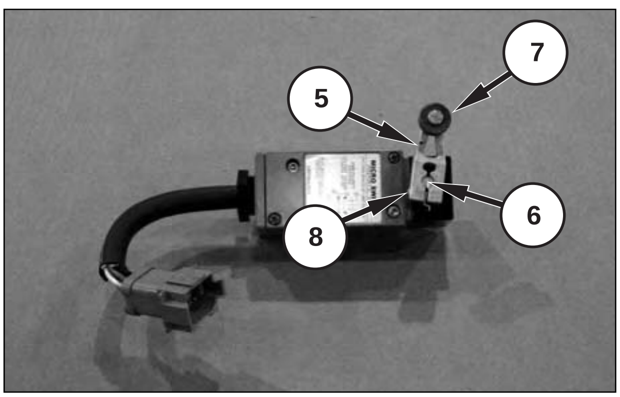


4. Disconnect harness connector (2), and remove two nuts (3), with the washers.

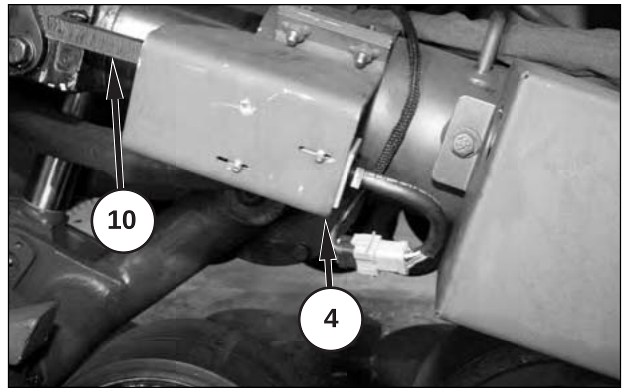
5. Slide the switch with two bolts out the front or rear of the recoil alert cover (4).

NOTE: The following steps show the procedure to install the recoil alert switch.

NOTE: New recoil alert switches are shipped without the actuator arm installed. Use the following procedure to install the actuator arm prior to installation of the recoil alert switch assembly.



6. Install actuator arm (5) on shaft (6). Rotate the arm so that the centerline of roller (7) is approximately 5 degrees clockwise from the vertical position, and then tighten pinch bolt (8).



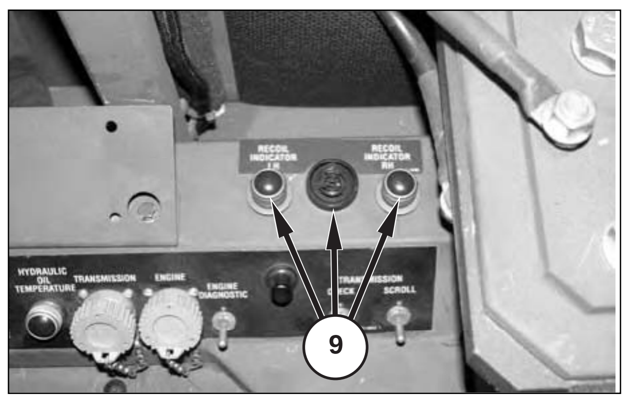
7. Install the recoil alert switch all the way to the rear of the adjustment slots on cover (4). Tighten two nuts (3) just tight enough to hold the switch in place but not so tight that the switch cannot be moved by hand.

8. Reconnect harness connector (2), and replace wire ties (1).

9. Turn the main disconnect switch to the ON position.

10. Move the start switch to the ON position.

NOTE: Do not start the machine.



11. Depress actuator arm (5) on the recoil alert switch, and check panel (9) for alarm actuation.

12. Adjust the recoil alert switch by sliding it to the front or rear of cover (4) until the roller on the actuator arm is **89 mm (3.5)** inches from recoil alert switch plate (10).

13. Move the start switch to the OFF position.

14. Tighten two nuts (3), with washers.

Recoil Alert Cover

Remove

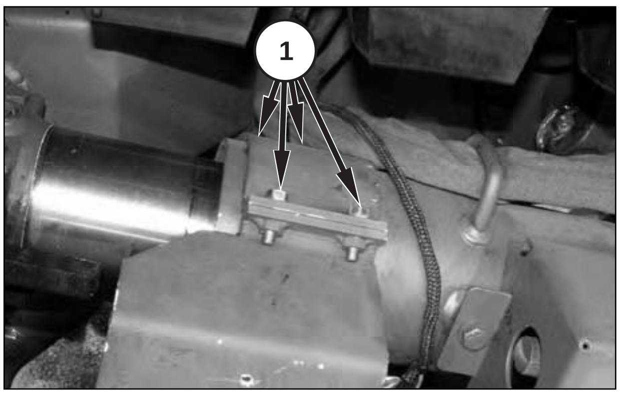
NOTE: The group number related to this procedure is 144-7169.

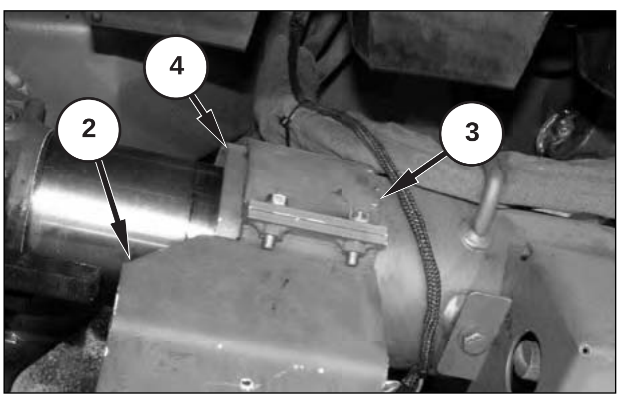
NOTE: The following procedure is for the component on the right side of the machine. The procedure for the component on the left side of the machine is the same.

Start By:

a. Remove the recoil alert switch. Refer to “Remove and Install, Recoil Alert Switch,” in this section.

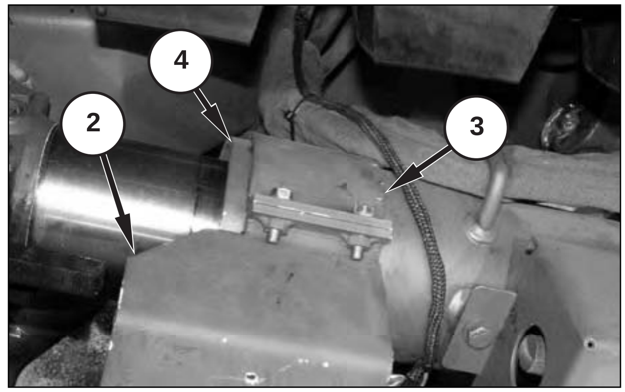
1. Remove four bolts (1), and washers.





2. Remove recoil alert switch cover (2) and retaining collar (3) from recoil cylinder (4).

Install



1. Install recoil alert switch cover (2) and retaining collar (3) on recoil cylinder (4). Position the collar approximately **25 mm (1 in)** back from the lip of the recoil cylinder lip (4). The top of cover (2) should be aligned horizontally with the cylinder.

2. Tighten four bolts (1), and washers.

End By:

Install the recoil alert switch.

NOTE: Lighting Group step 18 and **NOTE** text moved to page 13-28.01.

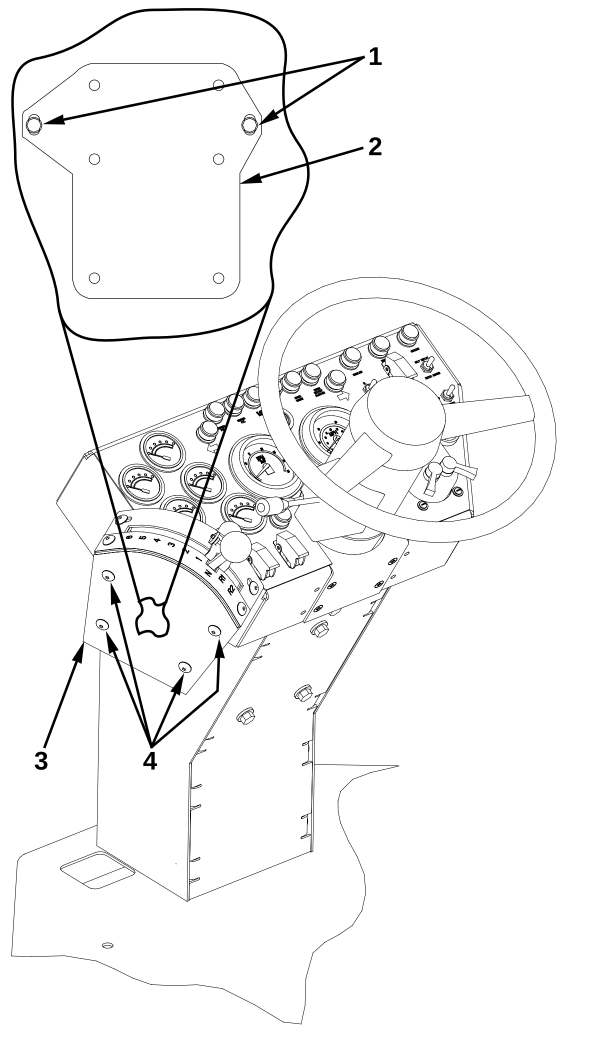
Transmission Control Switch

Remove and Install

NOTE: Group numbers related to this procedure include 198-8762 and 145-0076.

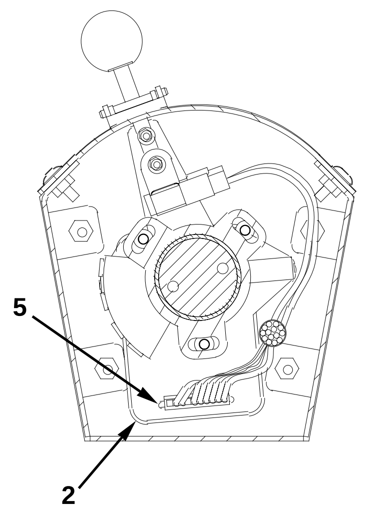
1. Move the transmission control lever into NEUTRAL and the start switch to the OFF position. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Machine Features, Transmission Control Lever," and "Monitoring Systems and Cab Features, Switches."

2. Turn the main disconnect switch to the OFF position. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Machine Features, Main Disconnect Switch."



3. Remove four screws (4), and remove cover (3).

4. Remove two screws and washers (1), and carefully pull transmission control switch (2) out.



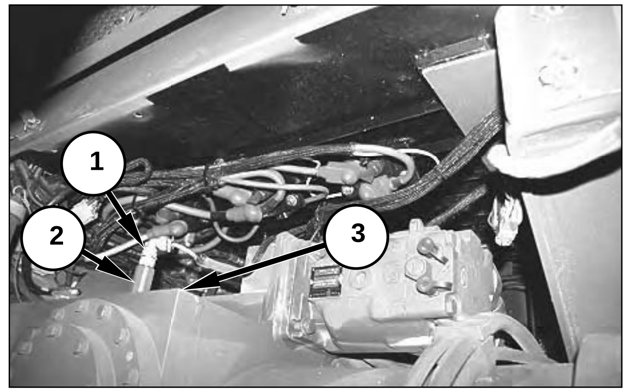
5. Disconnect harness connector C142 (5), and remove transmission control switch (2) from the housing.

NOTE: To install the transmission control switch, reverse the removal steps.

Transmission Speed Sensor

Remove and Install

NOTE: The group number related to this procedure is 150-1683.



1. Cut the lock wire, and disconnect transmission speed sensor harness connector C352 (1).

2. Remove transmission speed sensor (2), with the O-ring seal, from differential steering unit case (3).

NOTE: The following steps show the procedure to install transmission speed sensor (2).

3. Align a gear tooth with the mounting port for transmission speed sensor (2). If necessary, move the machine a small amount to align a gear tooth with the port. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE)* for information about machine operation.

NOTE: If the machine is moved while the transmission speed sensor is disconnected, the EPTC II may log a fault. For the procedure to clear faults logged by the EPTC II, refer to *Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Electronic Programmable Transmission Control (EPTC II),* "Testing and Adjusting, Detected Fault Troubleshooting."

4. Install transmission speed sensor (2) with the O-ring seal until the probe of the sensor contacts the gear tooth, and then back the sensor off one-quarter turn.

5. Reconnect connector C352 (1) to transmission speed sensor (2), and install lock wire. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Transmission and Torque Converter,* "Testing and Adjusting, Transmission Hydraulic System, Installation of Lock Wire on Transmission Gear Switch and Transmission Speed Sensor Connectors."

Vehicle Wiring Group

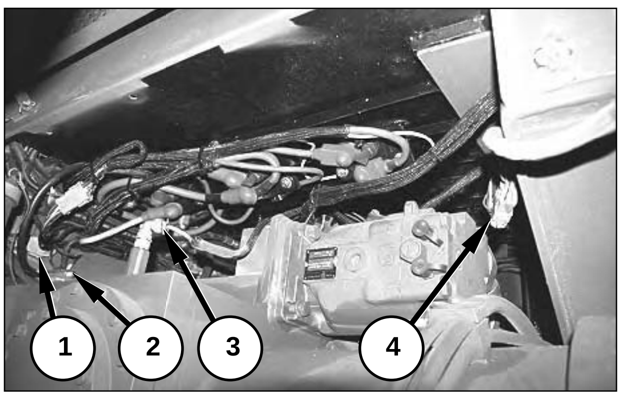
Remove and Install

NOTE: The group number related to this procedure is 124-5844.

1. Move the start switch to the OFF position. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Monitoring Systems and Cab Features, Switches."

2. Turn the main disconnect switch to the OFF position. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Machine Features," "Main Disconnect Switch."

3. Raise the radiator. Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Features, Radiator Tilt."



4. Remove the nut and washer from ground stud (2). Remove the ground wires from the stud, and mark the wires for correct connection during reassembly.

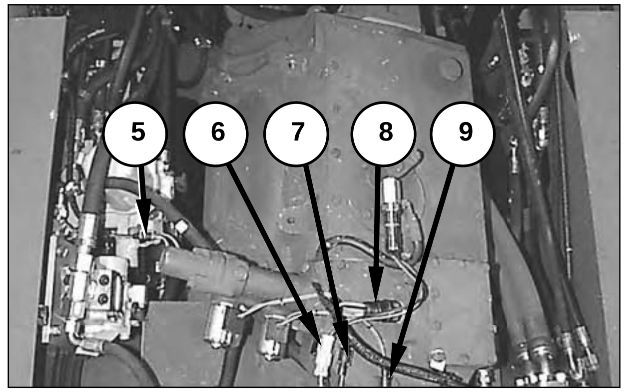
5. Disconnect left light harness connector C415 (1).

6. Disconnect right light harness connector C405 (4).

7. Cut the lock wire, and disconnect transmission speed sensor harness connector C352 (3).

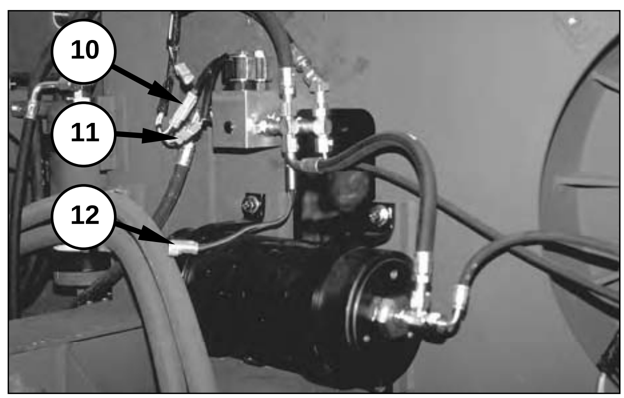
NOTE: When connector C352 (3) is reconnected to the transmission speed sensor, install lock wire. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Transmission and Torque Converter,* "Testing and Adjusting, Transmission Hydraulic System, Installation of Lock Wire on Transmission Gear Switch and Transmission Speed Sensor Connectors."

8. Remove the fuel tank. Refer to "Fuel Tank, Remove and Install" in *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Machine Systems*.



9. Disconnect lockup solenoid connector C302 (5), P2 pressure switch connector C342 (6), upshift solenoid connector C312 (7), and downshift solenoid connector C322 (9). Cut the lock wire, and disconnect transmission gear switch connector C332 (8).

NOTE: When connector C332 (9) is reconnected to the transmission gear switch, install lock wire. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Transmission and Torque Converter,* "Testing and Adjusting, Transmission Hydraulic System, Installation of Lock Wire on Transmission Gear Switch and Transmission Speed Sensor Connectors."



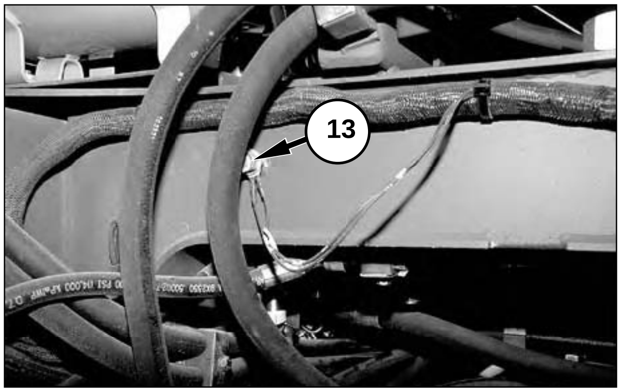
Transmission Removed for Photographic Purposes. Right Side of Machine Shown; Left Side Symmetrical.

10. Disconnect suspension lock solenoid connectors C323 (10) and C353 (11) from the right side of the machine.

NOTE: Disconnect the suspension lock solenoid connectors C303 and C343 from the suspension lock valve on the left side of the machine.

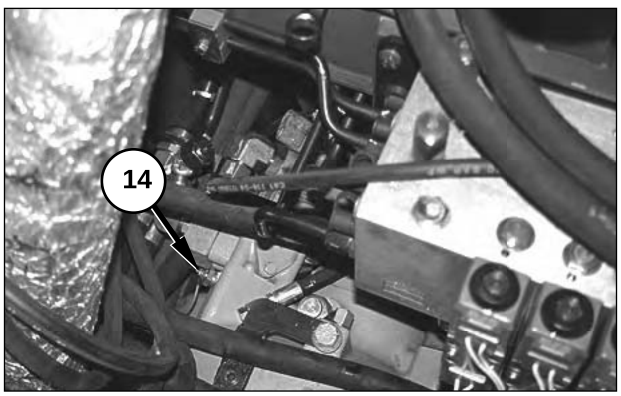
11. Disconnect track tension pressure switch connector C333 (12) from the right side of the machine.

NOTE: Disconnect the track tension pressure switch connector C313 from the suspension lock valve on the left side of the machine.

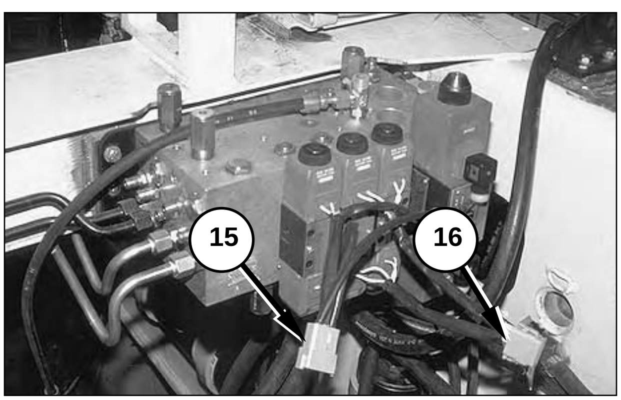


Transmission Removed for Photographic Purposes.

12. Remove nut (13) and ground wires from the ground stud on the back side of the frame crossbeam. Mark the ground wires for correct connection during assembly.

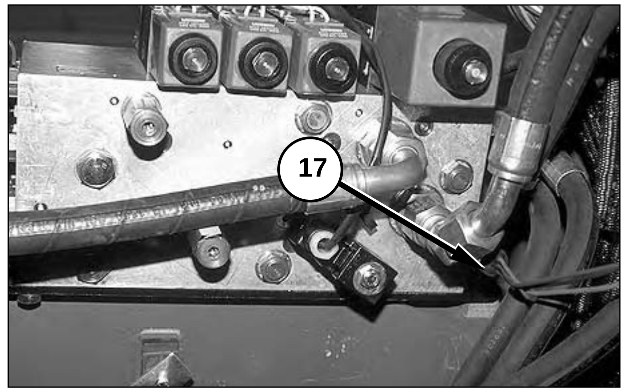


13. Disconnect the 442-GY wire from transmission oil temperature sensor (14).



Vehicle Shown Partially Disassembled for Photographic Purposes.

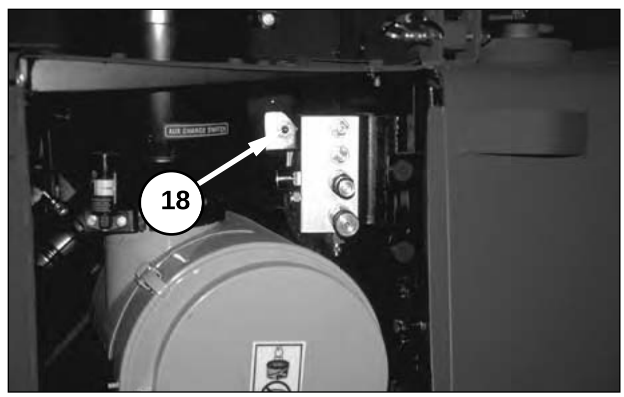
14. Disconnect multifunction control valve connectors C202 (15) and C204 (16).



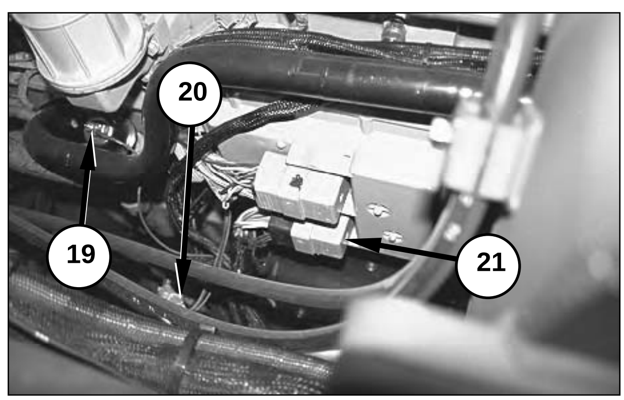
Multifunction Control Valve Shown Partially Disassembled for Photographic Purposes.

15. Disconnect brake pressure switch (17) from the machine harness.

NOTE: To locate the brake pressure switch connector, find brake pressure switch (17) on the bottom face of the multifunction control valve, and follow the wires from the switch to the connector.



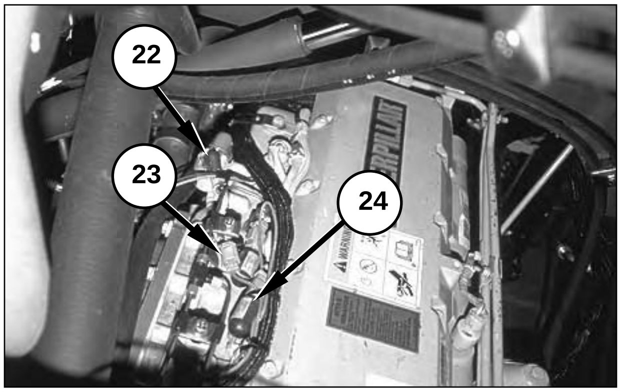
16. Disconnect the E765-PK wire from contact 1, the H788-WH wire from contact 2, and the E764-OR wire from contact 3 of undercarriage charge switch (18).



17. Disconnect the A476-PU wire from engine oil pressure sensor (19).

18. Disconnect engine oil pressure switch connector C211 (20).

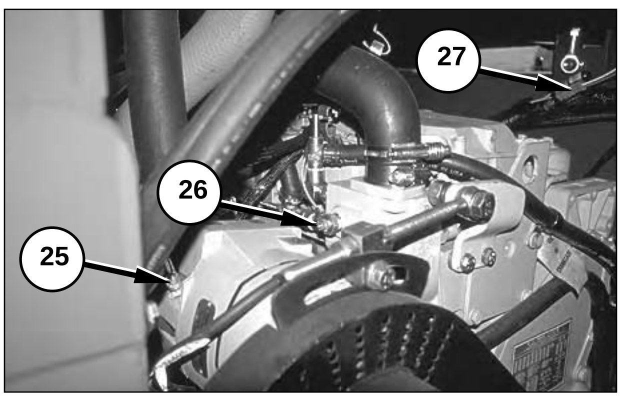
19. Disconnect ECM connector C201 (21). Upon reassembly, tighten the allen screw to a torque of **2.25 N•m (20 lb in)**.



20. Remove the caps and nuts, and remove the F793-RD-4 wire and the 160-PU-4 wire from intake air heater relay (22). Upon reassembly, tighten the nuts to a torque of **4.0 ± 0.5 N•m (35 ± 4 lb in)**.

21. Disconnect intake air heater relay harness connector (23), and remove the C987-RD wire from the plug.

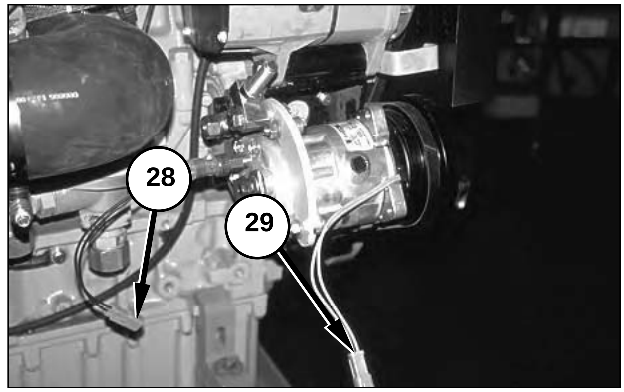
22. Disconnect arc suppressor (24) and remove the D796-OR wire from the connector.



23. Disconnect the 109-RD-2 wire from alternator terminal (25).

24. Disconnect the 441-OR wire from coolant temperature sensor (26).

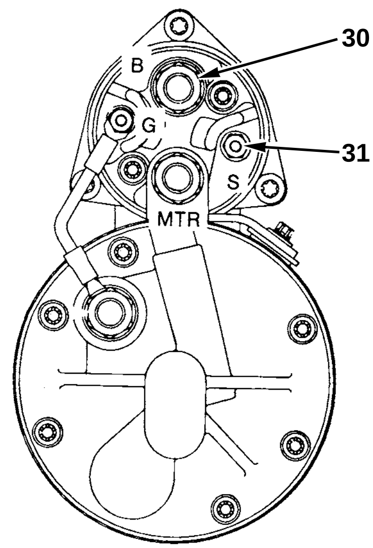
25. Disconnect kneeling limit switch connector C120 (27).



Engine Removed for Photographic Purposes.

26. Disconnect air conditioning pressure switch connector C221 (28).

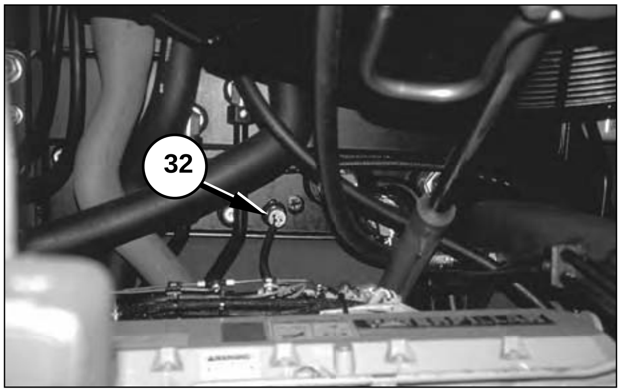
27. Disconnect air conditioning clutch solenoid connector C231 (29).



NOTE: The starter is located on the left side of the engine, below the ECM.

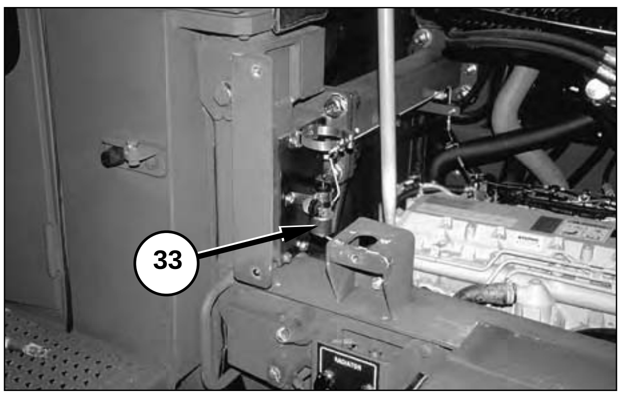
28. Disconnect the 101-RD-00 wire from terminal B (30) of the starter. Upon reassembly, tighten the nut on terminal B to a torque of **30.5 ± 3.5 N•m (22.5 ± 2.5 lb ft)**.

29. Disconnect the 304-WH-10 wire from terminal S (31) of the starter. Upon reassembly, tighten the nut on terminal S to a torque of **2.25 ± 0.25 N•m (20 ± 2 lb in)**.

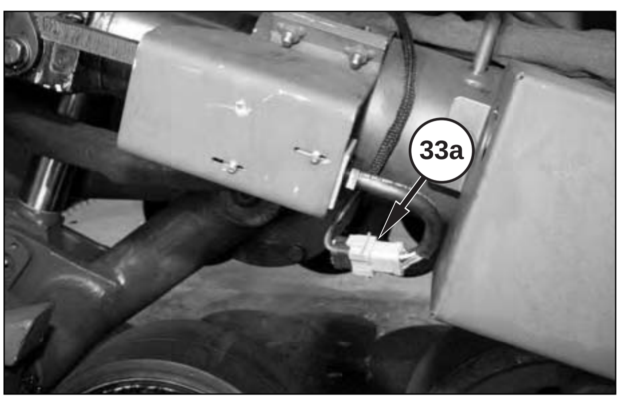


30. Disconnect hydraulic temperature sensor (32) from the machine harness.

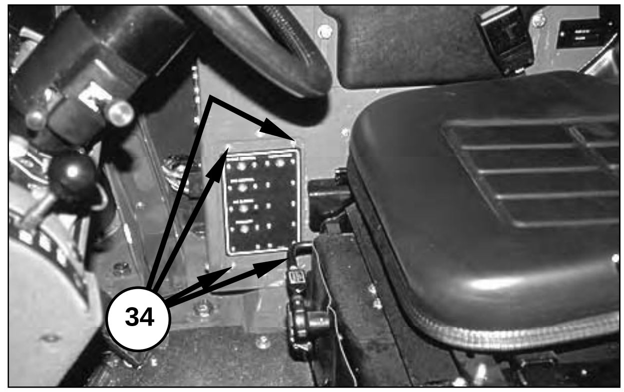
NOTE: Follow the wires from the sensor to the machine harness to find the connector.

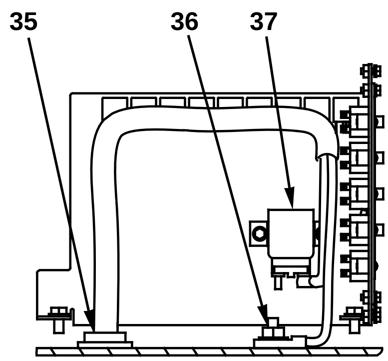


31. Disconnect start-aid solenoid connector C205 (33) from the machine harness.



31a. Disconnect recoil alert switch connector (33a) from both sides of the machine.



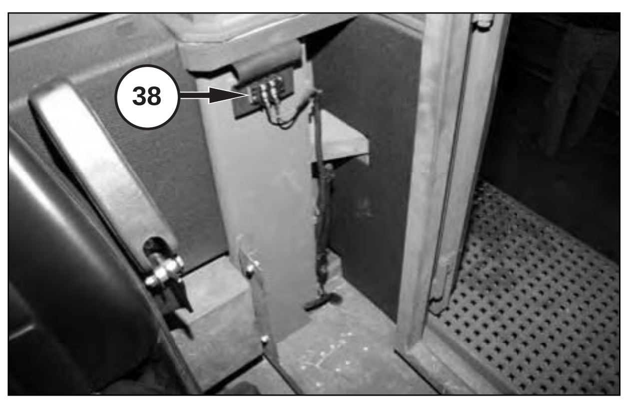


32. Remove four bolts and washers (34), and place the front circuit breaker panel out of the way.

33. Remove the nut and the 200-BK-00 wire from ground stud (36) on the floor of the cab, behind the circuit breaker panel.

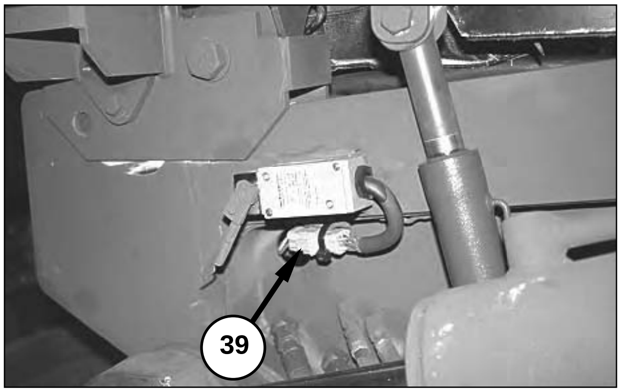
34. Disconnect the 112-OR-2 wire from blackout relay (37). Upon reassembly, tighten the nut to a torque of **5.0 ± 0.5 N•m (44 ± 4 lb in)**.

35. Push the wiring harness through hole (35).

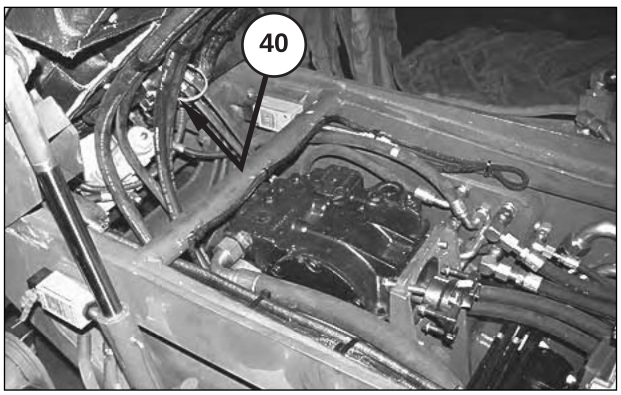


36. Disconnect the 105-RD wire and the 200-BK wire from power strip (38).

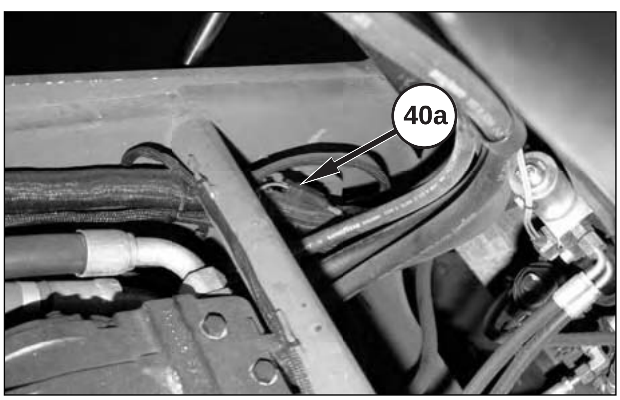
37. Raise the cab. Refer to “Maintenance Features, Cab Tilt” in *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover (DEUCE),* for the procedure to raise and lower the cab.



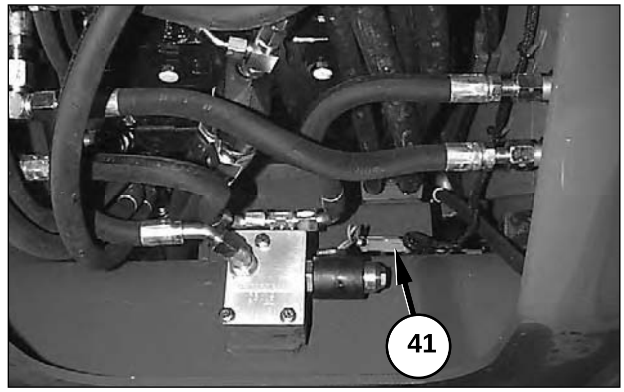
38. Disconnect blade position switch connector C140 (39).



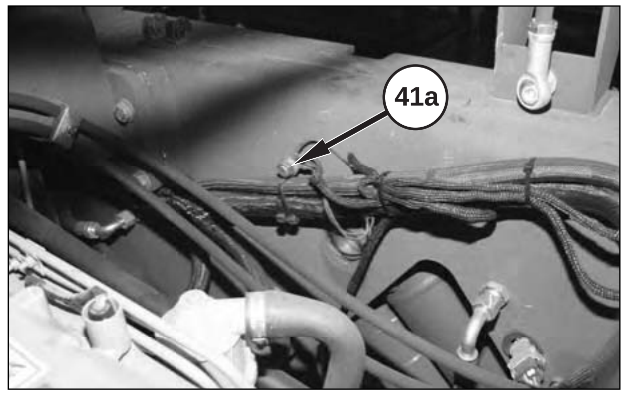
39. Disconnect steering solenoid connector (40).



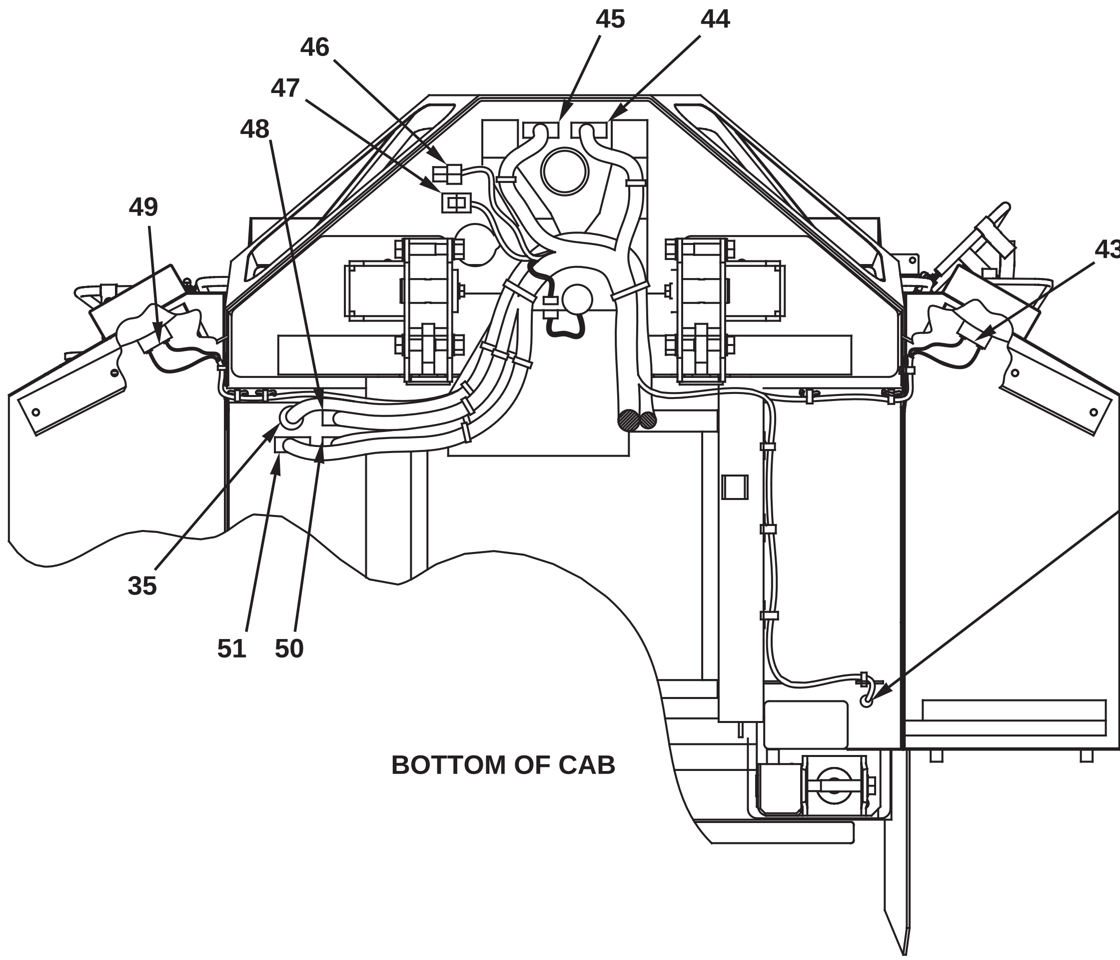
39a. Disconnect recoil alert connector (40a).



40. Disconnect blade lock solenoid connector C129 (41).



40a. Remove nut (41a) with washer and recoil alert ground wires from the ground stud on the side of the frame crossbeam. Mark the ground wires for correct connection during assembly.



41. Pull the harness through hole (42). Upon reassembly, apply **8T-9014 Clear RTV Silicone** to the grommet and harness interface.

42. Disconnect the 665-BR wire and the 206-BK wire from work lamp (43), and the 666-YL wire and the 206-BK wire from work lamp (49). Upon reassembly, tighten contact screws on work lamps (44 and 49) to a torque of **1.7 ± 0.25 N•m (15.0 ± 2.2 lb in)**.

43. Disconnect the 320-OR wire, and the 459-BU wire from recoil alert lamps. Disconnect the 478-GN wire from the recoil alert warning buzzer, and the 101-RD wire from contact block twelve on circuit breaker panel. Pull recoil alert harness through hole (42).

44. Disconnect harness connectors C101 (44), C102 (45), C103 (48), C104 (51), and C105 (50).

45. Pull the blackout switch harness through hole (35).

46. Disconnect throttle position sensor connector C115 (46).

47. Disconnect service brake switch connector SW21 (47).

NOTE: Cut harness straps as necessary, and remove the vehicle wiring harness. Upon reassembly, replace straps which were cut during disassembly.

NOTE: To install the vehicle wiring harness, reverse the removal steps.

TM5-2430-200-24

Schematic

Deployable Universal Combat Earthmover (DEUCE)

Electrical Schematic

PIN: 7RR00003-Up

Important Safety Information

Most Accidents involving product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “WARNING” as shown below.

The meaning of this safety alert symbol is as follows:

⚠ WARNING

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning, explaining the hazard, can be either written or pictorially presented.

Operations that may cause product damage are identified by NOTICE labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are therefore not all inclusive. If a tool, procedure, work method or operating technique not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and others. You should also ensure that the product will not be damaged or made unsafe by the operation, lubrication, maintenance or repair procedures you choose.

The information, specifications, and illustrations in this publication are on the basis of information available at the time it was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service given to the product. Obtain the complete and most current information before starting any job. Caterpillar dealers have the most current information available. For a list of the most current publication form numbers available, see the Service Manual Contents Microfiche, REG1139F.

NOTE: See the Electrical Schematics on Fold Out (FO) pages FO-5 through FO-25 in the back of this manual.

TM5-2430-200-24

Periodic Maintenance and Special Operation

Deployable Universal Combat Earthmover (DEUCE)

PIN: 7RR00003-Up

Important Safety Information

Most accidents involving product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product until you have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “WARNING,” as shown below.

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Table of Contents

Information Section

Operation Section

Maintenance Section

Foreword

Literature Information

This manual contains safety, operation, and maintenance information. The information contained in this manual is intended to be used by Unit personnel within the Army. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE)* for additional operation and maintenance information.

Guards and covers might have been removed for illustrative purposes. Read, study and keep this manual in Unit Maintenance.

Whenever a question arises regarding your machine, or this publication, please consult your Caterpillar dealer for the latest available information.

Safety

Refer to the "Safety" section in *Operator's Manual, Deployable Universal Combat Earthmover, (DEUCE)*, for a complete discussion of the safety instructions related to this machine.

Operation

This section contains operational information related to periodic maintenance, for use by Unit level personnel within the Army.

Photographs and illustrations guide service personnel through correct operating procedures and maintenance features of the machine.

Maintenance

The maintenance information is a guide to equipment care to be performed at the Unit level within the Army. The illustrated, step-by-step instructions are grouped by servicing intervals. Items without specific intervals are listed in the "When Required" section. Refer to the "Maintenance Section, Maintenance Intervals" in this module.

Maintenance Interval Schedule

Use the service hour meter to determine servicing intervals. Calendar intervals (daily, weekly, monthly) can be used instead of service hour meter intervals, if they provide more convenient servicing schedules and approximate the indicated service hour meter reading. Recommended service should always be performed at the interval that occurs first.

Under extremely severe, dusty or wet operating conditions, more frequent lubrication than is specified in the "Maintenance Intervals" index might be necessary.

Perform service at multiples of the original requirement. For example, when performing maintenance at every 250 service hours or three months, also service those items that require servicing at every 50 service hours or weekly.

Machine Description

The Deployable Universal Combat Earthmover (DEUCE) is an earthmoving machine capable of travelling between sites at high speed. The DEUCE is equipped with a 3126 Hydraulic Electronic Unit Injector (HEUI) engine that operates at two power levels, 197 kW (265 hp) and 138 kW (185 hp). The machine is equipped with a power, angle, and tilt (PAT) blade and a winch. The suspension on the machine can be activated for smooth operation at high speed, or locked, for a stable base when dozing.

California

Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the state of California to cause cancer, birth defects, and other reproductive harm.

Safety

Read and understand the *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE)* for safety information before performing any procedure in this manual.

Operation Section

Maintenance Features

Cab Tilt

WARNING

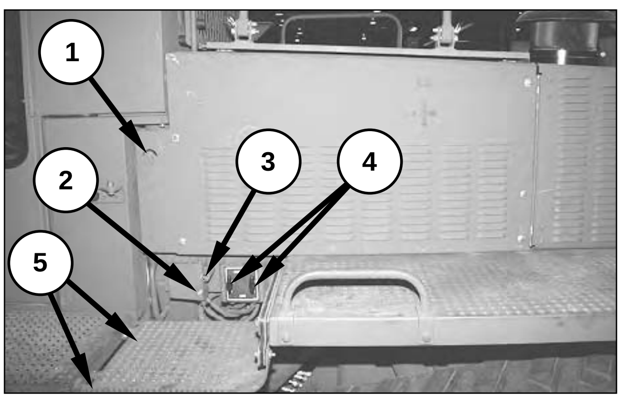
Do not position any part of the body between the cab and the machine frame when the cab is being raised or lowered. Use the bolts provided to secure the cab in the raised position before working between the cab and the machine frame. The cab could fall, resulting in injury or death.

Take care when entering the cab while the cab is in the raised position. Do not turn the steering wheel or move the machine with the cab raised. Personal injury may occur if three points of contact are not maintained.

Raise

NOTICE

Loose material should be removed from the cab before the cab is raised.



1. Place the transmission control lever in NEUTRAL, and ensure that the parking brake switch is in the ON position.

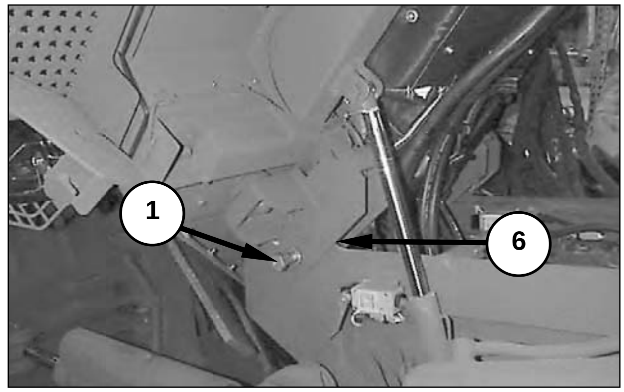
2. Remove two bolts (5) with the nuts and washers, and allow the walkway to hang down.

3. Remove bolt (1) and washer from each side of the cab.

4. Turn two valves (4) to the CAB position (pointing down).

5. Locate the pump handle (stored in the Basic Issue Item [BII] box) and use the slotted end to turn valve (2) clockwise to the stop.

6. Put the end of the pump handle into pump socket (3) and raise and lower the handle to operate the pump.



7. Continue pumping and install bolt (1) (removed in Step 2) through the hole in support (6) and the frame on both sides of the machine.

Lower

1. Remove bolt (1) from the hole in support (6) (one on each side of the cab).

2. Turn two valves (4) to the CAB position (pointing down).

3. Use the slotted end of the pump handle to turn valve (2) counterclockwise to the stop.

4. Put the end of the pump handle into pump socket (3), and raise and lower the handle to operate the pump.

5. Continue pumping until the cab is fully lowered, and reinstall bolt (1) and washer on each side of the cab. Tighten the bolts to a torque of 425 ± 50 N•m (315 ± 37 lb ft).

6. Raise the walkway and install two bolts (5) with the nuts and washers.

7. Return the pump handle to the BII box.

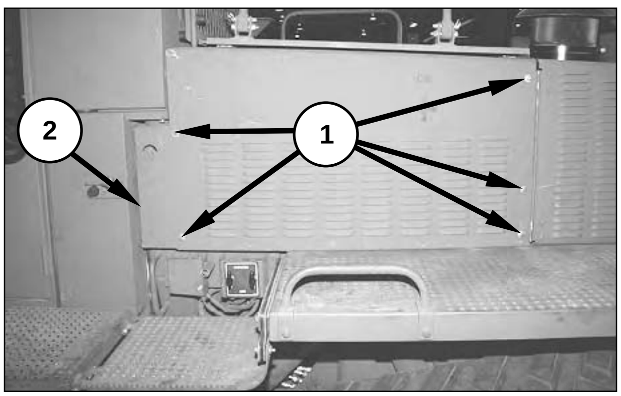
Radiator Tilt

WARNING

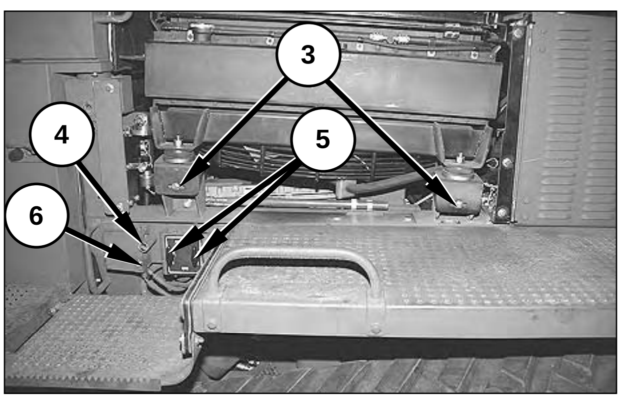
Do not position any part of the body between the radiator and the machine frame when the radiator is being raised or lowered. Use the radiator support to secure the radiator in the raised position before working between the radiator and the machine frame. The radiator could fall, resulting in injury or death.

Raise

1. Raise the rear windshield guard. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Monitoring Systems and Cab Features, Rear Windshield Guard."



2. Remove five bolts (1) with the washers, and cover (2).



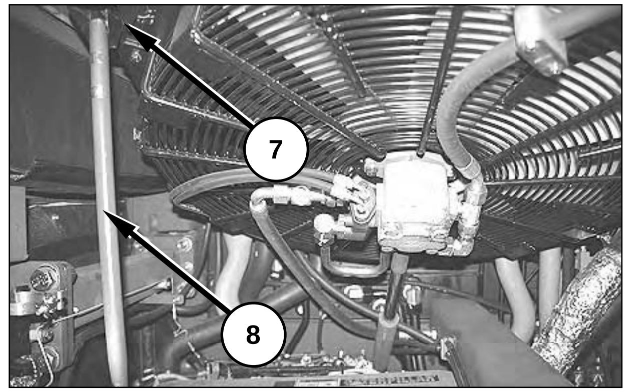
3. Remove two bolts (3) with the washers.

4. Turn two valves (5) to the RADIATOR position (pointing up).

5. Use the slotted end of the pump handle, located in the BII box, to turn valve (6) clockwise to the stop.

6. Insert the small end of the pump handle into pump socket (4), and raise and lower the handle to operate the pump.

7. Continue pumping until the radiator is fully raised.



8. Install radiator support (8) into locking mechanism (7) on the front corner of the radiator.

9. Use the slotted end of the pump handle to turn valve (6) counterclockwise to the stop.

10. Operate the pump to lower the radiator onto radiator support (8), locking the support into position.

Lower

1. Turn two valves (5) to the RADIATOR position (pointing up).

2. Use the slotted end of the pump handle to turn valve (6) clockwise to the stop.

3. Insert the pump handle into the pump, and raise and lower the handle to operate the pump.

4. Continue pumping until the radiator is raised enough to remove radiator support (8) from locking mechanism (7).

5. Lower radiator support (8), and fasten the radiator support into the storage clips.

6. Use the slotted end of the pump handle to turn valve (6) counterclockwise to the stop.

7. Operate the pump to lower the radiator. Install two bolts (3) with the washers.

8. Reinstall cover (2) using five bolts (1) and washers.

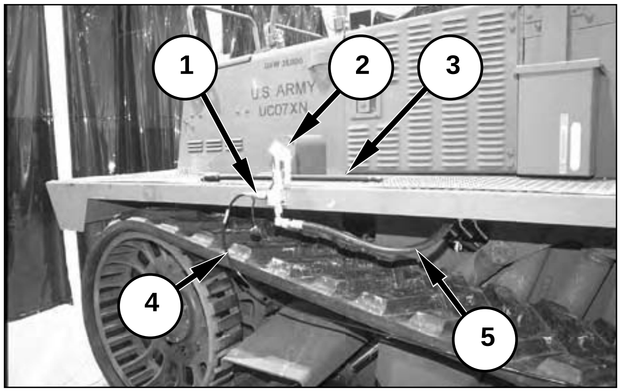
9. Return the pump handle to the BII box.

Emergency Blade Lift

Use this procedure to lift the blade if the machine is disabled.

WARNING

If the blade control lever is moved when the blade is above the ground, the blade will lower.



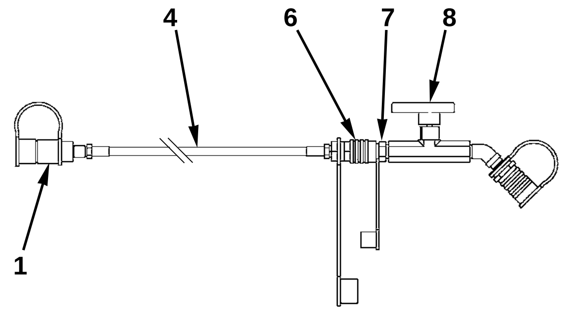
1. Install pump (2) (stored in the BII box) in the location provided on the right walkway. Use the two bolts and nuts that are provided with the pump.

2. Locate suction hose (5) and lines group coupler (4), stored in the BII box. Ensure that the hoses and couplings are clean.

3. Remove the cap from the fitting on the bottom port of pump (2), and connect but do not tighten one end of suction hose (5), as shown. Install the other end of the suction hose on the hydraulic tank drain port. Open the drain port. Loosen the fitting on the suction hose at the bottom port of the pump to bleed the air from of the suction hose. Catch the oil which flows from the hose in a suitable container, and dispose of the oil in accordance with local environmental regulations. After the air is bled from the suction hose, tighten the fitting.

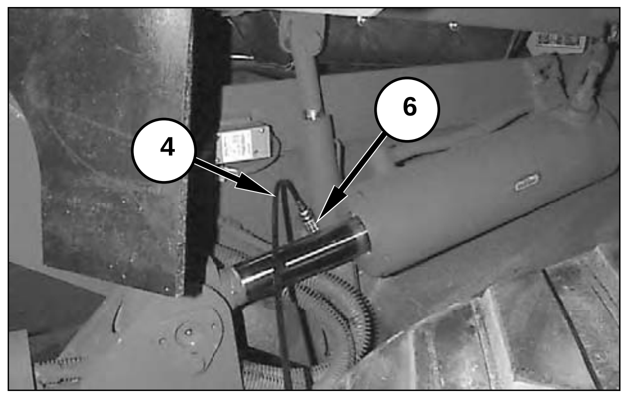
4. Remove the cap from the fitting in the side port of pump (2), and install coupling (1) of lines group coupler (4), as shown.

NOTE: To install coupling (1), snap the coupling onto the fitting. Turn the nut of the coupling clockwise until the nut is hand tight. The hose will turn with the nut.

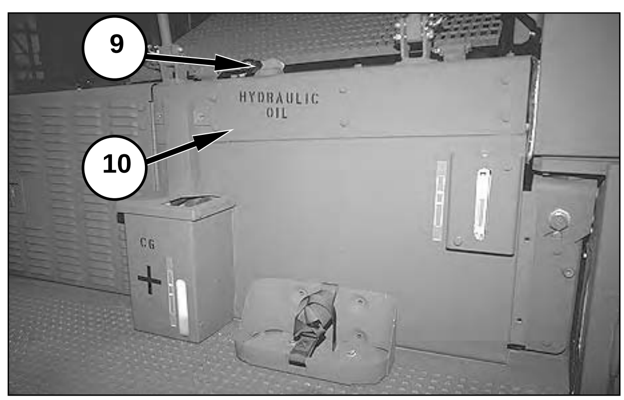


5. Disconnect coupling (6) and coupling (7) to remove valve (8) from lines group coupler (4).

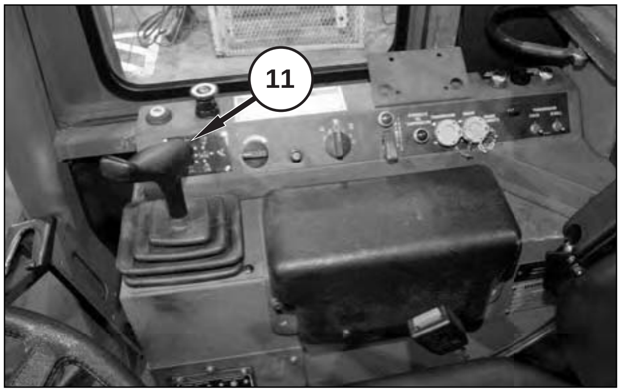
NOTE: Valve (8) can be left on lines group coupler (4). However, the valve must be open (knob in line with the hose).



6. Install coupling (6) of lines group coupler (4) to the pressure tap which is installed in the blade lift circuit. The pressure tap is located between the machine frame and the left blade lift cylinder.



7. Loosen cap (9) on hydraulic tank (10).



8. Hold blade control lever (11) in the RAISE position.

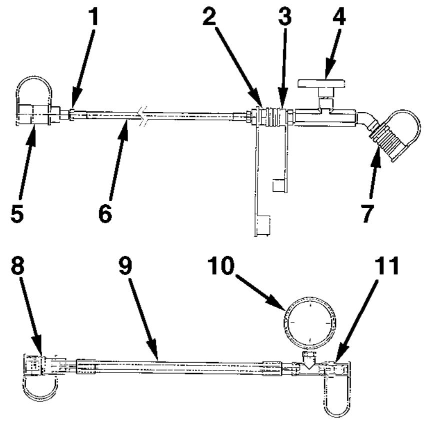
9. Use pump handle (3), stored in the BII box, to operate the pump and lift the blade.

10. Return blade control lever (11) to HOLD.

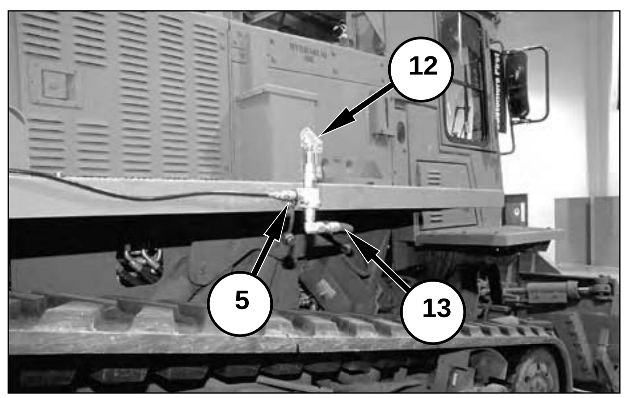
NOTE: It takes approximately 15 minutes of pumping to raise the blade fully on level ground. Reverse the steps in this procedure to remove the hoses and pump.

Manual Parking Brake Release

NOTE: Use this procedure to release the parking brakes if the machine is disabled and must be towed. The drive axles must also be removed before the machine is towed. Refer to "Operation Section, Towing Information" in this module.



1. Remove the lines group coupler (6) and the lines group gauge (9) from the BII compartment. Ensure that the hoses and couplings are clean. Disconnect coupling (2) from coupling (3) on the lines group coupler. Connect coupling (8) of the lines group gauge to coupling (3) of the lines group coupler. Connect coupling (11) of the lines group gauge to coupling (2) of the lines group coupler.



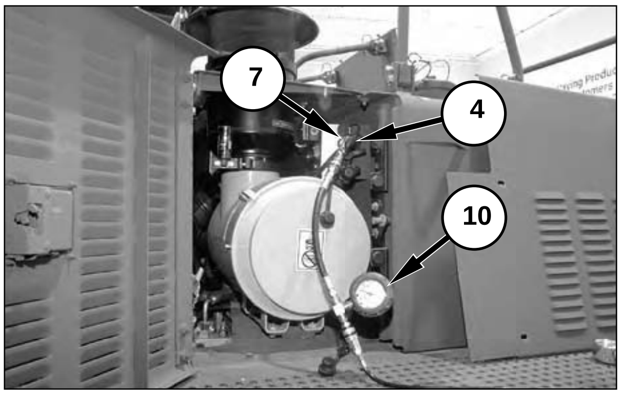
2. Install pump (12) (stored in the BII box) in the location provided on the right walkway. Use the two bolts and nuts that are provided with the pump.

3. Locate suction hose (13), stored in the BII box. Ensure that the hose and couplings are clean.

4. Remove the cap from the fitting on the bottom port of pump (12), and connect but do not tighten one end of suction hose (13), as shown. Install the other end of the suction hose on the hydraulic tank drain port. Open the drain port. Loosen the fitting on the suction hose at the bottom port of the pump to bleed the air from of the suction hose. Catch the oil which flows from the hose in a suitable container, and dispose of the oil in accordance with local environmental regulations. After the air is bled from the suction hose, tighten the fitting.

5. Remove the cap from the fitting in the side port of pump (12), and install coupling (5) of the lines group coupler, as shown.

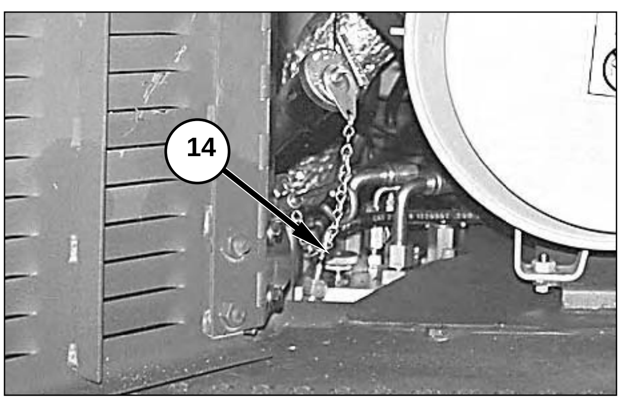
NOTE: To install coupling (5), snap the coupling onto the fitting. Turn nut (1) of the coupling clockwise until hand tight. The hose will turn with the nut.



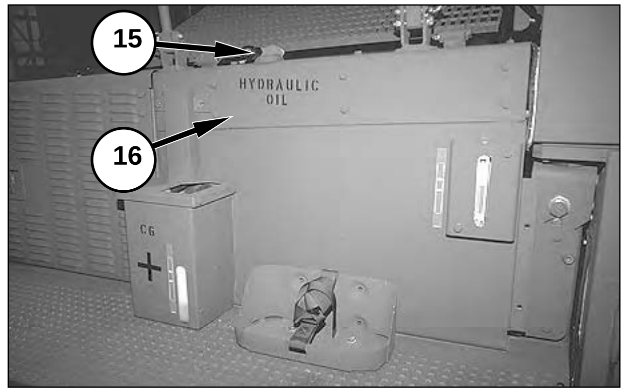
6. Install coupling (7) on the B-port, on the remote hydraulic tool manifold.

7. Open valve (4).

NOTE: Valve (4) is open when the knob is parallel with the hose and closed when the knob is perpendicular with the hose.



8. Close valve (14) by turning the gold knob on top of the multifunction valve clockwise until the knob stops.



9. Loosen cap (15) on hydraulic tank (16).

10. Use the pump handle, stored in the BII box, to operate pump (12) and release the parking brake.

11. When the pressure on gauge (10) reaches 6555 ± 345 kPa (950 ± 50 psi), close valve (4).

NOTE: The pressure developed by pump (12) may bleed down slowly. Every 15 minutes, open valve (4) and check the pressure on gauge (10). If the pressure is less than 6555 ± 345 kPa (950 ± 50 psi), operate the pump to increase the pressure. When the pressure is 6555 ± 345 kPa (950 ± 50 psi), close valve (4).

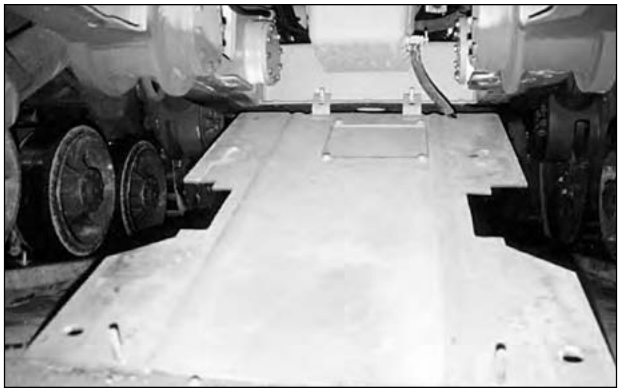
NOTICE

The rate at which the pressure will bleed down depends on the condition of the brakes. The 15 minute check interval is only a guideline. Some machines may require more frequent checks.

NOTE: To resume normal brake operation, close all valves which were opened, replace cap (15), remove all tooling, and open valve (14).

Bottom Cover Tilt

The engine and power train bottom covers can be configured as a back support to assist in servicing the components underneath the machine.



Engine Cover Shown, Power Train Cover Similar.

NOTE: Support the bottom cover with a floor jack. Dirt can accumulate on the top of the cover and increase the weight of the cover.

Remove the bolts which retain the cover. Hook the support brackets at the front of the cover on the pins provided. Let the back end of the cover rest on the ground. The weight of the engine cover is 36 kg (79 lb).

NOTE: The weight of the power train cover is 51 kg (111 lb).

Crank-Without-Inject

The crank-without-inject system is used to turn the engine over without starting it, for troubleshooting purposes. Exchange connectors (1) to disable the fuel injection system and allow the engine to be turned over without being starting.

NOTE: When the female end of the connector is connected to the male end which has the 200-BK wire at pin 1 and the H795-PK wire at pin 2, the engine is in the normal operating mode. When the female end of the connector is connected to the male end which has the H795-PK wire at pin 1 and the 200-BK wire at pin 2, the engine is in the CRANK-WITHOUT-INJECT mode.

NOTE: The crank-without-inject lamp on the instrument panel will come on when the engine is in the CRANK-WITHOUT-INJECT mode, and the blackout light switch is in either the SERVICE DRIVE or STOP LIGHT position.

Special Operational Preparations

Preparation for Arctic Operation

NOTE: The freeze protection of the engine coolant must be checked before the machine is moved into arctic conditions. For additional information, refer to “Maintenance Section, Cooling System Specifications” in *Operator’s Manual, Deployable Universal Combat Earthmover (DEUCE)*. If the freeze protection does not meet the expected operating conditions, refer to “Maintenance Section, Maintenance Intervals, Every 2000 Service Hours or Two Years, Cooling System, Change Coolant/Clean System,” in this module.

Procedure to Replace the Oil in the Main Vehicle Systems

Follow this procedure when the machine will be used in temperatures between –32 and -40°C (-25 to -40°F).

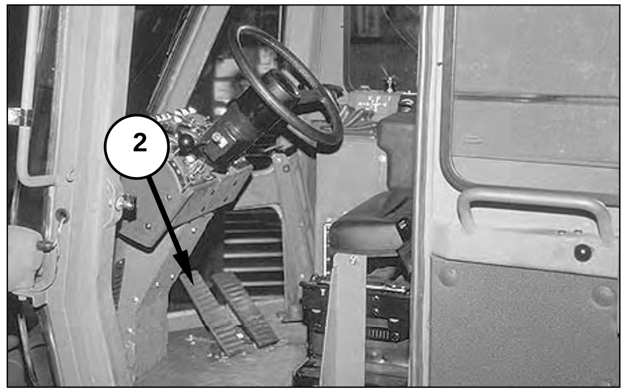
1. Park the machine on level ground and stop the engine.

2. Drain the fuel tank through drain valve (1) into a suitable container. The capacity of the fuel tank is approximately 341 L (91 U.S. gal). Dispose of, or store, the unused fuel according to local regulations.

3. Refill the fuel tank with Grade DF-A (arctic) fuel.

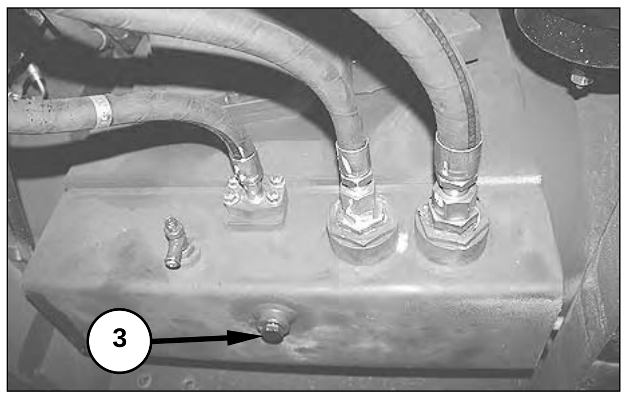
4. Operate the engine coolant heater. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* “Operation Section, Monitoring Systems and Cab Features, Switches,” and “Maintenance Section, Every 250 Service Hours or Three Months, Engine Coolant Heater.”

5. Operate the machine until all systems are at operating temperature.



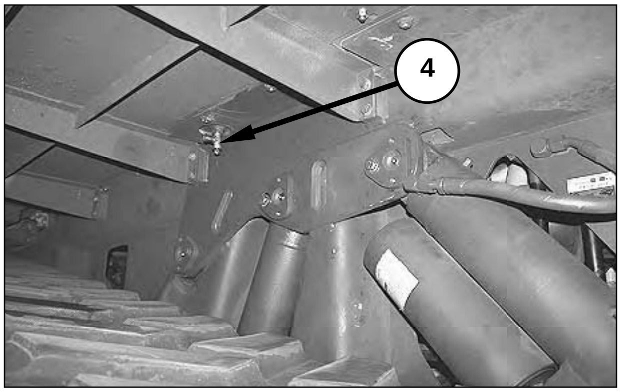
6. Fully depress service brake pedal (2) at least 120 times to discharge the brake accumulator.

7. Drain the power train oil from the differential steering case and the torque converter. Refer to the “Maintenance Section, Maintenance Intervals, Every 2000 Service Hours or Two Years, Power Train,” in this module.



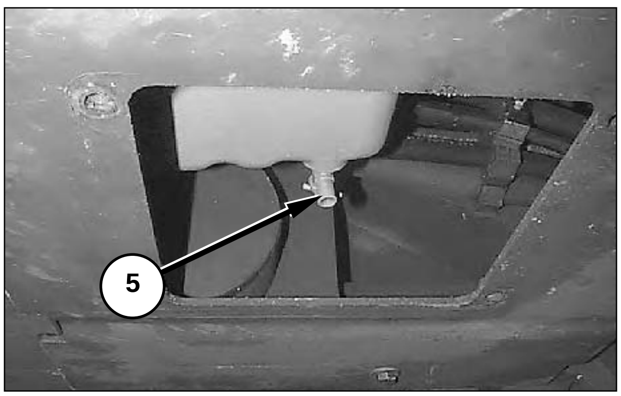
NOTE: When draining the power train oil from the differential steering case, remove drain plug (3) after the oil has drained through the drain valve; this will remove most of the oil remaining in the bottom of the differential steering case. Be sure to reinstall the drain plug before refilling the power train oil system.

8. Refill the differential steering case with 0W20 weight Transmission and Drive Train Oil (TDTO).



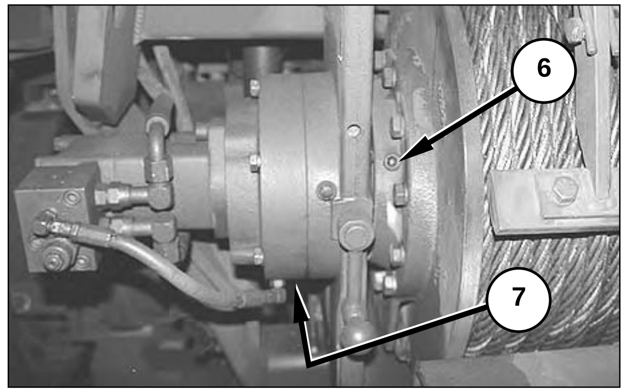
9. Drain the oil from the hydraulic tank through drain valve (4) and into a suitable container. The capacity of the hydraulic oil tank is approximately 72 L (19 U.S. gal). Dispose of the oil in accordance with local regulations.

10. Refill the hydraulic tank with 0W20 weight TDTO.



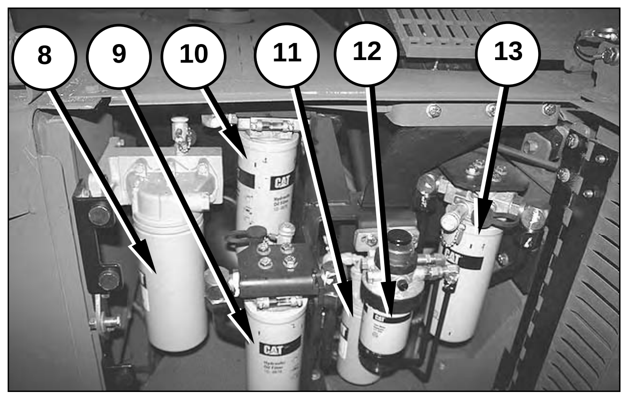
11. Remove the four bolts with washers and remove the access cover for the oil drain valve on the engine bottom cover. Drain the engine oil from drain valve (5) into a suitable container. The capacity of the engine oil system is approximately 35 L (9.2 gal). Dispose of the used engine oil according to local regulations.

12. Refill the engine with 0W20 weight Diesel Engine Oil (DEO).



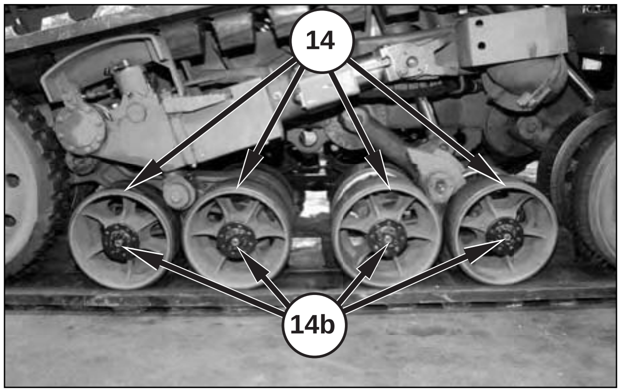
13. Drain the oil from the winch gearbox using drain port (6). The capacity of the winch gearbox is approximately 0.5 L (0.3 gal). Also drain the oil from the winch brake housing through port (7). The capacity of the winch brake housing is less than 0.5 L (0.3 gal).

14. Refill the winch gearbox with 0W20 TDTO.

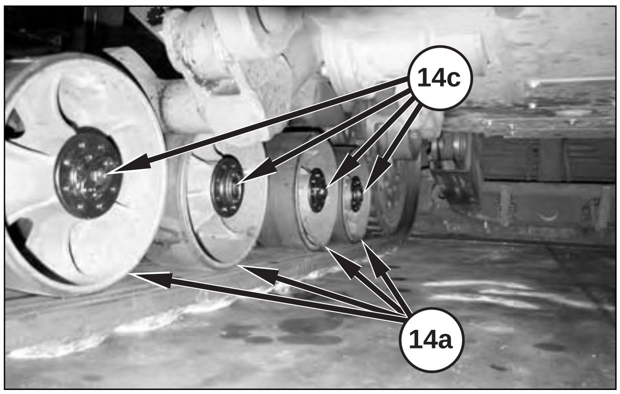


15. Replace engine oil filter (8), fuel filters (11) and (12), hydraulic filters (9) and (10), and power train oil filter (13).

16. Lift the machine until the drive belts are off the ground, and support the machine on suitable stands. For lifting information, refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Transportation Information, Machine Lifting and Tie Down." The stands should be placed under the machine frame. The weight of the machine is approximately 16 140 kg (35,500 lb).

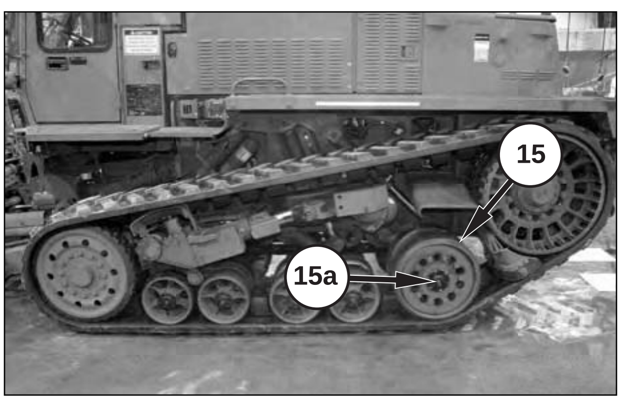


Outside Midrollers (14), (left side shown)



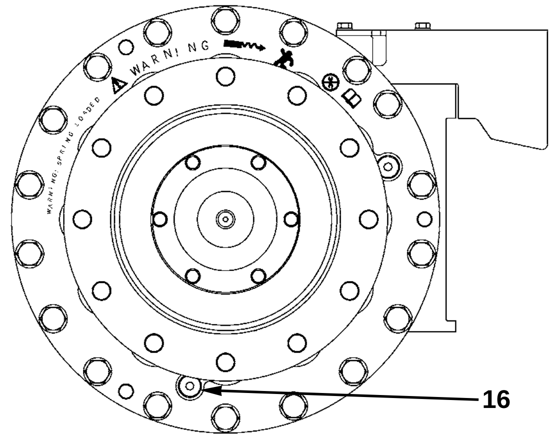
Inside Midrollers (14a), (left side shown)

17. Replace the oil in sixteen midrollers (14) and (14a) with the appropriate amount and type of oil until oil is visible in the sight gauges (14b) and (14c). Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Lubricant Viscosities and Refill Capacities."



18. Replace the oil in right and left rear idlers (15), (left side shown), with the appropriate amount and type of oil until oil is visible in the sight gauge (15a). Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Lubricant Viscosities and Refill Capacities."

19. Remove the outer front idler from the left and right sides of the machine. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Front Idler Group, Outer."



20. Remove drain plug (16), and drain the oil out of the brake housing on both sides of the machine. Catch the oil in a suitable container, and dispose of the oil in accordance with local environmental regulations. Replace the drain plug in each brake housing.

21. Install the outer front idler on the left and right sides of the machine.

22. Perform the suspension charging procedure. During the step to relieve existing pressure in the system, use a ratchet puller to displace as much oil as possible from the recoil cylinders, and use a floor jack to displace as much oil as possible from the other cylinders.

When the step to bleed air from each circuit is performed, do not close the bleed valve until approximately 3.8 L (1 U.S. gal) of oil has been displaced. Catch the displaced oil in a suitable container, and dispose of the oil in accordance with local environmental regulations.

Check the oil level in the hydraulic tank often during this procedure. Add 0W20 weight TDTO to the hydraulic tank when necessary.

NOTE: For a description of the suspension charging procedure, refer to *Specifications Systems Operation Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage, Steering, and Brakes,* "Testing and Adjusting, Suspension System Procedures, Suspension Hydraulic Charging Procedure." For a description of how to use a ratchet puller to displace oil from the recoil cylinders, refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Drive Belt."

23. Operate the machine for 30 minutes. During this time, operate each function of the blade to the end of the cylinder stroke in each direction. Operate the winch for at least ten revolutions in both directions. Operate the kneeling function in both directions five times.

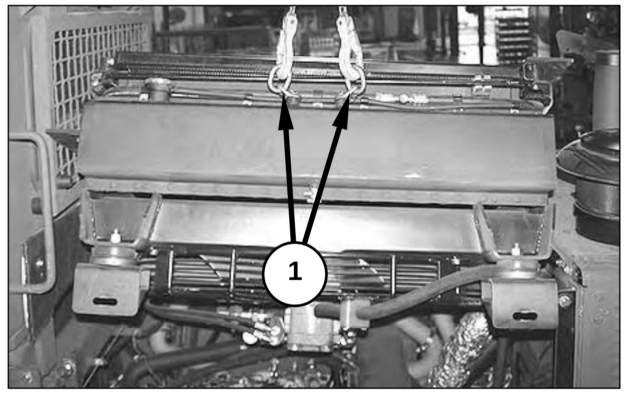
24. Repeat Steps 5 through 22 to remove the arctic grade oil that has mixed with the oil that remained in the system after the original oil was drained.

Procedure to Replace the Oil in the Cab/Radiator Tilt System

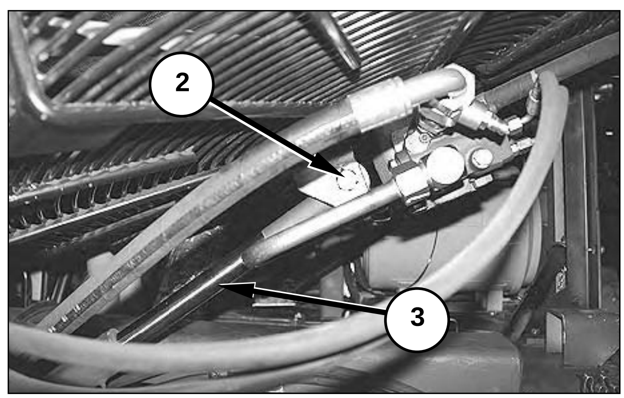
NOTE: If the oil in cab/radiator tilt pump has been replaced or supplemented with any oil that is not 0W20 TDTO, the oil in the cab/radiator tilt system must also be replaced. Follow the procedure below to replace the oil in the cab/radiator tilt pump system.

1. Raise the radiator. Refer to “Operation Section, Maintenance Features, Radiator Tilt,” in this module.

2. Raise the cab. Refer to “Operation Section, Maintenance Features, Cab Tilt,” in this module.

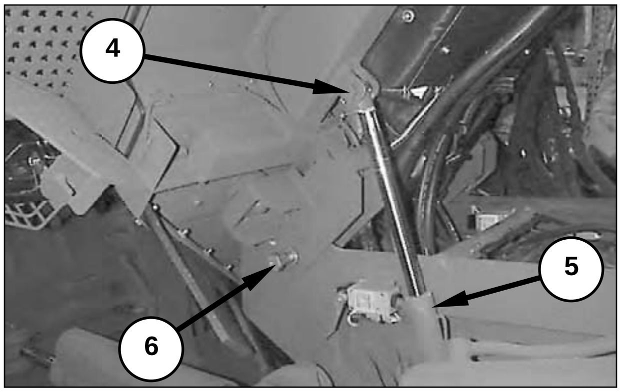


3. Install two 138-7573 Link Brackets (1), and support the radiator with a hoist. The weight of the radiator assembly is approximately 365 kg (800 lb).



4. Remove bolt (2) and the nut, washers and spacers.

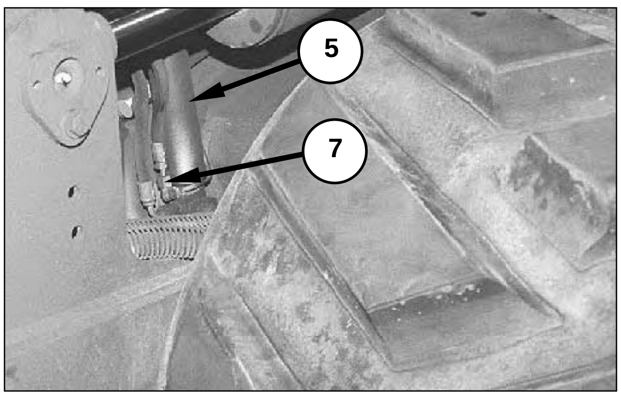
5. Retract radiator tilt cylinder (3) using the tilt pump.



6. Make sure that locking bolt (6) is in place on both sides of the cab.

7. Remove bolt (4) and the washers and spacers.

8. Retract cab tilt cylinder (5).

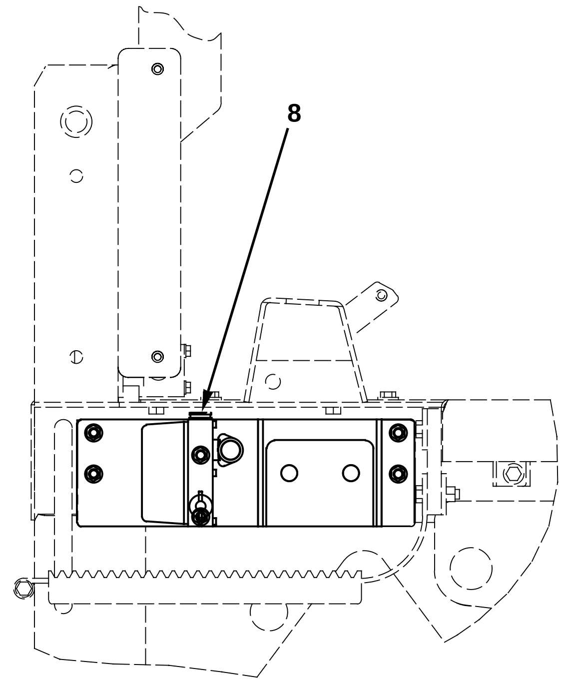


9. Disconnect line (7) on cab tilt cylinder (5).

10. Put the valves on the cab/radiator tilt pump system into position to raise the cab.

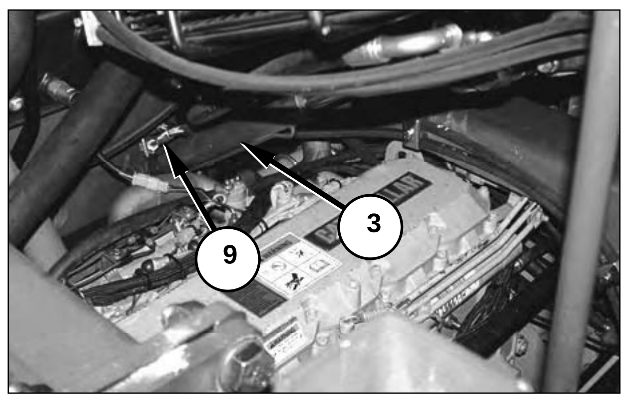
11. Place the end of line (7) into a suitable container, and operate the cab/radiator tilt pump until oil stops flowing from the line. The capacity of the cab/tilt radiator pump is approximately 1 L (0.25 U.S. gal).

12. Reconnect line (7) to cab tilt cylinder (5).



LEFT SIDE OF MACHINE

13. Remove cap (8) and refill the reservoir cab/radiator tilt pump approximately half way with 0W20 TDTO.



14. Disconnect line (9) from radiator tilt cylinder (3).

15. Place the end of line (9) into a suitable container.

16. Put the cab/radiator tilt pump system valves into position to raise the radiator.

17. Operate the cab/radiator tilt pump until the oil stops flowing from the end of line (9).

18. Reconnect line (9) to radiator tilt cylinder (3).

19. Refill the cab/radiator tilt pump with 0W20 TDTO.

20. Operate the cab/radiator tilt pump in the radiator RAISE position to align the hole in the end of radiator tilt cylinder (3) with the cylinder mount on the fan guard.

21. Reinstall bolt (2) with the nut, washers and spacers.

22. Remove link brackets (1) and the hoist.

23. Refill the cab/radiator tilt pump with 0W20 TDTO.

24. Operate the cab/radiator tilt pump in the cab RAISE position to align the hole in the end of cab tilt cylinder (5) with the hose in the cab mount.

25. Reinstall bolt (4) with the nut, washers and spacers.

26. Refill the cab/radiator tilt pump reservoir.

27. Lower, raise and then lower the cab.

28. Lower, raise and then lower the radiator.

29. Reinstall the cab retention bolts and the radiator covers.

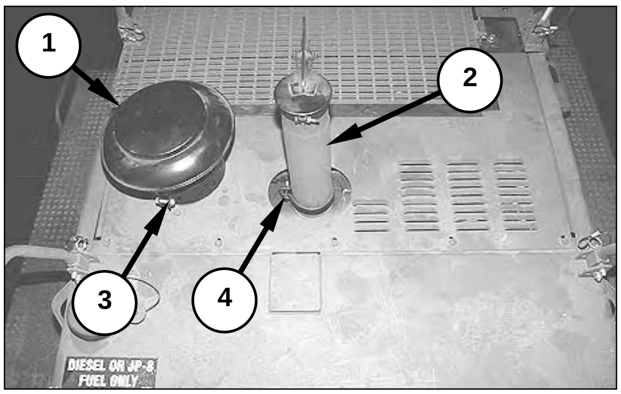
30. Refill the cab/radiator tilt pump with 0W20 TDTO.

Transportation Information

NOTE: Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Transportation Information" for more information related to transporting the machine.

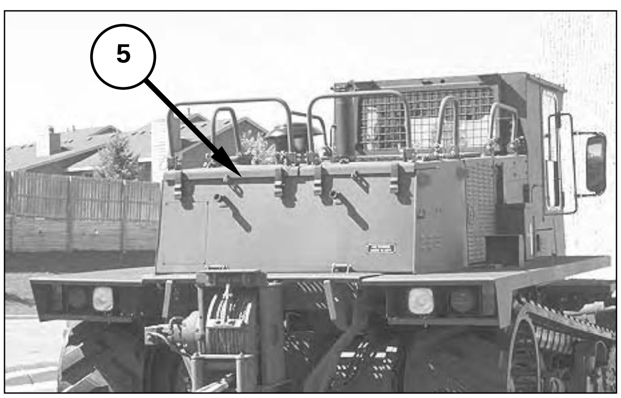
Machine Preparation for Low Velocity Air Drop (LVAD)

NOTE: Park the machine on a flat, level surface to remove the top half of the cab. If the machine is not level, there is an increased chance of breaking a window during the procedure.

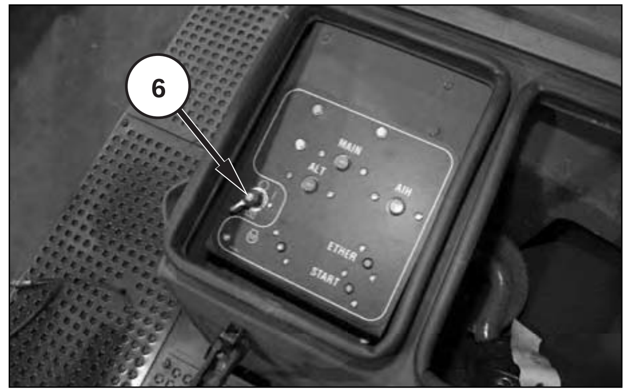


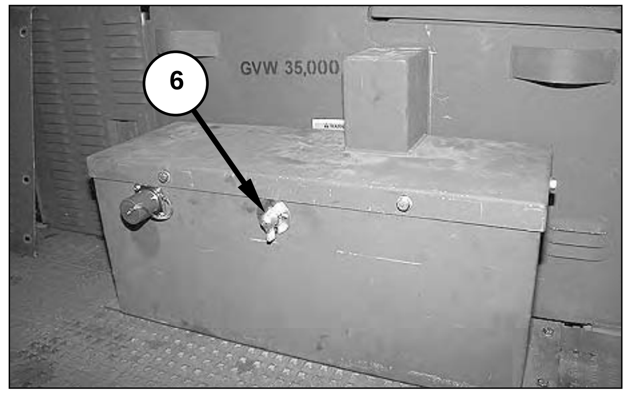
1. Remove clamp (4) and muffler extension (2).

2. Remove clamp (3), and precleaner hood (1).



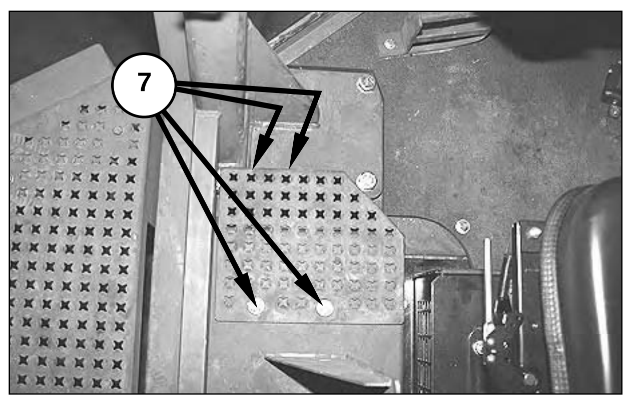
3. Store the muffler extension, precleaner assembly and the associated hardware in BII compartment (5).



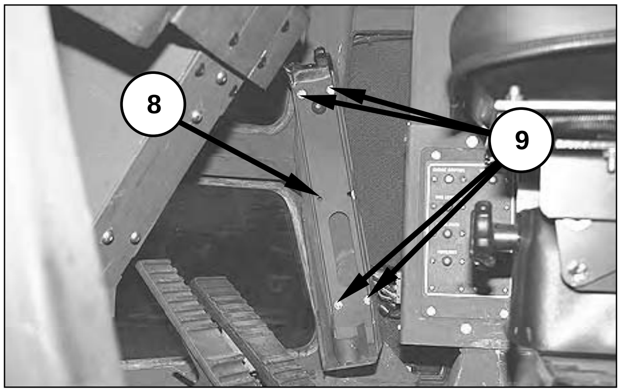


Arctic Battery Box (If Equipped)

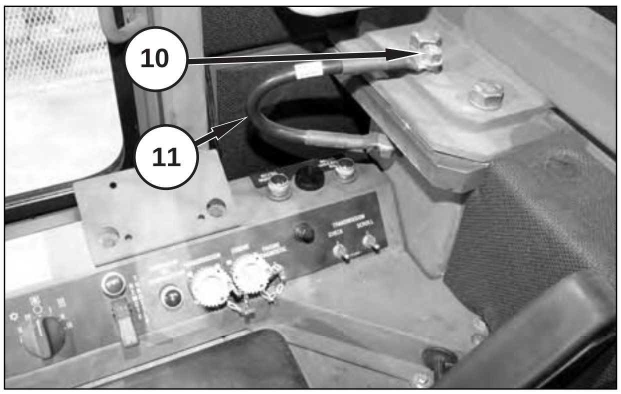
4. Move main disconnect switches (6) into the OFF position.



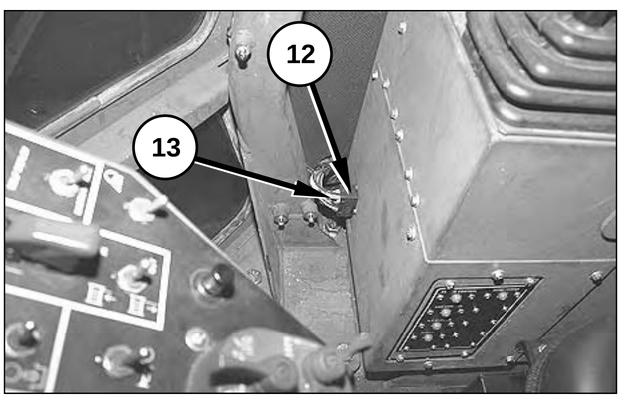
5. Remove four bolts (7) and the washers, and remove the tread plate.



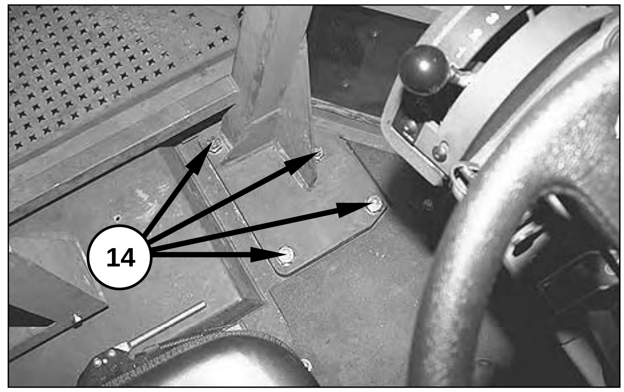
6. Remove four bolts (9) and the washers, and remove rifle bracket (8).



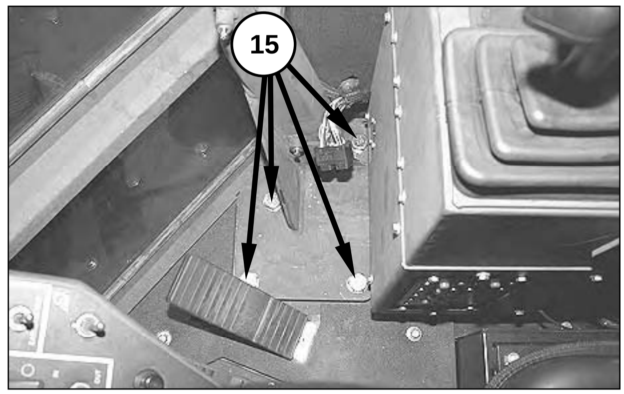
7. Remove one nut (10) with the washers, and disconnect ground cable (11) from the ground stud.



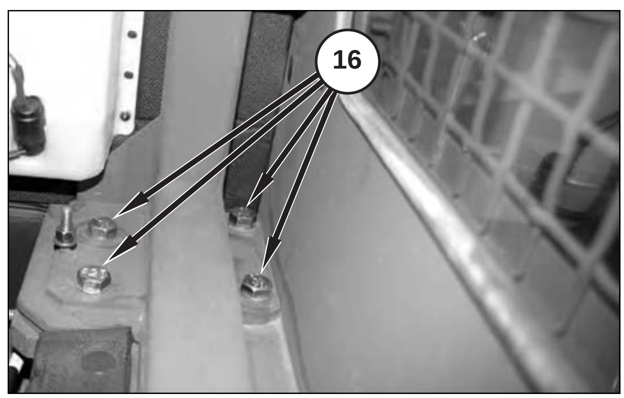
8. Loosen one screw (13), and disconnect connecter (12).



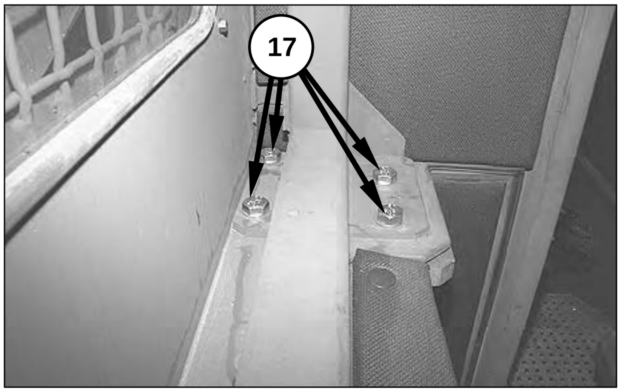
9. Remove four bolts (14) and washers from the left front corner of the cab floor.



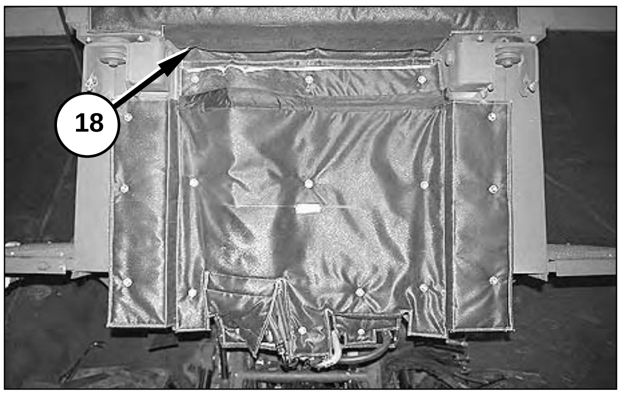
10. Remove four bolts (15) and washers from the right front corner of the cab floor.



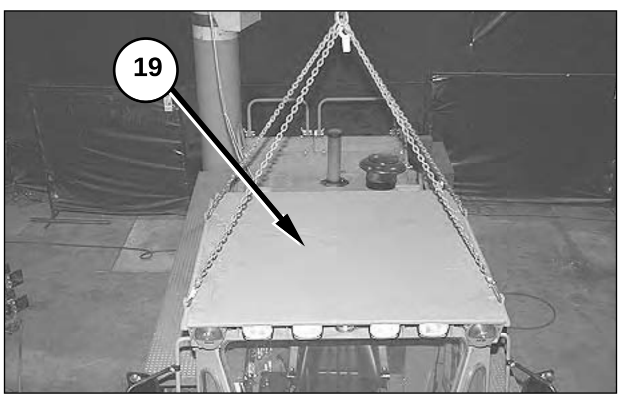
11. Remove four bolts (16) and washers from the right rear corner of the cab.



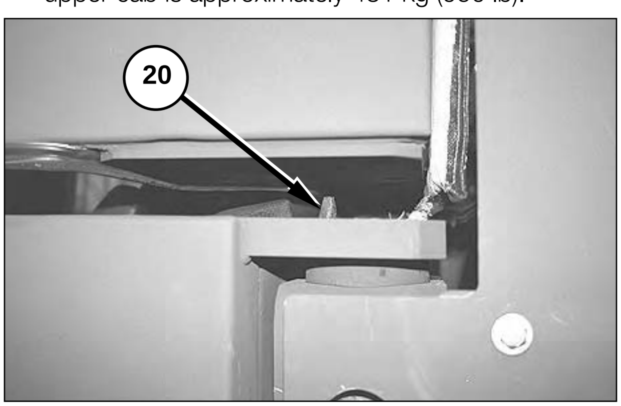
12. Remove four bolts (17) and washers from the left rear corner of the cab.

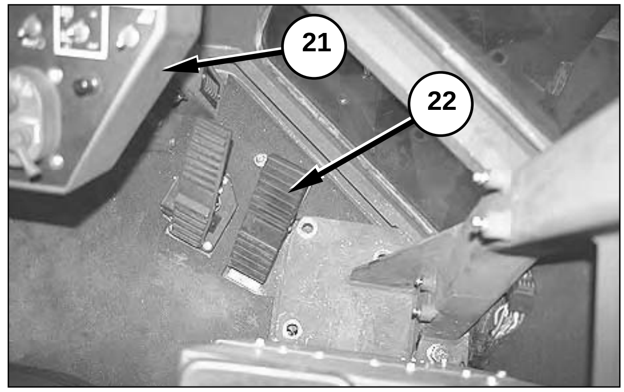


13. Detach the insulation cover on the back of the cab at seam (18).



14. Attach a hoist to upper cab (19). The weight of the upper cab is approximately 431 kg (950 lb).

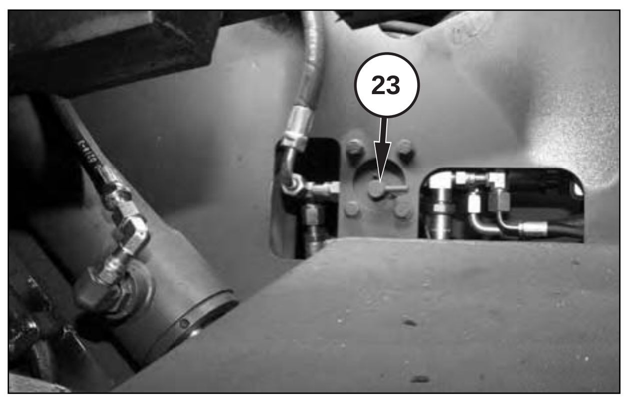




15. Lift the cab vertically for approximately 25 mm (1 in) to allow the mounting pads in the upper cab to clear guide pins (20) at the rear of the cab platform. Once the cab has cleared the guide pins, slowly move the cab forward until it has cleared accelerator pedal (22), and then remove the cab.

NOTE: Rig the DEUCE in accordance with FM 10-521 and TO 13C7-6-21.

NOTE: Pay close attention when lifting the cab away from the platform. Make sure that the cab does not damage accelerator pedal (22), instrument console (21), or the back of the operator's seat.

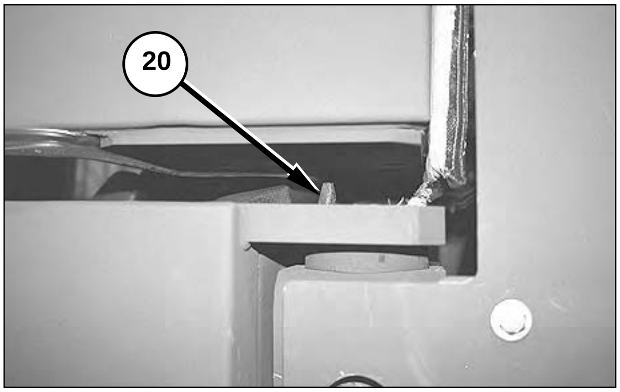


15a. Verify that suspension manual lockout valve (23, on both sides of the machine) are turned fully clockwise to the OPEN position.

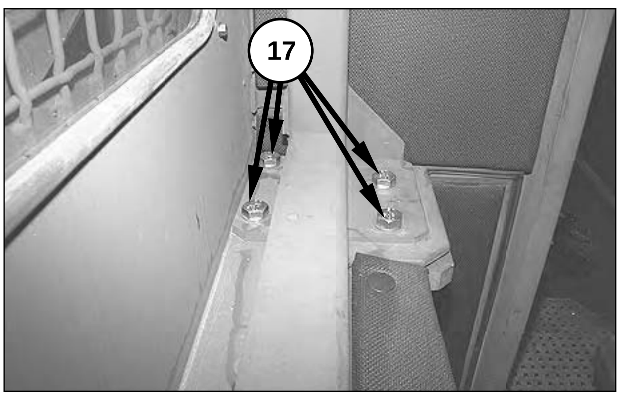
NOTE: The following procedure is for reconfiguring the machine after it has been air dropped.

NOTE: Before the cab is replaced, the integrity of the seals between the cab and the platform should be checked. Replace the seals if necessary. Reseal any areas that may leak with 4C9613 RTV Silicone-Clear.

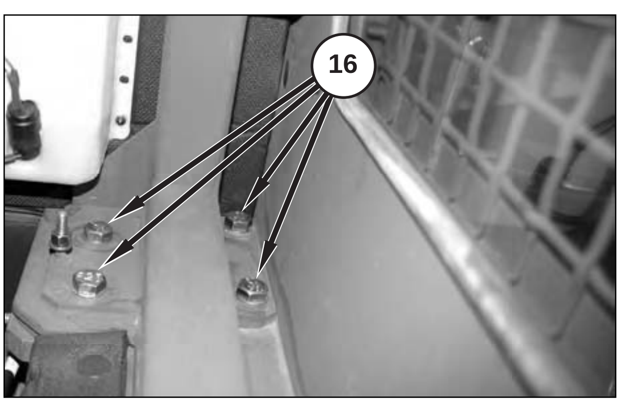
NOTE: The bolts installed in Steps 17, 18, 20 and 21 should not be torqued to specification until the cab has been seated on the frame and all the bolts are in place.



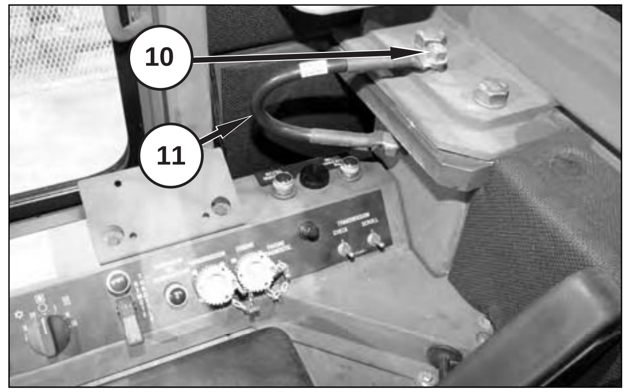
16. Lower the cab on guide pins (20) at the rear of the cab platform.



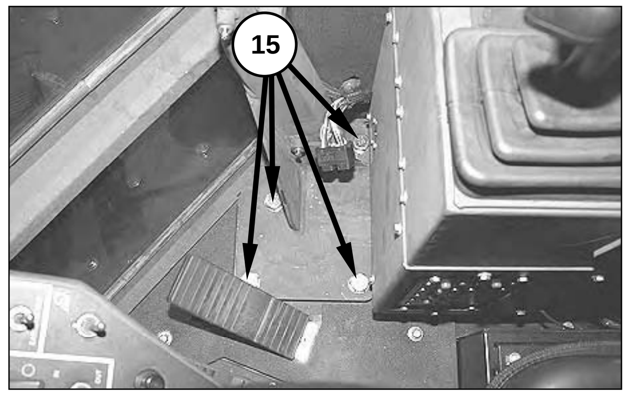
17. Install four bolts (17) and washers in the left rear corner of the cab. Tighten the bolts to a torque of 460 ± 60 N•m (340 ± 45 lb ft).



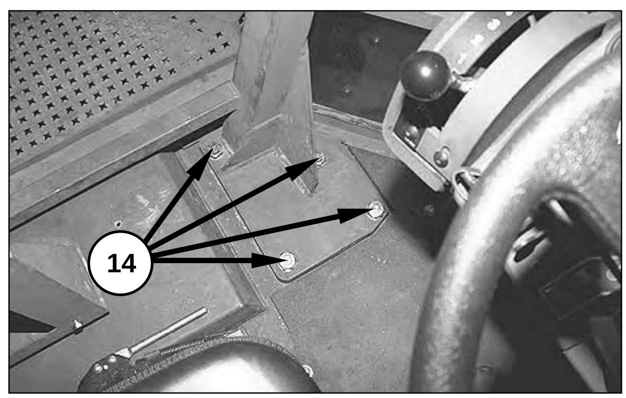
18. Install four bolts (16) and washers in the right rear corner of the cab. Tighten the bolts to a torque of 460 ± 60 N•m (340 ± 45 lb ft).



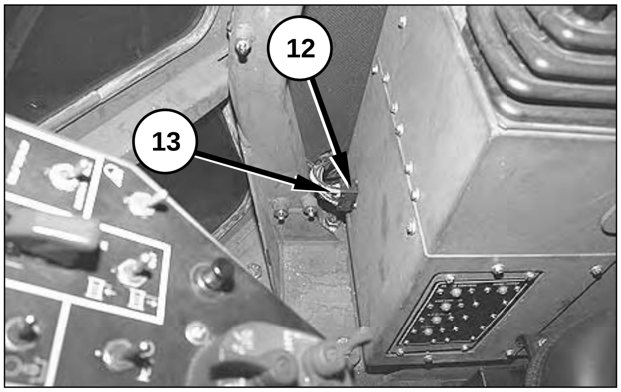
19. Connect ground cable (11) to the ground stud, and install nut (10) with the washers.



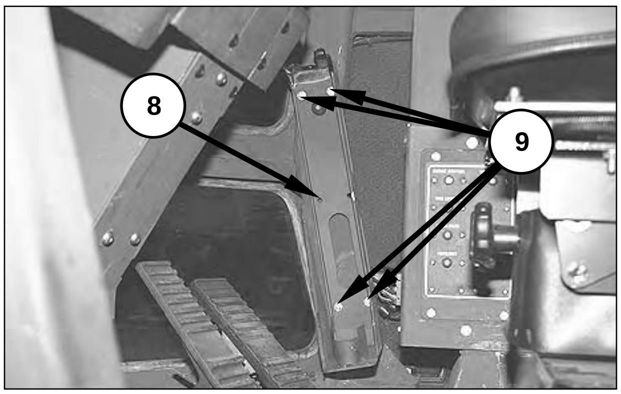
20. Install four bolts (15) and washers in the right front corner of the cab. Tighten the bolts to a torque of 460 ± 60 N•m (340 ± 45 lb ft).



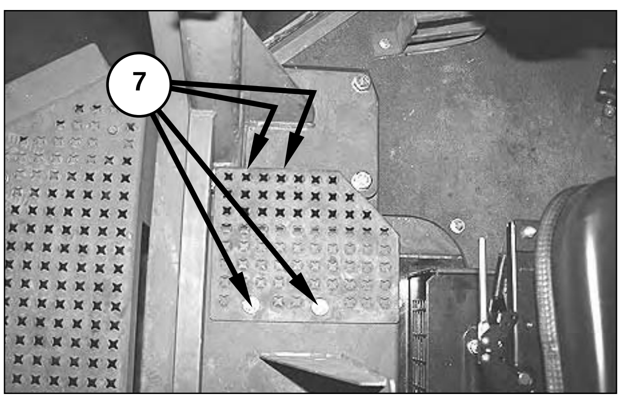
21. Install four bolts (14) with washers in the left front corner of the cab. Tighten the bolts to a torque of 460 ± 60 N•m (340 ± 45 lb ft).



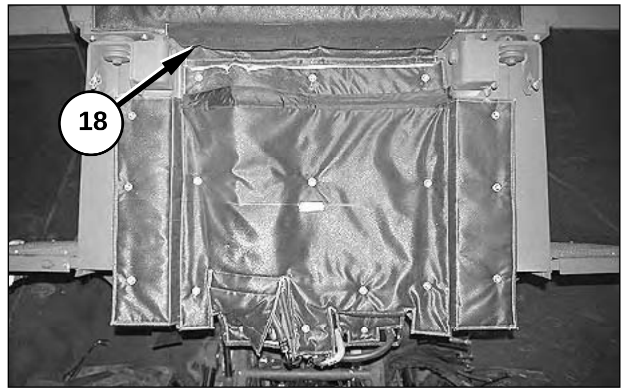
22. Connect connector (12) and tighten screw (13) to a torque of 0.9 N•m (8 lb in).



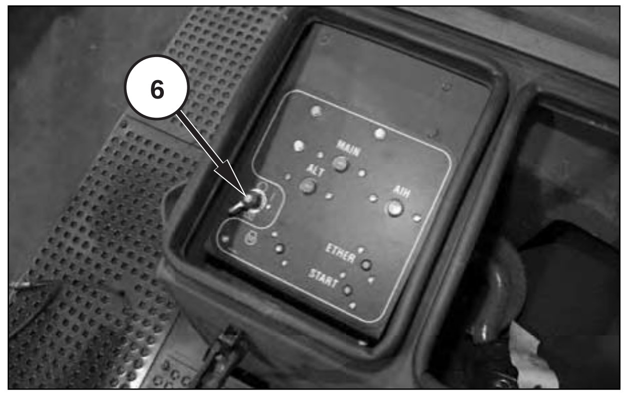
23. Install four bolts (9) and washers, and install rifle bracket (8).

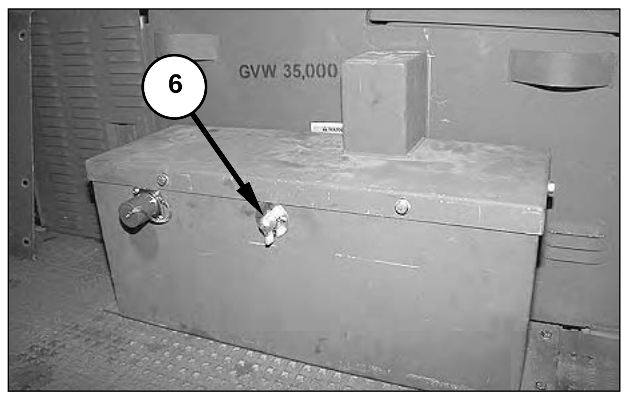


24. Install four bolts (7) and washers, and install the tread plate.



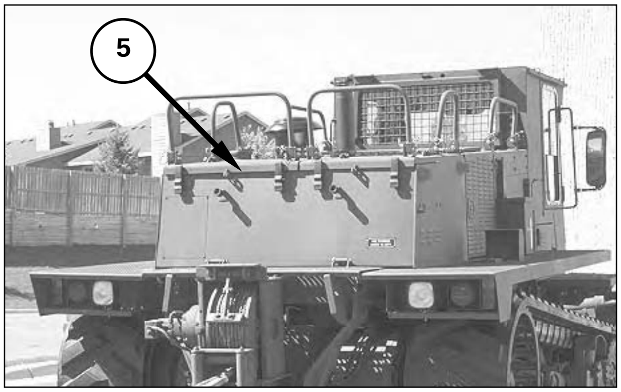
25. Attach the insulation cover at seam (18).



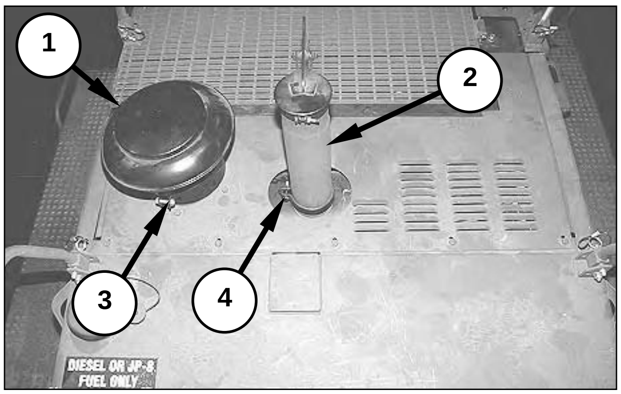


Arctic Battery Box (If Equipped)

26. Move main disconnect switches (6) into the ON position.



27. Retrieve the muffler extension, precleaner assembly and the associated hardware from BII compartment (5).



28. Install precleaner hood (1) with clamp (3).

29. Install muffler extension (2) with clamp (4). Make sure to install the muffler extension with the rain cap hinge facing towards the front of the machine, as shown.

Towing Information

General Information

WARNING

Personal injury or death could result from towing a disabled machine incorrectly.

Be sure all necessary repairs and adjustments have been made before a machine that has been towed to a service area is put back into operation.

Follow the recommendations below to properly perform the towing procedure.

These towing instructions are for moving a disabled machine a short distance, at low speed (no faster than 2 kph [1.2 mph]), to a convenient location for repair. These instructions are for emergencies only. Always haul a disabled machine if long distance moving is required.

The towing machine must have shielding to protect the operator if the tow line or bar breaks.

Do not allow an operator on the machine being towed since it is not possible to control the steering and braking.

Before towing, make sure the tow line or bar is in good condition and has enough strength for the towing situation involved. Use a towing line or bar with a strength of at least 1.5 times the gross weight of the towing machine to tow a disabled machine which is stuck in the mud, or when towing on a grade.

NOTICE

The winch cable is rated at 195 712 N (44,000 lb). This cable can be used for self-recovery but cannot be used to tow another DEUCE.

Do not use a chain for pulling. A chain link may break and cause injury. Use a wire rope cable with loop or ring ends. An observer (in a safe position) should stop the pulling procedure if the cable starts to break or unravel. Stop pulling whenever the pulling machine moves but the machine being towed does not.

Keep the tow angle to a minimum. Do not exceed a 30-degree angle from the straight ahead position.

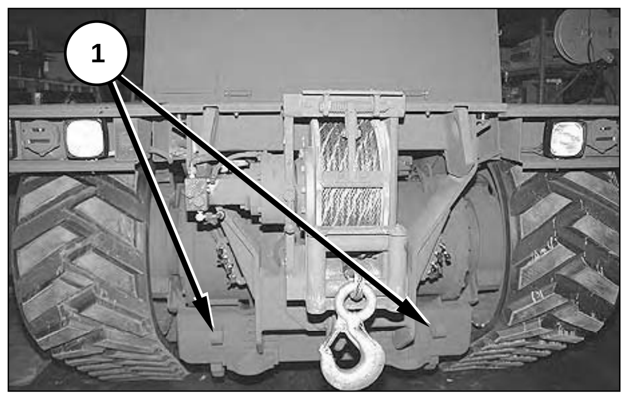
Quick machine movement could overload the tow line or bar and cause it to break. Gradual and smooth machine movement works better.

Normally, the towing machine should be as large as the disabled machine. Satisfy yourself that the towing machine has enough brake capacity, weight and power to control both machines for the grade and distance involved.

To provide sufficient control and braking when towing a disabled machine down a hill, a larger towing machine or additional machines connected to the front of the towing machine may be required. This will prevent the towed machine from rolling uncontrollably.

All possible situational requirements cannot be given, as minimal towing machine capacity is required on smooth, level surfaces, and increased capacity is required on inclines or where surface conditions are poor.

Any towed machine, when loaded onto a trailer, must be equipped with its own brake system which is operable from the operator's compartment.



When towing the machine, use towing brackets (1), at the rear of the machine, on both sides of the winch.

NOTICE

This machine is equipped with spring-applied parking brakes. The parking brakes must be hydraulically released before the machine can be towed. Also, the final drives must be disabled before the machine is towed. Failure to release the parking brake and/or to disable the final drives before the machine is towed can damage the machine. Notify Unit Maintenance to perform these procedures if the machine must be towed.

Preparation for Towing a Disabled Machine

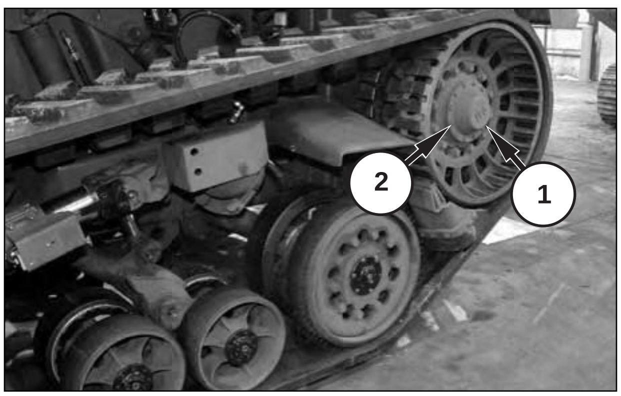
⚠ WARNING

Personal injury or death could result from towing a disabled machine incorrectly.

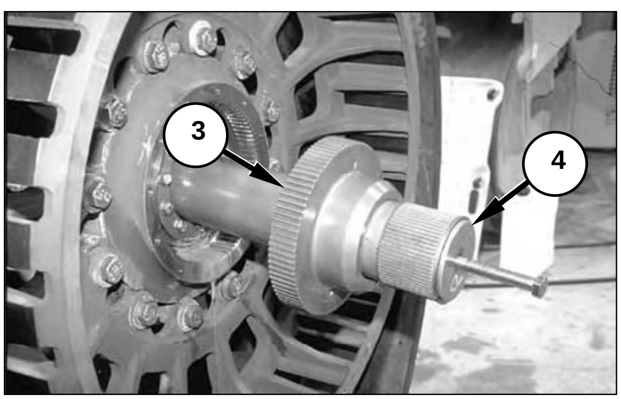
Be sure all necessary repairs and adjustments have been made before a machine that has been towed to a service area is put back into operation.

Follow the recommendations below to properly perform the towing procedure.

NOTE: Make sure to read and understand the information in "General Information," on the previous page, before towing the machine.



1. Remove twelve bolts (2) with washers, and cover group (1), with the O-ring.



2. Install a 20 mm bolt in the puller hole of drive shaft (4), and use two people to remove the drive shaft and coupling (3) together. The combined weight of the drive shaft and the coupling is 45 kg (100 lb).

3. Reinstall cover group (1) with twelve bolts and washers (2).

4. Repeat Steps 1 through 3 for the other side of the machine.

5. If the engine and hydraulic system are functional, start the engine and allow it to idle. Release the parking brake.

6. If the engine and hydraulic system are not functional, manually release the parking brake. Refer to "Manual Parking Brake Release," in the "Operation Section, Maintenance Features" section of this module.

Machine Storage

General Requirements

Engine

Caterpillar recommends that Volatile Corrosion Inhibitors (VCI oil) be used to prevent internal engine damage due to moisture during storage. These inhibitors evaporate inside the engine and then condense over the inside surfaces.

This evaporation and condensing process offers full protection to surfaces that cannot be reached with preservatives that require direct application. VCI oil will be easier to clean from the engine when the engine is removed from storage.

By simply running the engine to operating temperature, the volatile vapors are removed, leaving the mineral oil base. The oil should then be drained, and new oil and filters should be installed.

Cooling System

Cooling systems should be preserved with Caterpillar Antifreeze, or an equivalent. Caterpillar Antifreeze contains the necessary inhibitors to prevent corrosion and pitting. When used in the proper mixture, the antifreeze will prevent damage due to rust and freezing.

Although not recommended, it is common in warm climates to store the engine with plain, acceptable water in the cooling system. In such cases, the water must be treated with Caterpillar Supplemental Coolant Additive, or an equivalent.

NOTICE

Always fill the radiator completely full to prevent rusting of the top tank. Do not leave an air space.

All exposed surface areas will rust.

Caterpillar Antifreeze

Caterpillar Antifreeze contains the necessary corrosion inhibitors to protect the cooling system from rust, and to prevent the pitting of cooling system components. Use Caterpillar Antifreeze, and acceptable water, to provide the necessary coolant mixture required for the lowest ambient temperature anticipated.

For additional information about antifreeze, refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Cooling System Specifications." Caterpillar Antifreeze is available from your Caterpillar dealer.

Supplemental Coolant Additive

Use a 3-to-6 percent concentration of Caterpillar Cooling System Conditioner on engines that will be stored with water only in the cooling system. If the engine is stored with Caterpillar Antifreeze, there is no need to add conditioner before storage.

Refer to the coolant topics in the "Maintenance Section" of this module and to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Cooling System Specifications" for additional information about coolant. Caterpillar Cooling System Conditioner is available from your Caterpillar dealer.

Cooling System Cleaner

Caterpillar Cooling System Cleaner is designed to clean the cooling system of harmful scale and corrosion. It is available in 1.9 L (one-half U.S. gal) containers. Directions for use are printed on the container.

Equipment Needed

⚠ WARNING

To avoid personal injury, read and understand all directions and hazards printed on the labels of any product which is used to preserve your equipment.

Use all the necessary protective equipment required to do the job.

Sprayer

An air compressor with a sprayer attachment, or a Caterpillar 1P-0540 Flow Checking Tool Group, can be used to prepare the engine for storage.

The nozzle adjustment should give either a spray or a fog. The fog adjustment is better if access to the components is difficult. The spray is better for parts on the outside of the engine.

Paint

Parts on the outside of the engine or other machine components can best be protected by thorough use of a good quality paint. Paint provides good protection for a storage period of up to two years. Before painting, the part to be painted must be thoroughly cleaned.

Plastic Bags

Use black or dark plastic bags for storage. Clear plastic bags will not last for long periods of time.

Sealing Tape

Use sealing tape with good adhesive properties. Tape is available in two-inch rolls. Do not use duct tape; it will come loose.

A good quality sealing tape is available from the following suppliers:

3M Product Information Center

3M Center
Technical Tape Inc.
Building 5153N-06
St. Paul, MN 55144
U.S.A.

Telephone: (800) 364-3577

3M Industrial Tapes

3M Center
Building 220-8E0-04
St. Paul, MN 55144

NOX-RUST 1031B

NOX-RUST 1031B is a rust preventative that can be applied to any exposed (unpainted) machine surface. It can be applied by spraying, brushing, or dipping.

This product and additional information is available from:

Customer Service
Daubert Chemical Co. Inc.
4700 South Central Ave.
Chicago, IL 60638
U.S.A.

Telephone: (708) 496-7350

TARP Preservative

This preservative may be applied to any surface of the equipment except where paint is uncured (less than 48 hours old).

This product and additional information is available from:

Castrol North America
Castrol Industrial Inc.
149 Grant St.
North Aurora, IL 60542
U.S.A.

Telephone: (708) 892-8881

CYLIX 33

CYLIX 33 is to be used on all chromed surfaces of the hydraulic cylinders, to minimize corrosion and pitting of the rods.

This product and additional information is available from:

Customer Service
Dadant & Sons Inc.
51-T South Second St.
Hamilton, IL 62341
U.S.A.

Telephone: (217) 847-3324

1890 Protective Sealer

This protective sealer is available from distributors of Dow Corning products. This sealer is used to minimize the corrosion of electrical wiring, connectors, and components from salt water spray, salt mines, fertilizer plants, etc.

Be sure to observe all safety precautions and application instructions provided by the supplier.

Oils and Lubricants

Refer to *Operator’s Manual, Deployable Universal Combat Earthmover (DEUCE)*. Use only the specified oils for the engine crankcase, drive train, hydraulic system etc., as recommended.

Multipurpose Grease

Use 5P-0960 Multi-purpose Grease (MPGM), together with VCI oil to lubricate rod threads, ball joints, and linkages. The grease should contain 3-to-5 percent molybdenum disulfide and conform to MIL-M-7866. NLGI Number 2 Grade is suitable for most temperatures.

Filters

Refer to *Parts Manual, Deployable Universal Combat Earthmover (DEUCE)* for the necessary filter part numbers. These filters are available through your Caterpillar dealer.

Coolant Conditioner Test Kit

Use the 8T-5296 Coolant Conditioner Test Kit to check the concentration of the conditioner in the cooling system. Maintain the cooling system with a 3-to-6 percent conditioner concentration. Instructions are included with the kit.

Coolant and Battery Tester

The tester is used for checking the coolant freezing point and the condition of the battery fluid. Instructions are provided with the tester. The 5P-0957 Tester is available with the temperature scale in degrees Fahrenheit. The 5P-3514 Tester is available with the temperature scale in degrees Celsius.

VCI Oil

VCI oil can be used in all tanks: engine, fuel, hydraulic, power steering, transmission, differential, etc. VCI oil is an oil stabilizer and is rust preventative and can also be used in combination with any petro chemical. Apply by spraying or fogging.

Caterpillar recommends that VCI oil be used to prevent internal engine damage due to moisture during storage. These inhibitors evaporate inside the engine and then condense over the inside surfaces.

This evaporation and condensing process offers full protection to surfaces that cannot be reached with preservatives that require direct application. VCI oil is also easier to clean from the engine when removing the engine from storage.

By simply running the engine to operating temperature, the volatile vapors are removed, leaving the mineral oil base. The oil should then be drained and new oil and filters should be installed.

VCI oil should not be used full strength on non-ferrous metals where the oil will have direct, prolonged contact. The oil must be diluted, as recommended in the instructions that follow.

An engine cannot be successfully treated with VCI oil unless the engine is completely sealed for storage. VCI oil is so volatile that any opening left unsealed will allow the vapors to escape, causing the engine to loose its protection.

VCI, NOX-RUST VCI #10 oil or the equivalent oil gives both liquid and vapor protection to ferrous metal surfaces against corrosion caused by moisture. In a closed compartment, protection is either by direct contact with VCI oil or by contact with VCI vapors. See your local supplier for a similar type oil.

Additional information on the use of VCI oil and a list of suppliers outside the U.S.A. can be obtained by contacting:

Customer Service
Daubert Chemical Co. Inc.,
4700 S. Central Ave.
Chicago, IL 60638
U.S.A.
Telephone: (708) 496-7350

Diesel Fuel

Diesel fuel which is left in fuel tanks and fuel injection systems may result in sticking fuel pumps or malfunctioning fuel injection valves. Draining the fuel injection pump and refilling it with Caterpillar Calibrating Oil can minimize these problems.

Calibrating Oil is available from your Caterpillar dealer.

Diesel Fuel Biocide

To prevent the growth of small organisms in the diesel fuel, use diesel fuel biocide such as Biobor JF, or an equivalent.

Additional information on the use of diesel fuel biocide and a list of suppliers outside the U.S.A. can be obtained by contacting:

Angus Chemical Company
1500 E. Lake Cook Road
Buffalo Grove, IL 60089
U.S.A.
Telephone: (847) 215-8600

Hammond Technology
15760 West Hardy
Suite 400
Houston, TX 77060
U.S.A.
Telephone: (713) 999-2900

Buckman Laboratories Inc.
1256 N. MC Lean Blvd.
Memphis, TN 38108
U.S.A.
Telephone: (901) 278-0330
Telephone: (800) 937-7486

Engine Storage

If an engine is not used for prolonged periods, oil can run off the cylinder walls, piston rings, main bearings, connecting rod bearings, crankshaft, gears, and other parts that normally get lubrication.

This lack of lubricant allows corrosion to start on the metal, especially in areas of high humidity (water content in the air).

If the engine is started again before these surfaces get oil, the metal-to-metal contact will cause wear. To keep this wear at a minimum, use the crank-without-inject feature of the engine to turn the engine over without starting it. When oil pressure is shown on the pressure gauge, start the engine.

1. First, clean the engine of all dirt, rust, grease, and oil. Inspect the exterior of the engine, and paint areas that have paint damage with a good quality paint.

2. Remove any dirt from the air cleaner. Check all seals and gaskets and the filter element for damage.

3. Drain and replace the crankcase oil, and change the oil filter(s). Refer to “Maintenance Section, Maintenance Intervals, Every 250 Service Hours or Three Months,” in this module.

4. Add VCI oil to the crankcase at the rate of 3-to-4 percent by volume.

NOTE: If the engine crankcase is full, drain enough engine oil to add the mixture.

5. Remove the air filter element. Turn the engine at cranking speed using the crank-without-inject feature. Use a sprayer to add a mixture of 50% VCI oil and 50% engine oil into the air intake or turbocharger inlet. Install the air filter element, and completely enclose the element with dark plastic bags, sealing it with tape. Reinstall the air filter covers. Put tape over all openings to seal the VCI vapors in the engine.

6. Use a sprayer to apply a mixture of 50 percent VCI oil and 50 percent engine oil into the exhaust openings. The minimum application volume is 40 mL (1.4 oz). Seal the exhaust pipe, including the drain holes in the muffler.

7. Replace both primary and secondary fuel filters. Operate priming pump until resistance is felt.

Open the fuel tank drain valve, and allow any water or dirt to drain from inside the fuel tank. Apply a spray of 340ml (11oz) of 50% VCI and 50% engine oil to prevent rust in the fuel tank. Add 50 mL (2 oz) of commercial biocide (Biobor JF) to the fuel.

Apply a small amount of oil to the threads on the fuel tank filler neck, and install the cap. Seal all openings to the tank, to prevent the evaporation of the fuel and preservative.

8. Remove the fuel injectors and apply 30 mL (1 oz) of VCI oil mixture (50 percent VCI oil and 50 percent engine oil) into each cylinder. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI Diesel Engine,* “Unit Injectors” for the procedure to remove and install the fuel injectors.Use a bar (or other turning tool) to turn the engine over slowly; this will put the oil on the cylinder walls. Reinstall the fuel injectors.

9. Spray a thin amount of VCI oil mixture (50 percent VCI oil and 50 percent engine oil) on the flywheel, ring gear teeth, and starter pinion. Install the covers to keep in the VCI vapors.

10. Apply a heavy amount of multipurpose grease (MPGM) to all outside parts that move, such as rod threads, ball joints, linkages, etc.

NOTE: Install all covers and make sure that tape has been installed over all openings: air intake, exhaust, flywheel housing, crankcase breather, dipstick tubes, etc.

11. Under most conditions, it is best to remove the batteries and use them in another application, or put them in storage where they can be checked and electrically charged again when needed.

If the batteries are not removed, thoroughly clean the tops of the batteries. Apply an electrical charge to the batteries.

Disconnect the battery terminals. Put a plastic cover over the batteries.

12. Loosen the water pump, alternator and air conditioning belts.

13. Attach a tag to the engine with a notation of the date that the unit was preserved.

14. Inspect the engine every two or three months for corrosion. If the engine has signs of corrosion at the check period, repeat the protection procedure.

Cooling System

Clean the system and completely fill with a mixture of 50 percent Caterpillar Antifreeze and 50 percent approved water.

Removal From Storage

1. Remove all outside protective covers.

2. Change the oil and filters.

3. Check the condition of the V-belts. Tighten or replace the belts, if necessary.

4. Replace the fuel filter elements.

5. Remove the plastic covers from the air cleaner elements.

6. Use a bar (or other turning tool) to turn the engine in the normal direction of rotation; make sure there are no hydraulic locks or excessive resistance.

7. Before starting the engine, remove the valve cover and put a large amount of engine oil on the camshaft, cam followers, and valve mechanism to prevent damage to the mechanism.

8. To get immediate lubrication, and to prevent damage to the engine in the first few seconds after starting, pressure lubricate the engine. Refer to "Pressure Lubrication Procedure," in this section.

9. Check the condition of all rubber hoses. Replace, as necessary.

10. Before starting the engine, test the cooling system for a 3-to6 percent concentration of coolant conditioner. Add liquid coolant conditioner, if necessary. Test the coolant mixture for the proper nitrite level. Adjust the coolant mixture, as necessary.

11. Prime the engine with clean diesel fuel before starting.

12. On the first day of operation, check the entire engine several times for leaks and correct operation. Refer to "Initial Operation After Engine Storage," in this section.

Pressure Lubrication Procedure

The engine must have adequate lubrication during the first few seconds of operation. A "dry start" (without adequate lubrication) can cause bearing damage.

To prevent the possibility of a "dry start" and bearing damage during the first seconds of operation, pressure lubricate the engine by filling the main oil passages with oil under pressure.

Sources of clean oil under pressure, such as a service shop central oil supply, can be used for pressure lubrication.

1. Use a clean source of oil.

2. Put the correct amount of engine oil in the crankcase.

3. Connect the oil source to the engine's main oil passage.

4. Do not exceed an oil pressure of 242 ± 35 kPa (35 ± 5 psi).

Fill the crankcase with the correct oil. The amount of oil used in the pressure lubrication procedure must be subtracted from the refill capacity given in *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE)*. Maintain the oil level between the add and full marks on the dipstick.

Initial Operation After Storage

The quality of the oil control components used in Caterpillar engines is such that, following engine storage, only an operational check at the initial start is necessary before operation.

This operational check ensures that the correct pressures and temperatures are kept in the lubrication, cooling, and fuel systems, and that leaks are detected.

To be sure of a safe, uniform check at the initial start, use the following procedure:

1. Turn the engine at cranking speed, using the crank-without-inject system, until engine oil pressure is present.

2. Start the engine and allow it to run for 10 minutes at low idle speed.

3. Operate the engine for 15 minutes at half-load and three-quarter rated speed.

4. Operate the engine for 30 minutes at rated load and speed.

5. Check frequently for leaks such as oil, coolant, and fuel, during the first few hours of operation. Repair any leaks as soon as they are detected.

Machine Storage

Before storing the machine, perform all required maintenance procedures as recommended in *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Appendix A, Operator's Preventive Maintenance Checks and Services (OPMCS)—DEUCE" and in *Appendix B, Unit Preventive Maintenance Checks and Services (PMCS),* in this manual.

NOTICE

Do not store batteries outside in direct sunlight. Heat ages and discharges batteries.

If the equipment is to be stored for a short time (90 days or less) and the ambient temperature is above -18°C (0°F), use the procedure "Storage With Exercise," in this section.

If temperatures are below -18°C (0°F), and for long term storage (up to one year), use the storage procedure "Long Term Storage," in this section.

Long Term Storage (Up to One Year)

Following these procedures will reduce the possibility of damage during storage for one year or less. If the machine is to be stored for more than one year, the complete procedure must be repeated every year.

1. Perform a complete operational check of the equipment. Make all necessary repairs. Inspect all hydraulic systems before storage, and make all necessary repairs to the system, as needed.

2. Clean the machine thoroughly, to remove all dirt, mud, grease, and oil on all external surfaces.

3. Prepare all surfaces that are to be painted by removing any rust. Apply a good quality paint to all exposed surfaces. A good quality paint, applied properly to prepared surfaces, can protect exposed surfaces for up to two years.

Do not apply paint to the following surfaces:

• All chromed surfaces, such as hydraulic cylinder rods.

• Parts not subject to corrosion, such as plastic handles, shift guides, handle threads, and name plates.

• Transmission parts, such as: mounting studs; surfaces on input flanges which pass through seals, and electrical connections.

• Control valve stems on seal wiping surfaces.

• Surfaces on shafts which pass through seals.

• Machined mounting surfaces.

• Visually inspect the lift, tilt, and angle cylinder rods, and the center drive shaft slip seal area to ensure that they are free of paint.

• All other surfaces where paint would be detrimental to machine and/or implement operation and maintenance.

4. Park the machine in the storage area. Put blocks under the machine and make sure the machine is level. Park the machine on planks, timbers, or a similar surface, to keep it from freezing to the ground. Do not loosen the track tension. Cover the track with black plastic.

5. Perform all scheduled maintenance, as recommended in the OPMCS and UPMCS. Make sure that the recommended lubricant is applied to all lube points.

NOTE: VCI oil may be added to all lubrication systems, hydraulic tanks, and fuel tanks at a rate not to exceed 3 percent of volume. Larger concentrations of VCI oil can damage copper, lead, or zinc components. Refer to the oil manufacturer's recommendations for specific instructions.

6. Protect all areas subject to corrosion by applying a good quality preservative. These areas include:

• Blade control linkages.

• All lubricated surfaces, to prevent the control linkages from seizing.

• Control valve stems on seal wiping surfaces.

• Surfaces on shafts which pass through seals.

• Machine's mounting surfaces.

• Hand control and selector valve linkages.

• Input shafts and couplings.

7. Apply MPGM grease to all exposed areas, including:

• Pintle hook.

• Winch cable.

• Filler necks of the hydraulic oil tank, power train oil tank, fuel tank, crankcase, and cap threads.

8. Protect all hydraulic cylinder rods as follows:

• Extend all cylinder rods to their maximum length.

- Apply a thin coat of CYLIX 33, with a cloth applicator, to all exposed chrome-plated surfaces.
- Retract the cylinder rods to the normal position, and secure them.
- Secure all of the control valves into the NEUTRAL position.

9. Refer to “Engine Storage,” in this section, to prepare the engine for storage. This procedure covers systems such as lubrication, intake and exhaust, cooling, and fuel.

10. Remove the batteries and tape all battery cable ends. Store the batteries where they can be checked periodically and recharged. Discharged batteries will be damaged if they are stored in below freezing temperatures.

NOTICE

To prevent damage to the alternator, whenever the battery is disconnected for storage, disconnect the plug-in lead at the alternator, and tape the connection.

11. Apply 1890 Protective Sealer, or an equivalent, to all exposed electrical wires, cables, and connectors.

12. Seal all openings treated with VCI oil with a Grade C wrapper and pressure sensitive tape. Seal all:

- Engine openings.
- Exhaust pipe openings.
- Air cleaner intake openings.
- Oil filler and gauge openings.
- Electrical system openings.
- Transmission case openings.
- Final drive case openings.
- Battery terminal openings.
- Breather openings.
- Gauges and instrument panel (without protective covers) openings.

13. Remove the windshield wipers, and place them in a plastic bag. Store the bag inside the cab.

Apply oil to the door hinges, and grease the door latch plunger. Apply graphite to all key locks. Close all windows and secure the cab area.

14. Check the stored machine every 45 or 60 days, for signs of damage or deterioration. If rust or any other deterioration starts to occur, repeat this entire procedure.

15. Tag the machine as it is being stored, and list all of the work performed on the machine.

Removal of Machine From Storage

1. Inspect the machine for any damage or deterioration; make all necessary repairs.

2. Remove all coverings and tape.

3. Inspect all rubber hoses, lines, and belts for deterioration. Replace as necessary.

4. Check the track tension. Refer to “Maintenance Section, Maintenance Intervals, Every 250 Service Hours or Three Months, Drive Belts,” in this module, for the procedure.

5. Refer to “Removal From Storage,” and “Pressure Lubrication Procedure,” in “Engine Storage,” in this section, to prepare the engine.

6. Install fully charged batteries, or new batteries, and connect the alternator connector.

7. Check the oil level in all of the compartments, and drain or fill to the FULL mark on the gauge, according to the instructions in *Operator’s Manual, Deployable Universal Combat Earthmover (DEUCE).*

If there are indications of moisture in any compartment, drain the oil, change the filters, if equipped, and fill the compartment with new oil.

8. Perform all maintenance procedures, as recommended in the OPMCS and UPMCS.

9. On the first day the equipment is used, check the machine several times for leaks and correct operation.

10. Clean or install new fresh air and recirculating air filters.

11. Check and clean condensor and evaporator coils as necessary. Do not steam clean. Straighten any damaged fins on the evaporator coil and condensor coils with the 8T-9275 Fin Straightener, radiator tool group.

12. Check condensate drain lines for free flow of condensation and for the proper location of the drain valve. If necessary, flush the lines with water and relocate the valve. The condensate valve should be located between flush and 76 mm (3 in) from the end of the drain line.

13. Check and clean the clutch wire connection for the compressor. To check the cluch operation on systems with adjustable thermostats, turn the thermostat on and off. Some systems may require you to turn the air conditioning switch on and off. Systems that have the compressor protection system will need up to 30 seconds before the clutch engages.

NOTE: For systems that are not used for extended periods, run the compressor monthly for a minimum of 30 seconds. This will keep the shaft seal from drying out and leaking oil and refrigerant.

14. Check all hoses and connections for refrigerant leaks. Leaks can be identified by signs of oil and dust accumulation or dye accumulation. Check hoses for worn or scuffed (damaged) areas. Replace any damaged hoses. If necessary, add additional protection to new hoses or relocate them to avoid further damage.

NOTE: Do not vent refrigerant to the atmosphere.

NOTE: An R134a system requires an exact charge by weight. The charge must be within 0.01 kg (0.022 lb) of the listed charge. Frost on the R134a high side indicates a low charge.

15. Conduct air conditioning performance check. The ambient temperature needs to be 21 °C (70 ° F) or above for R134a systems. If the performance check shows a low charge or the system has not been used for one year, perform the following:

- Perform a leak check.
- Recover the system charge.
- Change the receiver-dryer, the dryrer, the in-line dryer or the accumulator with desiccant.
- Evacuate the system for 30 minutes.
- Recharge the system according to specifications.
- Perform another leak check.
- Complete a performance check again after the system has been fully charged.

16. Replace the dryer annually.

17. Inspect the service ports to ensure dust caps are in place.

Storage With Exercise

Up to 90 Days

Equipment which is stored for a short time (90 days or less) and exercised, will require less preparation than equipment stored for up to one year.

NOTE: If the equipment is in storage at temperatures below -18°C (0°F), do not exercise (operate) the equipment; use the storage procedure for equipment stored up to one year.

For good results during short term storage, operation of all moving parts, at regular intervals, is important. If ambient storage temperatures are between -18°C and +24°C (0°F and +75°F), operate the equipment at regular intervals.

If machines are to be stored and exercised during the winter months, make sure all of the compartments have the correct oil viscosity, as recommended in *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE)*.

1. Prepare the machine for storage, using the procedures in this module to protect the engine and the machine.

2. Fill the fuel tank completely full, or fill to a minimum of 10 percent and add 0.5 L (1 pint) of VCI oil, or an equivalent.

3. Park the machine and put blocks under it, making sure the machine is level and in a position that allows all driven components to move during exercise.

Exercising

All moving parts of a machine must be exercised during the storage period. Exercising renews protective oil films, allows seals to receive the necessary lubricant to prevent them from drying out and/or taking a set.

Do not exercise the equipment in temperatures below -18°C (0°F).

The machine should be exercised once every 45 to 60 days. During periods of high humidity, the machine may require more frequent exercise.

To exercise the machine, perform the following:

- Remove all intake and exhaust covers.

- Perform a walk-around inspection and prestart checks, as recommended in *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE)*.

- If any higher than normal leakage is found, do not start the engine until repairs have been made.

- Make sure that all fluid compartments are at the proper levels for operation. Ensure that there is no accumulation of water (condensation) in any machine compartment.

- Start the machine using the procedure in the *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE).*

- Ensure that all instruments and controls operate properly.

- Allow for a warm-up period, and then run the engine at operating temperature for at least 30 minutes, to drive off any accumulation of water vapor.

- During the 30-minute exercise period, operate all machine controls such as: steering, transmission, brake, etc. Stop the machine often, with the seals and bearings in different positions. This will prevent seal damage from being in a set position.

- Operate the blade and winch for at least one minute each.

- After completing the exercise period, reinstall all covers from all intake and exhaust openings.

Maintenance Section

Oil Analysis

Caterpillar recommends using the Army Oil Analysis Program (AOAP), or Caterpillar's Scheduled Oil Sampling (S·O·S), at regularly scheduled intervals, to complement a good preventative maintenance program.

These programs were developed to help users realize the highest possible value from their equipment by minimizing repair costs and maximizing availability. The programs are a series of diagnostic tests which analyze used lubricating oils from the oil wetted compartments of the equipment. By analyzing the used oils, problems may be identified early, before extensive component failure occurs. This reduces repair cost and downtime.

The S·O·S program is coupled with a wide range of repair options, so that when a problem is identified an appropriate repair plan is available. S·O·S can also measure the effectiveness of the user's maintenance program.

Obtaining Oil Samples

Several methods are used to obtain oil samples.

- Use an in-line sampling valve.
- Use a sampling gun inserted into the sump.
- Use the drain stream method when changing oil.

NOTE: These sampling methods are in the order of preference. If one of the first two methods is not feasible, then use the drain stream method.

When using the drain stream method to obtain an oil sample, take the sample after some oil has drained out but before the final drain. The oil at the beginning or end of the drain stream is not mixed well enough to represent oil circulating in the compartment and may carry debris that can give false S·O·S analysis results.

S·O·S Analysis

The S·O·S program is composed of three basic tests:

- Wear analysis.
- Chemical and physical tests.
- Oil condition analysis.

Wear analysis monitors the component's wear rates by measuring wear elements and contaminants found in the used oil. Through monitoring the used oil, normal component wear trends are determined. Many failures can be identified when wear trends and/or contaminants significantly exceed past trends.

Detectable failures are those caused by component wear and gradual dirt contamination. Wear analysis is not able to predict failures due to component fatigue, sudden loss of lubrication, or sudden ingestion of a large amount of dirt, since failures of this nature occur too rapidly.

Chemical and physical tests are used to determine whether the used oil has been contaminated with water, fuel, or antifreeze, and if these contaminants exceed maximum limits.

Oil condition analysis determines the degree of deterioration of the used oil by measuring the amount of sulfur products, oxidation, nitration and soot present in the used oil. It can also monitor additive depletion and detect ethylene glycol, Dowtherm and butyl cellosolve contamination.

Oil condition analysis can help regulate (reduce, maintain or extend) oil change intervals for a specific machine or engine in a given application. Oil condition analysis must always be used with wear analysis and the chemical and physical tests.

Consult your Caterpillar dealer for complete information and assistance in establishing a program for your equipment.

NOTE: After the warranty period has expired, follow AOAP guidelines outlined in DA PAM 738-750.

General Coolant Information

NOTICE

Adding coolant to an overheated engine could result in damage to the engine. Allow the engine to idle before adding coolant.

If the machine is to be stored in, or shipped to, an area with freezing temperatures, the cooling system must be protected to the lowest outside (ambient) temperature.

The engine cooling system is normally protected to -28 degrees Celsius (-20 degrees Fahrenheit) with Caterpillar Antifreeze, when shipped from the factory unless special requirements are defined.

In cold weather, check the specific gravity of the coolant solution frequently in order to ensure adequate protection.

Clean the cooling system if it is contaminated, if the engine is overheating, or if there is foam in the radiator.

Air pockets can form in the cooling system if the cooling system is filled at a rate that is greater than 20 L (5 U.S. gal) per minute.

After the cooling system is drained and refilled, operate the engine.without the radiator cap until the coolant reaches normal operating temperature and the coolant level stabilizes. Make sure that the coolant is maintained to the proper level.

Never operate the engine without a water temperature regulator (thermostat) in the cooling system. Cooling system problems can arise without a thermostat.

Many engine failures are related to the cooling system. Cooling system failures include the following problems: overheating, leakage of the water pump, plugged radiators, and cylinder liner pitting. These failures could be avoided with proper cooling system maintenance. Maintenance of the engine coolant is important to engine life and performance, as important as fuel quality and the maintenance of lubricating oils in the system.

Coolant performs three main functions:

- Coolant provides cooling by transferring heat from the engine to the air.
- Coolant provides corrosion protection.
- Coolant provides antiboil and antifreeze protection.

Coolant is normally composed of three elements:

- Water
- Additives
- Glycol

Water

NOTICE

Never use water alone without Supplemental Coolant Additive (SCA's) or inhibited coolant. Water alone is corrosive at engine operating temperatures and does not provide adequate boil protection.

Water transfers the heat in the coolant solution. For this reason, it is important to use water that meets the following recommendations. Water that does not meet the recommendations can interfere with the transfer of heat and can also be corrosive.

Distilled or deionized water is recommended for use in cooling systems. Do not use hard water or water that has been softened with salt. If distilled or deionized water is not available, use water that meets the minimum requirements listed in the Table 1.

Table 1

Caterpillar Minimum Acceptable Water Requirement		
Water Property	**PPM mg per liter Maximum**	**grains/U.S. gal Maximum**
Chloride[1] (Cl)	40	2.4
Sulfate[2] (SO_4)	100	5.9
Total Water Hardness[3]	170	10
Total Solids[4]	340	20
Acidity[5]	5.5 pH to 9.0 pH	

(1) See "ASTM D512b," "ASTM D512d," or "ASTM D4327."
(2) See "ASTM D516b," "ASTM D516d."
(3) See "ASTM D1126."
(4) See "ASTM D1888a."
(5) See "ASTM D1293."

For a water analysis, consult one of the following organizations:

- The Caterpillar Laboratory for an S•O•S Analysis
- The LOCC Corporation
- Local water department
- Agricultural agent
- Independent laboratory

Additives

Coolant additives help in the following ways:

- Preventing rust from forming
- Preventing scale and mineral deposits from forming
- Protecting metals from corroding
- Preventing cavitation of the liner
- Preventing coolant from foaming

Many additives are depleted during engine operation and these additives need to be replaced. This can be done through the addition of Supplemental Coolant Additives (SCA) to Diesel Engine Antifreeze/Coolant (DEAC) or by adding Extender to Extended Life Coolant (ELC).

Additives must be added at the proper concentration. Overconcentration of additives can cause the inhibitors to drop out-of-solution. This can cause a gel compound to form in the radiator. An overconcentration of additives can produce deposits on water pump seals that can cause water pump seal leakage. A low concentration of additives can produce the following problems:

- Pitting
- Cavitation erosion
- Rust
- Scale
- Foaming

Glycol

Glycol in the coolant provides anti-boil protection and freeze protection. Glycol in the coolant prevents water pump cavitation. Glycol in the coolant also reduces cylinder liner pitting. For optimum performance, Caterpillar recommends a solution that contains a 1:1 mixture of water and of glycol.

NOTE: Caterpillar engines with air-to-air aftercooling require a minimum of 30 percent glycol in order to prevent water pump cavitation.

Most conventional heavy-duty coolant/antifreezes use ethylene glycol. Propylene glycol may also be used. In a mixture that is 50 percent water, ethylene glycol and propylene glycol have similar properties that are relative to the following elements: heat transfer, freeze protection, control of corrosion, and compatibility with the seal. Check the glycol level of the coolant system with the 1U-7298 Coolant/Battery Tester (Celsius) or with the 1U-7297 Coolant/Battery Tester (Fahrenheit). Tables 2 and 3 define the freeze protection for ethylene glycol and for propylene glycol.

Table 2

Ethylene Glycol		
Concentration	Freeze Protection	Anti-Boil Protection
50 Percent	-36°C (-33°F)	106°C (223°F)
60 Percent	-51°C (-60°F)	111°C (232°F)

Table 3

Propylene Glycol		
Concentration	Freeze Protection	Anti-Boil Protection
50 Percent	-36°C (-20°F)	106°C (223°F)

NOTICE

Do not use propylene glycol in concentrations that exceed 50 percent glycol because of propylene glycol's reduced heat transfer capability. Use ethylene glycol in conditions that require additional freeze or anti-boil protection.

Coolant Recommendations

The following two coolants are used in Caterpillar machine engines:

Preferred—Caterpillar Extended Life Coolant (ELC) or a commercial ELC that meets the Caterpillar specification (EC-1).

Acceptable—A Caterpillar Diesel Engine Antifreeze/Coolant (DEAC) or a commercial heavy-duty coolant/antifreeze that meets "ASTM D4985," "ASTM D5345," or "MIL-A-46153" specifications.

NOTICE

Do not use a commercial coolant/antifreeze that only meets the "ASTM D3306" specification. This type of coolant/antifreeze is made for light duty automotive applications.

Caterpillar recommends a 1:1 mixture of water and glycol. This mixture of water and glycol will provide optimum heavy-duty performance as a coolant/antifreeze.

NOTE: Caterpillar DEAC does not require a treatment with an SCA at the initial fill. However, a commercial heavy-duty coolant/antifreeze that meets "ASTM D4985" or "ASTM D5345" specifications requires a treatment with an SCA at the initial fill.

Table 4

Service Life Before Flushing and Refilling	
Coolant	**Service Life**
Caterpillar ELC	6000 hours or 6 years
Caterpillar DEAC	3000 hours or 2 years
Commercial Heavy-Duty Coolant/Antifreeze	3000 hours or 1 year

Extended Life Coolant (ELC)

Caterpillar provides Extended Life Coolant (ELC) for use in the following applications:

- Heavy-duty diesel engines
- Natural gas engines
- Automotive applications

The anti-corrosion package for Caterpillar ELC is different from the anti-corrosion package for other coolants. Caterpillar ELC is an ethylene glycol base coolant. However, Caterpillar ELC contains organic corrosion inhibitors and antifoam agents with low amounts of nitrite. Caterpillar ELC has been formulated with the correct amounts of these additives in order to provide superior corrosion protection for all metals in the cooling system of diesel engines.

Caterpillar ELC extends the service life of the coolant to 6000 service hours or six years. ELC does not require the frequent additions of a Supplemental Coolant Additive (SCA). An Extender is the only additional maintenance that is needed at 3000 service hours or one-half of the service life.

ELC is available in a 1:1 premixed cooling solution with distilled water. The 1:1 premixed cooling solution of ELC will lower the freezing point of the coolant to a temperature of -36°C (-33°F). ELC Concentrate can be used to lower the freezing point to -51°C (-60°F) for arctic conditions.

Containers of several sizes are available. Consult your Caterpillar dealer for the part numbers.

ELC can be recycled. The drained coolant mixture can be distilled in order to remove the ethylene glycol and the water. The ethylene glycol and the water can be reused. Consult your Caterpillar dealer for more information.

Commercial ELC

If Caterpillar ELC is not used, then select a commercial ELC that meets the Caterpillar specification of EC-1 and either the "ASTM D5345" specification or the "ASTM D4985" specification. Do not use a long life coolant that does not meet the EC-1 specification. Follow the maintenance guide for the coolant from the supplier of the commercial ELC. Follow the Caterpillar guidelines for the quality of water and the specified coolant change interval.

ELC Cooling System Maintenance

Caterpillar ELC Extender

Caterpillar ELC Extender is a liquid that is added to the cooling system halfway through the ELC service life.

NOTICE

When using Caterpillar ELC, do not use standard SCA's or SCA filters. To avoid SCA contamination of an ELC system, remove the SCA filter base and plug off or by-pass the coolant lines.

The cooling system should be treated with 0.95 L (32 fl oz) of Extender at 3000 hours (one-half of the service life).

Changing to Caterpillar ELC

To change from heavy-duty coolant/antifreeze to the Caterpillar ELC, perform the following steps:

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the machine. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

1. Drain the coolant into a suitable container.

2. Dispose of the coolant according to local regulations.

NOTICE

Do not leave an empty SCA filter on an ELC system.

The filter housing may corrode and leak causing an engine failure.

Remove the SCA filter base and plug off or by-pass the coolant lines.

3. Remove the empty SCA filter and remove the filter base. Plug the coolant lines or bypass the coolant lines.

4. Flush the system with clean water in order to remove any debris.

5. Use Caterpillar cleaner to clean the system. Follow the instructions on the label.

6. Drain the cleaner into a suitable container. Flush the cooling system with clean water.

7. Fill the cooling system with clean water and operate the engine until the engine is warmed to 49 to 66°C (120 to 150°F).

NOTICE

Improper or incomplete rinsing of the cooling system can result in damage to copper and other metal components.

To avoid damage to the cooling system, make sure to completely flush the cooling system with clear water. Continue to flush the system until all signs of the cleaning agent are gone.

8. Drain the cooling system into a suitable container and flush the cooling system with clean water.

NOTE: The cooling system cleaner must be thoroughly flushed from the cooling system. Cooling system cleaner that is left in the system will contaminate the coolant. The cleaner may also corrode the cooling system.

9. Repeat Steps 7 and 8 until the system is completely clean.

10. Fill the cooling system with the Caterpillar ELC.

11. Attach the Special Publication, PEEP5027, "Label" to the radiator on the machine in order to indicate the use of Caterpillar ELC.

NOTE: Clean water is the only flushing agent that is required when the ELC is drained from the cooling system.

Contamination of the ELC Cooling System

NOTICE

Mixing ELC with other products reduces the effectiveness of the coolant and shortens coolant life.

Use only Caterpillar products or commercial products that have passed the Caterpillar EC-1 specification for pre-mixed or concentrate coolants. Use only Caterpillar Extender with Caterpillar ELC.

Failure to follow these recommendations can result in shortened cooling system component life.

In cooling systems that use Caterpillar ELC, do not add Diesel Engine Antifreeze/Coolant (DEAC) as a makeup coolant. Contamination of ELC by DEAC will defeat the advantages of ELC. If the ELC in the cooling system becomes contaminated by more than 10 percent of the total system capacity of DEAC or SCA, perform one of the following operations:

- Drain the cooling system into a suitable container. Dispose of the coolant according to local regulations. Flush the system with clean water. Fill the system with the Caterpillar ELC.

- Drain a portion of the cooling system into a suitable container according to local regulations. Then, fill the cooling system with premixed ELC. This should lower the contamination to less than 10 percent.

- Maintain the system as a conventional Diesel Engine Antifreeze/Coolant (DEAC). Treat the system with an SCA. Change the coolant at the interval that is recommended for the conventional Diesel Engine Antifreeze/Coolant (DEAC).

Extended Life Coolant (ELC) Cooling System Maintenance

NOTICE

Use only Caterpillar products or commercial products that have passed Caterpillar EC-1 specification for pre-mixed or concentrated coolants.

Use only Caterpillar Extender with Extended Life Coolant.

Mixing Extended Life Coolant with other products reduces the Extended Life Coolant service life. Failure to follow the recommendations can reduce cooling system components life unless appropriate corrective action is performed.

In order to maintain the correct balance between the antifreeze and the additives, you must maintain the recommended concentration of Extended Life Coolant (ELC). Lowering the proportion of antifreeze lowers the proportion of additive. This will lower the ability of the coolant to protect the system from pitting, from cavitation, from erosion, and from deposits.

Proper additions to the Extended Life Coolant

NOTE: Do not add ELC Concentrate as a makeup solution for maintaining the correct coolant level. The addition of the concentrated Extended Life Coolant will increase the concentration of glycol in the cooling system.

During daily maintenance, use the premixed ELC as a cooling system top-off. This will bring the coolant up to the proper level. Use ELC or use a coolant that meets Caterpillar specifications (EC-1). Check the specific gravity of the coolant system with the 1U-7298 Coolant/Battery Tester (Celsius) or with the 1U-7297 Coolant/Battery Tester (Fahrenheit). Use ELC Concentrate to restore the proper glycol concentration in the coolant system. This should be done before the engine is exposed to freezing temperatures.

NOTICE

Do not use a conventional coolant to top-off a cooling system using Extended Life Coolant.

Do not use supplemental coolant additives (SCA) other than Extender in cooling systems filled with Extended Life Coolant.

Extended Life Coolant Cooling System Cleaning

NOTE: If the cooling system is already using ELC, cleaning agents are not required to be used at the specified coolant change interval. Cleaning agents are only required if the system has been contaminated by the addition of some other type of coolant or by cooling system damage.

Clean water is the only cleaning agent that is required when ELC is drained from the cooling system.

ELC can be recycled. The drained coolant mixture can be distilled. The distillation process can remove the ethylene glycol and the water. Consult your Caterpillar dealer for more information.

After you drain the cooling system and after you refill the cooling system, operate the engine while the radiator filler cap is removed. Operate the engine until the coolant reaches the normal operating temperature and until the coolant level stabilizes. As needed, add the coolant mixture in order to fill the system to the proper level.

Diesel Engine Antifreeze/Coolant (DEAC)

Caterpillar recommends using Caterpillar Diesel Engine Antifreeze/Coolant (DEAC) for cooling systems that require a heavy-duty coolant/antifreeze. Caterpillar DEAC is an alkaline single-phase ethylene glycol type antifreeze that contains corrosion inhibitors and antifoam agents.

Caterpillar DEAC is formulated with the correct amount of Caterpillar Supplemental Coolant Additive (SCA). Do not use SCA at the initial fill when DEAC is used. The coolant that is in the engines of Caterpillar machines should be sampled after every 250 hours of operation. The results of the coolant sample will regulate the additions of the SCA. The life of the coolant for the Caterpillar DEAC is 3000 hours or every two years.

Caterpillar DEAC is available as either a concentrate or a 1:1 premixed cooling solution. If concentrated Caterpillar DEAC is used, Caterpillar recommends dilution with distilled water or with deionized water. If distilled water is not available or deionized water is not available, refer to General Coolant Information in order to determine the requirements for acceptable water.

Commercial Heavy-Duty Coolant/Antifreezes and SCA

If Caterpillar DEAC is not used, select a heavy-duty coolant/antifreeze with a low silicate content that meets "ASTM D4985" or "ASTM D5345." When a commercial heavy-duty coolant/antifreeze is used, the system must be treated with Caterpillar SCA. Maintain a concentration level in the cooling system that is between 3 percent and 6 percent by volume. If a Caterpillar SCA is not used, select a commercial SCA with a minimum concentration of 1200 mg per Liter (70 grains per gallon) or 1200 parts per million of nitrite content. Follow the recommended guidelines for adding SCA when you maintain the coolant. In all cases, the Caterpillar guidelines for acceptable water must be followed.

NOTE: When you are not using a Caterpillar DEAC, the cooling system must be drained once during every year. The cooling system must be flushed at this time as well.

Cooling System Maintenance

NOTICE

Never operate without a temperature regulator in the cooling system. Temperature regulators maintain the engine coolant at the proper operating temperature. Cooling system problems can develop without temperature regulators.

Check the solution of coolant/antifreeze (glycol concentration) frequently in order to ensure adequate freeze protection and protection from boiling. Check the glycol level of the coolant system with the 1U-7298 Coolant/Battery Tester (Celsius) or with the 1U-7297 Coolant/Battery Tester (Fahrenheit). Consult your Caterpillar dealer for information on coolant testers.

Supplemental Coolant Additive (SCA)

Caterpillar SCA has the following benefits:

- Prevention of corrosion to metals.
- Prevention of deposit formations of minerals.
- Prevention of cavitation of the cylinder liners.
- Elimination of foaming of the coolant.

Test the SCA concentration or submit a coolant sample to your Caterpillar dealer at every oil change. After every 250 service hours, liquid SCA or a SCA maintenance element may be needed. SCA additions are based on the results of coolant analysis. Your Caterpillar dealer has test kits that will evaluate the concentration of additives in Caterpillar DEAC.

Table 5 indicates the amount of Caterpillar SCA that is needed at the initial fill to treat commercial heavy-duty coolant/antifreezes. The table also shows the addition of an SCA for either liquid SCA or for the maintenance elements of a SCA. These additions are for commercial heavy-duty coolant/antifreezes and for Caterpillar DEAC.

NOTE: Due to the individual engine applications, the maintenance practices need to be periodically reviewed in order to maintain the cooling system.

Table 5

Caterpillar SCA Requirements for Heavy-Duty Coolant/Antifreezes		
Cooling System Capacity in L (U.S. gal)	Caterpillar Liquid SCA	
	Initial Fill(1)	250 Service Hour Maintenance(2)
42 L (11 U.S. gal)	1.42 L (48 oz) or one unit of both 3P2044 and 8T-1589	0.36 L (12 oz) or one unit 111-2372

(1) Use a Caterpillar SCA when you do not use a Caterpillar Antifreeze.
(2) Do not exceed the 6 percent maximum concentration. Check with the supplemental coolant additive test.

Cleaning the Heavy-Duty Cooling System

Caterpillar Cooling System Cleaners are designed to clean the system of harmful scale and of corrosion. Caterpillar Cleaners dissolve mineral scale, corrosion products, light oil contamination, and sludge. For the recommended service interval, refer to the Operation and Maintenance Manual, "Maintenance Intervals" in this section.

Conventional Coolant/Antifreeze Cooling System Maintenance

When you initially fill the cooling system with Caterpillar Diesel Engine Antifreeze/Coolant, it is not necessary to add a Supplemental Coolant Additive. Caterpillar Diesel Engine Antifreeze/Coolant already contains supplemental coolant additive. When you initially fill the cooling system with a commercial coolant that meets the requirements of "ASTM D4985", add a supplemental coolant additive. The supplemental coolant additive in Caterpillar Diesel Engine Antifreeze/Coolant and in commercial coolants must be replenished at regular service intervals. See the table for Supplemental Coolant Additive (SCA) in order to determine the correct quantity of liquid supplemental coolant additive to use.

S•O•S Coolant Analysis

Testing the engine coolant is important to ensure that the engine is protected from internal cavitation and from corrosion. The analysis also tests the ability of the coolant to protect the engine from boiling and from freezing. The S•O•S Coolant Analysis can be done at your Caterpillar dealer. Caterpillar S•O•S Coolant Analysis is the best way to monitor the condition of your coolant and your cooling system. S•O•S Coolant Analysis is a program that is based on periodic samples.

NOTICE

Do not use the same vacuum sampling pump for extracting oil samples that is used for extracting coolant samples.

A small residue of either type sample may remain in the pump and may cause a false positive analysis for the sample being taken.

Always use a designated pump for oil sampling and a designated pump for coolant sampling.

Failure to do so may cause a false analysis which could lead to customer and dealer concerns.

Recommended Interval for S•O•S Coolant Sample

Table 6

Recommended Interval		
Type of Coolant	Level 1	Level 2
DEAC	Every 250 Hours	Every 500 Hours
ELC	N/A	Every 500 Hours

Converted Systems

Perform a coolant analysis (Level 2) at 500 service hours for new systems or for converted systems that use ELC or use DEAC. This 500 hour check will also check for any residual cleaner that may have contaminated the system.

S•O•S Coolant Analysis (Level 1)

A coolant analysis (Level 1) is a test of the properties of the coolant.

The following properties of the coolant are tested:

- Glycol Concentration for freeze protection
- Ability to protect from erosion and corrosion
- pH
- Conductivity
- Water hardness
- Visual analysis
- Odor analysis

The results are reported, and appropriate recommendations are made.

S•O•S Coolant Analysis (Level 2)

Level 2 coolant analysis is a comprehensive chemical evaluation of the coolant. This analysis is also a check of the overall condition of the inside of the cooling system.

The S•O•S Coolant Analysis has the following five features:

- Full analysis of Level 1
- Identification of the source of metal corrosion and of contaminants

- Identification of buildup of the impurities that cause corrosion

- Identification of buildup of the impurities that cause scaling

- Determination of possible electrolysis within the machines' cooling system

The results are reported, and appropriate recommendations are made.

For more information on S•O•S Coolant Analysis, consult your Caterpillar dealer.

Fuel Specifications

General Fuel Information

- Purchase fuel from a reputable supplier.

- Use clean high-quality diesel fuel. If the fuel supply is questionable, refer to *Specifications Systems Operation Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine* “Specifications, Fuel System, Fuel Characteristics” for information about recommended fuels.

- Keep the fuel storage tank clean of water, debris and sediment.

- Drain water and sediment from the fuel storage tank weekly. Drain water and sediment before the tank is refilled.

- Keep the area around the fuel tank filler neck clean of debris in order to prevent contamination of the fuel tank.

- As required, clean the inside of the vehicle's fuel tank.

- Drain water and sediment from the vehicle's fuel tank daily. Drain the tank at the start of a shift. After the fuel tank has been filled, allow the fuel to settle for ten minutes. This will allow the water and sediment to separate from the fuel. Then, drain the water and sediment from the tank.

- Drain the water from the water separator daily.

- Change fuel filters at the scheduled interval. Never fill the new fuel filter with fuel before installation. Use the fuel priming pump to remove air from the system.

- Install breather filters on the fuel tanks.

Fuel Information for Diesel Engines

When diesel fuel is stored outdoors, the water will freeze after the water separates from the diesel fuel. Any effect that is caused by storing the fuel outdoors should immediately appear in the fuel. Fuel that is stored in underground tanks or fuel that is stored in a heated area will be easier to pump. However, moisture in the fuel will not freeze until the fuel is in the machine. Any effect that is caused by cold weather will not appear until the fuel has cooled to the outside temperature. It is preferable to determine any detrimental effects of temperature before the fuel is in the machine.

The two basic types of diesel fuel are No. 2 diesel fuel and No. 1 diesel fuel. No. 2 diesel fuel is a heavier diesel fuel than No. 1 diesel fuel. Heavier fuels can cause problems with fuel filters, fuel lines, fuel tanks, and fuel storage in cold weather. Heavier diesel fuels such as No. 2 diesel fuel can be used in diesel engines that operate in cold temperatures with a minimum amount of pour point depressant additive. For more information on fuels which include blends of No. 1 and No. 2 diesel fuel, consult your fuel supplier.

When you use No. 2 diesel fuel or other heavier fuels, some of the fuel's qualities may interfere with successful cold weather operation. Additional information about the characteristics of diesel fuel is available. This information contains a discussion on the modification to the characteristics of diesel fuel. There are several possible methods that can be used to compensate for the fuel qualities that may interfere with cold weather operation. These methods include the use of starting aids, engine coolant heaters, fuel heaters, and de-icers.

De-Icers

De-icers lower the freezing point of the moisture in the fuel. De-icers are not generally needed when fuel heaters are used. If you experience trouble, consult your fuel supplier for recommendations of a compatible commercial de-icer.

Diesel Fuel Recommendations

Diesel engines have the ability to burn a wide variety of fuels. These fuels are divided into two general groups. The two groups are called the preferred fuels and the permissible fuels.

The preferred fuels provide maximum engine service life and performance. The grade and specification of the preferred and permissible fuels are given in Table 7.

Table 7

Diesel Fuel Recommendations		
Group	**Grade**	**Specification**
Preferred	DF-1	ASTM D975
Preferred	DF-1	ASTM D975
Permissible	JP-8	Mil-T-83133D
Permissible	JP-5	Mil-T-5624R
Permissible	JETA-1	ASTM D1665

NOTE: For specific fuel requirements, refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine* “Specifications, Fuel System, Fuel Characteristics.”

In extreme cold ambient conditions, you may use the permissible fuels. However, the fuel that is selected should meet the requirements that are specified in *Specifications Systems Operation Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), 3100 HEUI DEUCE Engine* “Specifications, Fuel System, Fuel Characteristics.” These fuels are intended to be used in operating temperatures that are down to -54°C (-65°F).

NOTE: If a low quality fuel is used, the engine could exhibit the following problems: excessive wear of the fuel system, failure of the fuel system, and excessive wear of the engine that is caused by deposits or corrosion. Permissible fuels are lighter than DF-2 grades of fuel.

Lubricant Specifications

Lubricant Information

General Information

The information that is provided is the latest recommendations for Caterpillar engines and for Caterpillar machine compartments. This information supersedes all previous recommendations which have been published for Caterpillar machines. Special lubricants are required for some machine compartments and it will be necessary to continue to use these special products.

This information is only for Caterpillar machines. For more lubricant recommendations, see Special Publication, SEBU6251, "Caterpillar Commercial Diesel Engine Fluid Recommendations", Special Publication, SEBU6385, "Caterpillar On-Highway Diesel Truck Engine Fluid Recommendations", Special Publication, SEBU6400, "Caterpillar Gaseous Fueled Spark Ignited Engines Lubricant Recommendations", and Special Publication, SEBU7003, "Caterpillar 3600 Series Diesel Engine Fluid Recommendations."

Engine Oil

The Engine Oil Licensing and Certification System by the American Petroleum Institute is recognized by Caterpillar. For detailed information about this system, see the thirteenth edition of the "API publication No. 1509." Engine oils that bear the API symbol are authorized by API. Examples of the API symbol are shown in

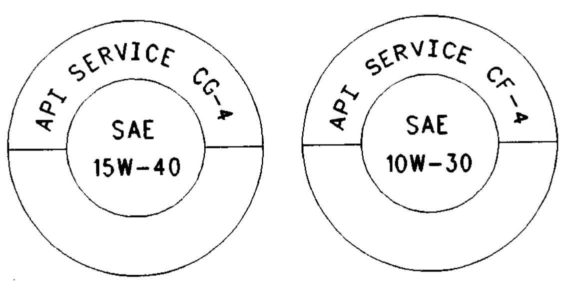


Illustration 1.

Diesel engine oils CD, CD-2, and CE have not been API authorized categories since 1 January 1996. Table 8 summarizes the status of the categories.

Table 8

Current	Obsolete
CF-4, CG-4, CH-4(1)	CE
CF	CC, CD
CF-2(2)	2 CD-2(2)

(1) CH-4 oil does not have a license for the API oil classification. Oils that were developed for the CH-4 classification are currently available in North America. However, oil companies cannot display CH-4 within the API symbol. A license from the API is anticipated in 1999. At that time, the oil companies will be allowed to list API CH-4 inside of the API symbol.
(2) CD-2 and CF-2 are categories for two-cycle diesel engines. Caterpillar does not sell engines that utilize CD-2 and CF-2 oils.

NOTE: CF is not the same classification as CF-4. API CF oils are only recommended for Caterpillar machine engines with precombustion chamber fuel systems (PC).

Transmission/Drive Train Oil

Transmission/drive train oils are classified by the TO-4 specifications. The specifications are developed by Caterpillar for use in Caterpillar transmissions and in Caterpillar final drives.

Gear Oil

Gear lubricants are classified by the API service classification and by the SAE viscosity grade that is defined in "SAE J306."

Grease

The classifications for grease are based on the "ASTM D217" worked penetration characteristics. The characteristics of the grease are given a number that relates to the consistency of the characteristics of the grease.

Terminology

Certain abbreviations follow the nomenclature of "SAE J754." Some classifications follow "SAE J183" abbreviations. In addition to Caterpillar definitions, there are other definitions that will be of assistance in purchasing lubricants. More information that pertains to the viscosity of lubricants is available.

Caterpillar Fluids

Caterpillar fluids have been approved by Caterpillar in order to increase the performance of Caterpillar components and the life of Caterpillar components. Caterpillar fluids that are currently used for engines and for machines are offered by Caterpillar dealers. Caterpillar fluids are also offered for continued refills. Consult your Caterpillar dealer for more information on these Caterpillar fluids.

Caterpillar recommends the use of the following Caterpillar fluids:

• Caterpillar Multigrade Diesel Engine Oil (DEO)

• Caterpillar Transmission/Drive Train Oil (TDTO)

• Caterpillar Multipurpose Tractor Oil (MTO)

• Caterpillar Hydraulic Oil (HYDO)

• Caterpillar Biodegradable Hydraulic Oil (HEES)

• Caterpillar Gear Oil (GO)

• Caterpillar Multipurpose Lithium Grease (MPG)

• Caterpillar Multipurpose Molybdenum Grease (MPGM)

• Caterpillar Special Purpose Grease (SPG)

• Caterpillar Premium Grease (CPG)

• Caterpillar Extended Life Coolant (ELC)

• Caterpillar Diesel Engine Antifreeze/Coolant (DEAC)

Engine Oil

Caterpillar Diesel Engine Oil (DEO)

Caterpillar DEO has been formulated with detergents, with dispersants, and with sufficient alkalinity in order to provide superior performance in Caterpillar diesel engines. The multigrade DEO is blended in SAE 10W30 and in SAE 15W40. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Lubricant Viscosities and Refill Capacities" to choose the correct lubricant viscosity grade. These lubricant viscosities are based on ambient temperatures. Multigrade oils provide the correct viscosity for a broad range of operating temperatures and for cold engine starts. Multigrade oils are also effective in maintaining low oil consumption and low concentrations of deposits on the pistons.

For maximum performance in the engines in Caterpillar machines, Caterpillar recommends the following engine oil:

• Caterpillar Diesel Engine Oil (DEO) that has an SAE 15W40 viscosity

• Caterpillar Diesel Engine Oil (DEO) that has an SAE 10W30 viscosity

Multigrade Caterpillar DEO can be used in other diesel engines and in gasoline engines. Consult the engine manufacturer's guide for the recommended specifications. Compare the specifications of the engine's manufacturer to the specifications of Caterpillar DEO. The current Caterpillar specifications are listed on the label and on the product data sheets.

Commercial Diesel Engine Oils

The performance of commercial diesel engine oils is based on API categories. The API categories were developed in order to provide commercial lubricants for a wide variety of diesel engines that operate at various conditions.

When a Caterpillar DEO is not used, use the following commercial oils:

• Multigrade CH-4 (Preferred oil)

• Multigrade API CG-4 (Preferred oil)

• Multigrade API CF-4 (Acceptable oil)

In order to make the proper choice of a commercial oil, refer to the following explanations.

CH-4 oils were developed in order to meet the requirements of the new high performance diesel engines. Also, the oil was designed to meet the requirements of the low emissions diesel engines. CH-4 oils are also acceptable for use in older diesel engines and in diesel engines that use high sulfur diesel fuel. CH-4 oils may be used in Caterpillar engines that use CG-4 and CF-4 oils. CH-4 oils will generally exceed the performance of CG-4 oils in the following critical areas: deposits on pistons, control of oil consumption, wear of piston rings, valve train wear, viscosity control, and corrosion.

Three new engine tests were developed for the CH-4 oil. The first test specifically evaluates deposits on pistons for engines with the two-piece steel piston. This test (piston deposit) also measures the control of oil consumption. A second test is conducted with moderate oil soot. The second test measures the following criteria: wear of piston rings, wear of cylinder liners, and resistance to corrosion. A third new test measures the following characteristics with high levels of soot in the oil: wear of the valve train, resistance of the oil in plugging the oil filter, and control of sludge.

In addition to the new tests, CH-4 oils have tougher limits for viscosity control in applications that generate high soot. The oils also have improved oxidation resistance. CH-4 oils must pass an additional test (piston deposit) for engines that use aluminum pistons (single piece). Oil performance is also established for engines that operate in areas with high sulfur diesel fuel.

All of these improvements allow the CH-4 oil to achieve optimum oil change intervals. CH-4 oils are recommended for use in extended oil change intervals. CH-4 oils are recommended for conditions that demand a premium oil. Your Caterpillar dealer has specific guidelines for optimizing oil change intervals.

NOTE: CH-4 oil does not have a license for the API oil classification. Oils that were developed for the CH-4 classification are currently available in North America. However, oil companies cannot display CH-4 within the API symbol. A license from the API is anticipated in 1999. At that time, the oil companies will be allowed to list API CH-4 inside of the API symbol.

CG-4 oils provide improved cleanliness of the piston, improved viscosity control, and improved crankcase cleanliness, especially when oil soot is a problem. CG-4 oils were primarily developed for diesel engines that operate on 0.05 percent sulfur. However, CG-4 oils can be used with diesel fuels that have a higher content of sulfur. The new oil TBN determines the maximum fuel sulfur level for CG-4 and CF-4 oils. See the Total Base Number (TBN) and Fuel Sulfur Levels for additional information. CG-4 oils are the first oils that passed tests for foam control and for viscosity shear loss. CG-4 oils must also pass tests for metal corrosion, tests for wear, and tests for oxidation.

CF-4 oils service a wide variety of modern diesel engines. This classification of oil was developed with 0.40 percent sulfur diesel fuel. The fuel that is used in the CF-4 tests is the type of diesel fuels that is commonly available worldwide. The CF-4 oils provide improved control of piston deposit. Improved control of oil is achieved when CF-4 oils are compared to CE oils. CF-4 oils also provide improved soot dispersion when these oils are compared to CF oils.

NOTE: Single grade CF oils or multigrade CF oils are not recommended for current Caterpillar diesel engines in Caterpillar machines.

Consult your Caterpillar dealer for the latest oil recommendations. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Lubricant Viscosities and Refill Capacities" for information about oil viscosity.

Some commercial oils that meet the API specifications may require shortened oil change intervals. The oil change intervals are determined by monitoring the oil conditions. The oil change intervals are also determined by wear metal analysis. The Caterpillar S•O•S Oil Analysis Program is preferred.

NOTICE

Failure to follow these recommendations can cause shortened engine life due to carbon deposits or excessive wear.

Total Base Number (TBN) and Fuel Sulfur Levels for Direct Injection (DI)

The TBN that is required in a new oil is dependent on the fuel sulfur level of the fuel that is being used. For direct injection engines that run on distillate diesel fuel, the minimum TBN of the new oil should be 10 times the fuel sulfur level. The TBN of the new oil is defined by "ASTM D2896." The absolute minimum TBN is five, even when low sulfur fuels are used. Refer to Illustration 2.

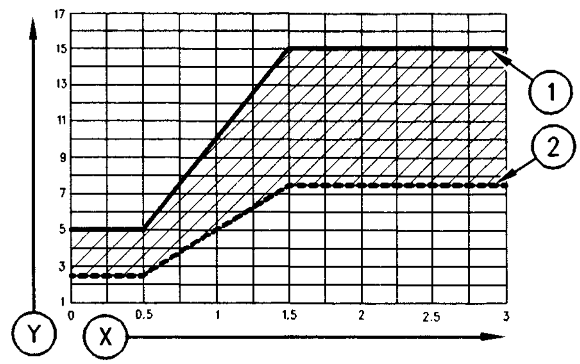


Illustration 2
(Y) The TBN that is shown by "ASTM D2896"
(X) Percentages of fuel sulfur by weight
(1) TBN of new oil
(2) Limit of used oil TBN

When the fuel sulfur exceeds 1.5 percent, choose an oil with the highest TBN that is within the CH-4 or within the API CG-4 or CF-4 categories. Shorten the oil change interval according to the oil analysis. The oil analysis should evaluate the oil condition and engine wear metals. Excessive piston deposits can be produced by an oil with a high TBN. These deposits can lead to a loss of control of the oil consumption and to the polishing of the cylinder bore.

NOTICE

Operation at fuel sulfur levels over 1.0 percent may require shortened oil change periods to maintain adequate wear protection.

Total Base Number (TBN) and Fuel Sulfur Levels for Precombustion Chamber

The TBN for a new oil depends on the fuel sulfur level of the fuel that is used. The TBN of the oil that is used in PC engines should be 20 times the fuel sulfur level. The TBN is defined in "ASTM D2896." Regardless of a low fuel sulfur level, the minimum TBN of new oil is five. Refer to illustration 3.

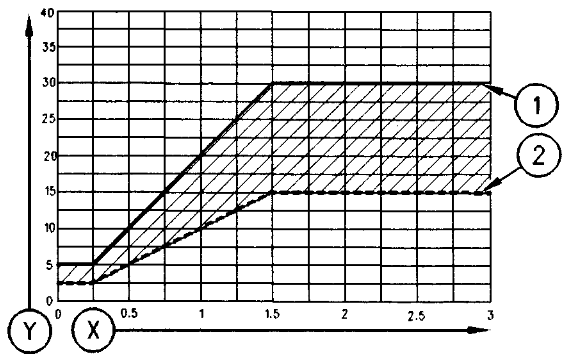


Illustration 3
(Y) The TBN that is shown by "ASTM D2896"
(X) Percentages of fuel sulfur by weight
(1) TBN of new oil
(2) TBN for used oil

NOTE: The used oil should be changed when the limit for the TBN is reached.

Whenever the fuel sulfur exceeds 1.5 percent, do the following tasks.

- Choose an oil with the highest TBN in the following categories:API CF, API CF-4, API CG-4, and CH-4

- Shorten the oil change interval if the oil analysis dictates.

The oil analysis should evaluate oil condition and wear metal analysis.

NOTICE

Operating PC engines at fuel sulfur levels over 1.0 percent may require shortened oil change intervals to maintain adequate wear protection.

Transmission/Drive Train Oil

Applications

- Power Shift Transmissions, Direct Drive Transmissions, and Winches

- Final Drives for Track-Type Tractors, Pipelayers, Skidders, Loaders, and Track-Type Excavators

- Differentials and Final Drives for Wheel Tractors, Loaders, Skidders, Compactors, Motor Graders, Off-Highway Tractors, and Trucks

Caterpillar Transmission/Drive Train Oil (TDTO)

Caterpillar Transmission/Drive Train Oil is balanced in order to give maximum frictional material life in power shift transmissions. Caterpillar Transmission/Drive Train Oil also eliminates brake chatter in wet brake applications in Caterpillar machines. This oil has passed the requirements for the TO-4 oil specification which includes the frictional requirements and gear wear requirements. This oil is offered in several lubricant viscosity grades. The SAE 60 viscosity grade is included for maximum component life at high ambient temperatures and for heavy-duty cycles.

NOTICE

This oil is formulated for transmissions and drive trains only, and should not be used in engines. Shortened engine life will result.

NOTE: Do not use the Caterpillar Gear Oil or commercial gear oil in the machines that are listed above. The gear oil can cause seals to fail. The seals can also leak. The gear oil may not be compatible with friction materials. The oil can reduce the efficiency of the transmission and the brake performance.

NOTE: Multigrade oils must meet the requirements of the Caterpillar TO-4M specification in order to be used in transmissions. Multigrade oils which use high molecular weight polymers as viscosity index improvers may lose the viscosity effectiveness. This effectiveness may be lost by the temporary shear of the polymer viscosity index improver. Permanent shear of the polymer viscosity index improver may also occur. This type of multigrade oils are not recommended for Caterpillar drive train compartments. The Caterpillar TO-4M requirement includes a test for the shear stability of multigrade oil.

Commercial Transmission/Drive Train Oils

If Caterpillar Transmission/Drive Train Oil is not used, use commercial oils that comply with the Caterpillar TO-4 or TO-4M specifications.

Synthetic Base Stock Oils

Synthetic base oils are acceptable for use in Caterpillar engines and in Caterpillar machines if these oils meet the performance requirements that are specified for a particular compartment. Each compartment has specific lubrication specifications in order to ensure proper lubrication and life of the system.

Synthetic base oils generally perform better than conventional oils in the following two areas:

- Synthetic base oils have improved flow at low temperatures especially in arctic conditions.

- Synthetic base oils have improved oxidation stability especially at high operating temperatures.

Some synthetic base oils have performance characteristics that enhance the service life of the oil. However, Caterpillar does not recommend automatic extending of the oil drain intervals for any type of oil. Oil drain intervals for Caterpillar diesel engines can only be adjusted after an oil analysis program that contains the following data:

- Oil condition and wear metal analysis (Caterpillar S•O•S Oil Analysis)

- Trend analysis

- Fuel consumption

- Oil consumption

Re-refined Base Stock Oils

Re-refined base oils are acceptable for use in Caterpillar engines and in Caterpillar machines if these oils meet the performance requirements that are specified for a particular compartment. Each compartment has requirements for lubrication and requirements for lubrication specifications in order to ensure proper lubrication and life of the system. Re-refined base oils can be used exclusively in finished oil or in a combination with new base oils. The U.S. military specifications and the specifications of other heavy equipment manufacturers also allow the use of re-refined base oils that meet the same criteria.

The process that is used to make re-refined oil should adequately remove all wear metals that were in the used oil and all additives that were in the used oil. Vacuum distillation and the hydrotreating of used oil are acceptable processes that are used for producing a re-refined base oil. Filtering is inadequate for the production of high quality, re-refined base oils from used oil.

Aftermarket Oil Additives

Caterpillar does not recommend the use of aftermarket additives in oil. It is not necessary to use aftermarket additives in order to achieve the machine's maximum service life or rated performance. Fully formulated, finished oils consist of base oils and of commercial additive packages. These additive packages are blended into the base oils at precise percentages in order to provide finished oils with performance characteristics that meet industry standards.

There are no industry standard tests that evaluate the performance of aftermarket additives in oil. There are also no industry standard tests that evaluate the compatibility of these aftermarket additives in a finished oil. Aftermarket additives may not be compatible with the finished oil's additive package, which could lower the performance of the finished oil. The aftermarket additive could fail to mix with the finished oil. This could produce sludge. Caterpillar discourages the use of aftermarket additives in finished oils.

To achieve the best performance from a Caterpillar engine, conform to the following guidelines:

- Select the proper Caterpillar oil or a commercial oil that meets the specifications of the compartment.

- Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Lubricant Viscosities and Refill Capacities" to find the correct oil viscosity grade for your machine.

- At the specified interval, service the engine or service the compartment. Use new oil and install a new oil filter.

- Perform maintenance at the intervals specified in *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Appendix A Operator's Preventative Maintenance Checks and Services (PMCS) DEUCE" and in "Appendix B, Unit Maintenance Preventative Maintenance Checks and Services (PMCS)" in this module.

Lubricating Grease

Caterpillar provides a number of greases in order to cover a variety of applications and extreme temperature conditions. See your Caterpillar dealer or see Special Publication, "One Safe Source" for the part numbers.

NOTE: Some greases may not be used with other greases. When you use commercial grease, make sure that the grease is compatible with the grease that is currently used in your system. If you have any questions concerning the compatibility of your grease, consult your supplier.

Multipurpose Greases

Multipurpose Lithium Complex Grease (MPGL)

Multipurpose Lithium Complex Grease is a general purpose lithium complex grease for medium-duty applications. This product has good characteristics at high temperatures such as a dropping point over 260°C (500°F).

MPGL grease contains additives and an antiwear inhibitor package. These additives provide extra protection in the following applications:

• Construction

• Agricultural

• Automotive

MPGL meets the requirements for extended service intervals of automotive chassis points and for extended service intervals of wheel bearings with disc brakes in automobiles, in vans, in taxi fleets, and in light trucks. This product meets the NLGI certification of "GC-LB." MPGL grease is available in NLGI Grade 2. Normal operating temperatures for this product are -28 to +149°C (-18 to +300°F). This product is also available as a white lithium complex grease.

Multipurpose Lithium Complex Grease with Molybdenum (MPGM)

MPGM grease is a general purpose lithium complex grease that is used for light-duty applications and for medium-duty applications. MPGM is available in NLGI Grade 2 or NLGI Grade 0. MPGM is strengthened with a molybdenum disulfide and with a high molecular weight polymer. The MPGM grease is strengthened for extra lubrication and for extra protection. MPGM grease contains unleaded additives. MPGM grease also contains antiwear inhibitors, inhibitors for oxidation, and corrosion inhibitors. These inhibitors are used for protection and for lubrication in many environments. The MPGM grease is formulated with a high viscosity base fluid and a polymer additive.

The MPGM has the following features:

• Protection against water washout

• Increased retention

• Resistance to heavy loads

This product is recommended for the following uses and applications: heavily loaded pin joints, journal bearings, heavy-duty automotive applications, agricultural applications, industrial applications, steel mill applications, mining applications, and off-highway equipment. This product meets the NLGI certification of "GC-LB." Normal ambient temperatures for NLGI Grade 0 are -28 to +149°C (-18 to +300°F). Normal ambient temperatures for NLGI Grade 2 are -18 to +149°C (-0 to +300°F).

NOTE: If MPGM is not available, use a multipurpose type grease which contains three to five percent molybdenum.

Special Purpose Grease (SPG)

Bearing Lubrication (SPG)

Bearing Lubricant is a lubricating grease with a polyurea thickener. This grease is available in NLGI Grade 2. This grease is recommended for high temperature antifriction bearings in the following applications: electric motors, alternators, fan drives, starters, and generators. The Bearing Lubricant (SPG) has an effective operating range of -29 to 177°C (-20 to 350°F).

Water and Temperature Resistant Grease (SPG)

The Caterpillar Water and Temperature Resistant Grease is designed for use whenever the following conditions are a concern: water washout, severe corrosion, and high operating temperatures. The grease provides extreme pressure, antiwear, oxidation, and corrosion protection without using barium, zinc, antimony, phosphorous, lead type additives, or sulfur type additives. Caterpillar Water and Temperature Resistant Grease is a grease that is friendly to the environment. The Water and Temperature Resistant Grease has excellent shear stability. The grease also resists breakdown in the presence of water. The Caterpillar Water and Temperature Resistant Grease behaves well in the following uses and applications: marine applications, bearings for washing equipment, automotive equipment applications, agricultural equipment applications, industrial applications, and construction equipment applications. This product meets the NLGI certification of "GC-LB." Normal operating temperatures for this product are -40 to 204°C (-40 to 400°F).

Caterpillar Premium Greases (CPG)

Desert Gold (CPG)

Caterpillar Desert Gold is a heavy-duty grease. This grease was developed for extreme environmental conditions. This grease is formulated with the following characteristics: high viscosity synthetic base fluid, polymers, molybdenum disulfide, high viscosity index, and high dropping point. This product will protect equipment against heavy shock load. This product protects against corrosion in extreme heat, in moist conditions, or in dusty conditions. This product has excellent characteristics of adhesion and of stability. Caterpillar Desert Gold provides longer protection than other greases. Caterpillar Desert Gold is an environmentally friendly grease which does not contain antimony, sulfur, barium, zinc, lead, or phosphorous. Normal operating temperatures are -6 to +230°C (+21 to +450°F). Caterpillar Desert Gold can operate at higher temperatures for a short time period. Caterpillar Desert Gold has additional protection for high pressure areas such as highly loaded pin joints.

Arctic Platinum (CPG)

Caterpillar Arctic Platinum is a super-premium extreme pressure lubricating grease developed for lubrication in temperatures below -18°C (0°F) to moderate operating temperatures. Arctic Platinum is available in grades 000, 00, 0, 1, and 2 to ensure flow in central lube systems in a variety of ambient temperatures from -60 to 18°C (-76 to 65°F). Caterpillar Arctic Platinum has a high drop point and contains five percent molybdenum disulfide for protection against extra heavy loads. Arctic Platinum provides excellent protection against corrosion and against oxidation. Caterpillar Arctic Platinum grease is an environmentally friendly grease which does not contain antimony, sulfur, barium, zinc, or phosphorous.

Caterpillar Arctic Platinum grease is designed for long life lubrication of the following components: horizontal pivot bearings, lower link bearings, steering cylinders, kingbolt bearings, upper hitch link bearings, and ejector carrier roller bearings. This grease is extra tacky for increased retention. It can be used on carbody bearings for excavators. Caterpillar Arctic Platinum has additional extreme pressure protection for highly loaded pin joints.

Specialty Lubricants

Table 9

Special Purpose Caterpillar Lubricants	
Item	**Size**
6V-4876 Lubricant(1)	500 g (17.6 oz)
5P-3931 Thread Compound(2)	150 g (5.3 oz)

(1) Recommended for use on typical components such as head bolt threads and washers.
(2) Recommended for mating connections such as exhaust manifold studs and exhaust manifold nuts.

Dry Film Lubricant

1U-8268 Dry Film Lubricant has the following characteristics: superior lubricity, excellent adhesion to most surfaces, fast dry times, and easy application

The dry lubricant can be used for the following applications: backhoe extendible stick, blade circles for motor graders, shift mechanisms, masts for lift trucks, slides that require frequent lubrication, locks that have tumblers, and applications that require a press fit.

Use this lubricant in a well ventilated area.

Cold Weather Lubricants

Before attempting to start the engine, make sure that the oil in the engine, oil in the transmission, and the oil in the hydraulic system are fluid enough to flow. Check the oil by removing the dipsticks. If the oil will drip from the dipstick, then the oil is fluid enough to start the engine. Do not use oil that has been diluted with kerosene. Kerosene will evaporate in the engine. This will cause the oil to thicken. Kerosene will cause swelling and softening of the silicone seals. If your machine is equipped with a gasoline starting engine (earlier machine), make sure that the oil is fluid enough to flow.

If the viscosity of the oil is changed for colder weather, also change the filter element. If the filter is not changed, the filter element and the filter housing can become a solid mass. Drain all hydraulic cylinders and lines. After you change the oil, operate the equipment in order to circulate the thinner oil.

When you start an engine or when you operate an engine in ambient temperatures that are below-20°C (-4°F) use base oils that can flow in low temperatures. These oils have lubricant viscosity grade of SAE 0W or of SAE 5W.

When you start a machine or when you operate a machine in ambient temperatures that are below -30°C (-22°F), use a synthetic base stock multigrade oil. The oil should have a lubricant viscosity grade of 0W or 5W. Use an oil with a pour point that is lower than -50°C (-58°F).

Because the number of acceptable lubricants is limited in arctic conditions, Caterpillar has special recommendations for arctic conditions. Caterpillar recommends the following lubricants for use in Arctic conditions: (The lubricants are listed by preference.)

Engine Oils

NOTICE

Using oils that are not recommended as first choice oils could result in shortened life of the engine.

First Choice is to use an API licensed CG-4 oil with a SAE 0W20, 0W30, 5W30, or 5W40 lubricant viscosity grade. An API licensed CF-4 oil with an SAE 0W20, 0W30, 5W30, or 5W40 lubricant viscosity grade may also be used.

Second Choice is to use an oil that contains the CG-4 additive package or to use an oil that contains the CF-4 additive package, but the oil has not been tested for the requirements of the API license. The oil must have an SAE 0W20, SAE 0W30, SAE 5W30, or SAE 5W40 lubricant viscosity grade.

Transmission/Drive Train Oils

NOTICE

Use of oils that are not recommended as first choice oils could result in shortened life to the transmission and final drive.

First Choice is to use oils that meet the following requirements: formulated from a full synthetic base stock without the viscosity index improvers that meet the performance requirements of the TO-4 specification and requirements for the SAE 30 lubricant viscosity grade. Typical lubricant viscosity grades are SAE 0W30, SAE 5W30 and SAE 0W20.

Second Choice is to use oils with a TO-4 type additive package and a lubricant viscosity grade of SAE 0W30, of 5W30, or SAE 0W20 but have not been tested against the TO-4 specifications.

Third Choice is to use API CF/TO-2 oils with an SAE 0W20, 0W30, or 5W30 lubricant viscosity grade.

NOTE: For maximum service life, use an oil with the highest lubricant viscosity grade that is allowed for the ambient temperature. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Lubricant Viscosities and Refill Capacities" to determine the recommended oil viscosity.

Lubricant Viscosities

The proper oil viscosity grade is determined by the minimum outside temperature when the machine is started and while the machine is operated. In order to determine the proper oil viscosity grade, refer to the "Min" column in the table. This information reflects the coldest ambient temperature condition for starting a cold machine and for operating a cold machine. Refer to the "Max" column in the table in order to select the oil viscosity grade for operating the machine at the highest temperature that is anticipated. Use the highest oil viscosity that is allowed for the ambient temperature when you start the machine.

Machines that are operated continuously should use oils that have the higher oil viscosity in the final drives and in the differentials. The oils that have the higher oil viscosity will maintain the highest possible oil film thickness. Consult your dealer if additional information is needed.

S•O•S Oil Analysis

Caterpillar recommends the use of the S•O•S oil analysis program in order to monitor the condition of your equipment. The S•O•S oil analysis program will complement your preventive maintenance program.

Obtaining S•O•S Oil Samples

Before you obtain an S•O•S oil sample, operate the machine until the oil is warm and the oil is well circulated. Then obtain the S•O•S oil sample.

In order to obtain a good oil sample, do not take the oil sample from the drain stream. The drain stream method can allow a stream of dirty oil from the bottom of the compartment to contaminate the sample. Likewise, never dip an oil sample from an oil container or pour a sample from a used filter.

NOTICE

Do not use the same vacuum sampling pump for extracting oil samples that is used for extracting coolant samples.

A small residue of either type sample may remain in the pump and may cause a false positive analysis for the sample being taken.

Always use a designated pump for oil sampling and a designated pump for coolant sampling.

Failure to do so may cause a false analysis which could lead to customer and dealer concerns.

There are two ways to obtain S•O•S oil samples. The following methods are listed in the order that is preferred:

- Use an in-line sampling valve for pressurized oil systems.

- Use a sampling gun that is inserted into the sump.

Use of the in-line sampling valve is the preferred method. This method provides samples that are less likely to be contaminated. Whenever you obtain the samples, obtain the samples from the same point. This makes the samples more representative of the oil that is in the system.

In order to obtain an oil sample from the engine compartment, it may be necessary to increase the engine's speed. Normally, the oil sample is taken at low idle. If the flow rate is too low, increase engine speed to high idle in order to obtain the oil sample.

In-line sampling valves cannot be used on nonpressurized oil systems such as differentials and final drives. Use of the sampling gun is the preferred method for nonpressurized oil systems.

Refer to the Operation and Maintenance Manual, "Maintenance Interval Schedule" for the proper interval.

The S•O•S oil analysis is composed of four basic tests:

- Wear metal analysis

- Infrared analysis for oil condition
- Tests for contamination of the oil by fuel, by water, and/or by antifreeze
- Particle Count for hydraulics, transmissions and other gear compartments

Consult your Caterpillar Dealer for complete information and assistance about the S•O•S oil analysis program.

Sampling Interval and Location of Sampling Valve

Take the oil samples as close as possible to the standard intervals. In order to receive the full value from S•O•S oil analysis, you must establish a consistent trend of data. In order to establish a pertinent history of data, perform consistent oil sampling that are evenly spaced.

Consult your Caterpillar dealer for complete information and assistance in establishing an S•O•S program for your equipment.

NOTE: After the warranty period has expired, follow AOAP guidelines outlined in DA PAM 738-750.

More Frequent S•O•S Sampling Improves Life Cycle Management

Traditionally, the suggested S•O•S sampling intervals have been at each oil change, 250 hours for engines, or every 500 hours for all other compartments. However in severe applications, more frequent oil sampling is recommended. If the machine is operated under a high load and/or high temperature condition, sample all compartments at every 250 hours of operation.

Application

Studies have revealed that obtaining oil samples at every 500 hours is too long a time interval in some applications in order to predict potential failure modes. A sampling interval at every 250 hours provides more data between oil change intervals. More data increases the chance for detecting a potential failure.

Determining Optimum Oil Change Intervals

Sampling the compartments at every 250 hours provides information for oil condition and for oil performance. This information is used to determine the optimum usable life of a particular oil. Also, more points of data will allow closer monitoring of component wear rates. Close monitoring also allows you to obtain the maximum use of the oil. For detailed information on extending oil change intervals, please contact your Caterpillar dealer.

Optimizing Component Life Cycle

An increase in the number of oil samples provides a better definition of the trends in data between oil change intervals. More oil samples will allow you to closely monitor wear patterns of components. This action will ensure that the full life of the components are achieved.

The standard interval that is used between S•O•S oil samples is 250 hours for all Caterpillar engines. While 500 hour intervals remain acceptable for nonengine compartments, these intervals are not necessarily optimum. If the machine is operated under a high load and/or high temperature condition, sample all compartments at the 250 hour interval.

Table 10

Compartment	Recommended Oil Change Interval	Recommended Sampling Interval	Sampling Valve	Oil Type
Engine	250 Hours	250 Hours	Yes	DEO
Transmission	500 Hours	500 Hours	Yes	TDTO
Hydraulics	1000 Hours	500 Hours	Yes	TDTO

Maintenance Intervals

When Required

Initial 50 Service Hours

Every 250 Service Hours or Three Months

Every 500 Service Hours or Six Months*

Every 1000 Service Hours or One Year*

Every 1000 Service Hours or When Required*

Every 2000 Service Hours or Two Years*

*Perform maintenance items from previous service intervals first.

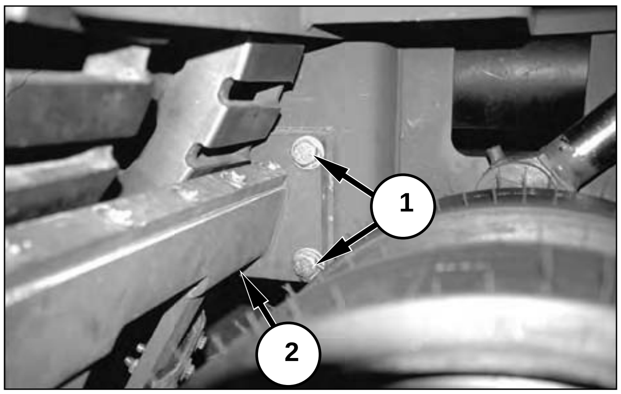
When Required

Read and understand the warnings and instructions contained in the "Safety" section of this module before performing any operation or maintenance procedure.

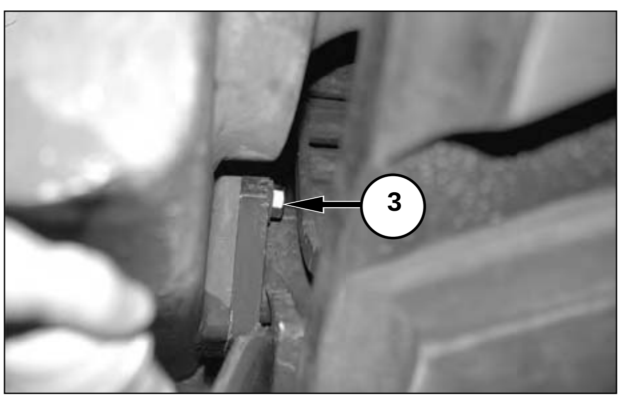
Idler Scrapers

Adjust Clearance

NOTE: Adjust the clearance when the rubber piece of the scraper group is not 1.5 ± 0.5 mm (0.06 ± 0.02 in) from the drive belt, and/or the top edge of the scraper is not 3 ± 1 mm (0.12 ± 0.04 in) from the drive wheel.



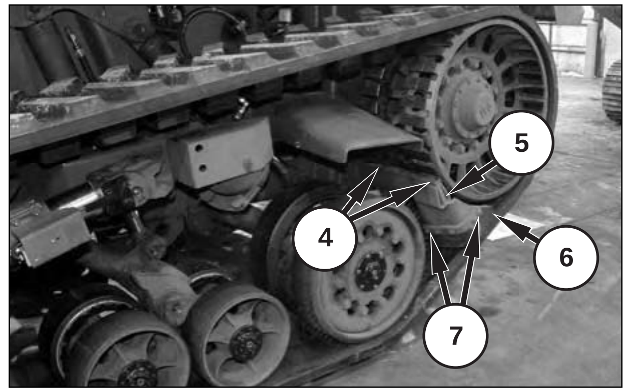
1. If a large adjustment of the top edge is necessary, loosen but do not remove two bolts (1) which hold idler scraper group (2) to the machine frame.



2. Loosen but do not remove bolt (3) on the inside of the machine frame.

3. Slide scraper group (2) closer to the drive wheels.

4. Apply 4C-4030 Thread Compound (Loctite™ 242) to the threads of bolts (1) and (3), and tighten the bolts.



5. To make a fine adjustment of the top edge, loosen five bolts (4), and slide bar (5) to within 3 ± 1 mm (0.12 ± 0.4 in) of the drive wheels.

6. To adjust rubber piece (6), loosen five bolts (7), and slide the rubber piece to within 1.5 ± 0.5 mm (0.06 ± 0.02 in) of the drive belt.

NOTE: If necessary, adjust the rubber piece on both sides of the guide blocks.

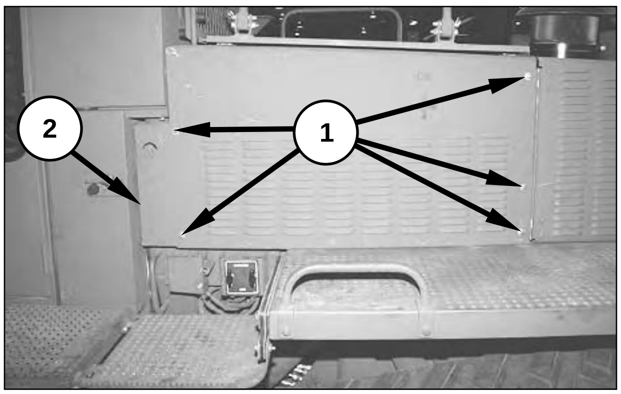
Start-Aid System

Replace Ether Cylinder

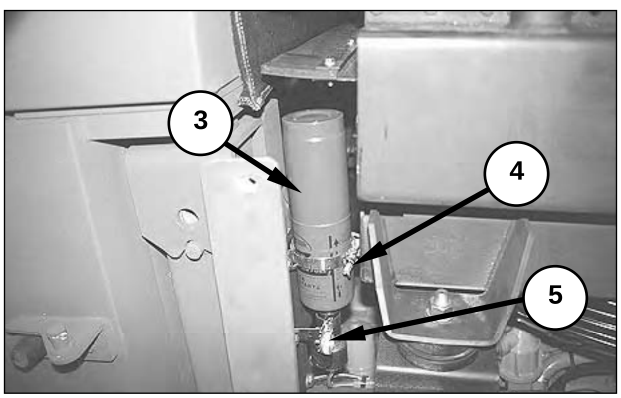
⚠ WARNING

Ether cylinders contain ethyl ether. Keep away from heat, sparks, or open flame. Do not puncture or incinerate the container. Do not store or use at above 93.3º C (200º F).

Keep out of reach of children. Avoid contact with the skin. Avoid breathing vapor. Do not mount the unit in an unventilated driver's compartment or store spare cylinders in the cab.



1. Remove five bolts (1) and cover (2).



2. Loosen clamp (4) by turning the nut counterclockwise.

3. Turn ether cylinder (3) counterclockwise (as viewed from above) and remove the cylinder. Dispose of the cylinder according to local regulations.

NOTE: If a new ether bottle will not be installed immediately, move cap (5) from the storage location to the open port where the ether bottle is installed. The cap will keep the ether cylinder installation port free of dirt and debris.

4. Install a new ether cylinder by inserting the cylinder in clamp (4) and turning clockwise (as viewed from above).

5. Tighten the nut on clamp (4) by hand, to hold the ether bottle in place.

6. Install cover (2) and five bolts (1).

Initial 50 Service Hours

Read and understand the warnings and instructions contained in the "Safety" section of this module, before performing any operation or maintenance procedure.

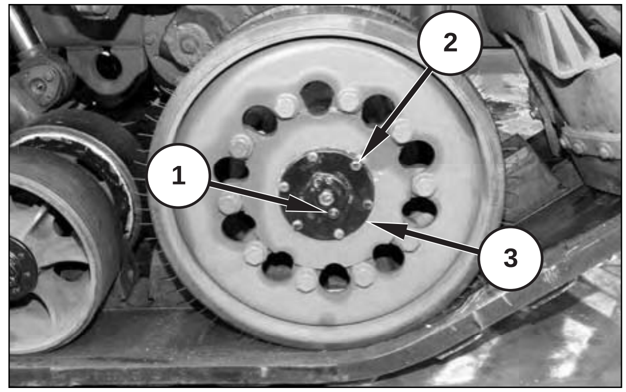
Power Train

Change Oil and Filters

Refer to the procedure in "Every 2000 Service Hours or 2 Years," in this section. Change the oil and filter only. There is no need to clean the screen and breather at this time.

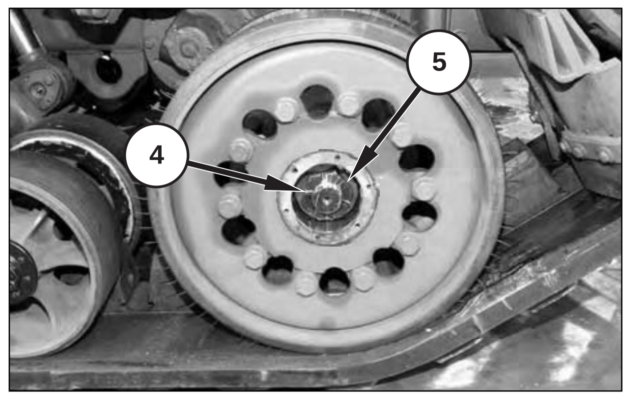
Rear Idler

Check Torque



1. Position the machine on a flat level surface so that the fill plug (1) is facing the bottom of the machine, and remove plug.

NOTE: Use a suitable container to catch any spilled oil, and dispose of the oil according to local regulations.



2. Remove eight bolts (2) with washers, and cover (3). Remove any remaining sealant on the cover and the mating surface.

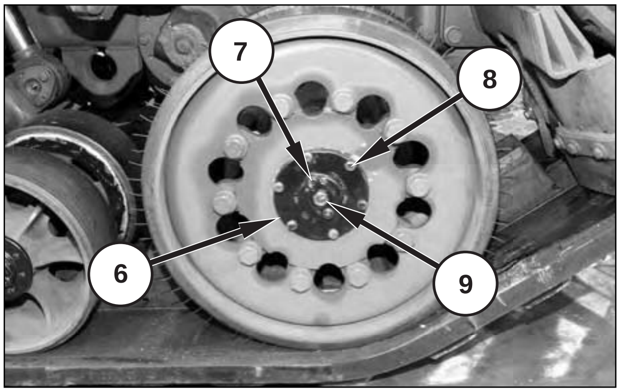
3. Remove cotter pin (4) through hole in swing arm shaft and the slot in nut (5).

4. Loosen nut (5), then retighten to 405 N•m (300 lb ft).

5. Install a 3B-5328 Cotter Pin through the hole in the swing arm shaft and the slots in nut (5).

NOTE: To prevent interference with the rear idler cover, do not bend the cotter pin over the end of the shaft.

6. Apply 6V-5765 Sealant (clear silicone) in a continuous bead on the sealing surface between cover (3) and the rear idler hub.



7. Position cover (6) so that fill plug (7) is approximately between the 10 o'clock and 2 o'clock positions. Install the cover (6) with eight bolts (8) and washers.

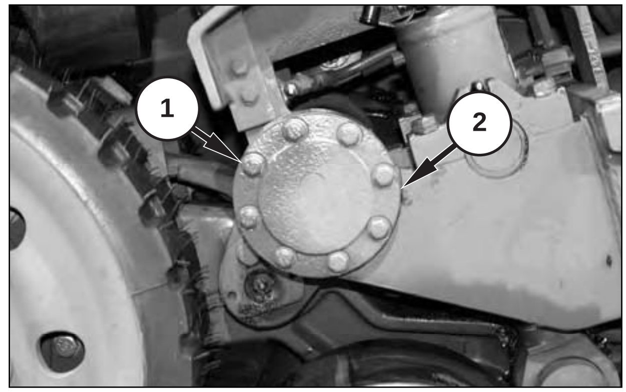
8. Refill the oil in the rear idler hub with the appropriate amount and type, until oil is visible in sight gauge (9). Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Lubricant Viscosities and Refill Capacities."

9. Recheck the oil level after a brief period, adding additional oil as necessary. When the oil level no longer decreases in the sight gauge, install an O-ring on plug (7), and install the plug in the fill hole.

10. Repeat steps 1 through 9 for rear idler on the opposite side of the machine.

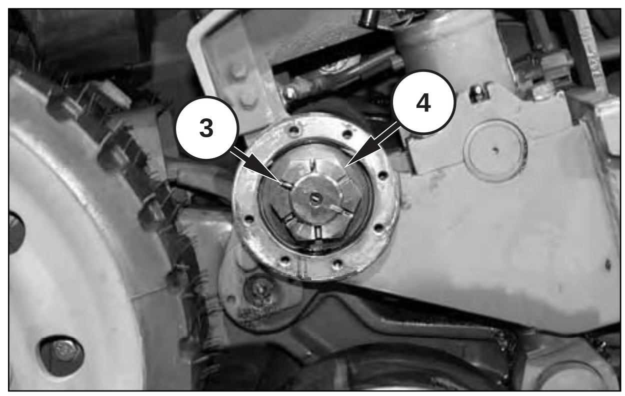
Offset Arm

Check Torque



1. Park the machine on a flat, level surface.

2. Remove eight bolts (1) with washers, and cover (2). Remove any remaining sealant on the cover and the mating surface.



3. Remove cotter pin (3) from nut (4).

4. Loosen nut (4), then retighten to 140 N•m (100 lb ft).

5. Install a 3B-5328 Cotter Pin through the hole in the shaft and the slots in nut (4).

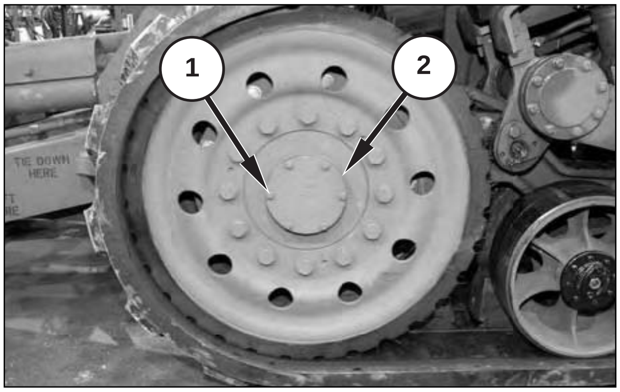
6. Apply 6V-5765 Sealant (clear silicone) in a continuous bead on the sealing surface of cover (2).

7. Install eight bolts (1) with washers, and cover (2).

8. Repeat steps 1 through 7 for the offset arm on the opposite side of the machine.

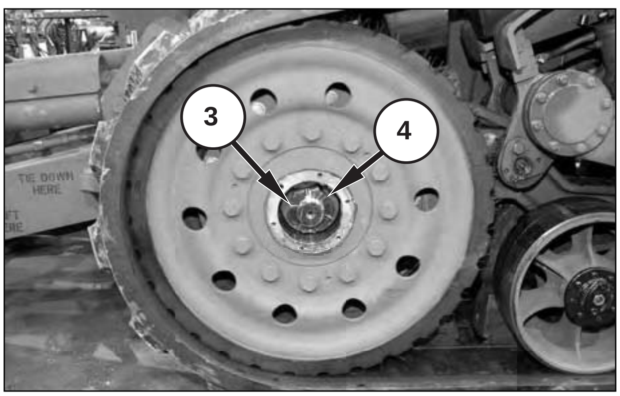
Brake Assembly

Check Torque



1. Remove six bolts (1) with washers, and cover (2) from both sides of the brake. Remove any remaining sealant on the cover and the mating surface. Catch any oil that may leak in a suitable container, and discard the oil according to local regulations.

NOTE: Any oil drained from the brake housing does not need to be replaced. The hydraulic system replaces the oil during normal operation.



2. Remove cotter pin (3) from nut (4).

3. Loosen nut (4), then retighten to 744 N•m (550 lb ft).

4. Install a 3B-5328 Cotter Pin through the hole in the shaft and the slots in nut (4).

5. Apply 6V-5765 Sealant (clear silicone) in a continuous bead on the sealing surface of cover (2).

6. Install six bolts (1) with washers, and cover (2).

7. Repeat steps 1 through 7 for the brake assembly on the opposite side of the machine.

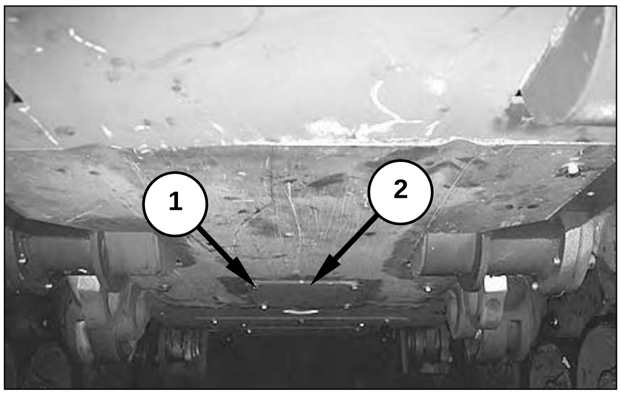
Every 250 Service Hours or Three Months

Read and understand the warnings and instructions contained in the "Safety" section of this module before performing any operation or maintenance procedure.

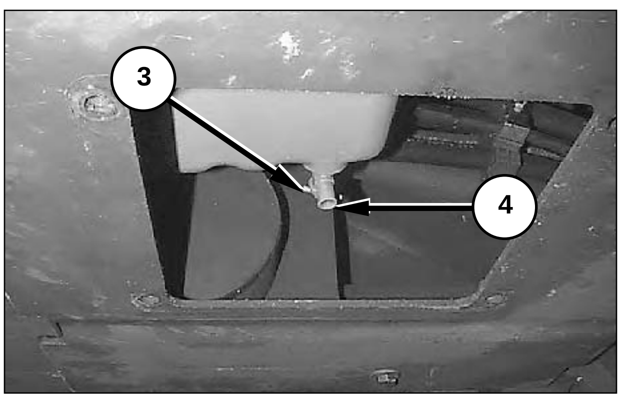
Engine Oil and Filter

Replace

1. Park the machine on a flat, level surface and stop the engine.



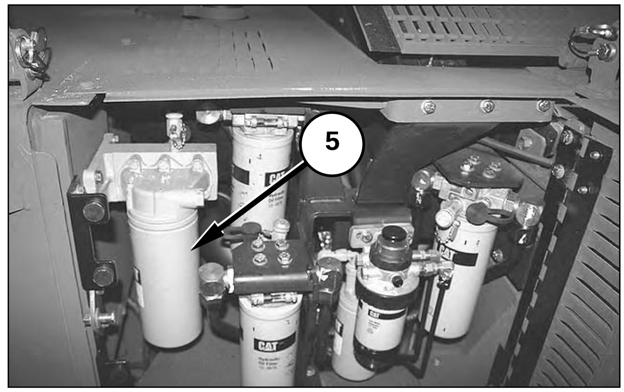
2. Remove four bolts (1) with washers, and access cover (2) from the bottom of the machine.



3. Attach a suitable drain hose to valve opening (4).

4. Open drain valve (3) and allow the oil to drain into a suitable container. The capacity of the engine oil pan is approximately 35 L (9.2 U.S. gal). Dispose of the oil in accordance with local regulations.

5. Close drain valve (3).

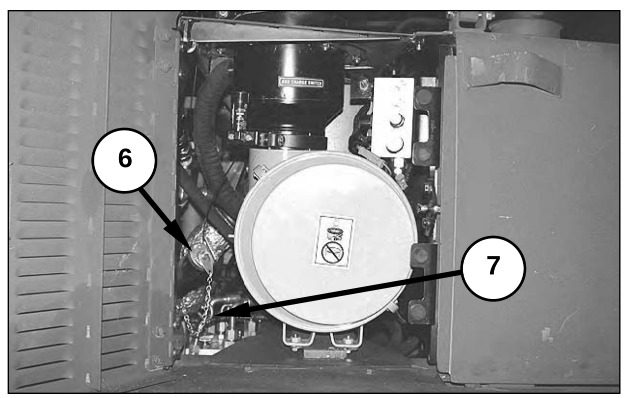


6. Open the oil filter compartment door.

7. Remove and discard engine oil filter (5). Dispose of the engine oil filter according to local regulations. Make sure that all of the old filter seal is removed from the filter base.

8. Apply a thin coat of oil to the seal on the new filter.

9. Install the filter by hand until the filter contacts the base, and then tighten the filter three-quarters of a turn more. There are rotation index marks spaced 90 degrees apart on each new filter; three-quarters of a turn is equivalent to a distance of three of the 90 degree marks.



10. Open the air filter compartment door, and remove cap (6) to add the oil. Refer to "Lubricant Viscosities and Refill Capacities" in *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE)* for the correct oil and quantity for this engine.

11. Always measure the oil level with dipstick (7) to make certain the quantity of oil added is correct.

12. Reinstall cap (6).

13. Start and operate the engine at low idle for about one minute.

14. Stop the engine and recheck the oil level on dipstick (7). Add oil if necessary.

15. Check for leaks at the oil filter base and the oil drain valve.

16. Remove the drain hose on valve opening (4).

17. Reinstall access cover (2) using four bolts (1) with washers.

18. Close the oil filter compartment and the air filter compartment doors.

NOTE: After the warranty period has expired, follow AOAP guidelines outlined in DA PAM 738-750.

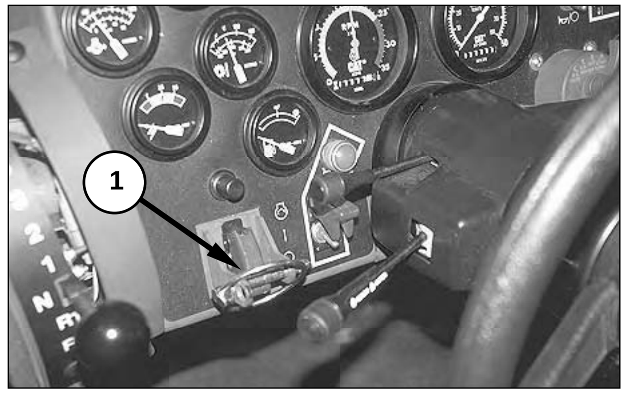
Fuel System

WARNING

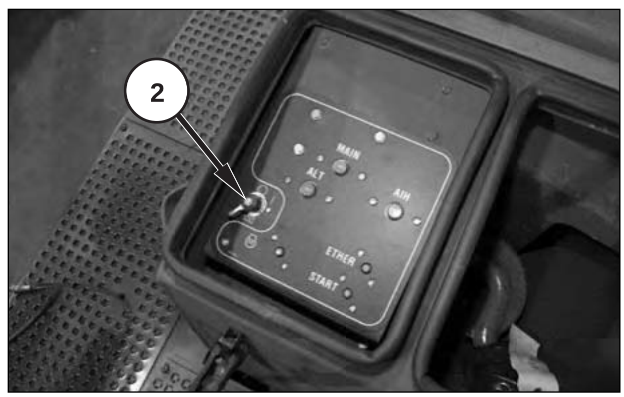
Diesel fuel is combustible. Do not smoke around diesel fuel. Open flames or sparks can cause a fire and/or explosion.

Replace Secondary Fuel Filter Element

1. Park the machine on flat, level ground and stop the engine.

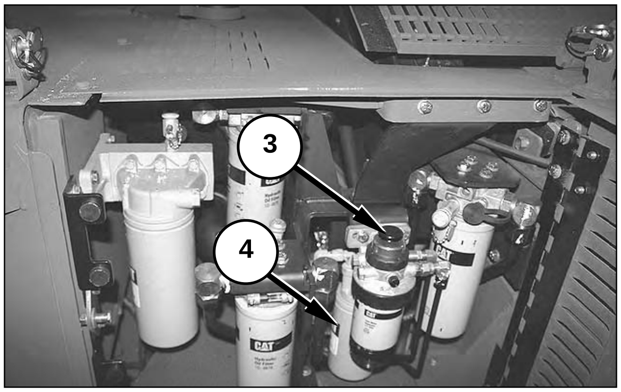


2. Move engine start switch (1) to OFF.



3. Turn main disconnect switch (2) to OFF.

NOTE: If the machine is equipped with arctic batteries, turn the main disconnect switch on the arctic battery box to OFF also. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Machine Features, Main Disconnect Switch."



4. Open the oil filter compartment door, and remove and discard secondary filter element (4). Ensure that all of the old gasket has been removed from the filter base.

NOTE: Once the filter is removed, drain any remaining fuel into a suitable container and dispose of the fuel according to local regulations.

NOTICE

Do not fill fuel filters with fuel before installing them. Contaminated fuel causes accelerated wear to fuel system parts.

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5. Coat the seal of the new filter with clean diesel fuel.

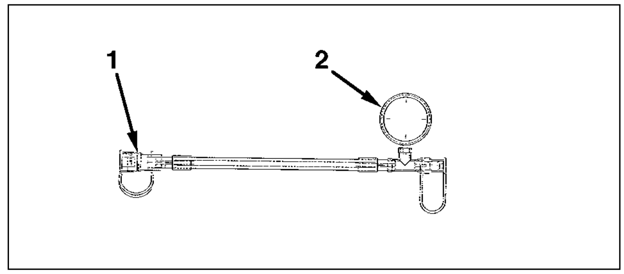
6. Install the new filter by hand. When the seal contacts the base, tighten the element three-quarters of a turn more.

7. Operate priming pump (3) to fill secondary filter element (4) with fuel.

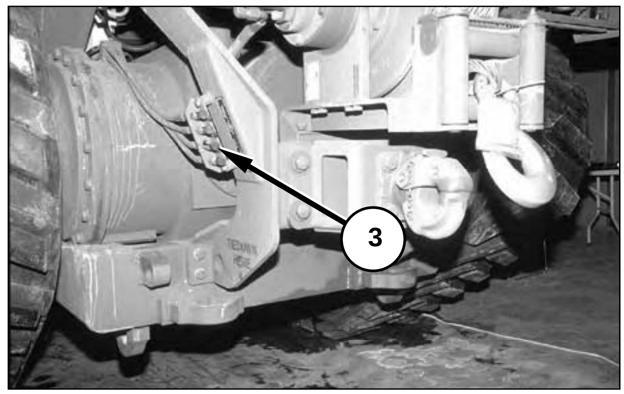
8. Close the oil filter compartment door.

Drive Belts

Check Tension



1. Remove the lines group gauge from the BII compartment.



2. Attach coupling (1) to the suspension charge port (3) marked “RECOIL,” at the rear of the machine.

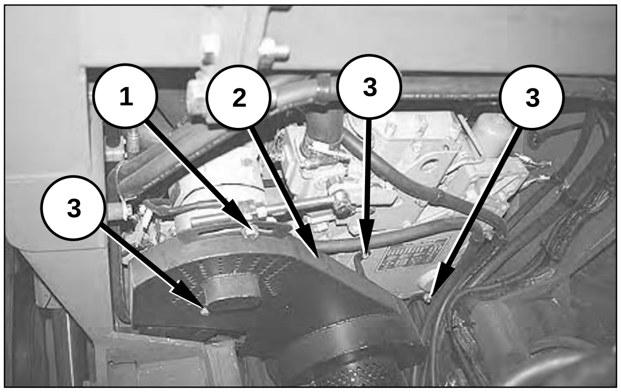
3. The pressure on gauge (2) should be 15 170 ± 690 kPa (2200 ± 100 psi).

4. If the pressure is low, charge the tension. Refer to *Systems Operation Testing and Adjusting, Undercarriage Steering and Brakes,* “Testing and Adjusting, Suspension System Procedures, Suspension Hydraulic Charging Procedure.”

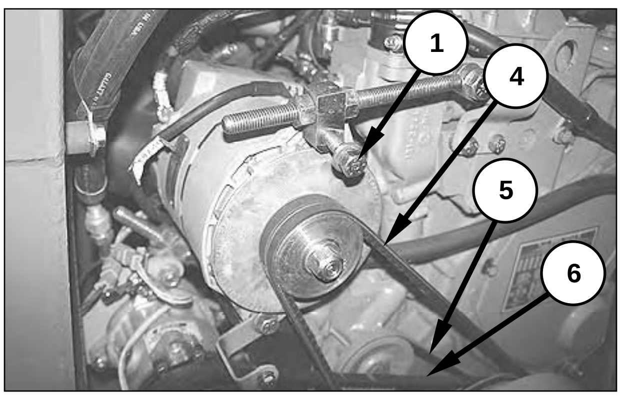
Engine V-Belts

Inspect and Adjust

1. Tilt the cab. For the procedure to tilt the cab, refer to "Operation Section, Maintenance Features, Cab Tilt" in this module.



2. Remove three bolts (3), one bolt (1) and belt guard (2).

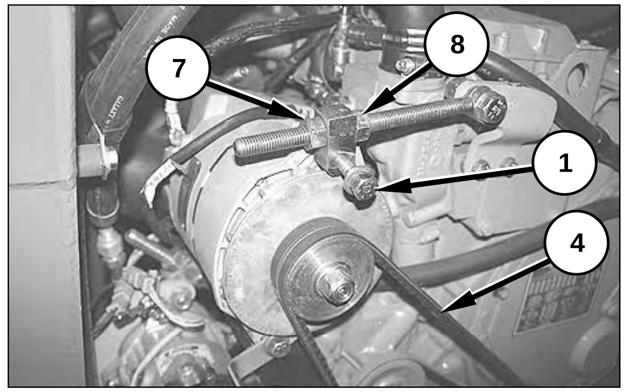


3. Check alternator belt (4) for wear. Replace the belt if the belt is damaged or cracked.

NOTE: Replace the alternator belts as a set. Never use an old belt and a new belt together.

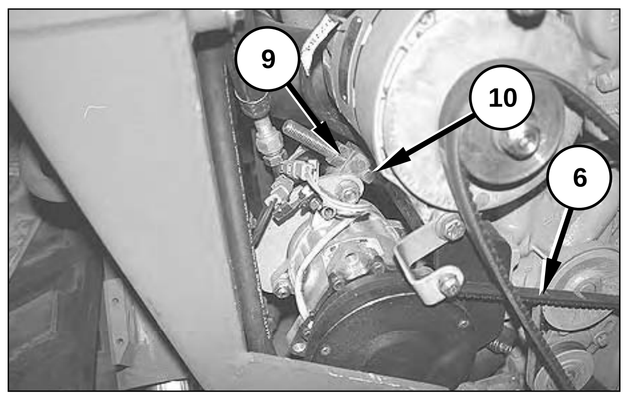
4. Check water pump belt (5) for wear. Replace the belt if the belt is damaged or cracked.

5. Check air-conditioning compressor belt (6) for wear. Replace the belt if the belt is damaged or cracked.



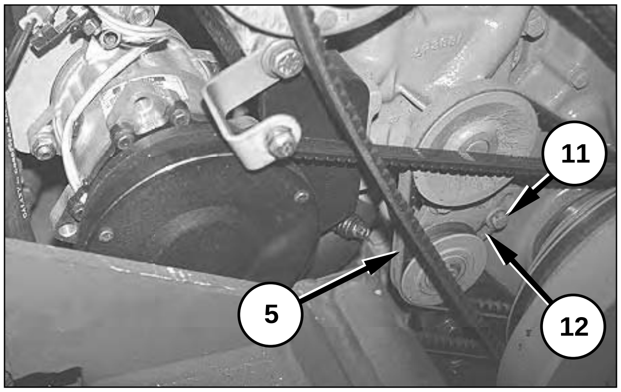
6. To adjust alternator belts (4), reinstall bolt (1). Loosen lock nut (7), and turn adjustment nut (8) to adjust the belt tension. Tighten new belts to a tension of 534 ± 22 N (120 ± 5 lb). Tighten used belts to a tension of 400 ± 44 N (90 ± 10 lb). When the belt tension is within specification, tighten the lock nut.

NOTE: Use the used-belt specification for any belt which has been running at rated speed for more than 30 minutes.



7. To adjust the tension of air-conditioning compressor belt (6), loosen lock nut (9), and turn adjustment nut (10). Tighten new belts to a tension of 534 ± 22 N (120 ± 5 lb). Tighten used belts to a tension of 400 ± 44 N (90 ± 10 lb). When the belt tension is within specification, tighten the lock nut.

NOTE: Use the used-belt specification for any belt which has been running at rated speed for more than 30 minutes.



8. To adjust water pump belt (5), loosen bolt (11), and rotate idler mount (12). Tighten new belts to a tension of 534 ± 22 N (120 ± 5 lb). Tighten used belts to a tension of 400 ± 44 N (90 ± 10 lb). When the belt tension is within specification, tighten the bolt.

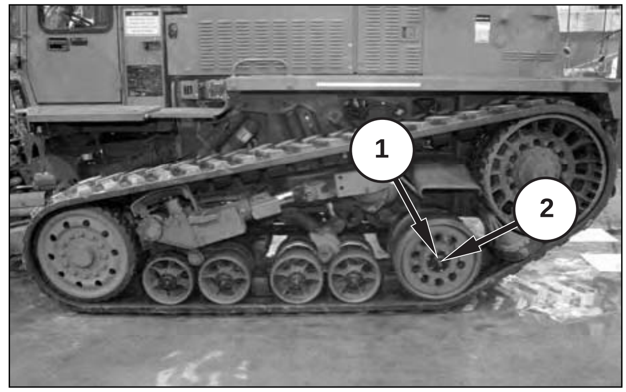
NOTE: Use the used belt specification for any belt which has been running at rated speed for more than 30 minutes.

9. Reinstall belt guard (2) with bolt (1) and three bolts (3).

10. Lower the cab.

Rear Idlers

Check Oil Level



1. Park the machine on flat, level ground and stop the engine.

2. Position the machine so fill plug (1) is facing the top of the machine.

3. Check the oil level in sight gauge (2). If the oil level is not visible in the sight gauge, remove fill plug (1), adding additional oil as necessary. When the oil level no longer decreases in the sight gauge, install an O-ring on the fill plug, and install the plug in the fill hole.

NOTE: For the appropriate amount and type of oil refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Lubricant Viscosities and Refill Capacities."

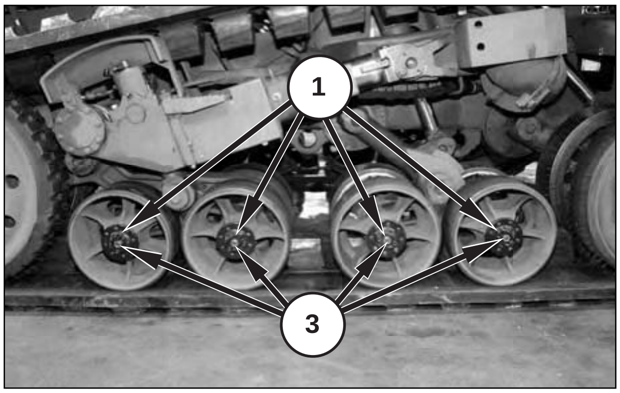
4. Repeat steps 1 through 3 for the rear idler on the opposite side of the machine.

Midrollers

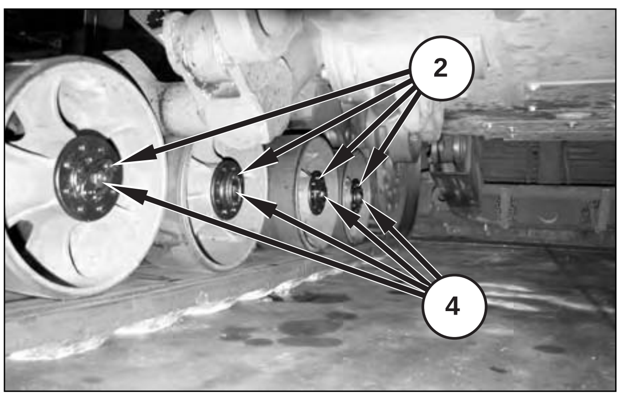
Check Oil Level

1. Park the machine on flat, level ground, and stop the engine.

2. Position the machine so fill plugs (1) and (2) are facing the top of the machine.



Outside Midrollers, (left side shown).



Inside Midrollers, (left side shown).

3. Check the oil level of both outside sight gauges (3), and inside sight gauges (4). If the oil level is not visible in the sight gauge, remove fill plug (1), adding additional oil as necessary. When the oil level no longer decreases in the sight gauge, install a 1J-9671 O-ring seal on fill plug, and install the plug in thethe fill hole.

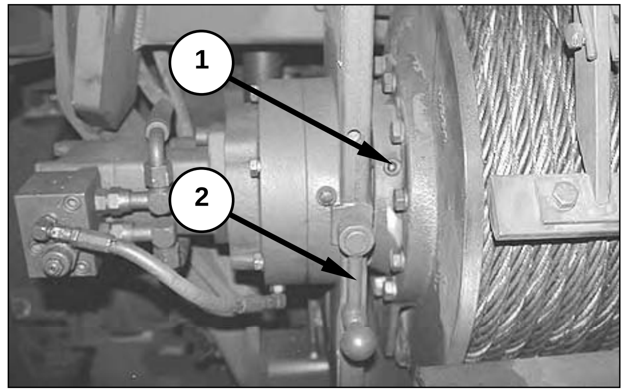
NOTE: For the appropriate amount and type of oil refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Lubricant Viscosities and Refill Capacities."

4. Repeat steps 1 through 3 for each midroller. There is a total of 16 midrollers.

Winch Gearbox

Check Oil Level

1. Park the machine on flat, level ground and stop the engine.



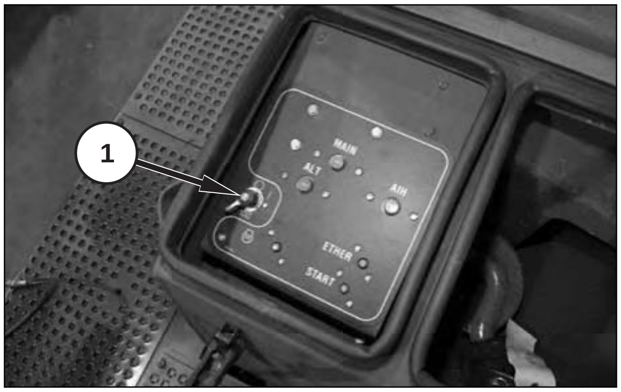
2. Move winch clutch lever (2) to DISCONNECT, and rotate the winch spool until check/fill plug (1) is horizontal (at the three o'clock position).

3. Remove check and fill plug (1). Maintain the oil level in the winch gearbox to the bottom of the check and fill hole.

4. Reinstall check and fill plug (1).

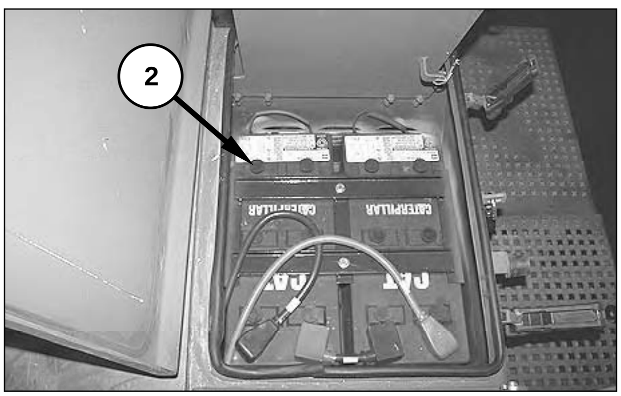
Batteries

Inspect



1. Turn the main disconnect switch to the OFF position.

NOTE: If the machine is equipped with arctic batteries, turn the main disconnect switch on the arctic battery box to OFF also. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Machine Features, Main Disconnect Switch."



2. Open the tool box cover and lift the tool tray.

NOTE: To secure the tool tray in the open position, clip the cable (attached to the bottom right side of the tool tray) to the bracket on the right side of the battery box.

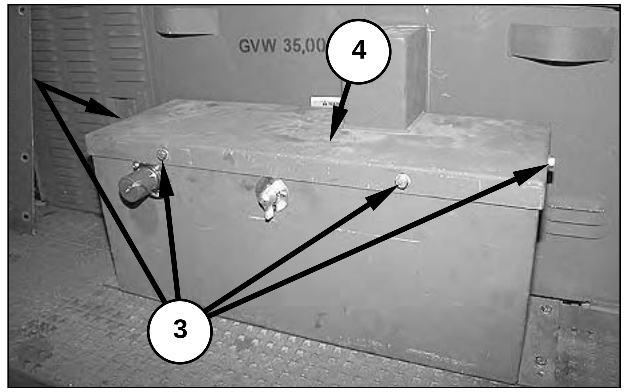
3. Open each of six caps (2), and add distilled water to maintain the electrolyte level to the top of the cell plates. The cell plates are visible beneath each cap.

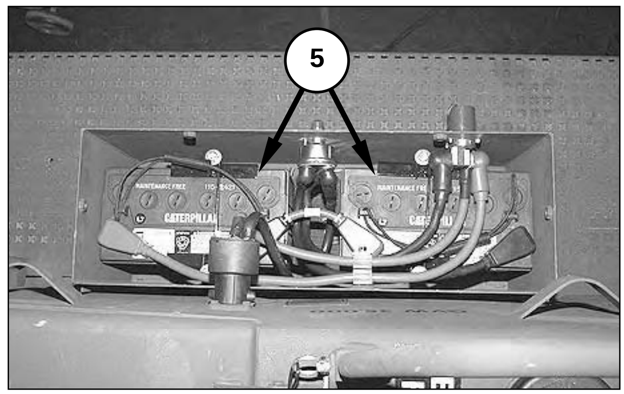
4. Reinstall each of six caps (2).

5. Check the battery terminals for corrosion. Clean the terminals if any corrosion is found. Apply petroleum jelly to the terminals to inhibit corrosion.

NOTE: Refer to *TM9-6140-200-14 Operator's, Unit, Direct Support and General Support Maintenance Manual* for Lead-Acid Storage Batteries.

6. Lower the tool tray and close the tool box cover.





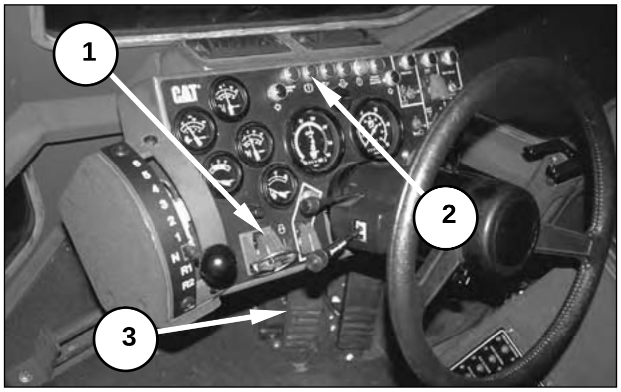
7. If the machine is equipped with arctic batteries (5), remove four bolts (3) with washers, and cover (4).

8. Check the battery terminals for corrosion. Clean the terminals if any corrosion is found. Apply petroleum jelly to the terminals to inhibit corrosion.

NOTE: The arctic batteries are a maintenance-free type and do not require the addition of distilled water to maintain the electrolyte level.

Brake Accumulator

Check



1. Start and run the engine for one minute to increase the accumulator pressure. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Before Starting the Engine" and "Engine Starting."

2. Stop the engine.

3. Move start switch (1) to the ON position.

4. While counting the number of applications, apply and release service brake pedal (3) until low brake pressure indicator (4) illuminates.

5. If low brake pressure indicator (4) illuminates with less than 10 applications of service brake pedal (3), charge the brake accumulator with dry nitrogen. Refer to *Specifications, Systems Operation, Testing and Adjusting, Deployable Universal Combat Earthmover (DEUCE), Undercarriage, Steering, and Brakes,* "Testing and Adjusting, Brake System Procedures, Accumulator Charging Procedure."

6. Move start switch (1) to OFF.

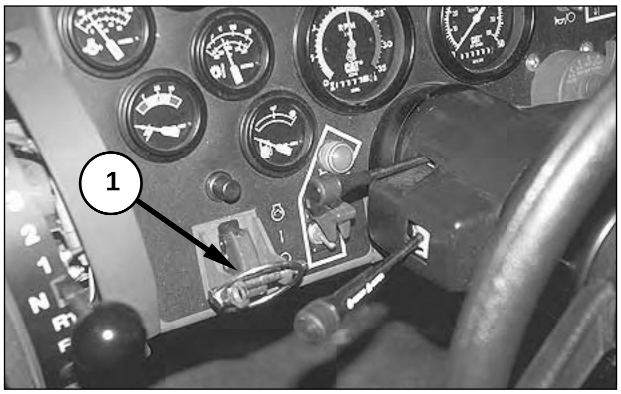
Every 500 Service Hours or Six Months

Read and understand the warnings and instructions contained in the "Safety" section of this module before performing any operation or maintenance procedure.

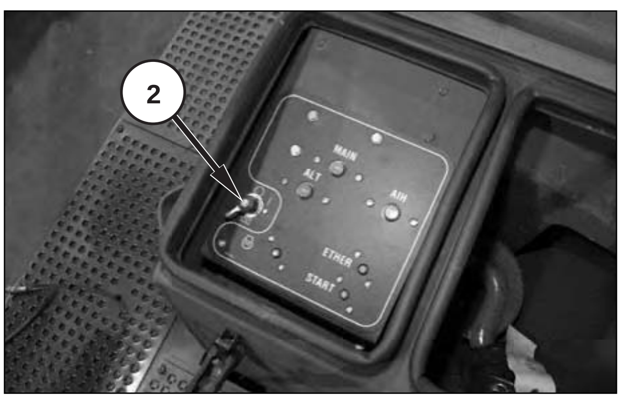
Fuel System

Replace Primary Filter and Water Separator

1. Park the machine on flat, level ground and stop the engine.

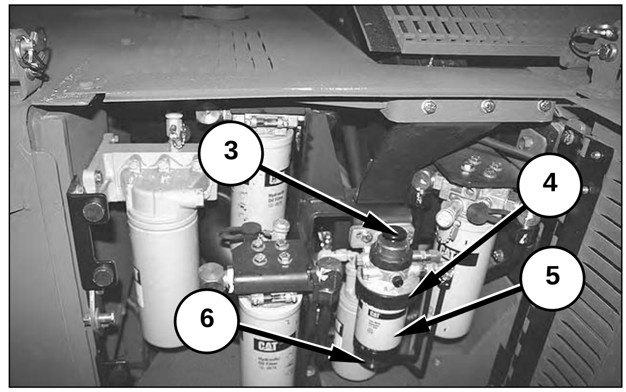


2. Move engine start switch (1) to OFF.



3. Turn main disconnect switch (2) to OFF.

NOTE: If the machine is equipped with arctic batteries, turn the main disconnect switch on the arctic battery box to OFF also. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Machine Features, Main Disconnect Switch."



4. Open the oil filter compartment access door.

5. Turn collar (4), and remove filter (5) with sight bowl (6).

NOTE: Once the filter is removed, drain any remaining fuel into a suitable container, and dispose of the fuel according to local regulations.

6. Remove sight bowl (6) from filter (5), and install the sight bowl on the new filter.

NOTICE

Do not fill fuel filters with fuel before installing them. Contaminated fuel causes accelerated wear to fuel system parts.

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7. Align the marks on the new filter with the grooves in the filter base, and insert the new filter into the filter base. Secure the filter in place with collar (4).

8. Operate priming pump (3) to fill the filter with fuel.

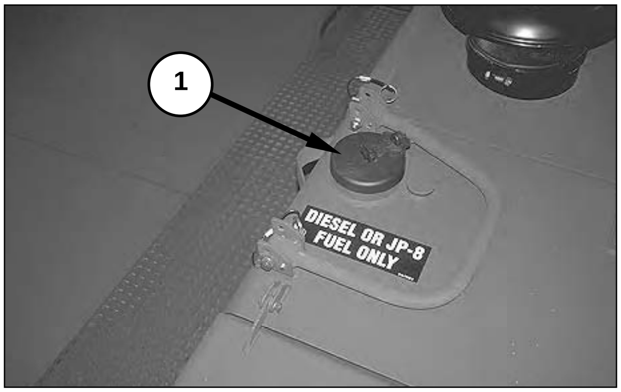
9. Close the air filter compartment doors.

Fuel Tank

Check Cap and Clean Fill Screen

WARNING

Diesel fuel is combustible. Do not smoke around diesel fuel. Open flames or sparks can cause a fire and/or explosions.



1. Remove fuel cap (1).

2. Remove the fill screen, and wash the screen in clean diesel fuel. Allow the screen to dry.

3. Reinstall the fill screen and fuel cap (1).

Cooling System

Test Coolant Additive Concentration

WARNING

At operating temperature, the engine coolant is hot and under pressure. Any contact with the skin can cause severe burns. Also, cooling system additive contains alkali. Avoid contact with the skin, eyes, and mouth. Do not open the engine coolant fill cap until the temperature of the engine coolant is below 36°C (98°F).

NOTICE

Read and understand the information under "Cooling System Specifications" in the "Maintenance" section of *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE)* before proceeding with maintenance of the cooling system.

To prevent engine damage, never add coolant to an overheated engine. Allow the engine to cool first.

Refer to "Cooling System Specifications" in the "Maintenance" section of *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE)* for all cooling system requirements before performing this maintenance procedure.

Caterpillar Antifreeze contains the necessary coolant additive precharge. Only add the supplemental coolant precharge after flushing the system, if Caterpillar Antifreeze is not being used.

NOTICE

The overconcentration of a supplemental coolant additive results in deposits on the higher temperature surfaces of the cooling system and creates a barrier that reduces the engine's heat transfer characteristics.

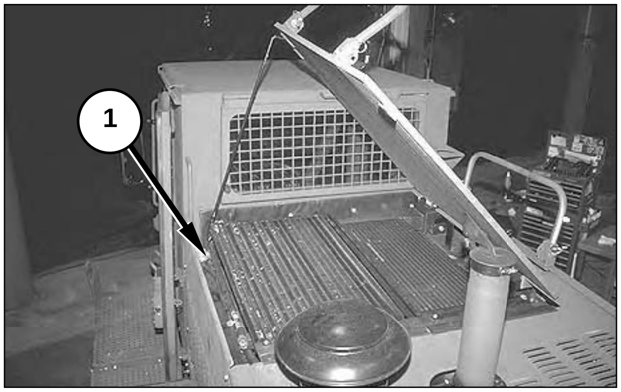
Reduced heat transfer can cause cracking of the cylinder head and other high temperature components. Excessive concentrations of coolant additive can also accelerate water pump seal wear.

Use the 8T-5296 Coolant Conditioner Test Kit to check for concentration.

Add Supplemental Coolant Additive

NOTICE

To prevent overinhibiting the engine's cooling system, never use both the supplemental coolant additive and a supplemental coolant additive element at the same time.



1. Raise the radiator guard and prop it open with the rod.

2. Loosen radiator fill cap (1) slowly, to relieve pressure, and remove the cap.

3. If necessary, drain enough coolant from the radiator to allow for the addition of the supplemental coolant additive.

4. Add 0.25 L (0.50 pt) of Caterpillar Supplemental Coolant Additive for every 38 L (10 U.S. gal) of cooling system capacity. For system capacity, refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Lubricant Viscosities and Refill Capacities."

5. Inspect the radiator filler cap gasket. Replace the cap if the gasket is damaged.

6. Install the filler cap, and lower the radiator guard.

Hydraulic System

Change Filters

1. Park the machine on flat, level ground and stop the engine.

2. Open the oil filter compartment door.

3. Remove oil filter (1). Make sure that all of the old filter seal is removed from the filter base.

4. Remove return oil filter (2). Make sure that all of the old filter seal is removed from the filter base.

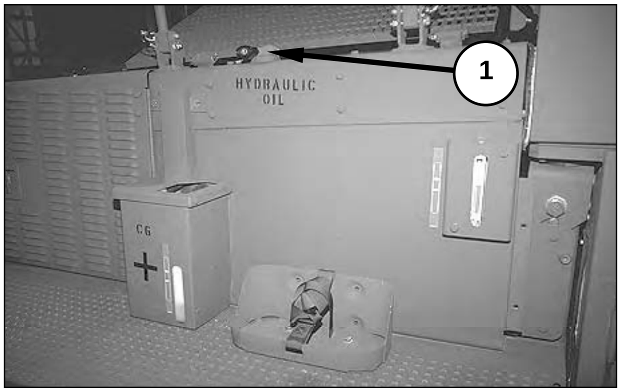
NOTE: Once the filters are removed, drain any remaining oil into a suitable container and dispose of the oil according to local regulations.

5. Apply a thin coat of oil to the seal on the new filters.

6. Install each filter by hand until the filters contact the base, and then tighten the filters three-quarters of a turn more. There are rotation index marks spaced 90-degrees apart on each new filter. Three-quarters of a turn is equivalent to a distance of three of the 90-degree marks.

7. Close the oil filter compartment door.

Clean Fill Screen



1. Remove fill cap (1) on the hydraulic oil tank.

2. Remove the inlet screen, and wash the screen in clean non-flammable solvent. Allow the screen to dry.

3. Reinstall the inlet screen and fill cap (1).

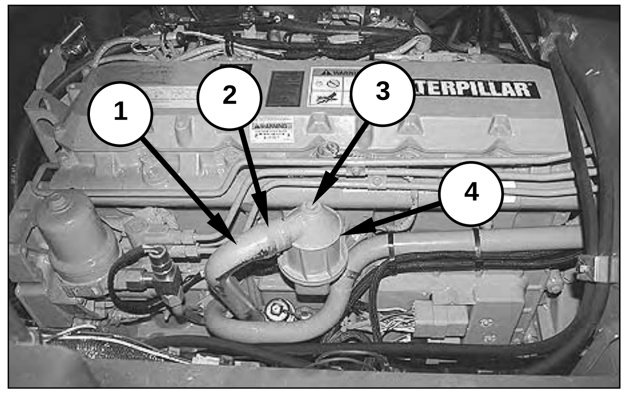
Engine Crankcase Breather

Clean

WARNING

Diesel fuel is combustible. Do not smoke around diesel fuel. Open flames or sparks can cause a fire and/or explosions.

1. Tilt the radiator. Refer to “Operation Section, Maintenance Features, Radiator Tilt” in this module.



2. Remove clamp (2) and hose (1).

3. Remove bolt (3).

4. Remove breather assembly (4) with the O-ring. Check the O-ring for damage, and replace the O-ring if necessary.

5. Clean breather assembly (4) in clean diesel fuel.

6. Reinstall breather assembly (4) and bolt (3). Tighten the bolt to a torque of 7 ± 2 N•m (62 ± 18 lb in).

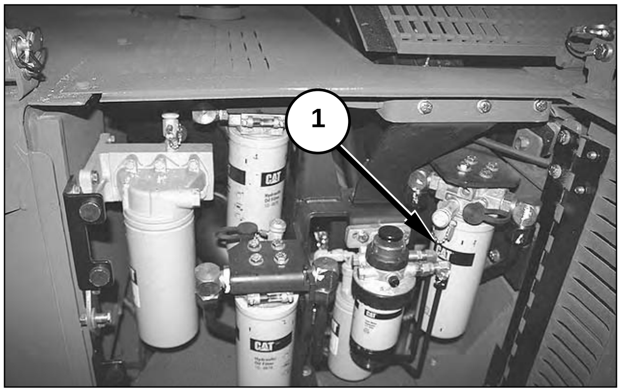
7. Reinstall hose (1) with clamp (2).

8. Lower the radiator.

Power Train

Change Filter

1. Open the oil filter compartment door.



2. Remove and discard power train oil filter (1). Make sure that all of the old filter seal is removed from the filter base. Dispose of the oil filter in accordance with local regulations.

NOTE: Once the filter is removed, drain any remaining oil into a suitable container and dispose of the oil according to local regulations.

3. Apply a thin coat of oil to the seal on the new filter.

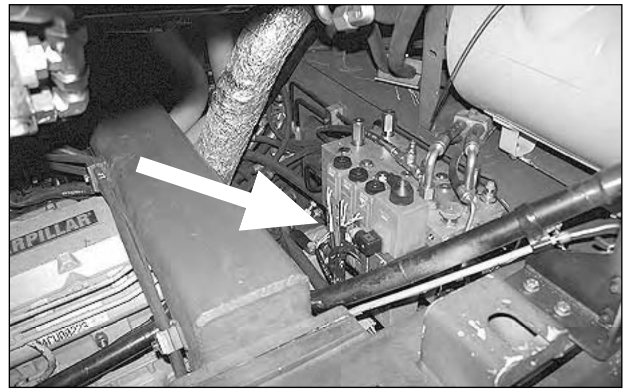
4. Install the filter by hand until it contacts the base, and then tighten the filter three-quarters of a turn more. There are rotation index marks spaced 90-degrees apart on each new filter. Three-quarters of a turn is equivalent to a distance of three of the 90-degree marks.

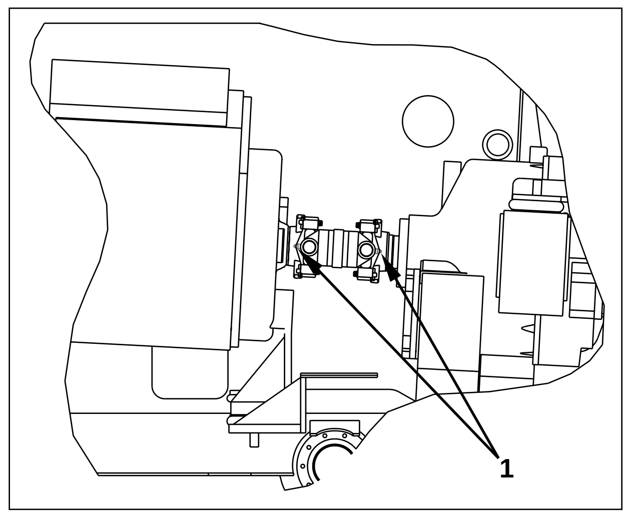
5. Close the oil filter compartment door.

Main Drive Shaft

Lubricate

1. Tilt the radiator. Refer to "Operation Section, Maintenance Features, Radiator Tilt" in this module.





2. Lubricate fittings (1). There are two fittings on the drive shaft.

NOTE: If necessary, rotate the engine to make the grease fittings accessible. Follow the "Crank-Without-Inject" procedure in "Operation Section, Maintenance Features" in this module, to turn the engine over.

WARNING

Do not turn the engine over while personnel are near the drive shaft. Stop the engine rotation before inspecting the position of the drive shaft grease fittings. Failure to follow these instructions may result in personal injury.

3. Lower the radiator.

Electrical Wiring

Inspect

1. Raise the radiator, tilt the cab and open the access doors on both sides of the machine.

NOTE: For radiator and cab tilt procedures, refer to "Operation Section, Maintenance Features, Radiator Tilt" and "Cab Tilt" in this module.

2. Check the visible electrical wiring for evidence of wear or damage. Repair or replace any damaged wiring.

3. Lower the radiator and cab.

Starter

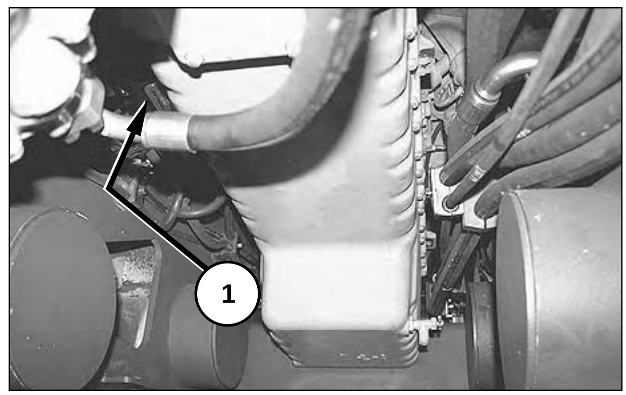
Inspect

1. Turn the main disconnect switch to OFF.

NOTE: If the machine is equipped with arctic batteries, turn the main disconnect switch on the arctic battery box to OFF also. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Machine Features, Main Disconnect Switch."

2. Lower the engine bottom guard.

NOTE: For the procedure to lower the engine bottom guard, refer to "Operation Section, Maintenance Features, Bottom Cover Tilt" in this module.



3. Visually inspect starter (1). Inspect the starter mounting cap screws and starter wiring for the presence of corrosion and loose connections. Tighten the mounting screws and any loose connections.

4. Raise the engine bottom guard.

Alternator

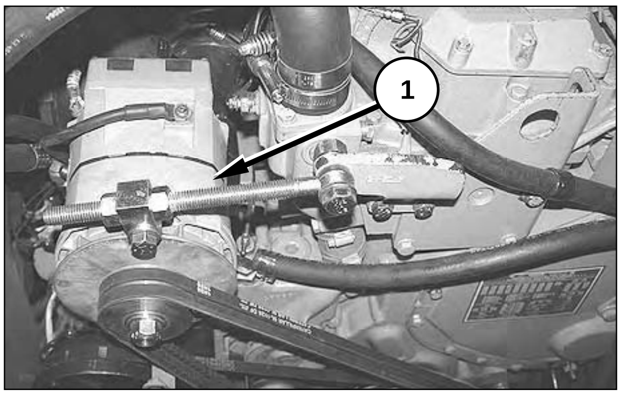
Inspect

1. Turn the main disconnect switch to OFF.

NOTE: If the machine is equipped with arctic batteries, turn the main disconnect switch on the arctic battery box to OFF also. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Operation Section, Machine Features, Main Disconnect Switch."

2. Tilt the cab and remove the belt guard from the front of the engine.

NOTE: For the cab tilt procedure, refer to "Operation Section, Maintenance Features, Cab Tilt" in this module. For the procedure to remove the belt guard, refer to "Maintenance Section, Every 250 Service Hours or Three Months, Engine V-belts" in this module.



3. Inspect alternator (1) for secure mounting and any cracks or bends in the mounting hardware. Inspect the alternator wiring for frays, bare wires, breaks and loose terminal connections.

4. Install the belt guard, and lower the cab.

Every 1000 Service Hours or One Year

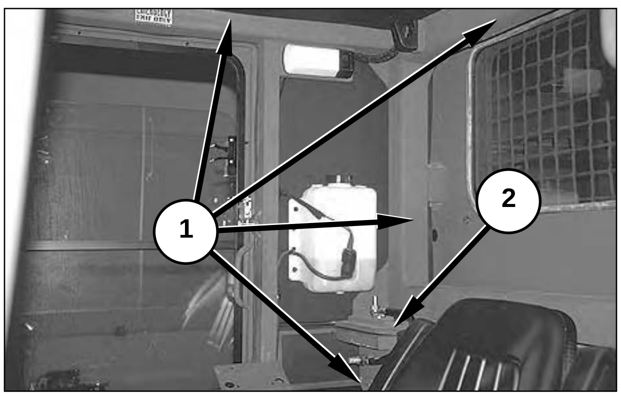
Read and understand the warnings and instructions contained in the "Safety" section of this module before performing any operation or maintenance procedure.

Rollover Protection System (ROPS)

Inspect

⚠ WARNING

The protection offered by this rollover protection system (ROPS) will be impaired if there has been structural damage, the machine has been overturned, or the system has been modified. This ROPS must be replaced after a roll-over. The ROPS on this machine includes the upper and lower sections of the cab. Seat belts must be worn while operating the vehicle.



NOTE: The inner frame of the cab is the ROPS.

1. Inspect structural tubing (1) in four corners (on the upper and lower sections of the cab) for cracks or other damage.

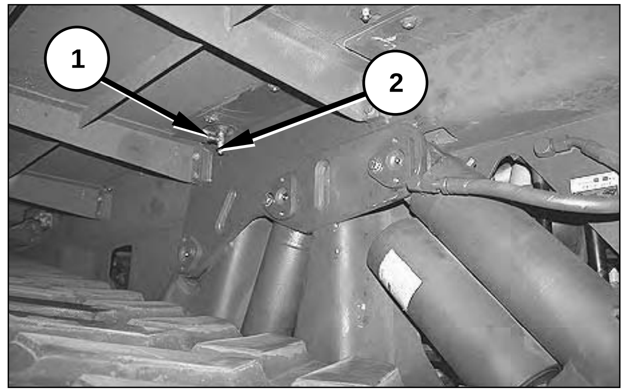
2. Inspect sixteen mounting bolts (2) in the four corners of the cab for tightness.

3. Replace the cab if there are any cracks in the structural tubing.

Hydraulic System

Change Oil and Clean Suction Screens

1. Park the machine on flat, level ground, and turn the engine off.

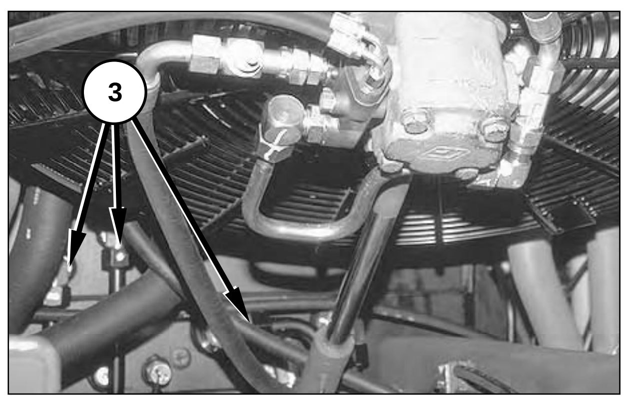


2. Attach a drain hose to opening (1) on drain valve (2), and put the open end of the hose into a suitable container.

3. Turn the nut on drain valve (2) counterclockwise to open the valve and allow the hydraulic oil to drain into the container. The capacity of the hydraulic tank is approximately 72 L (19 U.S. gal). Dispose of the hydraulic oil according to local regulations.

4. Turn the nut on drain valve (2) clockwise to close the valve.

5. Raise the radiator. Refer to "Operation Section, Maintenance Features, Radiator Tilt" in this module.



6. Disconnect three suction lines (3). Catch the oil in a suitable container, and dispose of the oil according to local regulations.

7. Remove the fitting elbow and screen adapter from each suction line location. Clean the screens in a clean, non-flammable solvent. Allow the screens to dry completely before reinstalling them. Replace the screens if they are damaged.

8. Reinstall the fitting elbow and screen adapter from each suction line location.

9. Reconnect three suction lines (3).

10. Refill the hydraulic tank with the correct oil for the expected operating conditions. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE)*, "Maintenance Section, Lubricant Viscosities and Refill Capacities" for the correct oil for each operating condition.

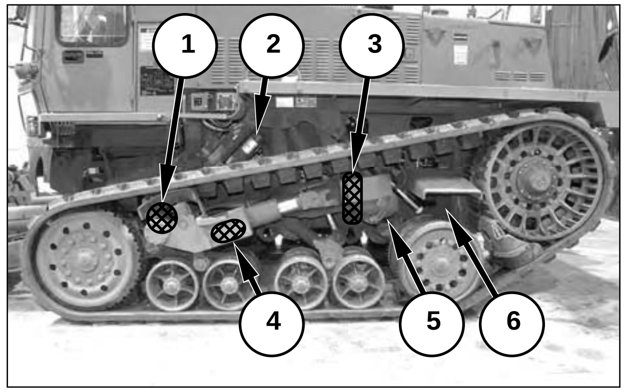
11. Start the engine, and check for and repair leaks on the three suction screens.

12. Lower the radiator.

13. Remove the drain hose from drain valve (2).

Accumulators

Check Nitrogen Precharge



There are 11 accumulators installed on this machine. Accumulators (2), (3), (4), (5), and (6) are located on both sides of the machine. Accumulator (1) is located under the cab in the center of the machine. Refer to *Specifications Systems Operation Testing and Adjusting, Undercarriage Steering and Brakes,* "Testing and Adjusting, Suspension System Procedures, Accumulator Charging Procedure" and "Brake System Procedures, Accumulator Charging Procedure" to check and adjust the nitrogen precharge pressure of the accumulators.

Every 1000 Service Hours or When Required

Read and understand the warnings and instructions contained in the "Safety" section of this module before performing any operation or maintenance procedure.

Engine Air Intake System

Change Filters

NOTE: Service the air inlet filters if the air inlet restriction indicator shows in the red zone. Replace the air inlet filters every 1000 service hours, regardless of their condition.

Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, When Required, Engine Air Intake System—Service Filter Elements" for the procedure to remove and install the air intake filters.

Fuel Tank

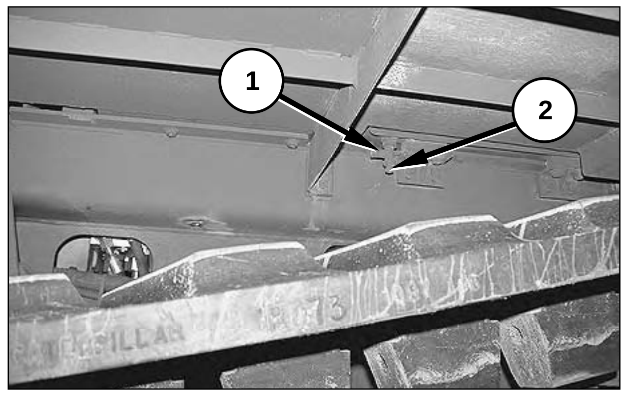
Drain Water and Sediment

WARNING

Diesel fuel is combustible. Do not smoke when working around diesel fuel. Open flames or sparks can cause a fire and/or explosion.

NOTE: It may be necessary to drain the water and sediment from the fuel tank prior to 1000 service hours of operation. Perform this procedure every 1000 service hours, even if there are no symptoms of water or sediment in the fuel.

1. Park the machine on flat, level ground.



2. Attach a suitable hose to opening (1) on drain valve (2). Open drain valve (2) and allow the fuel to drain into a suitable container. Continue draining the fuel until it runs clean, without sediment or water. Dispose of the drained fuel according to local regulations.

3. Close drain valve (2) and remove the hose from opening (1).

Every 2000 Service Hours or Two Years

Read and understand the warnings and instructions contained in the “Safety” section of this module before performing any operation or maintenance procedure.

Engine Valve Clearance

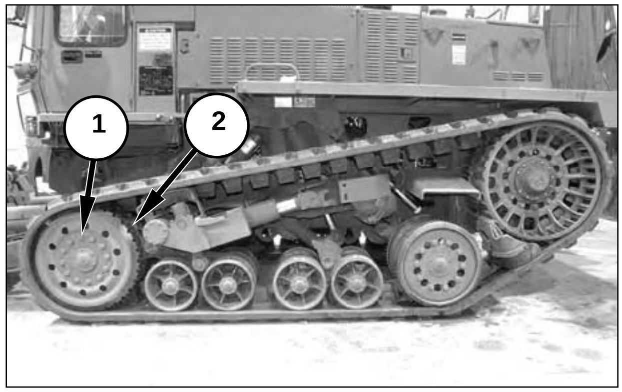
Adjust

Refer to *Specifications Systems Operation Testing and Adjusting, Deployable Combat Universal Earthmover (DEUCE), 3100 HEUI DEUCE Engine* “Testing and Adjusting, Air Intake and Exhaust System, Valve Lash” for the procedure to measure and adjust the engine valve clearance.

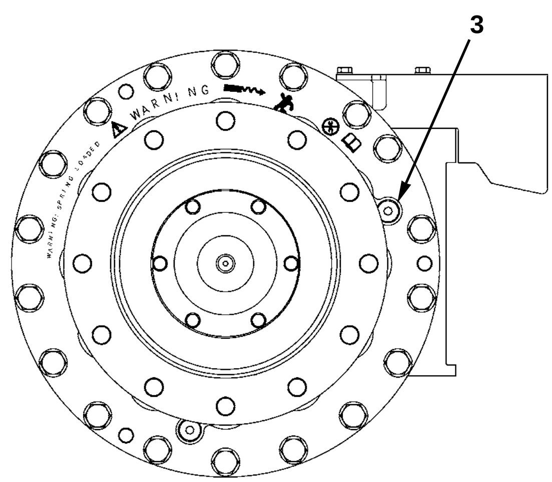
Brakes

Check Wear Material Thickness

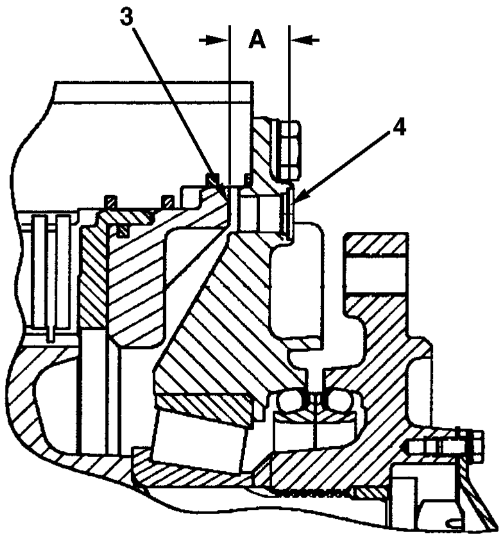
1. Release the drive belt tension on the left side of the machine. Refer to *Specifications Systems Operation Testing and Adjusting, Deployable Combat Universal Earthmover (DEUCE), Undercarriage, Steering, and Brakes,* “Testing and Adjusting, Suspension System Procedures, Suspension Hydraulic Charging Procedure.”



2. Remove 12 bolts (1) and washers, and remove outer idler (2). The weight of the outer idler is 73 kg (161 lb).



3. Remove plug (3) from the brake housing.



4. Measure distance (A) from counterbore surface (4) on the brake housing, to brake piston (3). Replace the brake disks if distance (A) is greater than 32.5 mm (1.28 in).

NOTE: Repeat Steps 1 to 4 for the right side of the machine. In Step 2, the inside idler on the right side of the machine must be removed. Refer to *Disassembly and Assembly, Deployable Universal Combat Earthmover (DEUCE), Power Train,* "Front Idler Group, Inner, Left and Right."

5. Install the idlers, and recharge the suspension system.

Cooling System

Change Coolant, Clean System

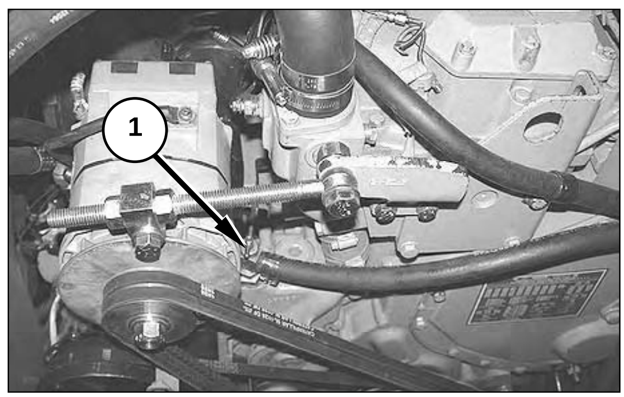
WARNING

At operating temperature, the engine coolant is hot and under pressure. Any contact with the skin can cause severe burns. Also, cooling system additive contains alkali. Avoid contact with the skin, eyes, and mouth. Do not open the engine coolant fill cap until the temperature of the engine coolant is below 36°C (98°F).

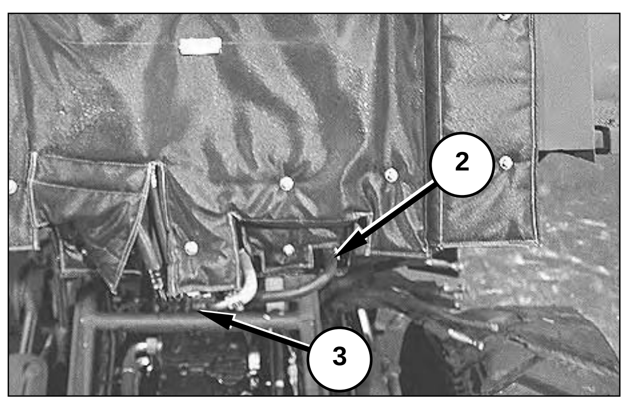
1. Park the machine on flat, level ground and stop the engine.

2. Raise the radiator. Refer to "Operation Section, Maintenance Features, Radiator Tilt" in this module.

3. Raise the cab. Refer to "Operation Section, Maintenance Features, Cab Tilt" in this module.



4. Close valve (1) by turning the valve fully clockwise.



5. Disconnect heater line (2) and remove clamp (3) from the bottom of the cab.

6. Remove the radiator fill cap.

7. Place the end of heater line (2) into a suitable container. The capacity of the cooling system is approximately 51 L (13.5 U.S. gal).

8. Open valve (1) by turning it fully counterclockwise. Allow the coolant to drain into the container. Dispose of the coolant according to local regulations.

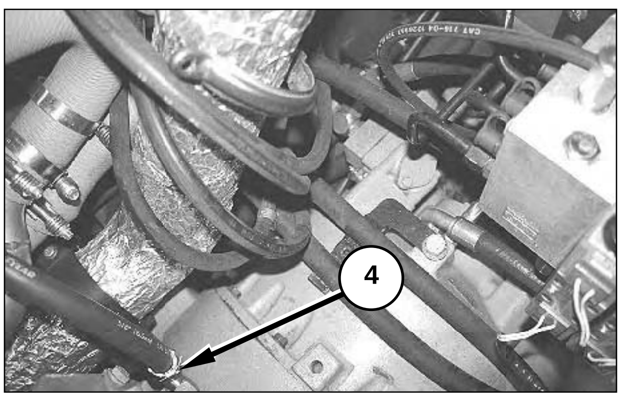
9. If the cooling system has been running with Caterpillar Coolant/Antifreeze, flush the system with clean water.

10. If the system has not been running with Caterpillar Coolant/Antifreeze, reconnect heater line (2) and refill the system with a 5% to 10% concentration of cooling system cleaner (4C-4612 Radiator Cleaner, Fast Acting Type, 18.92 L [5 U.S. gal]). Start and run the engine for 90 minutes, and then drain the cooling system cleaner and flush with clean water. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE)* for information about machine operation.

11. Reconnect heater line (2) and reinstall clamp (3).

12. Make sure that valve (1) is open by turning the valve fully counterclockwise.

13. Lower the cab.



14. Open shunt line valve (4) by turning the valve fully counterclockwise. Opening shunt line valve (4) allows air trapped in the engine block to escape.

15. Refill the cooling system with the correct concentration of coolant. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Cooling System Specifications" for information on the correct type and concentration of coolant.

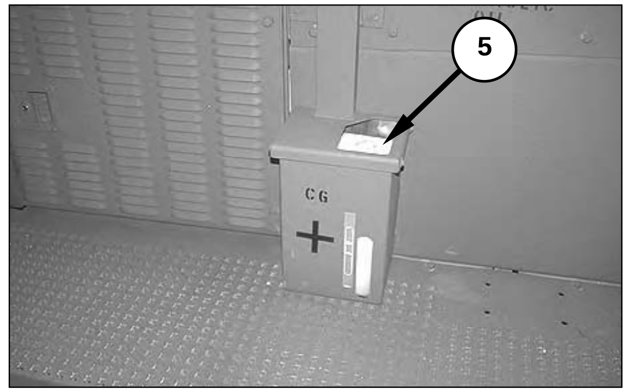
16. When the cooling system is full, start and run the engine with the radiator fill cap off. Run the engine until the thermostat opens and the coolant level stabilizes, and then stop the engine.

17. Close shunt line valve (4) by turning the valve fully clockwise.

18. Fill the radiator completely with coolant, and lower the radiator.

19. Reinstall the radiator fill cap.

20. Operate the engine again until it reaches normal operating temperature.

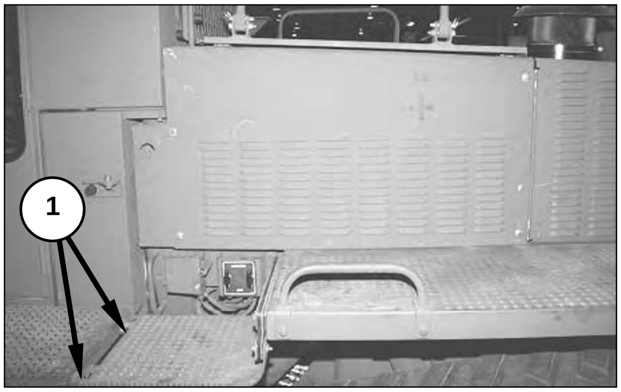


21. Add coolant to a level between the FILL and ADD marks on coolant overflow bottle (5).

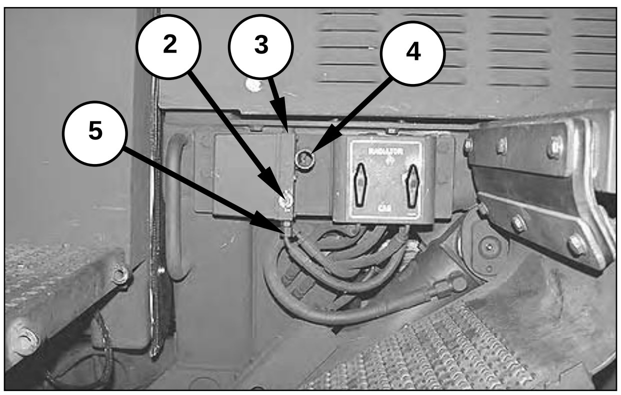
21. Operate the engine again until it reaches normal operating temperature, and then recheck the coolant level in coolant overflow bottle (5). Add coolant, as necessary.

Cab/Radiator Tilt Pump

Change Oil



1. Remove two bolts (1) and allow the walkway to hang down.



2. Disconnect line (5) and allow the oil to drain into a suitable container. With valve (2) turned fully clockwise, operate pump handle (4) and pump the oil out of the reservoir. The capacity of the cab/radiator tilt pump reservoir is approximately 0.44 L (1 pint).

3. Reconnect line (5).

4. Open fill port (3) and refill the reservoir with the correct oil for the expected operating conditions. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Lubricant Viscosities and Refill Capacities" for the possible oil types.

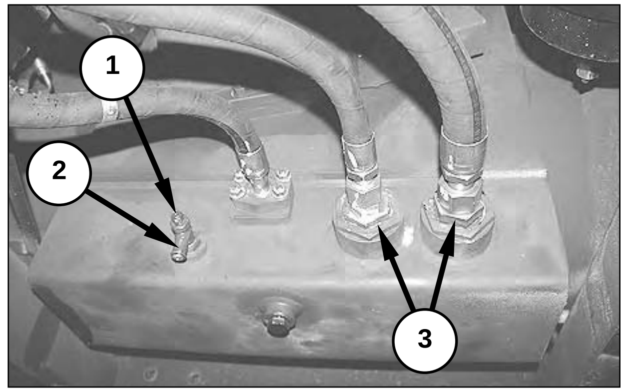
5. Reposition the walkway and reinstall two bolts (1).

Power Train

Change Oil and Clean Suction Screens

1. Park the machine on flat, level ground and stop the engine.

2. Remove the power train (rear) bottom cover. Refer to "Operation Section, Maintenance Features, Bottom Cover Tilt" in this module.



3. Connect a hose to port (2) and place the end of the hose into a suitable container to catch the used power train oil. The capacity of the power train system is approximately 152 L (40 U.S. gal).

4. Turn valve (1) counterclockwise to open the valve and drain the oil.

5. When the oil is done draining, turn valve (1) fully clockwise to close it.

6. Remove the hose installed on port (2).

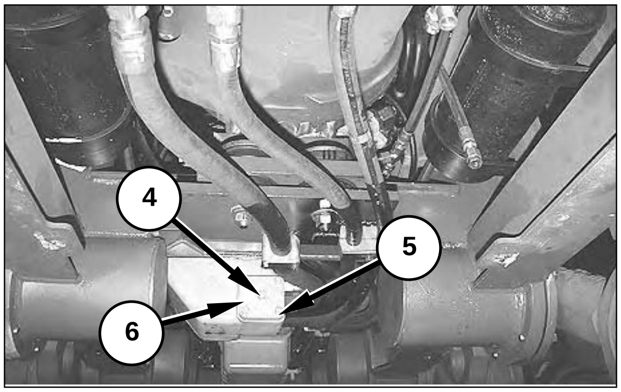
7. Disconnect suction lines (3).

8. Remove the two suction screens from the housing. Clean the suction screens in clean, nonflammable solvent and allow them to dry completely.

9. Reinstall the two suction screens.

10. Reconnect suction lines (3).

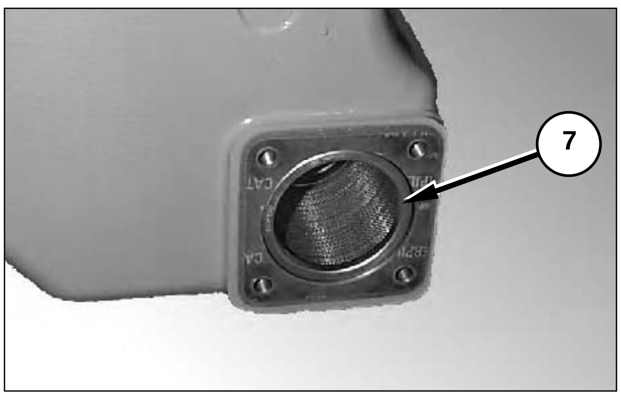
11. Remove the bottom cover from beneath the engine. Refer to "Operation Section, Maintenance Features, Bottom Cover Tilt" in this module.



12. Remove plug (4) and allow the oil contained in the torque converter to drain into a suitable container. The capacity of the torque converter is approximately 2 L (0.5 U.S. gal). Dispose of the oil in accordance with local regulations.

13. Reinstall plug (4) and remove four bolts (5), with washers, and cover (6), with a gasket.

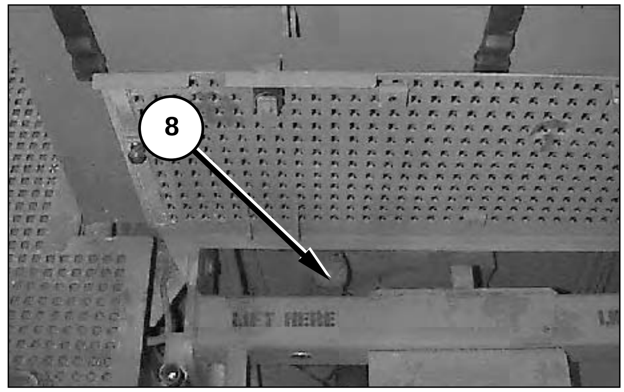
NOTE: Catch any remaining oil in a suitable container and dispose of the oil in accordance with local regulations.



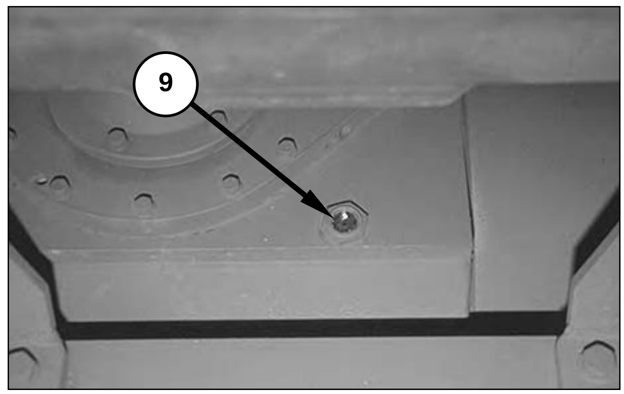
Engine and Torque Converter Shown Removed From Machine.

14. Remove and clean screen (7) in clean, nonflammable solvent. Allow the screen to dry completely. Replace the screen if there is damage.

15. Reinstall screen (7), cover (6) with a gasket, and four bolts (5) with washers. If necessary, install a new gasket. The part number of the gasket is 7L-3111.



16. Remove power train fill cap (8) and add the correct oil for the expected operating conditions. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Lubricant Viscosities and Refill Capacities" for the recommended oil types.



17. Continue adding oil until it is visible in power train oil sight gauge (9).

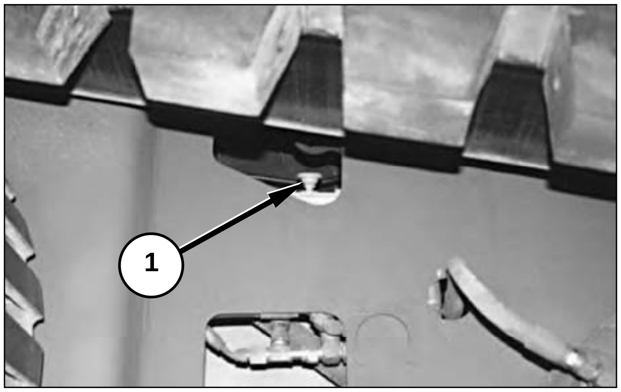
18. Start the engine and allow it to idle for 5 minutes, then stop the engine.

19. Continue adding oil until the oil is visible in power train oil site gauge (9).

20. Reinstall fill cap (8).

21. Check for leaks, and then reinstall the power train and engine bottom covers.

Clean Transmission Breather



1. Remove transmission breather (1).

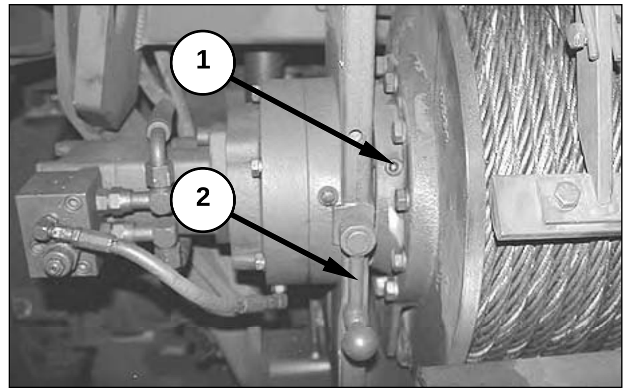
2. Clean transmission breather (1) in clean, nonflammable solvent. Allow the breather to dry completely.

3. Reinstall breather (1).

Winch Gearbox

Change Oil

1. Park the machine on flat, level ground and stop the engine.



2. Move winch clutch lever (2) to DISCONNECT, and rotate the winch spool until check/fill plug (1) is horizontal (at the three o'clock position).

3. Remove check/fill plug (1).

4. Rotate the winch spool so that the check/fill plug hole is facing down. Allow the oil to drain into a suitable container. The capacity of the winch gearbox is approximately 1.1 L (0.3 gal). Dispose of the used oil according to local regulations.

5. Rotate the winch spool so that the check/fill plug hole is horizontal. Maintain the oil level in the winch gearbox to the bottom of the check/fill hole. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Maintenance Section, Lubricant Viscosities and Refill Capacities" for the recommended lubricant to use.

6. Reinstall check/fill plug (1).

APPENDIX A
MAINTENANCE ALLOCATION CHART (MAC) FOR DEPLOYABLE UNIVERSAL COMBAT EARTHMOVER (DEUCE)

Section I. INTRODUCTION

1. THE ARMY MAINTENANCE SYSTEM MAC

This introduction (Section I) provides a general explanation of all maintenance and repair functions authorized at various maintenance levels under the “Two-Level Maintenance System” concept.

a. The Maintenance Allocation Chart (MAC) in Section II designates overall authority and responsibility for the performance of maintenance functions on the identi ed end item or component. The application of the maintenance functions to the end item or component will be consistent with the capacities and capabilities of the designated maintenance levels, which are shown on the MAC in column (4) as:

- *Field* - Includes three subcolumns, Unit (C (operator/crew), O (unit) maintenance, and Direct Support (F)
- *Sustainment* - Includes two subcolumns, General Support (H), and Depot (D).

b. Section III lists the tools and test equipment (both special tools and common tool sets) required for each maintenance function as referenced from Section II.

c. Section IV contains supplemental instructions and explanatory notes for a particular maintenance function.

2. MAINTENANCE FUNCTIONS

Maintenance functions are limited to and de ned as follows:

a. Inspect. To determine the serviceability of an item by comparing its physical, mechanical, and/or electrical characteristics with established standards through examination (e.g., by sight, sound, or feel).

b. Test. To verify serviceability by measuring the mechanical, pneumatic, hydraulic, or electrical characteristics of an item and comparing those characteristics with prescribed standards.

c. Service. Operations required periodically to keep an item in proper operating condition; e.g., to clean (includes decontaminate, when required), to preserve, to drain, to paint, or to replenish fuel, lubricants, chemical uids, or gases.

d. Adjust. To maintain or regulate, within prescribed limits, by bringing into proper position, or by setting the operating characteristics to speci ed parameters.

e. Align. To adjust speci ed variable elements of an item to bring about optimum or desired performance.

f. Calibrate. To determine and cause corrections to be made or to be adjusted on instruments or test, measuring, and diagnostic equipment used in precision measurement. Consists of comparisons of two instruments, one of which is a certi ed standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared.

2. MAINTENANCE FUNCTIONS (CONT)

g. Remove/Install. To remove and install the same item when required to perform service or other maintenance functions. Install may be the act of emplacing, seating, or fixing into position a spare, repair part, or module (component or assembly) in a manner to allow the proper functioning of an equipment or system.

h. Replace. To remove an unserviceable item and install a serviceable counterpart in its place. “Replace” is authorized by the MAC and the assigned maintenance level is shown as the third position code of the SMR code.

i. Repair. The application of maintenance services[1] including fault location/troubleshooting[2], removal/installation and disassembly/assembly[3] procedures, and maintenance actions[4] to identify troubles and restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, subassembly, module (component or assembly), end item, or system.

j. Overhaul. That maintenance effort (service/action) prescribed to restore an item to a completely serviceable/operational condition as required by maintenance standards in appropriate technical publications (i.e., DMWR). Overhaul is normally the highest degree of maintenance performed by the Army. Overhaul does not normally return an item to like new condition.

k. Rebuild. Consists of those services/actions necessary for the restoration of unserviceable equipment to a like new condition in accordance with original manufacturing standards. Rebuild is the highest degree of material maintenance applied to Army equipment. The rebuild operation includes the act of returning to zero those age measurements (e.g., hours/miles) considered in classifying Army equipment/components.

3. EXPLANATION OF COLUMNS IN THE MAC, SECTION II

a. Column (1), System. Column 1 lists the major systems by which all components and assemblies of the vehicle are divided. This division reflects the overall arrangement of the Commercial Off-The-Shelf (COTS) manuals for the vehicle.

b. Column (2), Component/Assembly. Column 2 contains the item names of components, assemblies, subassemblies, and modules for which maintenance is authorized.

c. Column (3), Maintenance Function. Column 3 lists functions to be performed on the item listed in Column 2. (For detailed explanation of these functions, see paragraph 2.)

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1. Services - Inspect, test, service, adjust, align, calibrate, and/or replace.
2. Fault location/troubleshooting - The process of investigating and detecting the cause of equipment malfunctioning; the act of isolating a fault within a system or unit under test (UUT).
3. Disassembly/assembly - The step-by-step breakdown (taking apart) of a spare/functional group coded item to the level of its least component that is assigned an SMR code for the level of maintenance under consideration (i.e., identified as maintenance significant).
4. Actions - Welding, grinding, riveting, straightening, facing, machining, and/or resurfacing.

d. Column (4), Maintenance Level. Column 4 specifies each level of maintenance authorized to perform each function listed in Column 3, by indicating work time required (expressed as man-hours in whole hours or decimals) in the appropriate subcolumn. This work-time figure represents the active time required to perform that maintenance function at the indicated level of maintenance. If the number or complexity of the tasks within the listed maintenance function vary at different maintenance levels, appropriate work-time figures are shown for each level. The work-time figure represents the average time required to restore an item (assembly, subassembly, component, module, end item, or system) to a serviceable condition under typical field operating conditions. This time includes preparation time (including any necessary disassembly/assembly time), troubleshooting/fault location time, and quality assurance time in addition to the time required to perform the specific tasks identified for the maintenance functions authorized in the maintenance allocation chart. The symbol designations for the various maintenance levels are as follows

Field

C . . . . Operator or crew maintenance
O . . . . Unit maintenance
F . . . . Direct Support maintenance

Sustainment

H . . . . General Support maintenance
D . . . . Depot maintenance

e. Column (5), Tools and Equipment Ref Code. Column 5 specifies, by code, those common tool sets (not individual tools), common TMDE, and special tools, special TMDE, and special support equipment required to perform the designated function. Codes are keyed to tools and test equipment in Section III.

f. Column (6), Remarks Code. When applicable, this column contains a letter code, in alphabetical order, which is keyed to the remarks contained in Section IV.

4. EXPLANATION OF COLUMNS IN TOOL AND TEST EQUIPMENT REQUIREMENTS, SECTION III

a. Column (1), Tool or Test Equipment Code. The tool and test equipment reference code correlates with a code used in the MAC, Section II, column 5.

b. Column (2), Maintenance Level. The lowest level of maintenance authorized to use the tool or test equipment.

c. Column (3), Nomenclature. Name or identification of the tool or test equipment.

d. Column (4), National Stock Number. The National Stock Number of the tool or test equipment.

e. Column (5), Tool Number. The manufacturer's part number, model number, or type number.

5. EXPLANATION OF COLUMNS IN REMARKS, SECTION IV

a. Column (1), Remarks Code. The code recorded in column 6, Section II.

b. Column (2), Remarks. This column lists information pertinent to the maintenance function being performed as indicated in the MAC, Section II.

Specialized Repair Activity (SRA) definition DELETED.

Section II. MAINTENANCE ALLOCATION CHART (MAC) FOR DEPLOYABLE UNIVERSAL COMBAT EARTHMOVER (DEUCE)

(1)	(2)	(3)	(4) Maintenance Level					(5)	(6)
			Field			Sustainment			
			Unit		Direct Support	General Support	Depot		
Group System	Component/ Assembly	Maintenance Function	C	O	F	H	D	Tools and Equipment Ref Code	Remarks Code
Engine									
	Aftercooler	Test			.8			1, 6, 7	
		Replace			3.1			1, 6	
	Air Conditioning Compressor	Test			1.0			1, 3, 7	
		Service			2.0			1, 3, 7	
		Replace			2.6			1, 3, 7	
	Air Cleaner Group	Service	.3						P
		Replace		.3				1, 3	
	Alternator	Inspect		.5					P
		Test		.5				1, 2	
		Replace		1.0				1, 3	
		Repair			1.5			1, 6	R4
	Cam Roller Follower (Lifter Assemblies)	Replace			12.5			1, 7	
	Camshaft	Replace			12.0			1, 7	
	Camshaft Bearings	Replace				1.2		1, 6, 7	
	Coolant Heater	Test		1.5				1, 2	
		Replace		1.0				1, 2	
		Repair		1.5				1, 2	
	Cooling System	Inspect	.7						P
		Service	1.0					1, 2	P
		Test		1.2				1, 2, 3, 4	
		Replace		2.0				1, 2, 16	
	Cooling Fan	Replace		1.0				1, 2, 16	
	Crankshaft	Replace			2.5	16.9		1, 2	
	Crankshaft Main Bearings	Replace			1.5	3.9		1, 7	
	Crankshaft Rear Seal	Replace			13.6			1, 7, 37	
	Cylinder Head Assembly	Replace			14.8			1, 7	
		Repair			2.0	3.0		1, 7	R2
	Electronic Control Module	Test		1.3				1, 2, 65, 70, 71	

(1) Group System	(2) Component/ Assembly	(3) Maintenance Function	(4) Maintenance Level: Field, Unit C	Field, Unit O	Field, Direct Support F	Sustainment, General Support H	Sustainment, Depot D	(5) Tools and Equipment Ref Code	(6) Remarks Code
	Electronic Control Module (continued)	Replace		1.7				1, 6, 65, 66, 67, 68, 69, 70, 71,	
	Engine Assembly	Inspect	.2	1.5					P
		Service	.2	1.8				1	P
		Test		4.0				1, 2, 3, 4, 5, 31, 49, 9, 12, 20, 30, 32, 33, 47, 48, 56, 58, 59	
		Replace			16.0			1, 7	
		Repair			4.0	28.6		1, 6, 7	R3
	Engine Support, Front	Replace		1.5				1, 2	
	Engine Support, Rear	Replace		1.5				1, 2	
	Ether Starting Aid	Service		.5				1, 2	I
	Ether Starting Aid Nozzles	Replace		1.9				1, 2	
	Exhaust Manifold	Test		.5				1, 2	
		Replace		6.2				1, 2, 4	
	Flywheel	Replace			1.0			1, 7	
	Flywheel Housing	Replace			1.0			1, 7	
	Front Housing & Camshaft Idler Gear Assembly	Replace			1.0			1, 2, 4	
	Fuel Filter	Replace		.1				1, 2	
	Fuel Filter Base	Replace		.6				1, 2	
	Fuel Injector Sleeves	Replace			4.8			1, 7, 55	
	Fuel Pressure Regulating Valve	Replace		1.9				1, 2	
	Fuel Transfer Pump	Replace		2.0				1, 2	
		Repair			1.0			1, 7	
	Hydraulic Pump Group	Replace			2.3			1, 7, 8	
	Injection Actuation Pressure Control Valve	Test			.8			1, 7, 22	
		Replace			1.3			1, 7	
	Inlet Manifold	Test			.8			1, 7, 6	
		Replace			1.8			1, 7	
	Intake Air Heater	Replace		.7				1, 3	
	Intake Air Heater Solenoid	Replace		.4				1, 3	

(1) Group System	(2) Component/ Assembly	(3) Maintenance Function	(4) Maintenance Level: Field, Unit C	Field, Unit O	Field, Direct Support F	Sustainment, General Support H	Sustainment, Depot D	(5) Tools and Equipment Ref Code	(6) Remarks Code
	Lifting Group (Front)	Replace		1.2				1, 2	
	Lifting Group (Rear)	Replace		1.5				1, 2	
	Muf er Group	Replace		2.5				1, 2	
		Repair		1.0				1, 2	
	Oil Cooler	Replace		1				1, 2	
	Oil Filter	Inspect	.1						P
		Replace		.3				1, 2	P
	Oil Filter Base	Replace		.5				1, 2	
	Oil Level Gauge Group	Replace		.7				1, 2	
	Oil Pan	Replace		3.5				1, 2	
	Oil Pump	Test		.8				1, 2, 3, 4	
		Replace		3.6				1, 2	
	Piston Cooling Tubes	Replace			4.2			1, 7	
	Pistons & Connecting Rod Assemblies	Replace				21.4		1, 7	
	Radiator Group	Inspect	.2						P
		Test		.5				1, 2	
		Replace			5.2			1, 7, 18	
		Repair			1.3			1, 7	
	Remote Fuel Filter Base	Replace		.8				1, 2	
	Rocker Arm Assemblies & Pushrods	Replace			5.1			1, 7, 10, 11, 41	
	Starter	Inspect		.3					P
		Test		.7				1, 2	
		Replace		3.2				1, 2	
		Repair			1.2			1, 7	R4
	Throttle Position Sensor	Test		1.0				1, 2, 65, 70, 71,	
		Replace		1.0				1, 2	
	Turbocharger	Test		1.0				1, 2	
		Replace		5.4				1, 2	
		Repair				3.0		1, 7	R1
	Unit Fuel Injector Pump Group	Test			1.0			1, 2, 65, 70, 71, 72,	
		Replace			7.1			1, 7	
	V-Belts	Inspect		.3					P

(1)	(2)	(3)	(4)					(5)	(6)
			Maintenance Level						
			Field			Sustainment			
			Unit		Direct Support	General Support	Depot		
Group System	Component/ Assembly	Maintenance Function	C	O	F	H	D	Tools and Equipment Ref Code	Remarks Code
		Adjust		1.0				1, 2	
		Replace		2.1				1, 3	
	Valve Cover	Replace		.9				1, 2	
	Valve Guides	Replace				1.2		1, 7	
	Valve Seat Inserts	Replace				1.2		1, 7	
	Valves	Adjust			1.9			1, 7, 49	
		Replace				0.6		1, 7	
		Repair			.3			1, 6, 7	
	Vibration Damper, Crankshaft Pulley & Crankshaft Front Seal	Replace		2.7				1, 2, 35,73	
	Water Pump	Test		1.8				1, 2	
		Replace		3.9				1, 2	
		Repair			1.2			1, 7	
	Water Pump Idler Pulley	Replace			1.1			1, 7	
		Repair			.4			1, 7	
	Water Temperature Regulator	Test		1.0				1, 2	
		Replace		1.3				1, 2	
Power Train									
	Belt Tensioner Group	Replace		3.0				1, 2, 64	
		Repair		2.1				1, 2	
	Brake Accumulator	Service		1.0				1, 23	P
		Replace			4.5			1, 7, 23,	
	Brake Group	Inspect	.2	.3					P
		Replace			4.5			1, 7, 15, 44, 42, 45	
		Repair			1			1, 7, 38	
	Brake Solenoid Valve	Replace			1.3			1, 7	
	Brake Pedal Assembly	Replace			.2			1, 7	
		Repair			.1			1, 7	
	Brake Pilot Unloading Valve	Replace			1.0			1, 7	
	Brake System Charge Filter	Adjust			2.5			1, 7, 23	
		Replace		.2				1	P
	Differential Steering Unit and Transmission	Replace			12.5			1, 7, 15	A

(1) Group System	(2) Component/ Assembly	(3) Maintenance Function	(4) Maintenance Level: Field: Unit C	Unit O	Direct Support F	Sustainment: General Support H	Depot D	(5) Tools and Equipment Ref Code	(6) Remarks Code
	Differential Steering Unit	Repair			2.0	8.0		1, 7, 17, 24, 34,52	R1
	Drive Belt	Inspect	.2						P
		Replace		2.3				1, 2	
	Drive Hub	Replace			4.5			1, 7, 24	
	Drive Shaft, Main	Service		.5				1, 2	P
		Replace		2.5				1, 2	
	Drive Shaft, Steering	Service		1.5				1, 2	P
		Replace		2.5				1, 2	
		Repair			.5			1, 7	
	Front Idler Group, Outer	Service		.5				1, 2	
		Replace			1.0			1, 7	
	Front Idler Group, Inner, Left, and Right	Service		.5				1, 2	
		Replace			1.0			1, 7	
	Front Suspension Accumulator - Bottom End, Left and Right	Inspect	.1						P
		Service		1.0				1, 23	P
		Replace			3.0			1, 7, 23	
	Front Suspension Accumulator - Top End, Left and Right	Inspect	.1						P
		Service		1.0				1, 23	P
		Replace			3.0			1, 7, 23	
	Front Suspension Cylinder, Left and Right	Inspect	.1						P
		Service	.5		.5			1, 7, 23	PX
		Replace			10.0			1, 7, 23	
	Kneeling Solenoid Valve, Left and Right	Replace			1.5			1, 7	
	Kneeling System	Adjust			1.5			1, 7, 23	
	Minor Bogie Accumulator, Left and Right	Inspect	.1						P
		Service		1.0				1, 23	P
		Replace			3.0			1, 7	
	Midroller Bogie Assembly	Inspect	.1	.3					P

(1)	(2)	(3)	(4)					(5)	(6)
			Maintenance Level						
			Field			Sustainment			
Group System	Component/ Assembly	Maintenance Function	Unit		Direct Support	General Support	Depot	Tools and Equipment Ref Code	Remarks Code
			C	O	F	H	D		
		Service			1.0			1, 7, 23	
		Replace			2.3			1, 7, 16, 63, 64	
	Minor Bogie Cylinder, Left and Right	Inspect	.1						P
		Service	.5						PX
		Replace			3.0			1, 7	
		Repair			1.0			1, 7	R5
	Middle Roller Group	Repair			3.0			1, 7, 39	
	Middle Suspension Cylinder, Left and Right	Inspect	.1						P
		Service	.5		.3			1, 7, 23	PX
		Replace			2.3			1, 7	
		Repair		1.0				1, 21	R5
	Middle Suspension Cylinder Accumulator, Left and Right	Inspect	.1						P
		Service		.5				1, 23	P
		Replace			2.3			1, 7	
	Planetary Transmission	Test			2.0			1, 7, 8, 53	
		Adjust			1.5			1, 7, 8	
		Replace			4.5			1, 7, 8	A
		Repair			2.0	8.0		1, 3, 7, 61, 62	R1
	Powertrain Filter Group	Replace		1.0				1, 2	P
	Powertrain Lubrication Pump	Replace			.7			1, 7	
		Repair			1.0			1, 7	
	Priority Valve	Replace			3.0			1, 7	
		Repair			.7			1, 7	
		Test			.5			1, 8	
	Rear Idler Hub	Inspect	.1	.2					P
		Replace			1.3			1, 7, 40, 64	
	Rear Idler Wheel	Replace			1.0			1, 7	
	Rear Suspension Cylinder, Left and Right	Inspect	.1						P
		Service			.5			1, 7, 23	

(1)	(2)	(3)	(4)					(5)	(6)
			Maintenance Level						
			Field			Sustainment			
Group System	Component/ Assembly	Maintenance Function	Unit		Direct Support	General Support	Depot	Tools and Equipment Ref Code	Remarks Code
			C	O	F	H	D		
		Replace			2.3			1, 7	
		Repair			1.0			1, 7	
	Recoil Accumulator, Left and Right	Inspect	.1						P
		Service	.5	.5				1, 23	P, PX
		Replace			1.5			1, 7, 23	
	Recoil Cylinder, Left and Right	Inspect	.1						P
		Service	.5		.5			1, 7, 23	PX
		Repair			1.5			1, 7	R5
	Steering Column	Replace			1.5			1, 7	
		Repair			1.0			1, 7, 19	R1
	Steering Control Valve	Test			.3			1, 7, 8, 29, 44	
		Replace			3.5			1, 7	
		Repair			.7			1, 7	R1
	Steering Motor	Test			1.0			1, 7, 8	
		Replace			2.3			1, 7	
		Repair			2.5			1, 7, 19	R1
	Steering Pump	Test			.4			1, 7, 8, 45, 51	
		Adjust			.8			1, 7, 8	
		Replace			2.6			1, 7	
		Repair			1.3			1, 3, 7	R1
	Steering Solenoid Valve	Replace			.8			1, 7	
		Repair			1.5			1, 7	
	Steering System	Adjust			1.0			1, 7, 23	
	Support Group, Left and Right	Replace			4.5			1, 7	
	Swing Arm - Front, Right and Left	Inspect	.1						P
		Service	.2						P
		Replace			3.0			1, 7, 64	
		Repair			3.5			1, 7	
	Swing Arm - Rear, Right and Left	Inspect	.1						P
		Service	.2						P
		Replace			3.0			1, 7, 64	
		Repair			3.5			1, 7	

(1) Group System	(2) Component/ Assembly	(3) Maintenance Function	(4) Maintenance Level: Field: Unit C	Unit O	Direct Support F	Sustainment: General Support H	Depot D	(5) Tools and Equipment Ref Code	(6) Remarks Code
	Torque Converter Group	Test			1.5			1, 7, 8	
		Replace			25.2			1, 7, 15	
		Repair			1	3		1, 7	R1
	Torque Converter Lock-up Control Valve	Test			1.2			1, 7	
		Replace			2.6			1, 7, 49	
		Repair			.4			1, 7	R1
	Transmission Control Valve	Replace			2.5			1, 7, 16	
		Repair			.8			1, 7	R1
	Transmission Hydraulic System	Adjust			1.5			1, 7, 8, 23	
Hydraulic System									
	Angle Cylinder	Inspect	.1						P
		Replace			1.2			1, 7	
		Repair			3			1, 7, 23	R5
	Blade Control Valve	Test			.8			1, 7	
		Adjust			1.0			1, 7	
		Replace			4.1			1, 7	
	Blade-Up Lock Valve	Replace			2.1			1, 7	
	Blade Hydraulic System	Inspect	.2						P
		Test						1, 7, 8, 23	
	Cab Tilt Cylinder	Replace			.9			1, 7	
	Cab/Radiator Tilt Control Valve	Replace			.6			1, 7	
	Cab/Radiator Tilt Pump	Service		.4				1, 2	P
		Replace		.5				1, 7	
	Fan Motor and Fan Guard	Replace		2.5				1, 7	
	Fan Pump	Replace		2.0				1, 7	
	Hydraulic Oil Cooler	Replace		3.5				1, 2	
	Hydraulic Tank Group	Inspect	.1						P
		Replace		1.5				1, 2, 15	
	Hydraulic Tank Pressure Relief Valve	Replace		1.5				1, 2	

(1) Group System	(2) Component/ Assembly	(3) Maintenance Function	(4) Maintenance Level: Field: Unit C	Unit O	Direct Support F	Sustainment: General Support H	Depot D	(5) Tools and Equipment Ref Code	(6) Remarks Code
	Implement Pump	Test			1.5			1, 7, 28, 44, 50, 51, 43	
		Replace			2.5			1, 7	
		Repair			1.5			1, 7	R1
	Lift Cylinder	Inspect	.1						P
		Replace			2.2			1, 7	
		Repair			3			1, 7, 23	R5
	Radiator Tilt Cylinder	Replace			1.5			1, 7	
	Remote Tool Manifold Valve	Replace			1.5			1, 7	
	Return Filter Base	Replace		.5				1, 2	
	Tank Group	Replace		5.4				1, 2	
	Tilt Cylinder	Inspect	0.1					1, 7	
		Replace			2.1				
		Repair			3			1, 7, 23	R5
	Winch Brake Assembly	Replace			1.0			1, 7	
	Winch Control Valve	Replace			2.5			1, 7	
	Winch Motor	Inspect	.1						P
		Service	.3	.7				2	P
		Replace		2.3				1, 2	
		Repair		2.5				1, 7	R1
Machine System									
	Air Cleaner Compartment Door	Replace		.5				1, 2	
	Air Conditioner Group	Replace			3.0			1, 2, 15	L
		Repair			1.0			1, 2	L
	Air Conditioning System	Service			1.0			1, 2, 7	L
	Bulldozer Blade	Service	.5						P
		Replace		4.0				1, 2	
		Repair			2.5			1, 7	
	Bulldozer C-Frame	Replace			7.1			1, 7	
	Cab Air Filters	Service	.6						P
		Replace		.6				1, 2	
	Cab Assembly	Inspect		.2					P
		Replace			31.5			1, 7, 57	
		Repair			6.5			1, 7	R6

(1) Group System	(2) Component/ Assembly	(3) Maintenance Function	(4) Maintenance Level: Field, Unit C	Field, Unit O	Field, Direct Support F	Sustainment, General Support H	Sustainment, Depot D	(5) Tools and Equipment Ref Code	(6) Remarks Code
	Cab Platform	Replace			12.5			1, 7	
		Repair			4.5			1, 7	R6
	Fender Group, Left	Replace		2.0				1, 2, 15	
	Fender Group, Right	Replace		2.0				1, 2, 15	
	Foot Rest	Replace		.7				1, 2	
	Fuel Tank	Service		.4				1, 2	P
		Replace		.7				1, 2	
	Hydraulic Tank Cover	Replace		.3				1, 2	
	Instrument Panel	Inspect	.1						P
		Replace		2.3				1, 2	
		Repair		2.8				1, 2	R6
	Middle Top Cover	Replace		.8				1, 2	
	Mirror	Inspect	.1						P
		Replace		.5				1, 2	
	Oil Filter Compartment Door	Replace		.7				1, 2	
	Operator's Console	Replace		7.1				1, 2	
		Repair		2.0				1, 2	R6
	Pintle Hook	Service	.1						P
		Replace		1.0				1, 2	
	Radiator Grill	Replace		1.2				1, 2	
	Radiator Side Cover	Replace		.5				1, 2	
	Ri e Bracket	Replace		.5				1, 2	
	Seat Assembly	Inspect	.1						P
		Replace		.7				1, 2	
	Single Tree	Replace		3.0				1, 2	
	SNCGRS Radio Bracket	Replace		.5				1, 2	
	Washer/Wiper	Service	.1						P
		Replace		1.2				1, 2	
	Windshield Wiper Motor Assembly	Replace		.3				1, 2	
	Window	Replace		1.2				1, 2	
	Window Guard	Replace		.8				1, 2	
Electrical System									
	Batteries, Main	Inspect	.5						P
		Test		.5				1, 2	

(1) Group System	(2) Component/ Assembly	(3) Maintenance Function	(4) Maintenance Level: Field, Unit C	Field, Unit O	Field, Direct Support F	Sustainment, General Support H	Sustainment, Depot D	(5) Tools and Equipment Ref Code	(6) Remarks Code
		Replace		1.5				1, 7	
	Batteries, Arctic	Inspect		.5					P
		Test		.5				1, 2	
		Replace		1.5				1, 7	
	Battery Wiring Group, Main	Inspect	.2						P
		Replace		3.0				1, 2	
	Blade-Up Limit Switch	Replace		1.0				1, 2	
	Cab Limit Switch	Replace		1.0				1, 2	
	Circuit Breaker Panel, Front	Service	.1						P
		Replace		3.5				1, 2	
	Circuit Breaker Panel, Rear	Service	.4						P
		Replace		1.0				1, 2	
	Console Wiring Group	Replace		4.5				1, 2	
	Engine Control Module (ECM)	Replace		1.5				1, 2	
	Electronic Programmable Transmission Control (EPTC II)	Test		1.0				1, 2, 46, 54	
		Replace		1.0				1, 2	
	Instrument Wiring Group	Replace		3.7				1, 2	
	Kneeling Limit Switch	Replace		1.0				1, 2	
	Lighting Group	Replace		.8				1, 2	
	Recoil Alert Assembly	Inspect							P
		Replace						1, 2	
	Transmission Control Switch	Replace		1.7				1, 2	
	Vehicle Wiring Group	Replace		24.0				1, 2	

Section III. TOOLS AND TEST EQUIPMENT FOR DEPLOYABLE UNIVERSAL COMBAT EARTHMOVER (DEUCE)

Tool or Test Equipment Reference Code	Maintenance Level	Nomenclature	National Stock Number	Tool Number/ Cage Code
1	O, F, H	Tool Kit, General Mechanic's: Automotive (SC 5180-90-N26)	5180-00-177-7033	W33004 (50980)
2	O	Shop Equipment, Organizational Repair, Light, Truck Mounted (SC 4940-95-CL-B03)	4940-00-294-9516	T13152 (50980)
3	O	Shop Equipment, Automotive Maintenance and Repair: OM Common No. 1, Less Power (SC 4910-95-CL-A74)	4910-00-754-0654	W32593 (19204)
4	O	Shop Equipment, Automotive Maintenance and Repair: OM Supplemental No. 1, Less Power (SC 4910-95-A73)	4910-00-754-0653	W32867 (19204)
5	O	Simpli ed Test Equipment for Internal Combustion Engines Reprogrammable (STE/ICE-R) TM 9-4910-571-12&P	4910-01-222-6589	A56243 (19207)
6	O, F	Shop Equipment, Contact Maintenance, Truck Mounted (SC 4940-95-CL-B04)	4940-00-294-9518	T10138 (81996)
7	F, H	Shop Equipment General Purpose Repair, Semitrailer Mounted (SC 4940-95-CL-B02)	4940-00-287-4894	T10549 (81349)
8	F, H	Tool Out t Hydraulic Systems Test and Repair (HSTRU) (SC 4940-95-CL-B07)	4940-10-036-5784	T30377 (97403)
9	O, F	3-Pin Connector	6150-01-481-7196	124-5643 (11083)
10	F	Clamp Assembly, Injector & J-Tube	4730-01-481-7345	125-2583 (11083)
11	F	Hex Ball	5120-01-437-3673	125-2584 (11803)
12	O, F	Injection Actuation Pressure Sensor	4730-01-481-7349	125-2589 (11083)
13	O, F	Wrench Offset	5120-01-480-4856	127-2277 (11083)
14	O, F	Wrench Offset	5120-01-491-0554	127-2279 (11083)

Tool or Test Equipment Reference Code	Maintenance Level	Nomenclature	National Stock Number	Tool Number/ Cage Code
15	O, F	Bracket, Link (3/4 in.)	5340-01-476-1734	138-7574 (11083)
16	F	Bracket, Link (1/2 in.)	5120-01-451-1401	138-7575 (11083)
17	F	Bracket, Link (1-3/4 in.)	4030-01-490-6181	138-7576 (11083)
18	F	Link	4940-01-268-2201	138-7573 (11083)
19	O, F	Puller Kit	5180-01-480-1268	145-5242 (11083)
20	O, F	Pin Removal Tool	5120-01-491-0560	151-6320 (11083)
21	F	Spanner	5120-01-491-0558	160-0261 (11083)
22	O, F	Wrench Set, Crowsfoot	5120-01-302-4387	5705566 (19207)
23	O, F	Charging Kit, Pressurizing	4940-01-046-7109	12252157 (19200)
24	F	Plate	5120-01-503-0231	1P0524 (11083)
25	O, F	Wrench Offset	5120-01-486-7815	1P3501 (11083)
26	O, F	Wrench Offset	5120-01-486-7822	1P3508 (11083)
27	O, F	Wrench Offset	5120-01-486-7834	1P3510 (11083)
28	F	Manifold	4730-01-486-6758	1U5216 (11083)
29	F	Hose, Nonmetallic	4720-01-375-5972	1777861 (11083)
30	O, F	Hose Assembly	4720-01-473-8746	1U5757 (11083)
31	F	Differential Pressure Group	6685-01-484-9403	1U5796 (11083)
32	O, F	Crimp Tool	5120-01-486-7811	1U5804 (11083)
33	O, F	Pin Removal Tool	5120-01-486-7830	1U5805 (11083)
34	F	Seal Installer	5120-01-486-7827	1U6437 (11083)
35	O	Inserter, Seal	5120-01-362-2026	1U7430 (11083)
36	F	Bar, Injector Removal	5120-01-486-7828	1U7587 (11083)
37	F	Inserter, Seal	5120-01-362-2027	1U7598 (11083)
38	F	Installer Assembly	5120-01-496-1429	1U8697 (11083)
39	O, F	Seal Installer	5120-01-486-7824	1U8840 (11083)
40	F	Seal Installer	5120-01-476-1431	4C9527 (11083)
41	F	Socket, Socket Wrench	5120-01-124-1773	5P0144 (11083)
42	O, F	Hose	4720-01-486-6756	1777860 (11083)
43	O, F	Coupler	4730-01-164-1777	F09011020 5-04 (01276)
44	F	Coupler	4730-01-375-5882	6V3966 (11083)
45	F	Coupler	4730-01-375-5884	6V4143 (11083)
46	O	Cable Probe Group	6625-01-484-9402	7X1710 (11083)

Tool or Test Equipment Reference Code	Maintenance Level	Nomenclature	National Stock Number	Tool Number/ Cage Code
47	O,F	40-Pin AEC Breakout	6150-01-475-8364	7X1715 (11083)
48	O,F	3-Pin DT Breakout	4910-01-473-8748	7X6370 (11083)
49	O, F	Bolt	5306-01-468-0660	8T0292 (11083)
50	F	Gauge	6620-01-486-7681	8T0820 (11083)
51	F	Gauge	6685-01-476-1427	8T0861 (11083)
52	F	Wrench, Spanner	5120-01-486-7813	8T2839 (11083)
53	F	Signal Generator Group	6625-01-476-1421	8T5200 (11083)
54	O	Adapter Cable	6625-01-484-9404	8T8726 (11083)
55	F	Injector Sleeve Replacement Tool	5180-01-466-1432	143-2099 (11083)
56	O, F	Slotted Socket for Coolant Temp Sensor	5120-01-486-7818	9U5103 (11083)
57	O, F	Socket, 36mm	5120-01-486-7819	9U6539 (11083)
58	O, F	DT Connector Service Kit		1753700 (11083)
59	O, F	Digital Multimeter	6625-01-486-6712	9U7330 (11083)
60	O, F	Wrench, Crowfoot, 2-7/8”	5120-01-335-1116	FC92A (55719)
61	F	Pliers	5120-01-486-7816	FT0883 (11083)
62	F	Pliers	5120-01-486-7835	FT0947 (11083)
63	F	Wrench, Spanner	5120-01-476-1430	FT1641 (11083)
64	O, F	Laser Pointer	7520-01-392-5300	1996 (3Y736)
65	O, F	Soldiers Portable On-System Repair Tool	6625-01-445-0085	13580703 (18876)
66	O, F	Engine Timing Probe	6695-01-473-8766	6V2197 (11083)
67	O, F	Timing Probe Cable	4910-01-473-8747	7X1695 (11083)
68	O, F	Timing Probe Adapter	5935-01-476-8825	7X1171 (11083)
69	O, F	O-ring	5330-00-843-7194	2D6392 (11083)
70	O, F	Caterpillar ET Software	7030-01-488-3978	JEBD3003 (11083)
71	O, F	Caterpillar Communications Adapter with NEXG4523 Communications Adapter PROM	6625-01-496-1432	1714400 (11083)
72	F	Injector Seating Tool	5180-01-480-8942	1731530 (11083)
73	O	Sleeve Installer		5P6208 (11083)
74	F	Tachometer, Stroboscopic	6680-01-355-7805	1U6602 (11083)

NOTES:
Tool or Test Equipment Reference Code item 59 is used during replacement of cab hold-down bolts.
Tools or Test Equipment Reference Code Items 13,14,22,25,26,and 62 are used during the replacement of various hydraulic lines and ttings

Section IV. REMARKS FOR DEPLOYABLE UNIVERSAL COMBAT EARTHMOVER (DEUCE)

(1) Remarks Code	(2) Remarks
A	Differential steering unit and transmission are removed together, then separated.
L	Repair by government or contractor-licensed personal.
P	Preventive Maintenance Checks and Services (PMCS).
PX	Operator Emergency Service.
R1	Limited Field Repair authorized (seals, gaskets & bearings).
R2	Limited Field Repair authorized (seals, gaskets, injectors, springs & valves).
R3	Limited Field Repair authorized (seals, gaskets, bearings, plug & cylinder heads).
R4	Limited Field Repair authorized (seals, bearings, gaskets, brushes & star gear).
R5	Limited Field Repair authorized (seals, gaskets, wipers & rings).
R6	Limited Field Repair authorized (replacement of broken or missing parts & minor welding).

Appendix B
Unit Preventive Maintenance Checks and Services (PMCS)

GENERAL

To ensure that the tractor is ready for operation at all times, it must be inspected systematically so that defects may be discovered and corrected before they result in serious damage or failure. This table contains a tabulated listing of preventive maintenance checks and services to be performed by Unit Maintenance personnel. All deficiencies and shortcomings will be recorded, as well as the corrective action taken, on DA Form 2404 at the earliest possible opportunity.

NOTE: After the warranty period has expired, follow AOAP guidelines outlined in DA PAM 738-750.

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES

A. The item numbers in the table indicate the sequence of the PMCS. Perform at the earliest (calendar time or service meter hours) intervals, shown below:

(1) Do your “Initial 50” preventive maintenance after the initial 50 service hours.
(2) Do your “Quarterly” preventive maintenance once every three months, or 250 service hours.
(3) Do your “Semiannual” preventive maintenance every six months, or 500 service hours.
(4) Do your “Annual” preventive maintenance every 12 months, or 1000 service hours.
(5) Do your “Biannual” preventive maintenance every 24 months, or 2000 service hours.

B. If something doesn’t work, troubleshoot with the instructions in this manual, or notify your supervisor.

C. Always do your preventive maintenance in the same order, so it becomes a habit. Once you’ve had some practice, you’ll spot anything wrong in a hurry.

D. If anything looks wrong and you can’t fix it, write it down on your DA Form 2404. If you find something seriously wrong, report it to Direct Support Maintenance as soon as possible.

WARNING

MIL-PRF-680 (Type III) is a flammable solvent that is potentially dangerous to personnel. Keep away from heat, sparks or open flame. The flash point of the solvent is 210°F (99°C). Use only in a well ventilated area. Inhaling vapors over a period of time can cause headaches and drowsiness. Use gloves to prevent irritation or inflammation of the skin. Solvent absorbed through the skin can result in internal disorders. If contact occurs, wash the affected area with water for 15 minutes. For eyes, flush with water and then seek immediate medical attention.

WARNING

Particles blown by compressed air are hazardous. Make certain the airstream is directed away from the user and other personnel in the area. To prevent injury, the user must wear protective goggles, or a face shield when using compressed air.

(1) Keep it clean: dirt, grease, oil and debris only get in the way and may cover up a serious problem. Clean as you work and as needed. Use dry cleaning solvent (MIL-PRF-680) to clean metal surfaces. Use soap and water when you clean rubber or plastic material.

(2) Cap screws, nuts and screws: check that they are not loose, missing, bent or broken. Look for chipped paint, bare metal, or rust around cap screw heads, and tighten any that are loose.

(3) Welds: look for loose or chipped paint, rust, or gaps where parts are welded together. If you find a bad weld, report it to Direct Support Maintenance.

(4) Electrical wires and connectors: Look for cracked or broken insulation, bare wires and loose or broken connectors. Tighten any loose connections and make sure the wires are in good condition.

(5) Hoses and fluid lines: Look for wear, damage and leaks. Make sure all clamps and fittings are tight. Wet spots show leaks, but a stain around a fitting or connector can also mean a leak. If a leak comes from a loose fitting or connector, tighten it. If something is broken or worn out, either correct it or report it to Direct Support Maintenance (See Maintenance Allocation Chart, Appendix A).

E. It is necessary for you to know how fluid leaks affect the status of your equipment. The following are definitions of the classes of leaks which will help you determine the status of your equipment. Learn and be familiar with them.

(1) Class I — Seepage of fluid (as indicated by wetness or discoloration) not great enough to form drops.

(2) Class II — Leakage of fluid great enough to form drops, but not enough to cause drops to drip from the item being checked/inspected.

(3) Class III — Leakage of fluid great enough to form drops that fall from the item being checked/inspected.

NOTICE

Equipment operation is allowable with minor leaks (Class I or II). Of course, consideration must be given to the fluid capacity in the item or system being checked or inspected. Class III leaks should be reported to your supervisor.

PMCS COLUMN DESCRIPTION

A. Item Number—The order in which the PMCS should be performed. These numbers are also used as a source of item numbers for the TM number column on DA Form 2404 Equipment Inspection and Maintenance worksheet when recording the results of the PMCS.

B. Interval—Tells when each check is to be performed.

C. Item to Be Inspected—Lists the checks to be performed.

D. Procedures—Describes the procedure by which the check is to be performed.

NOTE: Perform the Operator PMCS prior to or in conjunction with the Unit PMCS if:

(1) There is a delay between the daily operation and the Unit PMCS.
(2) The regular operator is not assisting or participating.

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES

Initial 50—Initial 50 Hours**, Quarterly—**Three Months or 250 Hours,
Semiannual—Six Months or 500 Hours, **Annual—**12 Months or 1000 Hours,
Biannual—24 Months or 2000 Hours

Item No.	Interval	Item to Be Inspected	Procedure
PROCEDURES FOR NEW OR RECONDITIONED MACHINE			
1	**INITIAL 50**	**POWER TRAIN**	Change the oil and filters. (Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover [DEUCE],* "Maintenance Section, Maintenance Intervals, Every 500 Service Hours or Six Months, Power Train.")
1a	**INITIAL 50**	**REAR IDLER**	Check Torque. (Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover [DEUCE],* "Maintenance Section, Maintenance Intervals, Intitial 50 Service Hours, Rear Idler.")
1b	**INITIAL 50**	**OFFSET ARM**	Check Torque. (Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover [DEUCE],* "Maintenance Section, Maintenance Intervals, Intitial 50 Service Hours, Offset Arm.")
1c	**INITIAL 50**	**BRAKE ASSEMBLY**	Check Torque. (Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover [DEUCE],* "Maintenance Section, Maintenance Intervals, Intitial 50 Service Hours, Brake Assembly.")

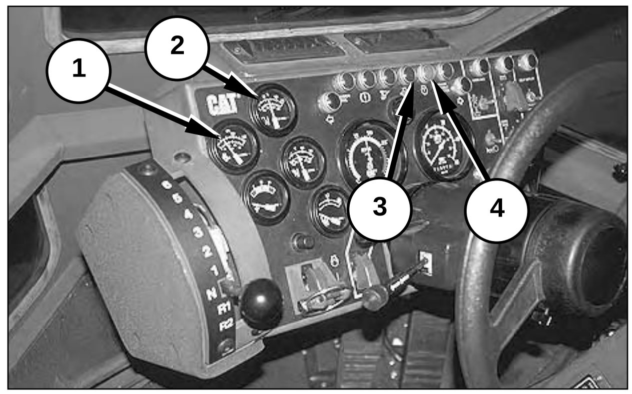
UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES

Initial 50—Initial 50 Hours**, Quarterly—**Three Months or 250 Hours,
Semiannual—Six Months or 500 Hours, **Annual—**12 Months or 1000 Hours,
Biannual—24 Months or 2000 Hours

Item No.	Interval	Item to Be Inspected	Procedure
ROAD TEST			
			Perform all "During" operation checks listed in TM5-2430-200-10, before performing the tasks below. Drive the machine over varied terrain for at least 15 minutes. This will provide time to check reported malfunctions and to locate unreported malfunctions.
2	**QUARTERLY**	**STARTER**	Listen for unusual noises and difficult cranking.
3	**QUARTERLY**	**ENGINE**	Observe the response to the accelerator. LISTEN for unusual noises. Watch for hesitation and varying idle speed. Be alert for excessive vibration and the smell of fuel, oil, coolant, and exhaust.
4	**QUARTERLY**	**BRAKES**	Reach a speed of approximately 10 mph and lightly apply the brake pedals with steady force. The machine should slow down immediately and stop smoothly.

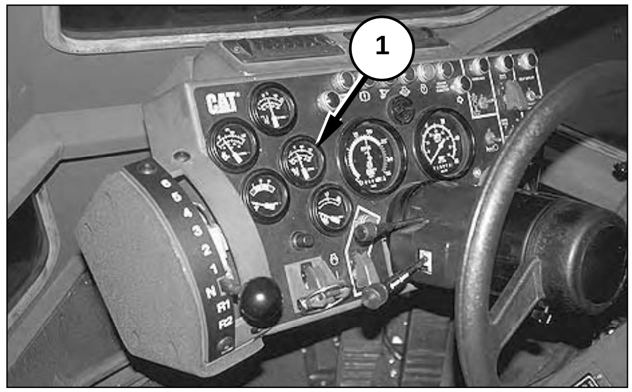
UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES

Initial 50—Initial 50 Hours**, Quarterly—**Three Months or 250 Hours,
Semiannual—Six Months or 500 Hours, **Annual—**12 Months or 1000 Hours,
Biannual—24 Months or 2000 Hours

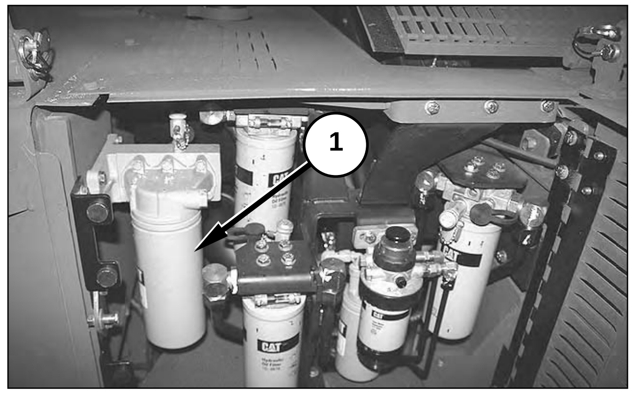
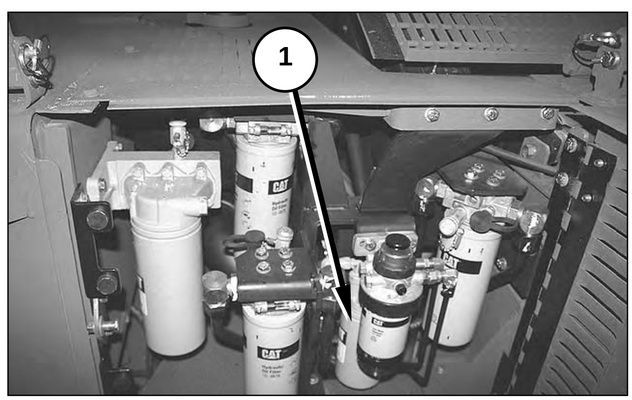
Item No.	Interval	Item to Be Inspected	Procedure
5	**QUARTERLY**	**ENGINE**	Check the engine instruments for operation in the normal range:  a. Engine oil pressure gauge (1) should read between 240 and 480 kPa (35 and 70 psi) when the engine is at full speed. NOTICE Stop the engine immediately if engine oil pressure indicator (3) does not turn off within 15 seconds after the engine is started. Do not operate the machine until the cause of the low oil pressure is determined. Damage to the machine will result. b. Engine coolant temperature gauge (2) should read less than 110°C (230°F). c. Engine oil pressure indicator (3) should be OFF. d. Check engine indicator (4) should be OFF.

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES

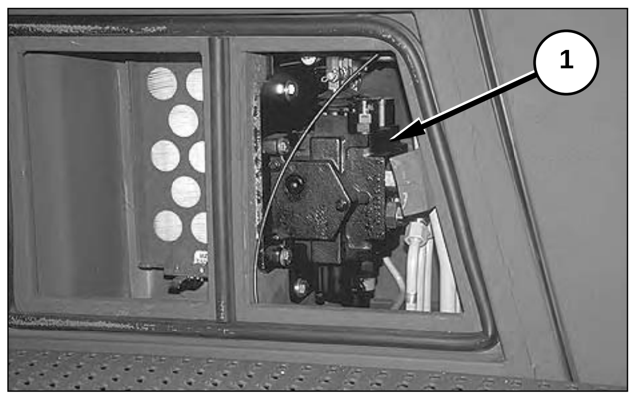
Initial 50—Initial 50 Hours**, Quarterly—**Three Months or 250 Hours,
Semiannual—Six Months or 500 Hours, **Annual—**12 Months or 1000 Hours,
Biannual—24 Months or 2000 Hours

Item No.	Interval	Item to Be Inspected	Procedure
6	**QUARTERLY**	**TRANSMISSION**	 a. Check transmission oil temperature gauge (1). The gauge should read less than 105°C (221°F) during normal operation. b. Put the machine into the SELF-DEPLOY mode, and check for the response to shifting and the smoothness of operation in all ranges. Verify that the transmission shifts automatically between all six forward gears. (Refer to *Operator’s Manual, Deployable Universal Combat Earthmover [DEUCE],* “Operation Section, Machine Operation, Self-Deploy Mode.”)

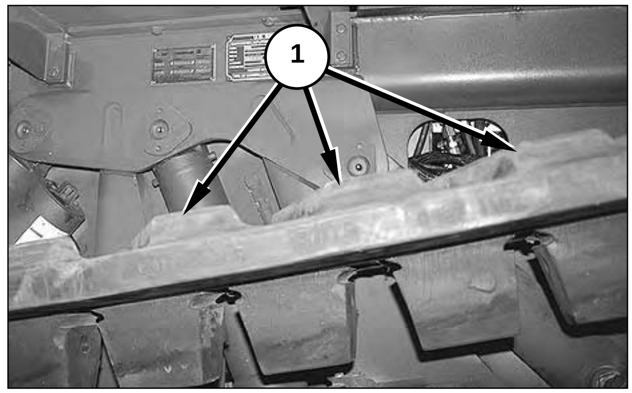
UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES
Initial 50—Initial 50 Hours**, Quarterly—**Three Months or 250 Hours,
Semiannual—Six Months or 500 Hours, **Annual—**12 Months or 1000 Hours,
Biannual—24 Months or 2000 Hours

Item No.	Interval	Item to Be Inspected	Procedure
			ENGINE
7	**QUARTERLY**	**ENGINE OIL**	 Engine oil filter (1) is located in the filter compartment, on the left side of the machine. Change the oil and oil filter. (Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover [DEUCE],* "Maintenance Section, Maintenance Intervals, Every 250 Service Hours or Three Months, Engine Oil and Filter.")
8	**QUARTERLY**	**FUEL SYSTEM**	 Secondary fuel filter (1) is located in the filter compartment, on the left side of the machine. Replace the secondary filter. (Refer to *Periodic*

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES
Initial 50—Initial 50 Hours**, Quarterly—**Three Months or 250 Hours,
Semiannual—Six Months or 500 Hours, **Annual—**12 Months or 1000 Hours,
Biannual—24 Months or 2000 Hours

Item No.	Interval	Item to Be Inspected	Procedure
			Maintenance and Special Operation, Deployable Universal Combat Earthmover [DEUCE], "Maintenance Section, Maintenance Intervals, Every 250 Service Hours or Three Months, Fuel System.")
		POWER TRAIN/HYDRAULIC SYSTEM	
9	**QUARTERLY**	**HYDRAULIC CONTROL VALVES**	 Hydraulic control valve (1) is located behind the door, on the right side of the cab. Check hydraulic control valves for leakage, wear, or cracks that could cause failure.

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES
Initial 50—Initial 50 Hours**, Quarterly—**Three Months or 250 Hours,
Semiannual—Six Months or 500 Hours, **Annual—**12 Months or 1000 Hours,
Biannual—24 Months or 2000 Hours

Item No.	Interval	Item to Be Inspected	Procedure
		UNDERCARRIAGE	
10	**QUARTERLY**	**DRIVE BELT**	 Grousers (1) are the tread surface of the drive belts. a. Check 10 grousers for wear. Lay a straight edge over 3 or 4 grousers on the top side of the belt. Using the straight edge, measure the height of the grousers relative to the belt carcass. Take two measurements per grouser, one at the outside end and one at the inside end. Replace the belt if the average height of the grousers is less than 10 mm (0.4 in). Cut exposed breaker ply wires flush with the belt.

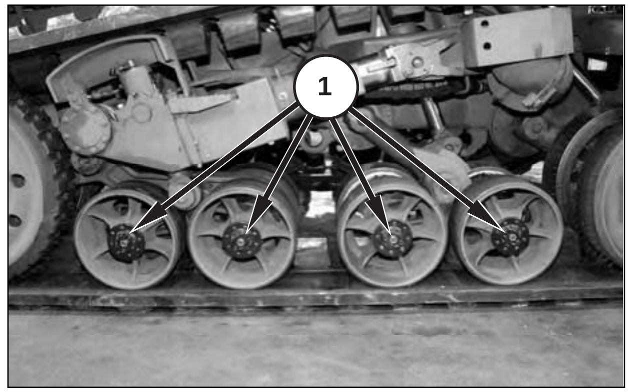
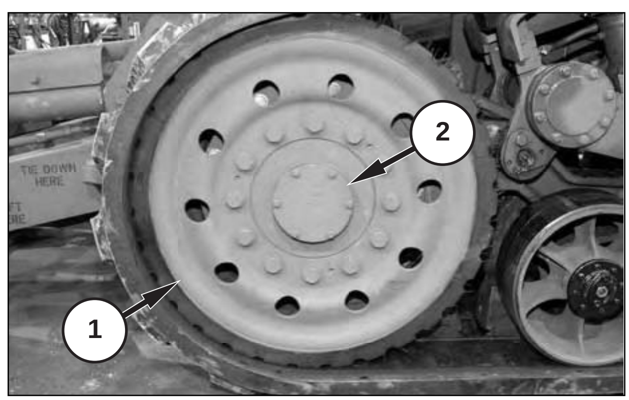
UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES

Initial 50–Initial 50 Hours**, Quarterly–**3 Months or 250 Hours, **Semi-annual–**6 Months or 500 Hours, **Annual–**12 Months or 1000 Hours, **Bi-annual–**24 Months or 2000 Hours

Item No.	Interval	Item to Be Inspected	Procedure
10	**QUARTERLY**	**DRIVE BELT**	b. Check drive belts for protruding main/zero degree cables. The 72 main/zero degree cables run lengthwise inside the belt. If a main/zero degree cable protrudes, the cable must be cut or ground flush with the belt surface. If more than 8 ft. of cable is exposed or 28 of the 72 cables are broken , the belts must be replaced NOTICE Failure to remove protruding cables will cause damage to the belts, front idlers, midrollers and rear idlers. **WARNING** **To prevent injury, the user must wear protective gloves and goggles, or a face shield when cutting or grinding cables.**

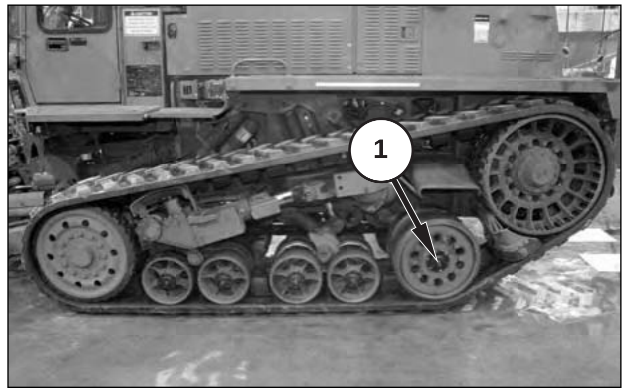
UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES

Initial 50—Initial 50 Hours**, Quarterly—**Three Months or 250 Hours,
Semiannual—Six Months or 500 Hours, **Annual—**12 Months or 1000 Hours,
Biannual—24 Months or 2000 Hours

Item No.	Interval	Item to Be Inspected	Procedure
11	**QUARTERLY**	**MIDROLLERS**	 a. Check the oil level in site gages on midrollers (1). The oil level should be visible in the sight gauge. (Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover [DEUCE],* “Maintenance Section, Maintenance Intervals, Every 250 Service Hours or Three Months, Midrollers.”) b. Check for damage, wear and leaks around the shafts.
12	**QUARTERLY**	**FRONT IDLERS**	 Check front idlers (1) for damage, wear and leaks around hubs (2).

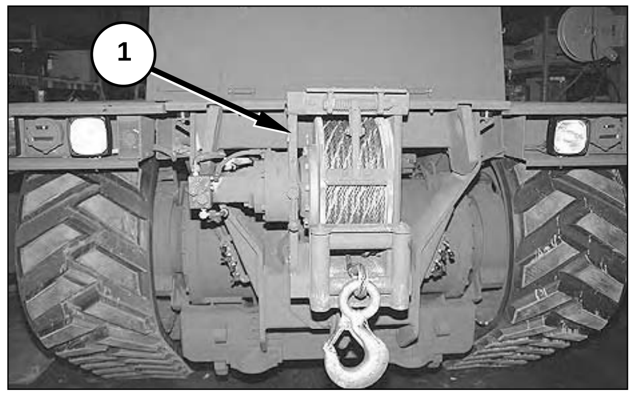
UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES

Initial 50—Initial 50 Hours**, Quarterly—**Three Months or 250 Hours, **Semiannual—**Six Months or 500 Hours, **Annual—**12 Months or 1000 Hours, **Biannual—**24 Months or 2000 Hours

Item No.	Interval	Item to Be Inspected	Procedure
13	**QUARTERLY**	**REAR IDLERS**	 a. Check the oil level in sight gauges on right and left rear idlers (1). The oil level should be visible in the sight gauge. (Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover [DEUCE],* “Maintenance Section, Maintenance Intervals, Every 250 Service Hours or Three Months, “Rear Idlers.”) b. Check for damage, wear and leaks around the shaft.
14	**QUARTERLY**	**ACCUMULATORS**	Check the brake accumulator. (Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover [DEUCE],* “Maintenance Section, Maintenance Intervals, Every 250 Service Hours or Three Months, Brake Accumulator.”)

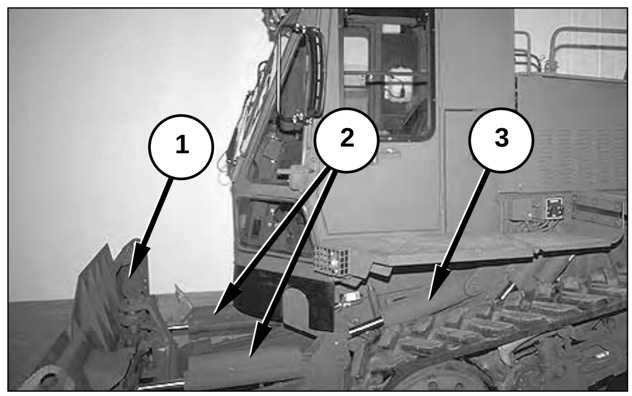
UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES

Initial 50—Initial 50 Hours**, Quarterly—**Three Months or 250 Hours,
Semiannual—Six Months or 500 Hours, **Annual—**12 Months or 1000 Hours,
Biannual—24 Months or 2000 Hours

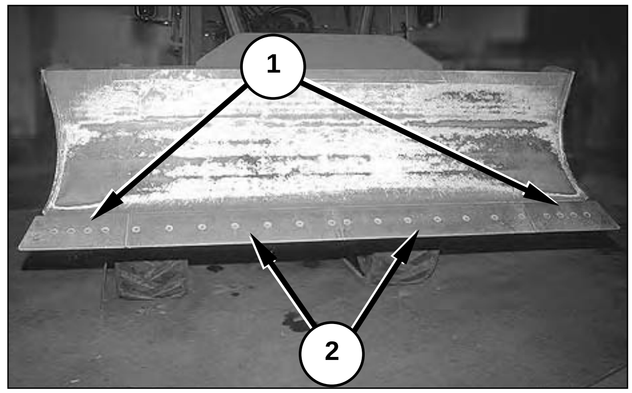
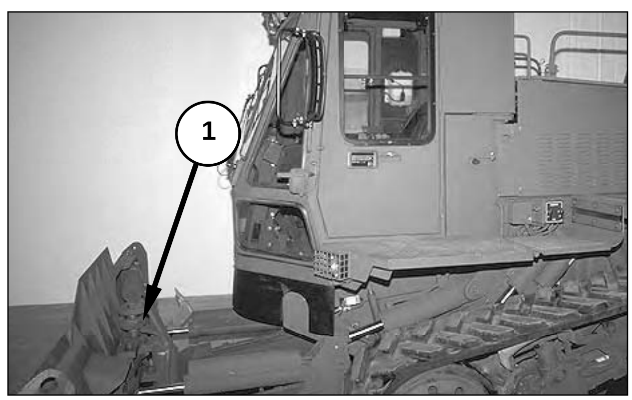
Item No.	Interval	Item to Be Inspected	Procedure
		WINCH	
15	**QUARTERLY**	**WINCH**	 Winch (1) is located at the rear of the machine. a. Inspect the winch motor for leaks. b. Inspect the winch support for cracks or loose and missing fasteners. c. Check the gearbox oil level. (Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover [DEUCE],* "Maintenance Section, Maintenance Intervals, Every 250 Service Hours or Three Months, Winch Gearbox.")

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES

Initial 50—Initial 50 Hours**, Quarterly—**Three Months or 250 Hours, **Semiannual—**Six Months or 500 Hours, **Annual—**12 Months or 1000 Hours, **Biannual—**24 Months or 2000 Hours

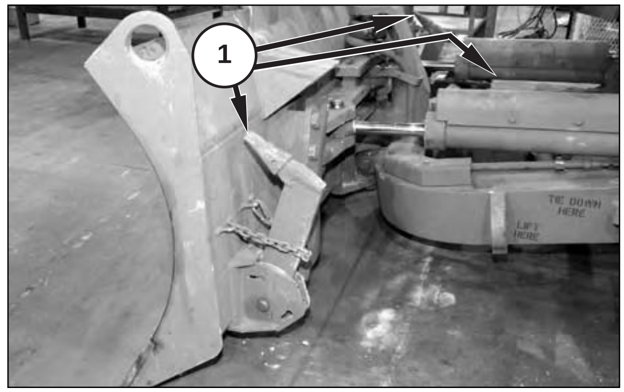
Item No.	Interval	Item to Be Inspected	Procedure
		HYDRAULIC CONTROLS	
16	**QUARTERLY**	**LINES/FITTINGS**	Follow the routing of all hydraulic lines, hoses and tubing, and inspect for loose fittings, cracks, bends, breaks, and leaks.
17	**QUARTERLY**	**LIFT, TILT, AND ANGLE CYLINDERS**	 The bulldozer has one tilt cylinder (1), two angle cylinders (2) and two lift cylinders (3). a. Inspect the cylinder lines for loose fittings, cracks, bends, breaks and leaks. b. Inspect the cylinders for leaks and secure mounting.
18	**QUARTERLY**	**HYDRAULIC TANK**	a. Inspect the hydraulic tank for loose fittings and damaged lines. b. Inspect the hydraulic tank for cracks, breaks, and leaks.

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES
Initial 50—Initial 50 Hours**, Quarterly—**Three Months or 250 Hours,
Semiannual—Six Months or 500 Hours, **Annual—**12 Months or 1000 Hours,
Biannual—24 Months or 2000 Hours

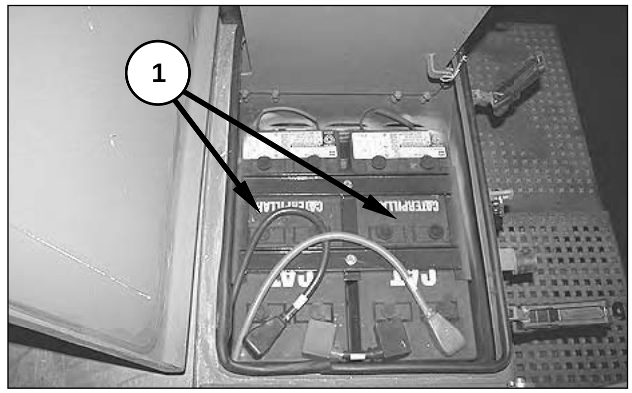
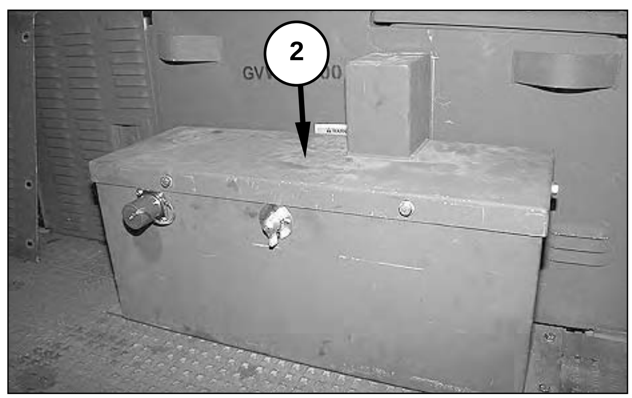
Item No.	Interval	Item to Be Inspected	Procedure
		BLADE	
19	**QUARTERLY**	**DOZER BLADE**	 Inspect cutting edges (2) and end bits (1) for damage and wear. Flip or replace the component if the cutting edge or end bits are worn so that the mounting adapter is exposed.
20	**QUARTERLY**	**TRUNNION**	 Inspect for trunnion (1) cracks, bending and missing mounting hardware.

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES

Initial 50—Initial 50 Hours**, Quarterly—**Three Months or 250 Hours,
Semiannual—Six Months or 500 Hours, **Annual—**12 Months or 1000 Hours,
Biannual—24 Months or 2000 Hours

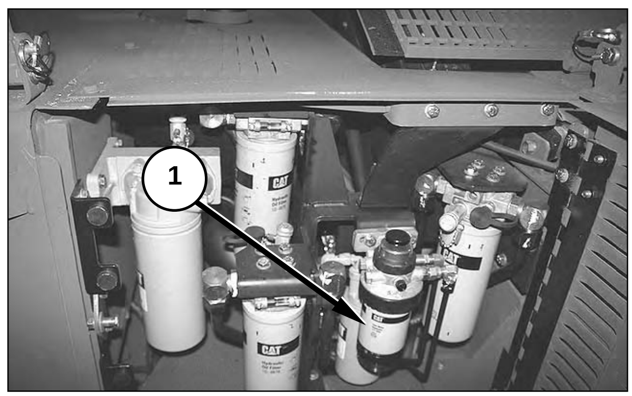
Item No.	Interval	Item to Be Inspected	Procedure
21	**QUARTERLY**	**BACK RIPPERS**	 Inspect ripper teeth (1) for damage and wear. There are four rippers on the bulldozer. Replace the teeth if the adapter tip is exposed.
		CAB	
22	**QUARTERLY**	**DEFROSTER**	Inspect the defrosters for correct operation.
23	**QUARTERLY**	**HEATER**	Inspect the heater for correct operation.
24	**QUARTERLY**	**WINDSHIELD WIPERS**	Inspect the windshield wipers.
25	**QUARTERLY**	**INSTRUMENTS AND GAUGES**	a. Inspect all instruments and gauges for signs of damage, and loose or missing hardware. b. Inspect electrical connections for frays, splits, breaks and missing insulation.
26	**QUARTERLY**	**CONTROL PANEL LIGHTS**	Inspect lamp sockets and lenses for damage, and check for loose or damaged wiring.

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES
Initial 50—Initial 50 Hours**, Quarterly—**Three Months or 250 Hours,
Semiannual—Six Months or 500 Hours, **Annual—**12 Months or 1000 Hours,
Biannual—24 Months or 2000 Hours

Item No.	Interval	Item to Be Inspected	Procedure
		ELECTRICAL SYSTEM	
27	**QUARTERLY**	**BATTERIES**	 Standard batteries (1) are located in the tool box compartment at the right rear of the machine.  If the machine is equipped with arctic batteries, they are located beneath cover (2) in a box on the left fender. Inspect. (Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover [DEUCE],* “Maintenance Section, Maintenance Intervals, Every 250 Service Hours or Three Months, Batteries.”)

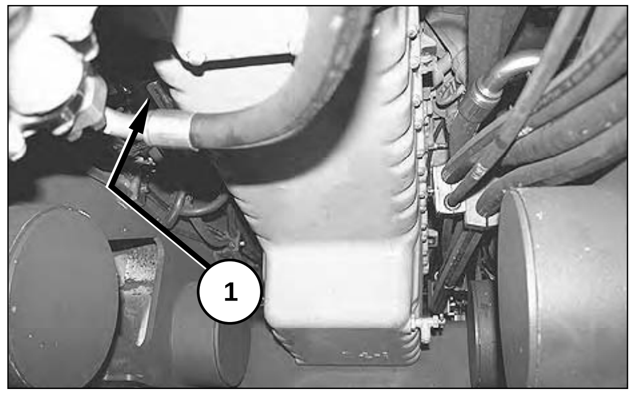
UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES

Initial 50—Initial 50 Hours**, Quarterly—**Three Months or 250 Hours, **Semiannual—**Six Months or 500 Hours, **Annual—**12 Months or 1000 Hours, **Biannual—**24 Months or 2000 Hours

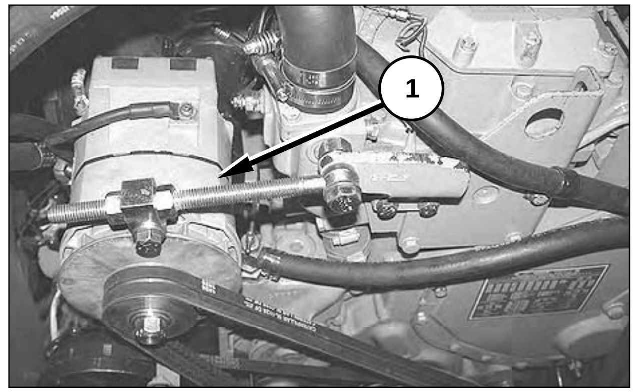
Item No.	Interval	Item to Be Inspected	Procedure
		INSTRUCTION PLATES	
28	**QUARTERLY**	**DATA, CAUTION, WARNING PLATES**	Inspect data, caution and warning plates for completeness, secure retention and readability. Refer to *Operator's Manual, Deployable Universal Combat Earthmover (DEUCE),* "Safety Section" and "General Section."
		ENGINE	
29	**SEMIANNUAL**	**FUEL SYSTEM**	 Fuel filter and water separator element (1) is located in the filter compartment on the left side of the machine. a. Change the filter and water separator element. (Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover [DEUCE],* "Maintenance Section, Maintenance Intervals, Every 500 Service Hours or Six Months, Fuel System.") b. Check the cap and fill screen on the fuel tank. (Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover [DEUCE],* "Maintenance Section, Maintenance

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES

Initial 50—Initial 50 Hours**, Quarterly—**Three Months or 250 Hours,
Semiannual—Six Months or 500 Hours, **Annual—**12 Months or 1000 Hours,
Biannual—24 Months or 2000 Hours

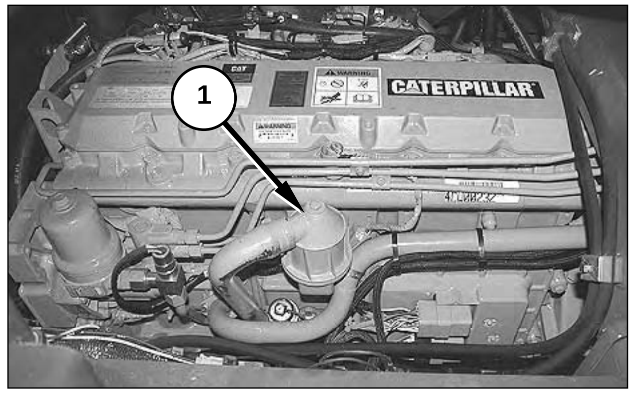
Item No.	Interval	Item to Be Inspected	Procedure
			Intervals, Every 500 Service Hours or Six Months, Fuel Tank.")
30	**SEMIANNUAL**	**STARTER**	 Starter (1) is located beneath a cover on the bottom of the machine, on the left side of the engine. Inspect. (Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover [DEUCE],* "Maintenance Section, Maintenance Intervals, Every 500 Service Hours or Six Months, Starter.")

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES
Initial 50—Initial 50 Hours**, Quarterly—**Three Months or 250 Hours,
Semiannual—Six Months or 500 Hours, **Annual—**12 Months or 1000 Hours,
Biannual—24 Months or 2000 Hours

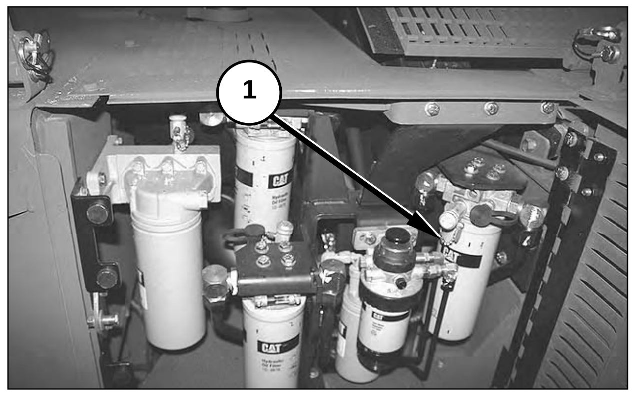
Item No.	Interval	Item to Be Inspected	Procedure
31	**SEMIANNUAL**	**ALTERNATOR**	 Alternator (1) is located beneath a cover at the front of the engine, beneath the cab. Inspect. (Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover [DEUCE],* "Maintenance Section, Maintenance Intervals, Every 500 Service Hours or Six Months, Alternator.")
32	**SEMIANNUAL**	**COOLING SYSTEM**	a. Test the cooling additive. (Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover [DEUCE],* "Maintenance Section, Maintenance Intervals, Every 500 Service Hours or Six Months, Cooling System.") b. Inspect the radiator, water pump, engine oil cooler, hydraulic oil cooler, and the torque converter oil cooler for leaks and secure mounting. c. Inspect the radiator core for clogged or bent fins, leaks, and protruding debris. Clean the clogged core and remove debris. Straighten bent fins. d. Inspect fan blades for cracks, breaks, and missing or loose fasteners. e. Inspect cooling fan motor lines for leaks.

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES

Initial 50—Initial 50 Hours**, Quarterly—**Three Months or 250 Hours, **Semiannual—**Six Months or 500 Hours, **Annual—**12 Months or 1000 Hours, **Biannual—**24 Months or 2000 Hours

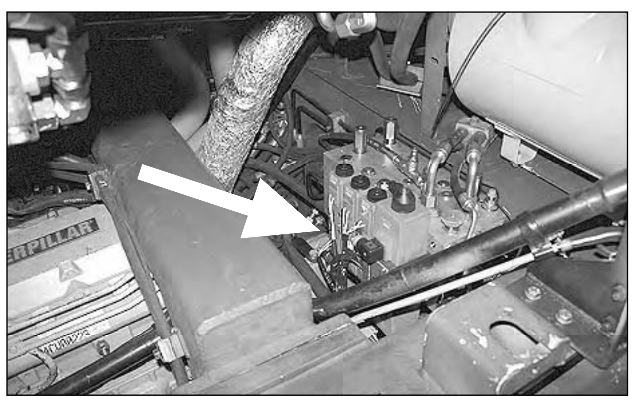
Item No.	Interval	Item to Be Inspected	Procedure
33	**SEMIANNUAL**	**ENGINE CRANK-CASE BREATHER**	 Engine crankcase breather (1) is located on the left side of the engine, beneath the radiator. Clean engine crankcase breather (1). (Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover [DEUCE],* “Maintenance Section, Maintenance Intervals, Every 500 Service Hours or Six Months, Engine Crankcase Breather.”)
34	**SEMIANNUAL**	**ELECTRICAL WIRING**	Inspect all engine compartment wiring for frays, splits, missing insulation, and poor connections. Replace or repair any damaged wires.

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES
Initial 50—Initial 50 Hours**, Quarterly—**Three Months or 250 Hours,
Semiannual—Six Months or 500 Hours, **Annual—**12 Months or 1000 Hours,
Biannual—24 Months or 2000 Hours

Item No.	Interval	Item to Be Inspected	Procedure
		POWER TRAIN/HYDRAULIC SYSTEM	
35	**SEMIANNUAL**	**POWER TRAIN LUBRICATION SYSTEM**	 Change filter (1). (Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover [DEUCE],* “Maintenance Section, Maintenance Intervals, Every 500 Service Hours or Six Months, Power Train.”)

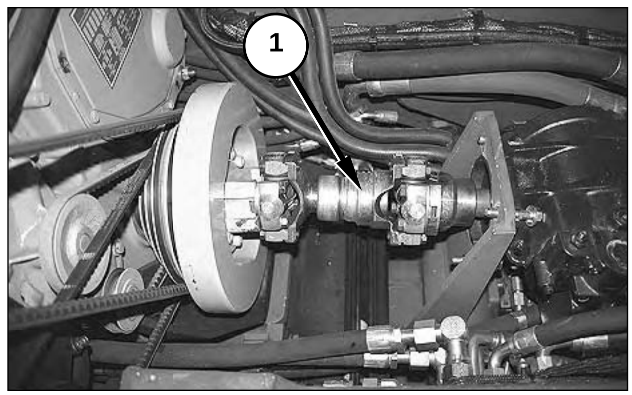
UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES

Initial 50—Initial 50 Hours**, Quarterly—**Three Months or 250 Hours,
Semiannual—Six Months or 500 Hours, **Annual—**12 Months or 1000 Hours,
Biannual—24 Months or 2000 Hours

Item No.	Interval	Item to Be Inspected	Procedure
36	**SEMIANNUAL**	**HYDRAULIC SYSTEM**	 Charge oil filter (2) and hydraulic return filter (1) are located in the filter compartment on the right side of the machine. Change the filters, and clean the fill screen. (Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover [DEUCE],* “Maintenance Section, Maintenance Intervals, Every 500 Service Hours or Six Months, Hydraulic System.”)
37	**SEMIANNUAL**	**MAIN DRIVE SHAFT**	 The main drive shaft (arrow) is located between the torque converter and the transmission, behind the engine. a. Lubricate. (Refer to *Periodic Maintenance and Special Operation, Deployable*

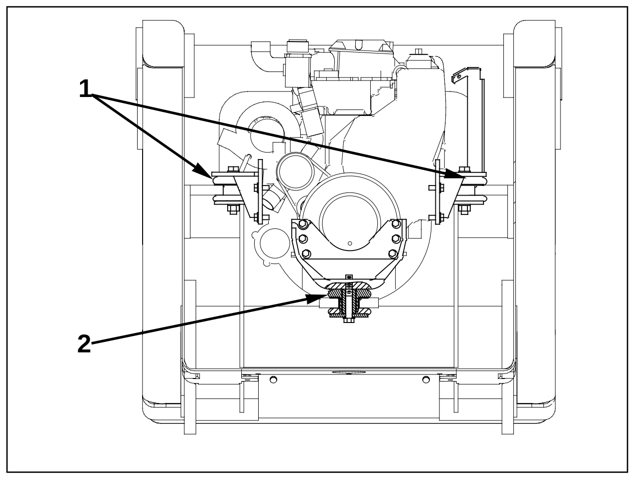
UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES

Initial 50—Initial 50 Hours**, Quarterly—**Three Months or 250 Hours,
Semiannual—Six Months or 500 Hours, **Annual—**12 Months or 1000 Hours,
Biannual—24 Months or 2000 Hours

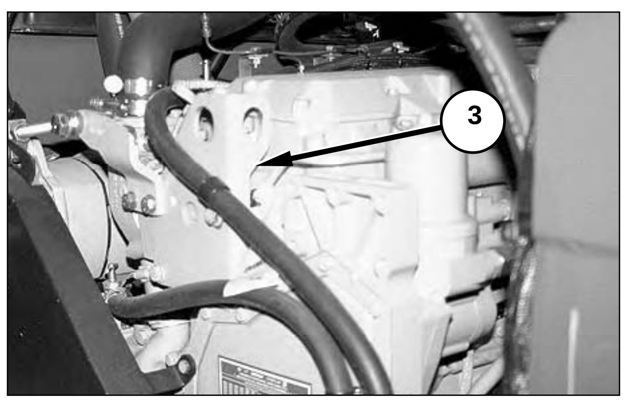
Item No.	Interval	Item to Be Inspected	Procedure
			Universal Combat Earthmover [DEUCE], "Maintenance Section, Maintenance Intervals, Every 500 Service Hours or Six Months, Main Drive Shaft.") b. Check for bends, cracks and a twisted condition.
38	**SEMIANNUAL**	**STEERING PUMP DRIVE SHAFT**	 Steering pump drive shaft (1) is located beneath two covers, underneath the cab. Check for bends, cracks and a twisted condition.

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES
Initial 50—Initial 50 Hours**, Quarterly—**Three Months or 250 Hours,
Semiannual—Six Months or 500 Hours, **Annual—**12 Months or 1000 Hours,
Biannual—24 Months or 2000 Hours

Item No.	Interval	Item to Be Inspected	Procedure
		ENGINE	
39	**ANNUAL**	**FUEL SYSTEM**	Drain water and sediment from the fuel tank. (Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover [DEUCE],* “Maintenance Section, Maintenance Intervals, Every 1000 Service Hours or When Required, Fuel Tank.”)
40	**ANNUAL**	**ENGINE MOUNTS/ LIFTING BRACKETS**	



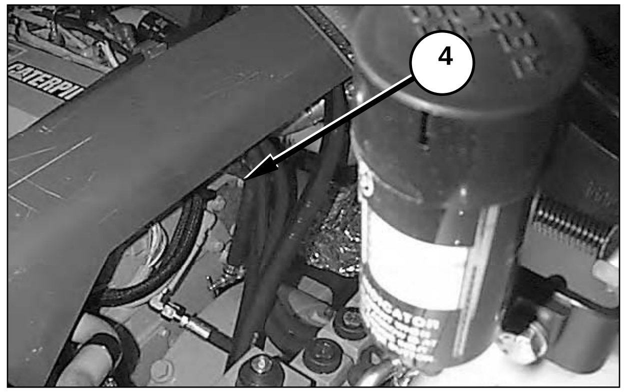
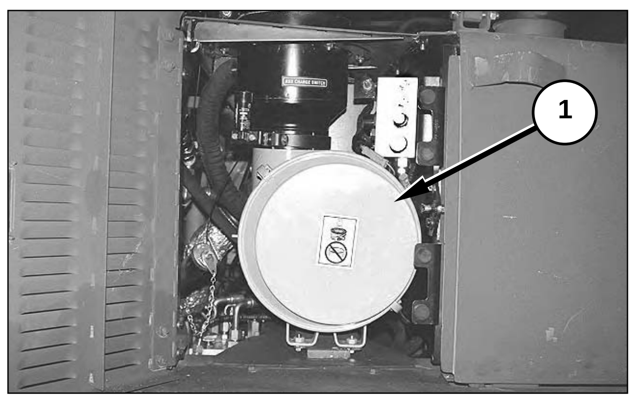
There are two rear engine mounts (1) (one on each side of the engine). There is one front engine mount (2).



There is one lifting bracket (3) on the front of the engine.

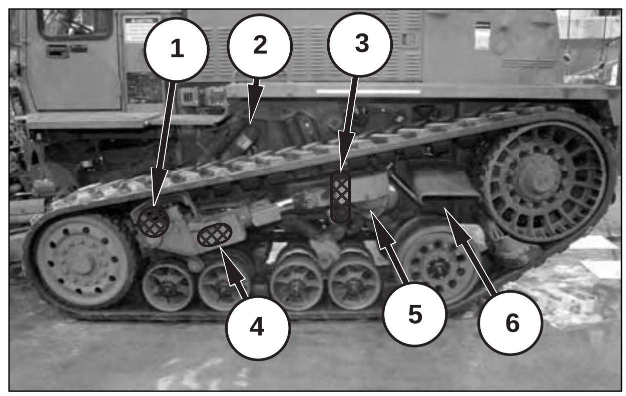
UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES

Initial 50—Initial 50 Hours**, Quarterly—**Three Months or 250 Hours,
Semiannual—Six Months or 500 Hours, **Annual—**12 Months or 1000 Hours,
Biannual—24 Months or 2000 Hours

Item No.	Interval	Item to Be Inspected	Procedure
41	**ANNUAL**	**AIR INTAKE SYSTEM**	 There are two lifting brackets (4) at the rear of the engine (one for each side). Inspect engine mounts and lifting brackets for wear, cracks, splits, broken welds, and missing mounting hardware.  The air intake filters are located inside air intake filter housing (1) on the left side of the machine. Change the filter. (Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover [DEUCE],* “Maintenance Section, Maintenance Intervals, Every 1000 Service Hours or When Required, Engine Air Intake System.”)

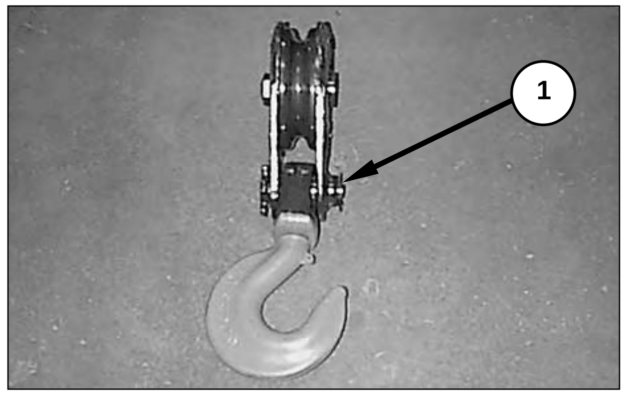
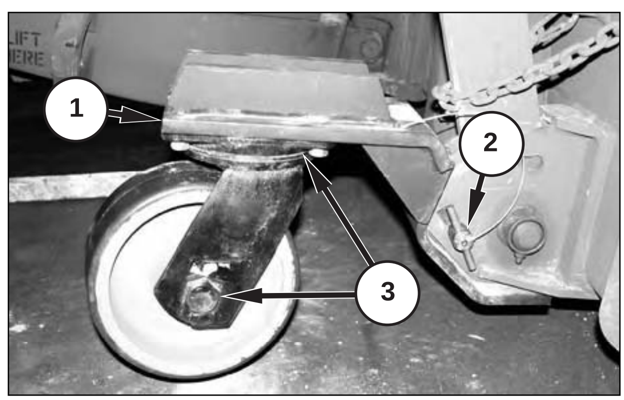
UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES

Initial 50—Initial 50 Hours**, Quarterly—**Three Months or 250 Hours, **Semiannual—**Six Months or 500 Hours, **Annual—**12 Months or 1000 Hours, **Biannual—**24 Months or 2000 Hours

Item No.	Interval	Item to Be Inspected	Procedure
		POWER TRAIN/HYDRAULIC SYSTEM	
42	**ANNUAL**	**HYDRAULIC SYSTEM**	Change the oil, and clean the suction screens. (Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover [DEUCE],* “Maintenance Section, Maintenance Intervals, Every 1000 Service Hours or One Year, Hydraulic System.”)
		UNDERCARRIAGE	
43	**ANNUAL**	**ACCUMULATORS**	 Check the accumulator nitrogen precharge. There are 11 accumulators installed on this machine. Accumulators (2), (3), (4), (5) and (6) are located on both sides of the machine. Accumulator (1) is located under the cab in the center of the machine. (Refer to *Specifications Systems Operation Testing and Adjusting, Deployable Universal Combat Earthmover [DEUCE], Undercarriage Steering and Brakes,* “Systems Operation, Suspensions System Procedures, Accumulator Charging Procedure” to check and adjust the nitrogen precharge pressure of the accumulators.)

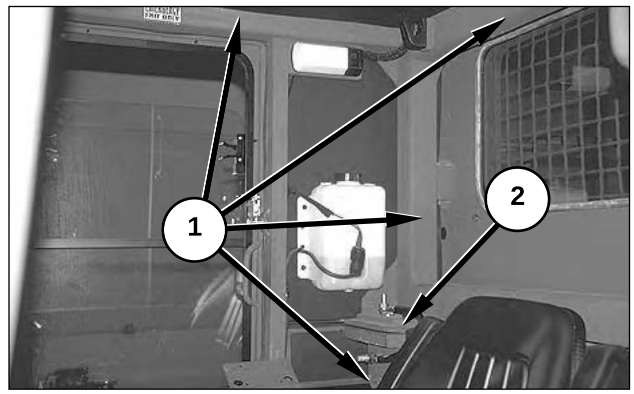
UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES

Initial 50–Initial 50 Hours**, Quarterly–**3 Months or 250 Hours, **Semi-annual–**6 Months or 500 Hours, **Annual–**12 Months or 1000 Hours, **Bi-annual–**24 Months or 2000 Hours

Item No.	Interval	Item to Be Inspected	Procedure
		WINCH	
44	**ANNUAL**	**CABLE**	Unwind the cable completely and inspect for kinks, frays and wear.
45	**ANNUAL**	**DOUBLER BLOCK**	 **Doubler block (1) is normally stored in the BII compartment, at the rear of the machine.** Inspect doubler block (1) for bending or cracking. Replace the doubler block if it is bent or cracked.
45A	**ANNUAL**	**CASTOR WHEEL ASSEMBLY**	 **Castor wheel assembly (1) is normally stored in the BII compartment at the rear of the machine.** Inspect castor wheel assembly (1) for loose or missing pin assembly (2), and replace if missing. Check for free rotation of the wheel at each axis (3).

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES

Initial 50–Initial 50 Hours**, Quarterly–**3 Months or 250 Hours, **Semi-annual–**6 Months or 500 Hours, **Annual–**12 Months or 1000 Hours, **Bi-annual–**24 Months or 2000 Hours

Item No.	Interval	Item to Be Inspected	Procedure
		CAB	
46	**ANNUAL**	**ROPS**	 Check the ROPS. Look for cracks or damage to structural tubing (1), and loose hardware (2) in the four corners of the cab. (Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover [DEUCE],* "Maintenance Section, Maintenance Intervals, Every 1000 Service Hours or One Year, Rollover Protection System [ROPS].")
		ENGINE	
47	**BIANNUAL**	**COOLING SYSTEM**	Change the coolant. (Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover [DEUCE],* "Maintenance Section, Maintenance Intervals, Every 2000 Service Hours or Two Years, Cooling System.")
48	**BIANNUAL**	**ENGINE VALVE CLEARANCE**	Adjust. (Refer to *Specifications Systems Operation Testing and Adjusting, Deployable Combat Universal Earthmover [DEUCE], 3100 HEUI DEUCE Engine* "Testing and Adjusting,

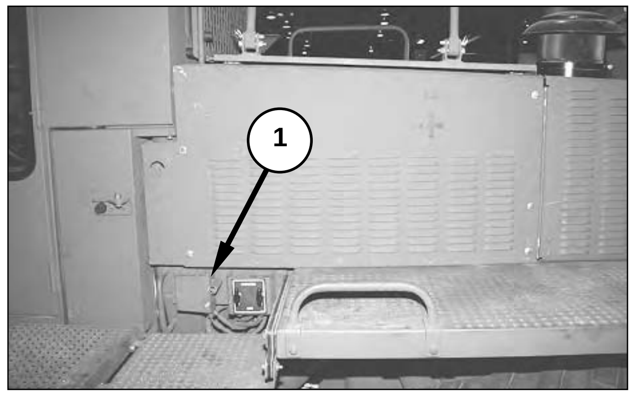
UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES

Initial 50–Initial 50 Hours**, Quarterly–**3 Months or 250 Hours, **Semi-annual–**6 Months or 500 Hours, **Annual–**12 Months or 1000 Hours, **Bi-annual–**24 Months or 2000 Hours

Item No.	Interval	Item to Be Inspected	Procedure
			Air Intake and Exhaust System, Valve Lash.”)
		POWER TRAIN/HYDRAULIC SYSTEM	
49	**BIANNUAL**	**POWER TRAIN LUBRICATION SYSTEM**	Change the oil, and clean the suction screens. (Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover [DEUCE],* “Maintenance Section, Maintenance Intervals, Every 2000 Service Hours or Two Years, Power Train.”)
		UNDERCARRIAGE	
50	**BIANNUAL**	**BRAKES**	Check the wear material thickness. (Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover [DEUCE],* “Maintenance Section, Maintenance Intervals, Every 2000 Service Hours or Two Years, Brakes.”)
		WINCH	
51	**BIANNUAL**	**WINCH**	Change the gearbox oil. (Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover [DEUCE],* “Maintenance Section, Maintenance Intervals, Every 2000 Service Hours or Two Years, Winch Gearbox.”)

UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES

Initial 50–Initial 50 Hours**, Quarterly–**3 Months or 250 Hours, **Semi-annual–**6 Months or 500 Hours, **Annual–**12 Months or 1000 Hours, **Bi-annual–**24 Months or 2000 Hours

Item No.	Interval	Item to Be Inspected	Procedure
		HYDRAULIC CONTROLS	
52	**BIANNUAL**	**CAB AND RADIATOR TILT PUMP**	 Cab and radiator tilt pump (1) is located on the left side of the machine. Change the oil. (Refer to *Periodic Maintenance and Special Operation, Deployable Universal Combat Earthmover [DEUCE],* "Maintenance Section, Maintenance Intervals, Every 2000 Service Hours or Two Years, Cab and Radiator Tilt Pump.")

TM5-2430-200-24

Specifications

Deployable Universal Combat Earthmover (DEUCE)

Appendix C: Torque Specifications

PIN: 7RR00003-Up

Important Safety Information

Most accidents involving product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “WARNING” as shown below.

The meaning of this safety alert symbol is as follows:

⚠ WARNING

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning, explaining the hazard, can be either written or pictorially presented.

Operations that may cause product damage are identified by NOTICE labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are therefore not all inclusive. If a tool, procedure, work method or operating technique not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and others. You should also ensure that the product will not be damaged or made unsafe by the operation, lubrication, maintenance or repair procedures you choose.

The information, specifications, and illustrations in this publication are on the basis of information available at the time it was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service given to the product. Obtain the complete and most current information before starting any job. Caterpillar dealers have the most current information available. For a list of the most current publication form numbers available, see the Service Manual Contents Microfiche, REG1139F.

Specifications Section

General Torque Information

WARNING

Mismatched or incorrect fasteners can result in damage, malfunction, and possibly injury.

Do not mix metric-dimensioned fasteners and inch-dimensioned fasteners.

Exceptions to these torques are given in the appropriate section of the maintenance manual.

Prior to the installation of any hardware, ensure that components are in near-new condition: bolts and threads must not be worn or damaged.; threads must not have burrs of nicks; and hardware must be free of rust and corrosion. Clean the hardware with a noncorrosive cleaner. Do not lubricate the fastener threads except, for the rust preventive. The rust preventive should be applied by the supplier of that component, in preparation for shipping and storage. Other applications for lubricating components may also be specified in the appropriate section of the maintenance manual.

Standard Torque for Metric Fasteners

Metric Nuts and Bolts	
Thread Size Metric	**Standard Torque**
M6	12 ± 3 N•m (9 ± 2 lb ft)
M8	28 ± 7 N•m (21 ± 5 lb ft)
M10	55 ± 10 N•m (41 ± 7 lb ft)
M12	100 ± 20 N•m (75 ± 15 lb ft)
M14	160 ± 30 N•m (120 ± 22 lb ft)
M16	240 ± 40 N•m (175 ± 30 lb ft)
M20	460 ± 60 N•m (340 ± 44 lb ft)
M24	800 ± 100 N•m (590 ± 75 lb ft)
M30	1600 ± 200 N•m (1180 ± 150 lb ft)
M36	2700 ± 300 N•m (2000 ± 220 lb ft)

Table 1

Metric Taperlock Studs	
Thread Size Metric	**Standard Torque**
M6	8 ± 3 N•m (6 ± 2 lb ft)
M8	17 ± 5 N•m (13 ± 4 lb ft)
M10	35 ± 5 N•m (26 ± 4 lb ft)
M12	65 ± 10 N•m (48 ± 7 lb ft)
M16	110 ± 20 N•m (80 ± 15 lb ft)
M20	170 ± 30 N•m (125 ± 22 lb ft)
M24	400 ± 60 N•m (300 ± 44 lb ft)
M30	750 ± 80 N•m (550 ± 60 lb ft)
M36	1200 ± 150 N•m (880 ± 110 lb ft)

Table 2

Standard Torque for Inch Fasteners

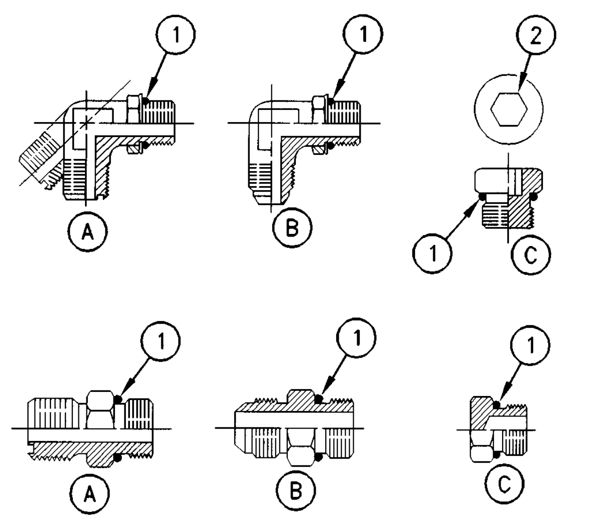
Inch Nuts and Bolts	
Thread Size Inch	**Standard Torque**
1/4	12 ± 3 N•m (9 ± 2 lb ft)
5/16	25 ± 6 N•m (18 ± 4 lb ft)
3/8	47 ± 9 N•m (35 ± 7 lb ft)
7/16	70 ± 15 N•m (50 ± 11 lb ft)
1/2	105 ± 20 N•m (75 ± 15 lb ft)
9/16	160 ± 30 N•m (120 ± 22 lb ft)
5/8	215 ± 40 N•m (160 ± 30 lb ft)
3/4	370 ± 50 N•m (275 ± 37 lb ft)
7/8	620 ± 80 N•m (460 ± 60 lb ft)
1	900 ± 100 N•m (660 ± 75 lb ft)
1 1/8	1300 ± 150 N•m (960 ± 110 lb ft)
1 1/4	1800 ± 200 N•m (1320 ± 150 lb ft)
1 3/8	2400 ± 300 N•m (1780 ± 220 lb ft)
1 1/2	3100 ± 350 N•m (2280 ± 260 lb ft)

Table 3

Inch Taperlock Studs	
Thread Size Inch	Standard Torque
1/4	8 ± 3 N•m (6 ± 2 lb ft)
5/16	17 ± 5 N•m (13 ± 4 lb ft)
3/8	35 ± 5 N•m (26 ± 4 lb ft)
7/16	45 ± 10 N•m (33 ± 7 lb ft)
1/2	65 ± 10 N•m (48 ± 7 lb ft)
5/8	110 ± 20 N•m (80 ± 15 lb ft)
3/4	170 ± 30 N•m (125 ± 22 lb ft)
7/8	260 ± 40 N•m (190 ± 30 lb ft)
1	400 ± 60 N•m (300 ± 44 lb ft)
1 1/8	525 ± 60 N•m (390 ± 44 lb ft)
1 1/4	750 ± 80 N•m (550 ± 60 lb ft)
1 3/8	950 ± 125 N•m (700 ± 90 lb ft)
1 1/2	1200 ± 150 N•m (880 ± 110 lb ft)

Table 4

Standard Torque for O-Ring Face Seal Fittings and 37-Degree Flared Fittings



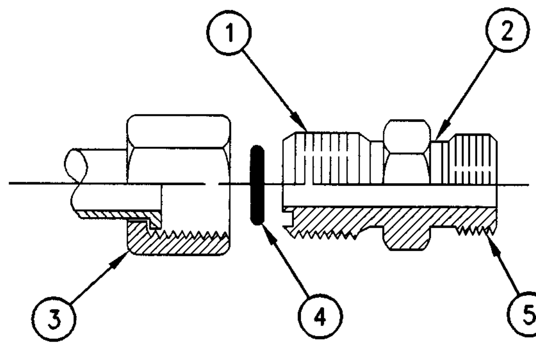
(A) O-ring face seal. (B) 37 degree flare. (C) O-ring plug with hexagon head. (1) O-ring seal. (2) Hexagon head.

Ferrous Straight Thread O-Ring Fitting Torques for Mating with Ferrous Materials		
Outer Diameter of the Nominal Tube	Thread Size Inch	Standard Torque
3.18 mm (0.125 inch)	5/16–24	5.0 ± 1.5 N•m (4 ± 1 lb ft)
4.76 mm (0.188 inch)	3/8–24	12 ± 2 N•m (16 ± 1 lb ft)
6.35 mm (0.250 inch)	7/16–20	22 ± 2 N•m (16 ± 1 lb ft)
7.94 mm (0.312 inch)	1/2–20	30 ± 3 N•m (22 ± 2 lb ft)
9.52 mm (0.375 inch)	9/16–18	48 ± 5 N•m (35 ± 4 lb ft)
12.70 mm (0.500 inch)	3/4–16	82 ± 8 N•m (60 ± 6 lb ft)
15.88 mm (0.625 inch)	7/8–14	143 ± 15 N•m (105 ± 11 lb ft)
19.05 mm (0.750 inch)	1 1/16–12	190 ± 20 N•m (140 ± 15 lb ft)
22.22 mm (0.875 inch)	1 3/16–12	250 ± 25 N•m (185 ± 18 lb ft)
25.40 mm (1.000 inch)	1 5/16–12	300 ± 30 N•m (220 ± 22 lb ft)
31.75 mm (1.250 inch)	1 5/8–12	350 ± 30 N•m (260 ± 22 lb ft)
38.10 mm (1.500 inch)	1 7/8–12	430 ± 40 N•m (320 ± 30 lb ft)
50.80 mm (2.000 inch)	2 1/2–12	450 ± 45 N•m (330 ± 33 lb ft)

Table 5

NOTE: Use 50 percent of the torque values from Table 5 when the fitting, the plug, or the port material is nonferrous.

O-Ring Face Seal Fittings



O-Ring Face Seal Fittings
(1) O-ring face seal fitting. (2) O-ring groove. (3) Nut for the O-ring face seal. (4) O-ring seal. (5) Straight thread O-ring fitting.

Ferrous Straight Thread O-Ring Fitting	
Thread Size Inch	Standard Torque
9/16–18	25 ± 3 N•m (18 ± 2 lb ft)
11/16–16	37 ± 4 N•m (27 ± 3 lb ft)
13/16–16	54 ± 5 N•m (40 ± 4 lb ft)
1–14	86 ± 8 N•m (65 ± 6 lb ft)
1 13/16–12	125 ± 15 N•m (90 ± 11 lb ft)
1 7/16–12	165 ± 15 N•m (120 ± 11 lb ft)
1 11/16–12	200 ± 20 N•m (150 ± 15 lb ft)
2–12	225 ± 20 N•m (165 ± 15 lb ft)

Table 6

Fitting Installation

The tightening sequence for the fasteners that attach a tube assembly or hose assembly to the machine is very critical to the proper function of the machine. The sealing surfaces of the tube or hose assembly should be secured squarely. The sealing surfaces of the tube or hose assembly should be tightened to the serviced component (control valve, cylinder, hydraulic motor, etc). Perform this procedure prior to the final tightening of any clamps or clips used to fasten the tube or hose assembly to the machine.

Installation of the Hydraulic Line

1. For a metal tube to hose installation, install the tube, and tighten all bolts finger tight at the rigid end.

2. Install the hose, and tighten all bolts finger tight.

3. Do not allow the hose to make contact with the machine or with another hose.

4. Tighten the bolts to the specified torque on both connections.

5. Start the engine.

6. Move the implement control levers to all of the positions.

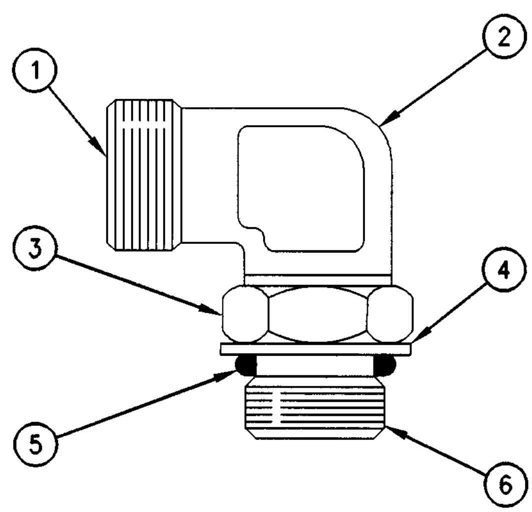
7. Look at the hose during movement of the implement. Ensure that the hose is not in contact with the machine or with other hoses.

8. Shut off the engine.

9. If necessary, put the hose in a new position so that the hose will not make contact with the machine or with other hoses when the machine implement is moved.

Assembly of Fittings with Straight Threads and O-Ring Seals

This type of fitting is used in many applications. The tube end of the fitting will vary in design so that the fitting can be used in many different applications. However, the same installation procedure can be used for each fitting. If the tube end of the fitting body and the illustration (elbow or straight body) match, assemble the sleeve on the tube before connecting the tube to the end.



Elbow Body Assembly.
(1) End of the fitting body that connects to the tube. (2) Fitting body. (3) Locknut. (4) Backup washer. (5) O-ring seal. (6) End of the fitting that goes into the other part.

1. Put locknut (3), backup washer (4) and O-ring seal (5) as far back on fitting body (2) as possible. Hold these components in this position. Turn the fitting into the part that is used for the fitting. Turn the fitting until backup washer (4) contacts the surface of the part that is used for backup washer (4).

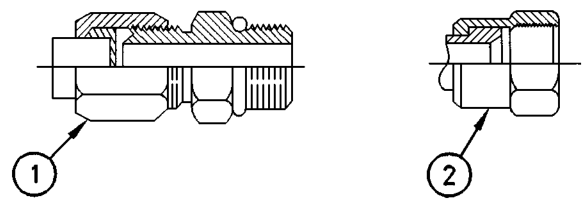
2. To put the fitting assembly in the correct position, turn fitting body (2) outward to a maximum of 360 degrees. Tighten locknut (3) to the torque shown in the correct chart for the fitting that is used.

NOTE: If the fitting is a connector (straight fitting), the hex on the body fakes the place of the locknut. To install this type of fitting, tighten the hex against the face of the part for the hex.

Torques for Flared and O-Ring Fittings

The torques shown in Tables 7 and 8 should be used on the nut of the following fittings: 37-degree flared fittings, 45-degree flared fittings, inverted flared fittings, O-ring plugs for a recessed drive, O-ring fittings for the air conditioning, and swivel nuts. The torques should be used for applications that allow the following working pressures: 7750 to 34,450 kPa (1125 to 5000 psi). The torque depends on the size and type of fitting.

37-Degree Flared Fittings



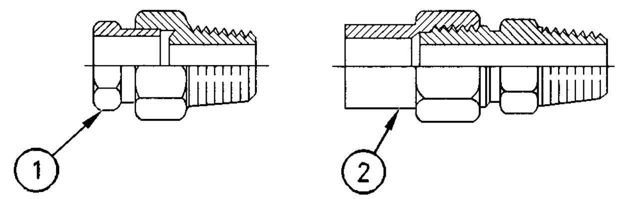
(1) 37-degree flared fitting. (2) Swivel nuts.

Nuts for 37 Degree Flared Fittings		
Outer Diameter of the Nominal Tube	**Thread Size Inch**	**Standard Torque**
3.18 mm (0.125 inch)	5/16	5.0 ± 1.5 N•m (4 ± 1 lb ft)
4.76 mm (0.188 inch)	3/8	11 ± 2 N•m (8 ± 1 lb ft)
6.35 mm (0.250 inch)	7/16	16 ± 4 N•m (12 ± 3 lb ft)
7.94 mm (0.312 inch)	1/2	20 ± 5 N•m (15 ± 4 lb ft)
9.52 mm (0.375 inch)	9/16	25 ± 5 N•m (18 ± 4 lb ft)
9.52 mm (0.375 inch)	5/8	35 ± 5 N•m (26 ± 4 lb ft)
12.70 mm (0.500 inch)	3/4	50 ± 7 N•m (37 ± 5 lb ft)
15.88 mm (0.625 inch)	7/8	65 ± 7 N•m (48 ± 5 lb ft)
19.05 mm (0.750 inch)	1 1/16	100 ± 10 N•m (75 ± 7 lb ft)
22.22 mm (0.875 inch)	1 3/16	120 ± 10 N•m (90 ± 7 lb ft)
25.40 mm (1.000 inch)	1 5/16	135 ± 15 N•m (100 ± 11 lb ft)
31.75 mm (1.250 inch)	1 5/8	180 ± 15 N•m (135 ± 11 lb ft)
38.10 mm (1.500 inch)	1 7/8	225 ± 15 N•m (165 ± 11 lb ft)
50.80 mm (2.000 inch)	2 1/2	320 ± 30 N•m (240 ± 22 lb ft)

Table 7

NOTE: Use 50 percent of the torque values from Table 7 when the fitting, the plug, or the port material is nonferrous.

45-Degree Flared and 45-Degree Inverted Flare Fittings

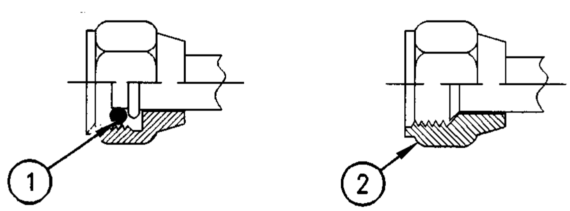


(1) 45-degree inverted flared fittings. (2) 45-degree flared fittings.

45 Degree Flared Fittings and 45 Degree Inverted Flare Fittings		
Outer Diameter of the Nominal Tube	**Thread Size Inch**	**Standard Torque**
3.18 mm (0.125 inch)	5/16	5.0 ± 1.5 N•m (4 ± 1 lb ft)
4.76 mm (0.188 inch)	3/8	8.0 ± 1.5 N•m (6 ± 1 lb ft)
6.35 mm (0.250 inch)	7/16	11 ± 2 N•m (8 ± 1 lb ft)
7.94 mm (0.312 inch)	1/2	17 ± 3 N•m (13 ± 2 lb ft)
9.52 mm (0.375 inch)	5/8	30 ± 3 N•m (22 ± 2 lb ft)
11.11 mm (0.438 inch)	11/16	30 ± 3 N•m (22 ± 2 lb ft)
12.70 mm (0.500 inch)	3/4	38 ± 4 N•m (28 ± 3 lb ft)
15.88 mm (0.625 inch)	7/8	50 ± 5 N•m (37 ± 4 lb ft)
19.05 mm (0.750 inch)	1 1/16	90 ± 8 N•m (65 ± 6 lb ft)
22.22 mm (0.875 inch)	1 1/4	100 ± 10 N•m (75 ± 7 lb ft)

Table 8

Air-Conditioning Fittings



(1) O-ring seal. (2) 45-degree flare fitting.

Metric Nuts and Bolts			
O-Ring Fitting End		45 Degree Flare Fitting End	
Thread Size Inch	Standard Torque	Steel Tubes Standard Torque	Aluminum Tubes Standard Torque
5/8–18	14 ± 4 N•m (10 ± 3 lb ft)	30 ± 3 N•m (22 ± 2 lb ft)	23 ± 3 N•m (17 ± 2 lb ft)
3/4–16	27 ± 4 N•m (20 ± 3 lb ft)	52 ± 5 N•m (38 ± 4 lb ft)	33 ± 4 N•m (24 ± 4 lb ft)
7/8–14	40 ± 4 N•m (30 ± 3 lb ft)	60 ± 7 N•m (44 ± 5 lb ft)	38 ± 4 N•m (28 ± 3 lb ft)
1 1/16–14	45 ± 5 N•m (33 ± 4 lb ft)	75 ± 8 N•m (55 ± 6 lb ft)	50 ± 5 N•m (37 ± 4 lb ft)

Table 9

Tapered Pipe Thread Fittings

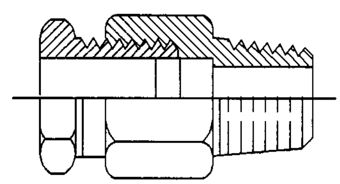
Tapered Pipe Thread Fittings		
Thread Size of the Pipe Inch	Standard Torque	
	Threads with 5P-3413 Pipe Sealant	Threads without Pipe Sealant
1/16–27	10 N•m (7 lb ft)	10 N•m (7 lb ft)
1/8–27	16 N•m (12 lb ft)	16 N•m (12 lb ft)
1/4–18	20 N•m (15 lb ft)	25 N•m (18 lb ft)
3/8–18	35 N•m (26 lb ft)	45 N•m (33 lb ft)
1/2–14	45 N•m (33 lb ft)	60 N•m (44 lb ft)
3/4–14	60 N•m (44 lb ft)	75 N•m (55 lb ft)
1–11 1/2	75 N•m (55 lb ft)	90 N•m (65 lb ft)
1 1/4–11 1/2	90 N•m (65 lb ft)	110 N•m (80 lb ft)
1 1/2–11 1/2	110 N•m (80 lb ft)	130 N•m (95 lb ft)
2–11 1/2	130 N•m (95 lb ft)	160 N•m (120 lb ft)

Table 10

NOTE: Use 50 percent of the torque values from Table 10 when the fitting, the plug, or the port material is nonferrous.

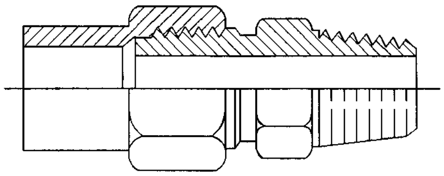
Tightening Other Fittings

Hi Duty Tube Fittings (Shear Sleeve)



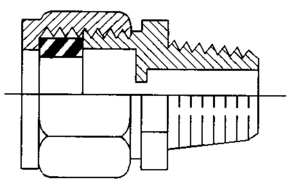
After the tube has been put through the nut, and after the tube makes contact against the tube shoulder in the fitting body, turn the nut with a wrench until a small decrease in torque is felt. The small decrease in torque indicates that the sleeve has been broken off of the nut. Hold the tube in order to prevent the tube from turning. Tighten the nut for an additional one and a half turns.

Hi Seal Fittings



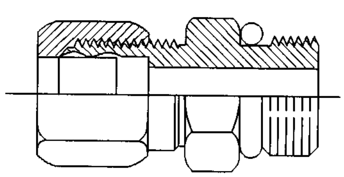
Put the nut and sleeve over the tubing so that the short and heavy end of the sleeve is facing the end of the tubing. Put the tube end against the counterbore in the body of the fitting, and tighten the nut until the nut is over the last thread on the body. The remainder of the space is used whenever the fitting is removed and installed again.

Nonflared Tube Fittings



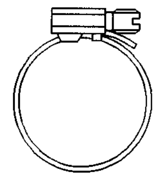
Put the nut and the sleeve over the tube. The head of the sleeve or the shoulder end of the sleeve should be next to the nut. Push the tube into the counterbore of the fitting body as far as possible. Turn the nut clockwise until the sleeve holds the tube and until the sleeve prevents the tube from moving. Tighten the nut an additional one and one-quarter turns. The sleeve should be seated and should give a locking action. When it is necessary to assemble the tube fitting again, put the sleeve over the tube and tighten the nut until a sudden increase in torque is felt. Next, tighten the fitting an additional one-sixth to one-third turn in order to seat the sleeve.

Flex Fittings



Put the nut and sleeve over the tubing, and push the tube into the counterbore of the fitting body as far as possible. Tighten the nut until the nut is against the hex part of the fitting body.

Torques for Standard Hose Clamps–Worm Drive Band Type

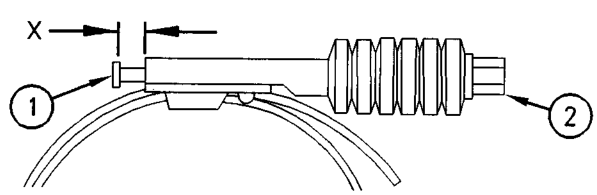


Torque for Constant Torque Hose Clamps

Width of Clamp	Initial Installation Torque on New Hose
7.9 mm (.31 inch)	0.9 ± 0.2 N•m (8 ± 2 lb ft)
13.5 mm (.53 inch)	4.5 ± 0.5 N•m (40 ± 4 lb ft)
15.9 mm (.63 inch)	7.5 ± 0.5 N•m (65 ± 4 lb ft)
Width of Clamp	**Reassembly or Retightening Torque**
7.9 mm (.31 inch)	0.7 ± 0.2 N•m (6 ± 2 lb ft)
13.5 mm (.53 inch)	3.0 ± 0.5 N•m (27 ± 4 lb ft)
15.9 mm (.63 inch)	4.5 ± 0.5 N•m (40 ± 4 lb ft)

Table 11

Use a constant torque hose clamp in place of any standard hose clamp. Ensure that the constant torque hose clamp is the same size as the standard hose clamp. Due to extreme temperature changes, the hose will heat set. Heat setting can cause hose clamps to loosen. Loose hose clamps can result in leaks. There have been reports of component failures that have been caused by hose clamps that have loosened. The constant torque hose clamp will help prevent these failures.



Use a torque wrench properly install the constant torque hose clamps. The constant torque hose clamp is installed correctly under the following conditions:

Screw tip (1) extends 6.35 mm (0.250 in) (X) beyond the housing.

The belleville washers are collapsed nearly flat after screw (2) is tightened to a torque of 11 ± 1 N•m (98 ± 9 lb in).

Electronic Troubleshooting

Deployable Universal Combat Earthmover (DEUCE)

Appendix D: 3100 HEUI DEUCE Engine

PIN: 7RR00003-Up

Important Safety Information

Most accidents involving product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “WARNING” as shown below.

The meaning of this safety alert symbol is as follows:

WARNING

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning, explaining the hazard, can be either written or pictorially presented.

Operations that may cause product damage are identified by NOTICE labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are therefore not all inclusive. If a tool, procedure, work method or operating technique not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and others. You should also ensure that the product will not be damaged or made unsafe by the operation, lubrication, maintenance or repair procedures you choose.

The information, specifications, and illustrations in this publication are on the basis of information available at the time it was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service given to the product. Obtain the complete and most current information before starting any job. Caterpillar dealers have the most current information available. For a list of the most current publication form numbers available, see the Service Manual Contents Microfiche, REG1139F.

The Diagnostic Process

GATHER INFORMATION

- Talk to driver directly, if possible. Fill out "PA-10: Operator Questionnaire" on page 23.
- Compare operator's response from the Questionnaire to "PA-11: Questionnaire Response" on page 24.
- What exactly are the symptoms?
- When did the symptoms begin?
- Under what conditions does the problem occur?
- Check the repair history of vehicle.
- What happened, in what order (be specific)?

VERIFY OPERATIONAL PROBLEM

- Is the engine performing as expected (refer to System Operation description)?
- When possible, repeat conditions to repeat problem.

DETERMINE PROBABLE CAUSES

- Repair any ACTIVE Diagnostic Codes first using the procedures in this manual.
- What subsystem could cause the problem?
- What subsystem does the manual suggest?

NARROW LIST OF CAUSES

- Use driver information gathered above.
- Check LOGGED Diagnostic Codes.
- If more than one symptom, are there common causes?
- AVOID PRE-CONCEIVED IDEAS!

TEST SUBSYSTEM 1.

2.

3.

4.

- Use procedure in manual.
- **Connector checks are extremely important, check every pin, socket, and wire.**

P-1.0 Electronic System Overview

System Operation

The Engine has a Hydraulic Electronic Unit Injector fuel system. The injection pump, fuel lines and nozzles required for fuel injection in mechanical Caterpillar engines have been replaced with a hydraulic electronic unit injector in each cylinder. Some mechanical drive components, cam lobes, lifter, push rod, and rocker arms required for fuel injection in mechanical or Electronic Unit Injector Caterpillar engines have been replaced with a high pressure oil system.

A solenoid on each injector controls the amount of fuel delivered by the injector. A gear-driven pump raises the normal engine operating oil pressure to injector actuation pressure levels required by the injectors. An Electronic Control Module (ECM) sends a signal to the injection actuation pressure control valve to control injection pressure, and another signal to each injector solenoid to inject fuel.

Electronic Controls

The Engine electronic system consists of the Electronic Control Module (ECM), Engine Sensors, Injection Actuation Pressure Control Valve, and Vehicle Interface. The ECM is the computer which controls the 3126 HEUI engine. The Personality Module in the ECM contains the software which controls how the ECM behaves (the personality module stores the operating maps that define power rating, torque curves, rpm, etc).

Engine Governor

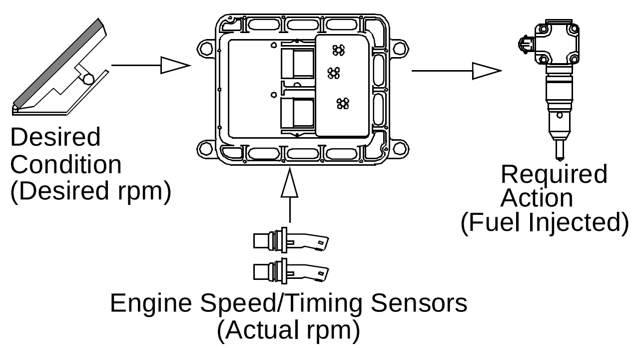
The Electronic Control system on the engine serves as the engine governor. The Electronic Control system determines when and how much fuel to deliver to the cylinders, as well as injection pressure based on the actual and desired conditions at any given time during starting and operation.

Basic Governor

The basic governor operation considers the desired and actual conditions, and then takes action to best accommodate the desired conditions.

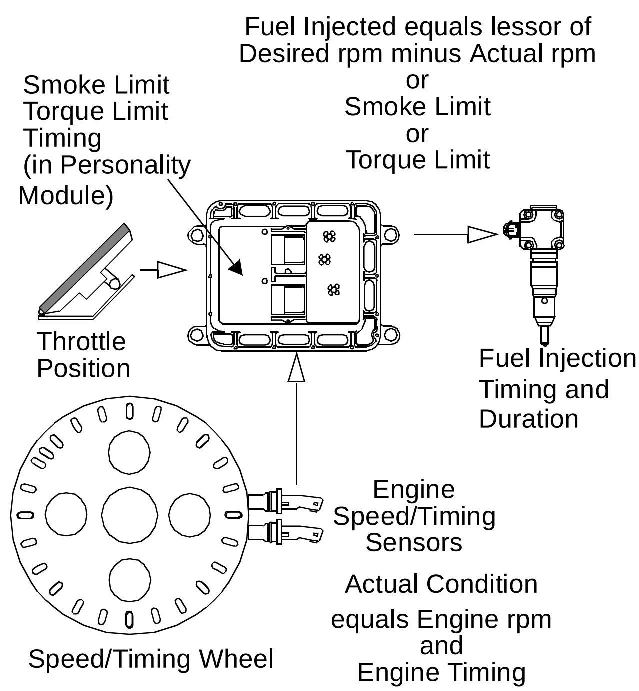
The desired conditions are typically the position of the accelerator pedal, or desired engine rpm when in Engine Speed Switch control. The actual conditions are based on current operating conditions such as coolant temperature, load conditions, etc.

Desired rpm minus Actual rpm equals Fuel Injected



Timing Considerations

Once the ECM has determined how much fuel is required, it must next determine when to inject the fuel. Injection timing is determined by the ECM after considering input from the coolant temperature sensor, inlet manifold air temperature sensor, and boost pressure sensor.



The ECM knows the cylinder position for timing because of the signal from the Engine Speed/Timing Sensors. The ECM adjusts timing for best engine performance, fuel economy and white smoke control. Actual and Desired Timing cannot be viewed with Caterpillar Electronic Technician (ET).

The ECM knows where top center on cylinder #1 is from the signal provided by a unique pattern positioned on the Speed/Timing Wheel. The ECM decides when injection should occur relative to top center and provides the signal to the injector at the desired time.

Fuel Injection

The ECM controls the amount of fuel injected by varying signals to the injectors. The injectors will pump fuel only if the injector solenoid is energized. The ECM sends a high voltage signal to energize the solenoid. The energized solenoid lifts the poppet off its seat, closing the oil path to drain and opening the inlet for the high pressure oil. The high pressure oil enters the injector and acts on an intensifier piston, increasing the pressure and injecting fuel. By controlling the timing and duration of the high voltage signal, the ECM can control injection timing and the amount of fuel injected.

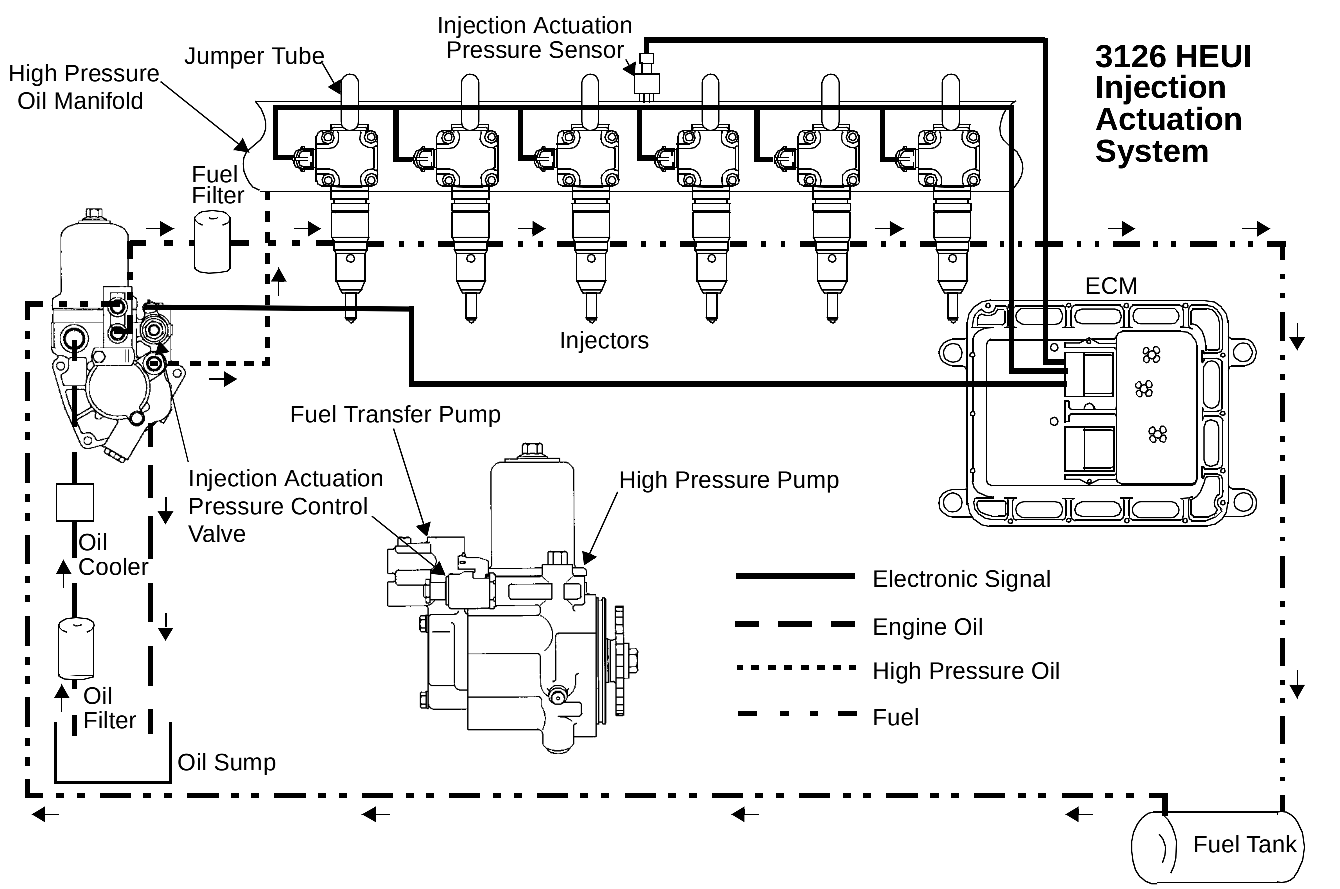
The ECM also controls the pressure of the fuel injected into the cylinder by controlling the injection actuation pressure control valve. The injection actuation pressure control valve is a dump valve closely controlling the output pressure of the high pressure oil pump.

The Personality Module inside the ECM sets certain limits on the amount of fuel that can be injected. **FRC Fuel Pos** is a limit based on boost pressure to control the air/fuel ratio for emissions control. When the ECM senses a higher boost pressure (more air into cylinder), it increases the **FRC Fuel Pos** limit (allows more fuel into cylinder).

Rated Fuel Pos is a limit based on the power rating of the engine and rpm. It is similar to the rack stops and torque spring on a mechanically governed engine. It provides power and torque curves for a specific engine family and rating. All of these limits are determined at the factory in the Personality Module and cannot be changed in the field. Injection timing depends on engine rpm, load and other operating factors.

Injection Actuation Pressure System

The ECM controls fuel injection by controlling oil. The pressure of the oil in the high pressure oil manifold is controlled by the ECM through control of the injection actuation pressure control valve. The injection actuation pressure control valve (dump valve) controls the high pressure pump outlet pressure by dumping excess flow back to the oil sump.



The ECM monitors the pressure in the high pressure manifold through the injection actuation pressure sensor. The injection actuation pressure sensor is located in the top of the manifold on the left side of the engine. The injection actuation pressure sensor signal (**Inj Act Pr**) is compared by the ECM to the desired injection actuation pressure (**Des Inj Act Pr**). The ECM determines the **Des Inj Act Pr** based on several inputs and changes the position of the injection actuation pressure control valve (**Inj Act Output**) to adjust the oil pressure in the high pressure manifold.

High pressure oil is routed from the pump to the high pressure manifold through a steel tube. From the manifold the oil is routed to each injector through short jumper tubes. All injectors have a constant supply of oil while the engine is running. Cutting out an injector disables the electrical signal to the injector solenoid, but does not interrupt the oil flow to the injector.

Self-Diagnostics

The electronic system has some ability to diagnose itself. When a problem is detected, a diagnostic code is generated and the Check Engine Lamp is turned ON. In most cases, the code is also stored in permanent memory (Logged) in the ECM.

When diagnostic codes occur, they are called **Active**. They indicate a problem of some kind currently exists. They should always be serviced first. If an engine has an Active Code, find the code in the front of this manual and proceed to the indicated page to diagnose the cause.

Diagnostic codes stored in memory are **Logged**. Since the problem may have been temporary or may have been repaired since the time it was logged, logged codes do not necessarily mean something needs to be repaired. They are instead meant to be an indicator of probable causes for intermittent problems.

Some of the codes require passwords to clear. Codes not requiring passwords to clear are automatically deleted from memory after 50 ECM operating hours.

Diagnostic Codes Effect on Engine Performance

This manual contains a table listing all of the **PID-FMI Diagnostic** codes, along with the page number where details regarding the cause, performance affect, and troubleshooting of the code can be located.

The table on “PA-12: Possible Performance Effect of Active Diagnostic Codes” on page D-25 lists all 3126 HEUI Diagnostic Codes, and whether each code may or may not affect engine performance.

Diagnostic Codes are provided to indicate an electrical or electronic problem has been detected by the ECM. In some cases the engine performance can be affected when the condition causing the code exists. More frequently, however, the operator cannot detect any difference in the engine performance.

If the operator indicates a performance problem occurs whenever the Check Engine Lamp is flashing, one of the Diagnostic Codes may be the cause of the problem, and should be corrected.

If the operator does not indicate a problem with the engine performance and a Diagnostic Code is logged by the ECM, it indicates the ECM detected an abnormal condition, but it did not affect performance.

If this is the case, unless there are several occurrences of the specific diagnostic code in a very short period of time, or the ECM is indicating the problem exists at the present time, there is most likely nothing wrong with the electronic system.

Event Codes are provided to indicate operational problem has been detected in the engine by the ECM. This usually does not indicate an electronic malfunction. Event codes typically are not an indication of an electronic system problem.

Lifetime Totals Stored In The ECM

The ECM maintains engine total data for the following parameters.

Total Time is engine running hours (it does not include time when the ECM is powered ON without the engine running).

Total Fuel indicates the number of gallons consumed over the life of the engine.

Programmable Parameters

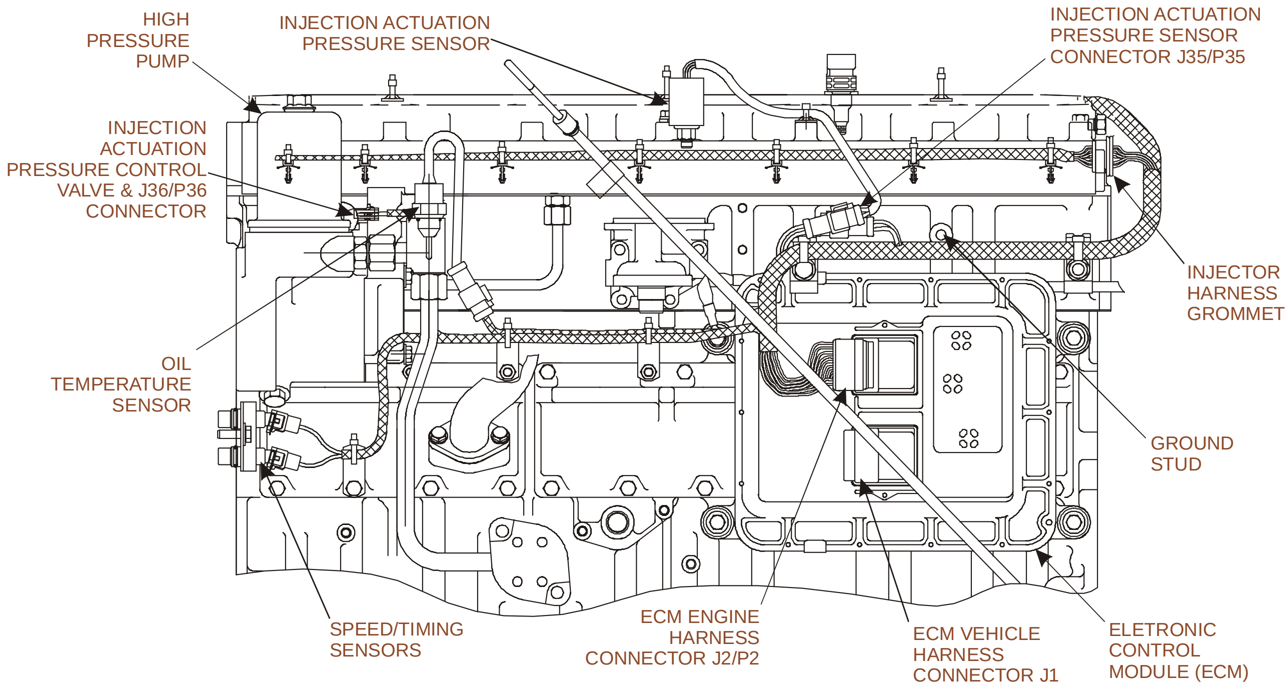
Certain parameters that affect engine operation may be changed with Caterpillar ET. The parameters are stored in the ECM, and are protected from unauthorized changes by passwords. These parameters are “System Configuration Parameters”. **System Configuration Parameters** are set at the factory and affect emissions or power ratings within a family of engines. Factory Passwords must be obtained and used to change System Configuration Parameters.

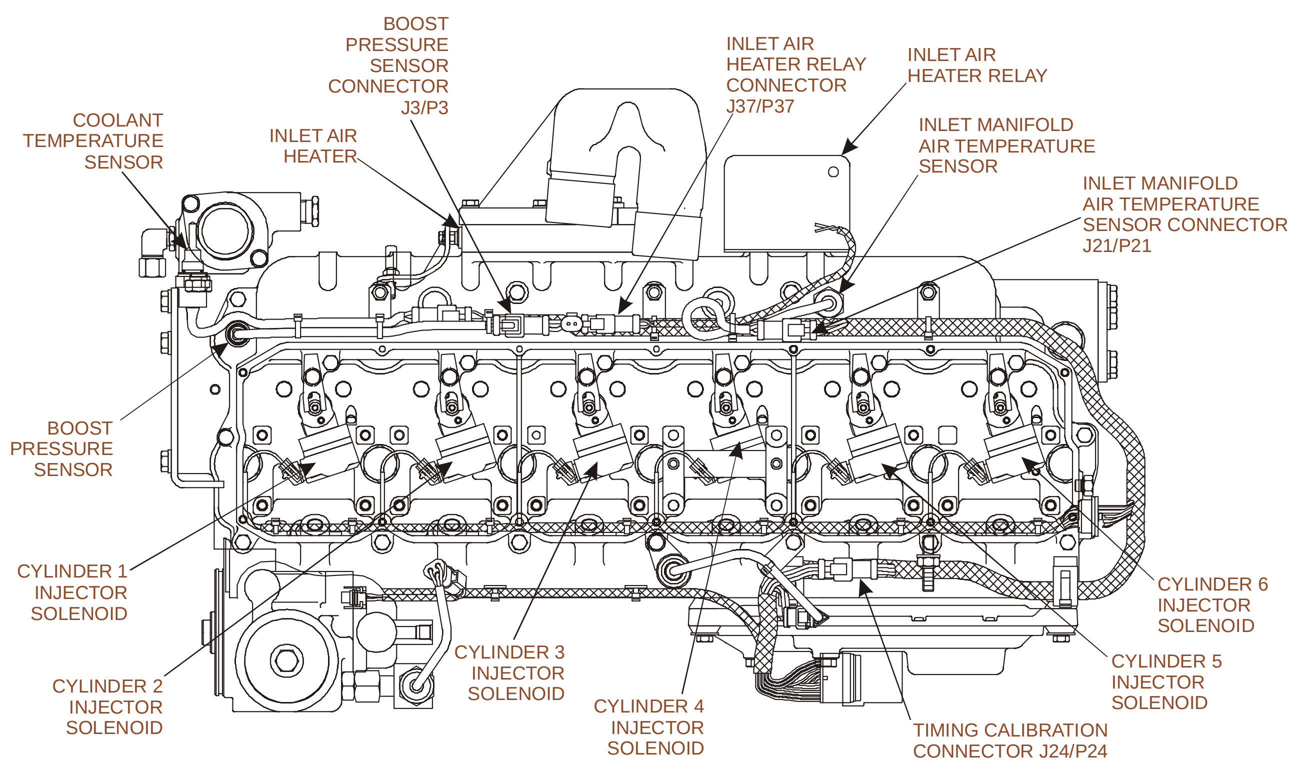
Passwords

System Configuration Parameters are protected by **Factory Passwords**. Factory passwords are calculated on a computer system available only to Caterpillar dealers. Since factory passwords contain alphabetic characters, only an ECAP or Caterpillar Electronic Technician may change System Configuration Parameters. System Configuration Parameters affect power family or emissions.

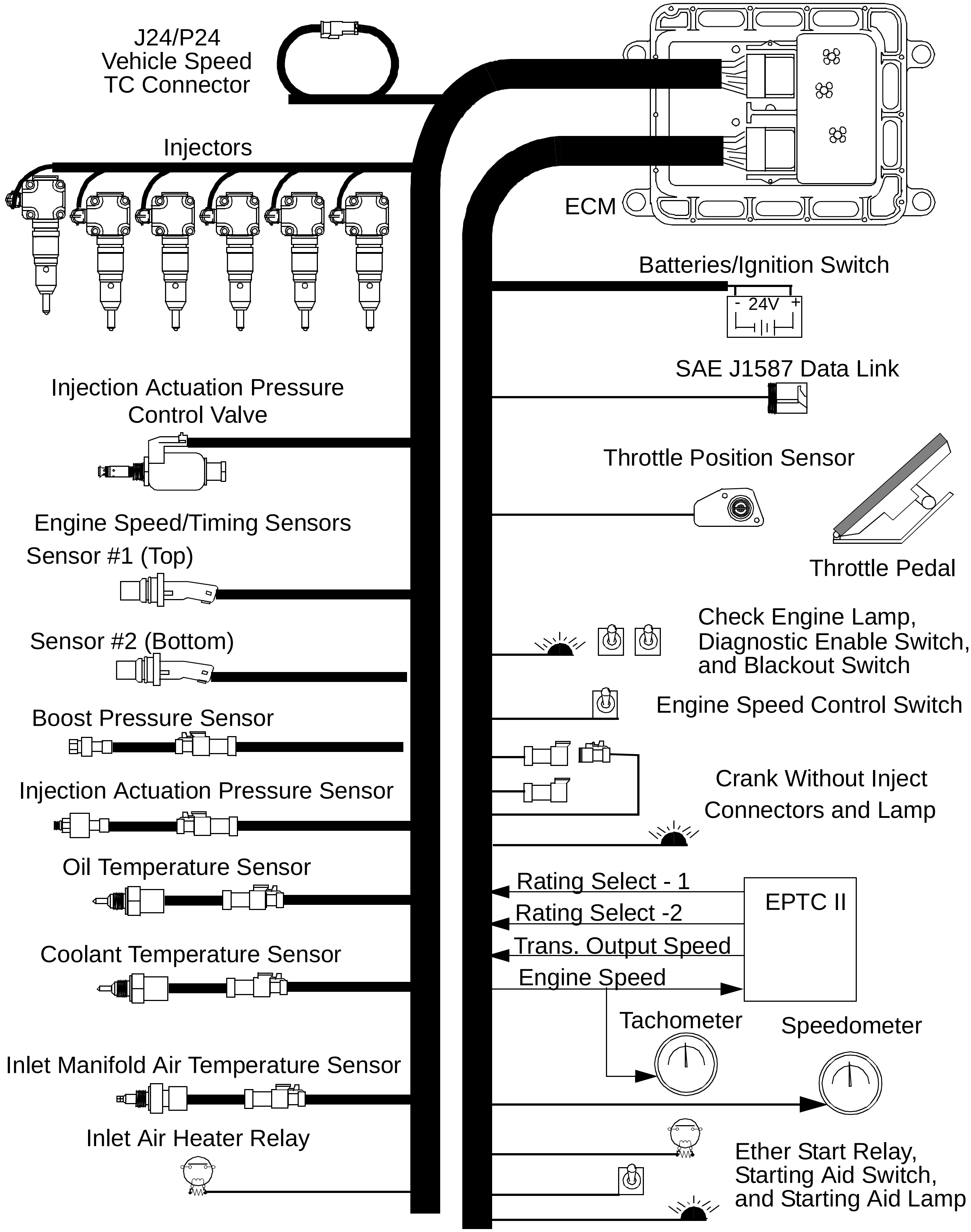
See section “P-2.0 Programming Parameters” on page D-13, for more details when passwords are needed and how to obtain them.

3126 HEUI Sensor and Connector Locations





Engine Electronic System Component Diagram



Electrical Connectors and Functions

Electrical Connectors and Functions

J/P No.	Function
J1/P1	ECM Connector (40-pin, OEM Harness Connector)
J2/P2	ECM Connector (40-pin, Engine Harness Connector)
J3/P3	Boost Pressure Sensor Connector (3-pin)
J4/P4	Engine Speed/Timing Sensor #2 Connector (2-pin)
J9/P9	Engine Speed/Timing Sensor #1 Connector (2-pin)
J10/P10	Coolant Temp Sensor Connector (3-pin)
J11/P11	Throttle Position Sensor Connector (3-pin)
J21/P21	Inlet Manifold Air Temperature Sensor Connector (3-pin)
J24/P24	Vehicle Speed/TC Connector (2-pin)
J29/P29	Injector Solenoid Cylinder #1 Connector (2-pin)
J30/P30	Injector Solenoid Cylinder #2 Connector (2-pin)
J31/P31	Injector Solenoid Cylinder #3 Connector (2-pin)
J32/P32	Injector Solenoid Cylinder #4 Connector (2-pin)
J33/P33	Injector Solenoid Cylinder #5 Connector (2-pin)
J34/P34	Injector Solenoid Cylinder #6 Connector (2-pin)
J35/P35	Injection Actuation Pressure Sensor Connector (3-pin)
J36/P36	Injection Actuation Pressure Control Valve Connector (2-pin)
J37/P37	Inlet Air Heater Relay Connector (2-pin)
J40/P40	Starting Aid Solenoid Connector (2-pin)
J42/P42	Crank Without Inject Connector
J51/P51	Oil Temperature Sensor Connector

Service Tools

Caterpillar Electronic Technician (ET) is designed to help the service technician analyze and locate faults or problems within the system. It is required to perform some sensor calibrations electronically, and to read or change engine parameters. ET requires a personal computer with the ET software installed and a Caterpillar Communication Adapter to translate from the Vehicle ATA Data Link to the computer RS-232 port.

ET communicates with the 3126 HEUI Electronic Control Module to read Diagnostic Codes, to read the various sensor output signals such as engine rpm, and controls electronic calibration of the 3126 HEUI sensors through the ECM.

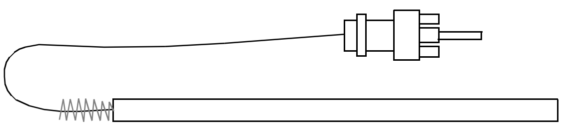
There are several adapter cables, Breakout T cables, probes, etc, that are used with the service tools in order to access measurements of signals. A multimeter that is capable of measuring voltage, resistance, and Duty Cycle (such as the 9U7330) is also required. Other Special Tools include those needed to measure pressure or temperature.

3126 HEUI Service Tools

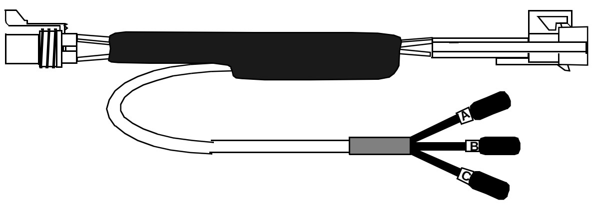
Part No.	Description
	IBM PC Compatible - Minimum- 486 33 MHz SL or SXL processor or greater, 8 Mb RAM, 70 Mb of available hard disk space, VGA monitor or display, CD-ROM, 3.5 in 1.44 Mb diskette drive, Windows 3.1 or greater, Windows NT, Windows 95 or IBM OS/2 Warp 3.0 or greater, RS232 port with 16550AF UART, Built in pointing device or mouse. Recommended- 133 MHz processor, 24 Mb RAM, 1Gb of available hard disk space, Super VGA monitor or display, 4X CD-ROM, 3.5 in 1.44 Mb diskette drive, Windows NT, Windows 95 or IBM OS/2 Warp 3.0 or greater, RS232 port with 16550AF UART, Built in pointing device or mouse.
JERD2129	All Engine and Machine Data CAT ET Subscription
1714400	Communication Adapter
NEXG4523	Communication Adapter Software SPM Version 1.2
7X1425	RS232 Cable- Connects PC to Communication Adapter
139-4166	Connector Cable- Connects ECM to Communication Adapter
1U5805	Pin Removal Tool (14 AWG wire) used for removing pins and sockets from Deutsch Connectors
8T5318	Pin Removal Tool (16 & 18 AWG wire) used for removing pins and sockets from Deutsch Connectors
9U7330	Fluke Digital Multimeter

Part No.	Description
1753700	DT Connector Service Kit
1U5804	Crimp tool for Deutsch pin and socket terminals
7X6370	3-Pin DT Breakout T. Breakout T harness is inserted in series between a 3126 HEUI harness jack and plug to permit voltage measurement on an operating system
124-5643	3-Pin Packard Connector Breakout T
7X1715	40-Pin AEC Square Breakout T
122-8842	Injector Actuation Pressure Control Valve Connector Harness Section. Used to connect to the IAPCV for resistance measurement and as a harness bypass or replacement
122-8840	Engine Speed Timing Sensors Harness Section. Used to connect to the Engine Speed Timing Sensors for resistance measurement and as a harness bypass or replacement
7X1710	Signal Reading Probes
6V2197	Engine Timing Probe
7X1171	Timing Probe Adapter
7X1695	Deutsch DT Timing Probe Cable
5P7277	Voltage Test Lamp
9U5103	Slotted Socket for Coolant Temperature Sensor Removal
9S9082	Turning Tool permits turning engine by hand
6V9130	Temperature Adapter Group
125-2589	Injection Actuation Pressure Sensor T Diagnostic Fitting. Used to check actual high pressure manifold pressure compared to the sensor reading. Allows connection of the sensor and the 8T0852 Pressure Gauge to the high pressure manifold
9S8007	#3 Straight Thread O-ring Plug. Used to plug unused port of 125-2589 Injection Actuation Pressure Sensor T Diagnostic Fitting

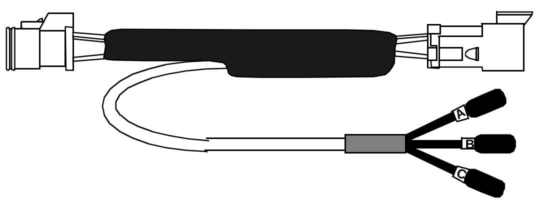
Part No.	Description
7J0204	#3 Plug O-ring Seal. Used to plug unused port of 125-2589 Injection Actuation Pressure Sensor T Diagnostic Fitting.
3J7352	#4 Straight Thread O-ring to #4 JIC Connector. Used to connect to hose coupling of 8T0852 Pressure Gauge.
3J7354	#4 O-ring Seal. Used to connect to hose coupling of 8T-0852 Pressure Gauge.
8T0852	Pressure Gauge (0-5800 psi, 0-40000 kPa). Used to measure the injection actuation pressure in the high pressure oil manifold, and output of the high pressure pump.
8S7169	1/4 NPTF (gauge to bushing) Coupling. Connects to 8T-0852 Pressure Gauge.
3B6768	1/4 X 1/8 NPTF (coupling to hose assembly for 8T-0852 Pressure Gauge) Bushing.
1U5757	Diagnostic Hose Assembly for 8T-0852 Pressure Gauge.
8C7310	#6 O-ring Face Seal Female to #6 JIC Male Connector
5P5008	#6 JIC Female to #4 JIC Male Connector
6V9508	#6 O-ring Face Seal Plug (plug off line to manifold)
6V8397	#6 O-ring Face Seal Plug O-ring Seal
7J0204	#3 Plug O-ring Seal. Used to plug unused port of 125-2589 Injection Actuation Pressure Sensor T Diagnostic Fitting.
3J7352	#4 Straight Thread O-ring to #4 JIC Connector. Used to connect to hose coupling of 8T0852 Pressure Gauge.
3J7354	#4 O-ring Seal. Used to connect to hose coupling of 8T-0852 Pressure Gauge.



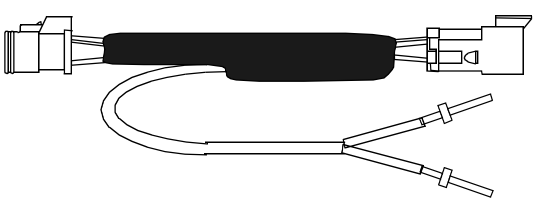
6V2197 Timing (TC) Probe



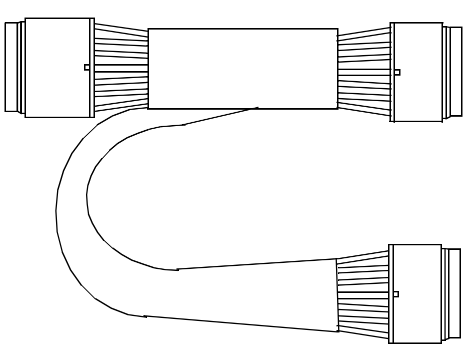
124-5643 3-Pin Packard Breakout T



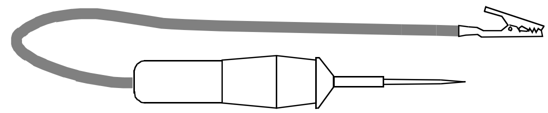
7X6370 3-Pin DT Breakout T



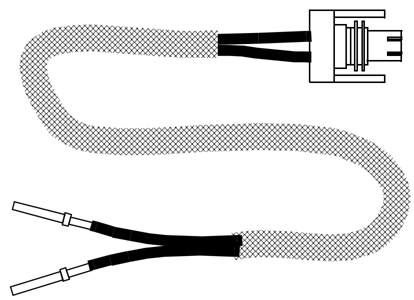
125-3662 Engine Sensor Harness Bypass



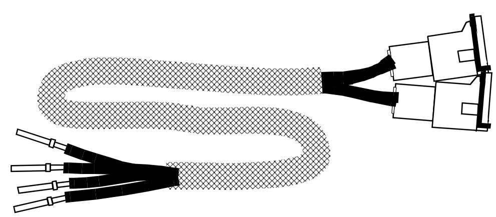
7X1715 40-Pin Square Breakout T



5P7277 Voltage Test Lamp



122-8842 Injector Actuation Pressure Control Valve Connector Harness Section



122-8840 Engine Speed Timing Harness Section Sensors

P-2.0 Programming Parameters

Certain programmable parameters affect engine operation. These parameters may be changed using Electronic Technician (ET). The parameters are stored in the ECM, not the Personality Module. Any parameter can be read. However, passwords protect parameters from unauthorized changes.
System Configuration Parameters can be altered only with the proper **factory passwords** using ET.

NOTE: For details on how to read and change parameters using ET, refer to the Caterpillar Electronic Technician Getting Started Manual, included with the software.

Connecting Electronic Technician (ET)

The Communications Adapter is powered by 24 volts DC from the machine batteries. This permits operation near the engine compartment or in the cab, to obtain readings during machine operation.
Use the following procedure to connect the service tool to the engine.

1. Turn the ignition switch to the OFF position. If the keyswitch is not placed in the OFF position, the engine may start and run.
2. Connect the 139-4166 cable between the Cab Data Link Connector and the Communication Adapter CONTROL connector.
3. Connect the 7X1425 cable between the laptop RS232 serial port and the Communication Adapter SERVICE TOOL connector.
4. Turn the ignition switch to the ON position to begin testing. The Service Tool will operate with the engine running, or with the engine OFF, ignition key ON. If the Tool does not communicate with the ECM, refer to “PB-21: ATA (SAE J1587/1708) Data Link Test” on page D-89.

NOTE: The Service Tool may restart during engine cranking due to a voltage dip on the battery line.

System Configuration Parameters

System Configuration Parameters affect emissions or rated power of the engine. They are programmed at the factory and would normally never need to be changed through the life of the engine. System Configuration Parameters **must** be reprogrammed if an ECM is replaced, but not if the Personality Module is replaced (unless the engine rating changes). Proper values for these parameters are stamped on the Engine Information Plate, located on the valve cover or intake manifold. **Factory Passwords** are required to change these parameters. The following is a description of the System Configuration Parameters.

Full Load Setting

Number representing fuel system adjustment made at the factory to “fine tune” the fuel system. The correct value for this parameter is stamped on the Engine Information Plate. A new ECM must have this parameter programmed to avoid generating a Diagnostic Code 253-02 Check Customer Or System Parameters (56).

Full Torque Setting

Similar to Full Load Setting. This parameter must be programmed or a Diagnostic Code 253-02 Check Customer Or System Parameters (56) will be generated.

Personality Module Code

This code prevents use of incorrect personality module for this engine. Each power rating family and emission certification has a different code associated with it. When a personality module is replaced, this code (stored in the ECM) **must** match the one in the introduced personality module or the engine will only operate at low idle and a Diagnostic Code 253-02 Check Customer Or System Parameters (56) will be generated.
When rerating the engine, programming this code to “0” will prompt the ECM to read and match its stored code to the Personality Module Code. This code **does not** need to be programmed when a personality module is replaced, as long as the new module is of the same family and emission year.
If the Personality Module is of a different family, then pistons, injectors, etc may need to be changed and the Engine Information Plate must also be changed to reflect the new rating.

Engine Serial Number

This number should be programmed to match the engine serial number stamped on the Engine Information Plate. A new ECM is delivered with the engine serial number programmed to 0XX00000.

Programming a New ECM

The Electronic Control Module (ECM) is the center of the electronic control system. When a problem occurs, it is easy to jump to the conclusion that the ECM is responsible. That is usually the wrong conclusion.

Most failures occur at a sensor input/output, or in the wiring and connectors. Follow the troubleshooting procedures in this manual, and do not replace an ECM on speculation!

However, when troubleshooting indicates that a failure has, in fact, occurred in the ECM, the following procedure outlines the steps required to replace a faulty ECM.

ECM Replacement Procedure

1. Ensure the new ECM repairs the problem by first temporarily installing the new ECM. Do this by hanging it on the side of the engine. Flash Program the same Personality Module from the suspect ECM to the new ECM. Program any parameters necessary to check the ECM for the test. Program the parameters exactly the same as they were in the suspect ECM. Check out the new ECM. If it repairs the problem, reconnect the old ECM using the same Personality Module as the new ECM. Recheck the old ECM to verify the problem stays with the ECM.

NOTE: If an ECM replacement is required, the ECM parameters and timing calibration can be transferred from the suspect ECM to the replacement ECM. Timing calibration will NOT be necessary. This feature requires Caterpillar Electronic Technician (ET) and is only possible if the existing ECM can communicate with Caterpillar Electronic Technician (ET).

2. Record ECM lifetime Totals.

- Record Total Time and Total Fuel Data.

3. Replace the faulty ECM, temporarily connect the new one by connecting both ECM Connectors. Do not mount the ECM to the engine until the timing calibration has been performed.

4. Flash program the Personality Module into the new ECM (if not already installed). **The new ECM is shipped with a blank Personality Module.**

5. Obtain Factory Passwords.

- Using the Factory Passwords Worksheet (in this section), record the following information from the Engine Information Plate: Full Load Setting, Full Torque Setting, Engine Serial Number.
- Use ET to access “Read/Change System Configuration Parameters”. When the Factory Specified Passwords screen appears, record the following information, ECM serial number, Engine serial number, ET serial number, Total Tattletale, and Reason Code.

- Leave ET on the Factory Specified Passwords screen and obtain the Factory Passwords. Fill out the “Factory Passwords Worksheet” on page D-21.

NOTE: Full Load Setting (FLS), Full Torque Setting (FTS) and engine serial number can be programmed without factory passwords on a new ECM.

6. Program the new ECM.

NOTE: On initial powerup of a new ECM, certain parameters must be programmed to avoid a 253-02 Check Customer Or System Parameters (56) Diagnostic Code. These parameters are Full Load Setting (FLS), Full Torque Setting (FTS), and Engine Serial Number.

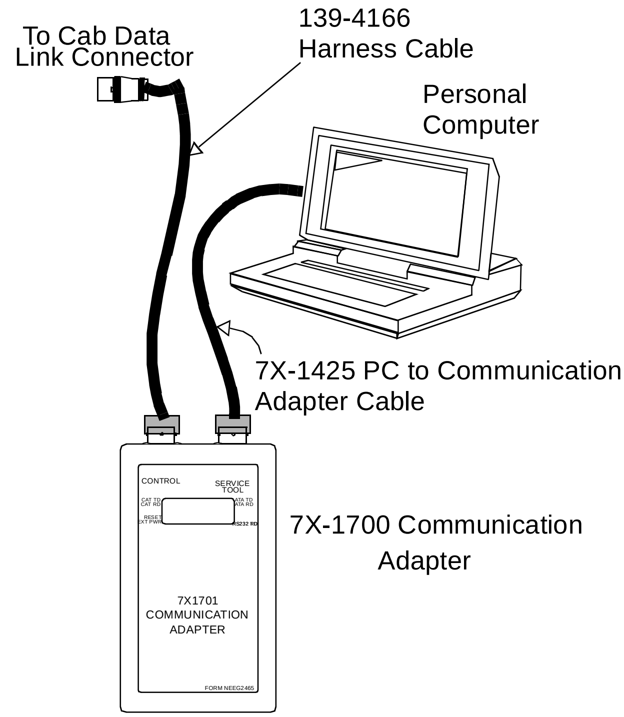
- Use ET to access Read/Change System Configuration Parameters. Enter the Full Load Setting, Full Torque Setting, and Engine serial number recorded on the worksheet.
- Use ET to access “Read/Change Current Totals” (from the Read/Change Current Totals main menu). Record information using the “Factory Passwords Worksheet” to obtain the Factory Passwords. Enter the Totals recorded on the worksheet from the original ECM.
- Use ET to access “Calibrate Sensors”, and calibrate the Engine Speed/Timing Sensor (refer to procedure “PC-31: Engine Speed/Timing Circuit Test” on page D-98).

7. Install the new ECM on the engine.

Programming a Personality Module Using Flash Programming

NOTE: Operation of the engine following programming of the Personality Module is identical to operation following replacement of the Personality Module chip. The only difference is the software was already programmed into the chip for you when you replaced the chip. Now you are actually performing the programming function. For example, if rerating an engine, there is still a need for Factory Passwords to change the Personality Module Code.

1. Connect components as shown below.



2. Start the **WinFlash** Program within **ET**.

3. Select the engine Personality Module part number to be programmed into the ECM, and proceed with programming the Personality Module. A new ECM is shipped with a blank Personality Module.

WinFlash Messages and Their Meaning.

NOTE: A new ECM comes with a blank (previously unprogrammed) personality module. A blank personality module will prompt you for all three of the following messages. The information contained in the “ECM Status” will be scrambled and meaningless if the module has not been previously programmed (this is normal).

- Message - **“The engine ID in the flash file does not match the engine ID in the ECM.”**
- Meaning - The ECM has a personality module for a different engine. For example, the ECM has a 3126 personality module, and you are attempting to program a 3116 personality module.
- What you should do. Stop the transfer and access information about “ECM Status” under the “Electronic Control Module” menu. Ensure the file you are about to transfer is for the same engine it will be installed.

- Message- **“The application ID in the flash file does not match the application ID in the ECM.”**
- Meaning- The ECM has a personality module for a different application. For example, if you attempt to program a 3126 Marine personality module into the DEUCE engine.
- What you should do. Stop the transfer and access information about “ECM Status” under the “Electronic Control Module” menu. Ensure the file you are about to transfer is for the Deuce application.
- Message- **“The ECM ID in the flash file does not match the ECM ID in the ECM.”**
- Meaning- The ECM is not for use in the Deuce application.
- What you should do. Stop the transfer and access information about “ECM Status” under the “Electronic Control Module” menu. Ensure the ECM on the engine is for the Deuce application.

4. Start the engine and check for proper operation.

- Program any parameters not previously in the old personality module if 253-02 Check Customer Or System Parameters (56) Diagnostic Code is active. Read the diagnostic code from the Service Tool Active Diagnostic Code screen to determine the parameter(s) requiring programming.
- **Remember,** on initial powerup of a new ECM, three parameters must be programmed to avoid a 253-02 Check Customer Or System Parameters (56) Diagnostic Code: Full Load Setting (FLS), Full Torque Setting (FTS), and Engine Serial Number.

Factory Passwords Worksheet

NOTE: A mistake in recording these parameters will result in incorrect passwords.

Dealer Code .... ________

Customer Name .... ________

Address ____

____

____

Phone Number _________________________ _______

From Engine Information Plate

Engine S/N .... ________

Full Load Setting .... ________

Full Torque Setting .... ________

From Machine Odometer

Engine Miles (km)... ________

From “Factory Passwords” Screen on ET

Service Tool Serial Number........................... ________

Engine Serial Number .... ________

Electronic Control Module S/N .... ________

Total Tattletale .... ________

Reason Code .... ________

NOTE: The following two parameters are necessary, and therefore only displayed, when re-rating an engine.

From Interlock .... ________

To Interlock... ________

Factory Passwords

Factory Password #1.................................... ________

Factory Password #2.................................... ________

Service Information Report

After verifying the correct repair has been performed on the machine, it is critical to provide concise, detailed information. This information helps Caterpillar better serve you and the Customer.

Recommendations

Customer's Complaint

Provide a copy of the "PA-10: Operator Questionnaire" on page D-23 Include comments for the Customer's Complaint section of the report indicating if the Check Engine Lamp was ON **continuously or intermittently**, if **symptoms** such as the engine had low power are present, indicate this.

Failure Cause

Comments on Failure Cause should include the **number of diagnostic codes logged** and if the **code was Active**. Indicate the source of the problem and how it was discovered, such as **followed Procedure PC-31**, or a visual inspection indicated **wire abrasion** on the engine harness, or dynamometer testing showed **power below specification @ 1700 rpm and above due to loss of cylinder 4 injector**. Please be specific.

How You Repaired It

Comments on How You Repaired It should include information such as **repaired the wiring harness**, **changed FLS/FTS as per factory instructions**, etc.

Troubleshooting Without a Diagnostic Code

PA-10: Operator Questionnaire

Ask the operator to answer the following questions before attempting to repair an intermittent problem, or a problem with symptoms but no diagnostic codes.

Questions	Yes	Comments
1. Did the Check Engine Lamp come ON during or after the time the problem occurs? - How long does/did it stay ON?		
2. How often does the problem occur? - Can you (the operator) take the machine and demonstrate the problem within one hour?		
3. Has the machine been serviced by others for the same problem? - If so, when and where?		
4. Did the engine completely shutdown, requiring a restart using the ignition switch? - How long do you have to wait before you can restart it after the shutdown?		
5. Did the engine hesitate/burp/misfire **without** a complete shutdown?		
6. Did the dash gauges or lights momentarily turn OFF when the problem occurred? - Any other observations about machine components?		
7. Does the problem occur only at specific engine loads? - If so, at what load (light, medium, or heavy)?		
8. Does the problem occur at a specific **engine** operating temperature? - If so, at what **engine** temperature?		
9. Does the problem occur only when above or below specific **outside** temperatures? - In what temperature range?		
10. Does the problem occur during other conditions (during or after rain, or spray washing)?		
11. Does the problem only occur when using the accelerator, not in Engine Speed Control Switch ON mode?		

PA-11: Questionnaire Response

	Response
1.	If the Check Engine Light came ON there will be a logged diagnostic code. Check the charts on the following pages to determine if the operator's indicated symptoms agree with the symptoms associated with the diagnostic code. If the operator's symptoms do not match the symptoms for the diagnostic code, troubleshooting the diagnostic code will not correct the problem. Try to duplicate these conditions. If there are not any logged diagnostic codes, check the ECM battery connections as per "PB-11: ECM Battery Circuits Test" on page D-48.
2.	If the problem is easily repeatable, take the machine for a drive with ET connected and note conditions when the problem occurs. Ensure to operate the machine after correcting the problem and duplicate the operating conditions before releasing the machine, to verify the problem is corrected.
3.	If the machine has been to other shops for the same problem, call the other shop and find out what has already been done. Review SIMS reports, if updated information is available. Avoid replacing the same components again unless absolutely sure they are the problem. It is unlikely a component will fail again following a recent replacement.
4.	Troubleshoot why the engine will not restart. Repairing the reason for the engine not starting should repair the reason the engine shut down. If the engine shuts down completely check the ECM battery connections, ground connections, fuel system, fuel quality and engine speed/timing sensors. If it will not restart, refer to "PA-17: Engine Cranks But Will Not Start" on page D-31.
5.	Refer to "PA-18: Engine Misfires, Runs Rough Or Is Unstable" on page D-34 if the problem IS easily repeatable or "PA-21: Intermittent Low Power Or Power Cutouts" on page D-37 if the problem IS NOT easily repeatable.
6.	If other machine devices are affected, the wiring is the most likely problem. Refer to "PB-11: ECM Battery Circuits Test" on page D-48 for information on inspecting the ECM battery connections.
7.	Operate the engine under similar load conditions. Check the low pressure fuel lines for restrictions, fuel/water separator, and fuel tanks for foreign objects blocking the fuel supply.
8.	Operate the engine at this temperature while attempting to duplicate the problem.
9.	If the problem only occurs at specific outside temperatures, troubleshoot the problem at these temperatures, if possible.
10.	If the problem seems to occur during/after the engine is subjected to rain/spray washing, thoroughly inspect the connectors for moisture entry. Refer to "PB-10: Inspecting Electrical Connectors" on page D-43 for more details.
11.	Check for logged diagnostic codes associated with the throttle position sensor. Refer to "PB-12: Throttle Position Sensor Circuit Test" on page D-53.

PA-12: Possible Performance Effect of Active Diagnostic Codes

Diagnostic Code Description		Engine Runs Rough/ Misfires	Low Power	Engine RPM Reduced	Engine Shutdown
1 - 05	Cylinder 1 Open Circuit	3	3		
1 - 06	Cylinder 1 Short Circuit	3	3		
2 - 05	Cylinder 2 Open Circuit	3	3		
2 - 06	Cylinder 2 Short Circuit	3	3		
3 - 05	Cylinder 3 Open Circuit	3	3		
3 - 06	Cylinder 3 Short Circuit	3	3		
4 - 05	Cylinder 4 Open Circuit	3	3		
4 - 06	Cylinder 4 Short Circuit	3	3		
5 - 05	Cylinder 5 Open Circuit	3	3		
5 - 06	Cylinder 5 Short Circuit	3	3		
6 - 05	Cylinder 6 Open Circuit	3	3		
6 - 06	Cylinder 6 Short Circuit	3	3		
22 - 13	Check Timing Sensor Calibration				
35 - 11	Rating Select Switch Inputs Are Incorrect		3	3	
41 - 03	8 Volt Supply Above Normal				
41 - 04	8 Volt Supply Below Normal				
42 - 11	Injection Actuation Press Control Valve Driver	3			3
64 - 02	Loss of Engine RPM Signal #2	3[1]			3[1]
64 - 08	Engine Speed w/o Pattern on Speed Sensor#2	3[1]			3[1]
64 - 11	No Pattern on Speed Sensor#2	3[1]			3[1]
70 - 05	Inlet Air Heater Open Circuit				
70 - 06	Inlet Air Heater Short Circuit				
84 - 01	Loss of Vehicle Speed Signal			3	
91 - 08	Invalid Throttle Signal			3	
91 - 13	Throttle Sensor Calibration			3	

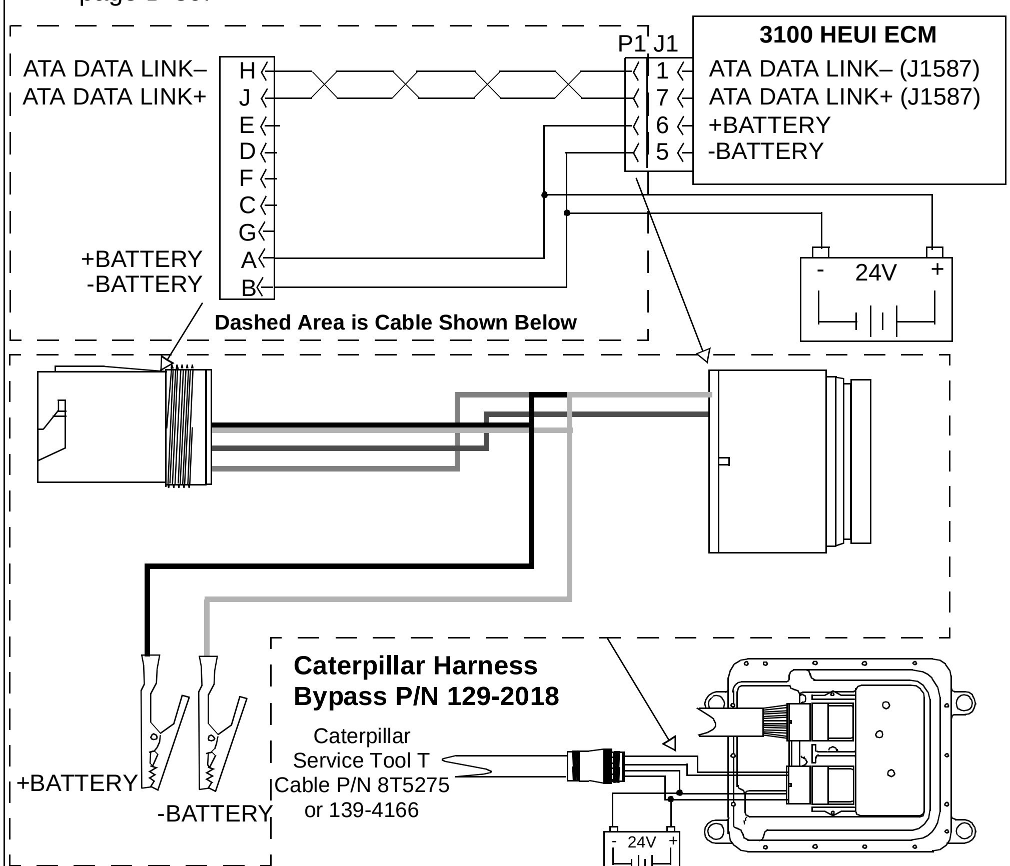
[1] Performance problems occur only if Speed/Timing Sensor #1 fails.

Diagnostic Code Description	Engine Runs Rough/ Misfires	Low Power	Engine RPM Reduced	Engine Shutdown
102 - 03 Boost Pressure Sensor Open Circuit		3		
102 - 04 Boost Pressure Sensor Short Circuit		3		
105 - 03 Intake Manifold Temp. Sensor Open Circuit	3[2]	3[2]		
105 - 04 Intake Manifold Temp. Sensor Short Circuit	3[2]	3[2]		
110 - 03 Coolant Temperature Sensor Open Circuit	3[2]	3[2]		
110 - 04 Coolant Temperature Sensor Short Circuit	3[2]	3[2]		
129 - 03 Check Engine Lamp Open Circuit				
129 - 04 Check Engine Lamp Short Circuit				
131 - 05 Ether Start Relay Open Circuit	3[2]			
131 - 06 Ether Start Relay Short Circuit	3[2]			
132 - 05 Starting Aid Lamp Open Circuit				
132 - 06 Starting Aid Lamp Short Circuit				
133 - 05 Crank Without Inject Lamp Open Circuit				
133 - 06 Crank Without Inject Lamp Short Circuit				
164 - 00 Injection Actuation Pressure Out of Range	3	3		
164 - 02 Injection Actuation Pressure Sensor Erratic				
164 - 03 Injection Actuation Press Sensor Open Circuit	3	3		
164 - 04 Injection Actuation Press Sensor Short Circuit	3	3		
164 - 11 Injection Actuation Pressure System		3		3
168 - 02 Low or Intermittent Battery Power to ECM	3			3
175 - 03 Oil Temperature Sensor Open Circuit	3[2]	3[2]		
175 - 04 Oil Temperature Sensor Short Circuit	3[2]	3[2]		
190 - 02 Loss of Engine RPM Signal on Sensor#1				
190 - 08 Engine Speed w/o Pattern on Spd Sensor#1				
190 - 11 No Pattern on Speed Sensor#1				
232 - 03 5 Volt Supply Above Normal	3	3		
232 - 04 5 Volt Supply Below Normal	3	3		
252 - 11 Incorrect Engine Software				
253 - 02 Check Customer or System Parameters		3	3	
266 - 02 Crank Without Inject Inputs Are Incorrect				

[2] Only when outside temperatures are cold.

PA-13: ET Will Not Communicate With The ECM

• Probable root causes:	• Perform the following tests:
1. Service Tool Cable problem or machine harness data link wiring problem.	• **Cycle the ignition key switch.** If the Service Tool still does not communicate, try to start the engine. • **If the engine will not start,** refer to “PA-17: Engine Cranks But Will Not Start” on page D-31. • **If the engine will not crank,** refer to “PA-16: Engine Will Not Crank” on page D-30. • **If the engine starts, but will not communicate,** - Check the ET connections and wiring. Connect another ET to the system, and also try another Service Tool Harness to determine if the problem is with the ET or Service Tool Harness. - Disconnect ECM Connector P1 from the ECM. Remove the two Data Link Lines pin-1 (ATA Data Link-) and pin-7 (ATA Data Link+). Connect a 40-Pin Breakout T into J1/P1 and access the power (pin-6), ground (pin-5), Data Link+ (pin-7), and Data Link- (pin-1) pins. Make jumper wires and connect these directly to the Service Tool Harness as shown below. For further information, refer to “PB-21: ATA (SAE J1587/1708) Data Link Circuit Test” on page D-89.



PA-13: ET Will Not Communicate With The ECM (Continued)

• Probable root causes:	• Perform the following tests:
2. Service Tool Connector is receiving battery voltage but the ECM is not.	• Verify ignition key switch is in the ON position and any override switches are not creating the problem. Start the engine. Connect ET. If communication occurs after the engine is started, but not with just the ignition key in the ON position, some type of override switch or system is preventing power to the ECM.
3. New ECM with a Blank Personality Module.	• A new ECM has an unprogrammed Personality Module in it. The engine will not start or communicate until the Personality Module in the ECM is Flash Programmed.

PA-14: ECM Will Not Accept Factory Passwords

• Probable root causes:	• Perform the following tests:
1. Incorrect screen (ET expects customer passwords).	• Verify that ET is on factory password screen (and expects Factory Passwords rather than Customer Passwords).
2. Incorrect information used to obtain password.	• Verify the following information. - Engine serial number used to calculate password was from ET screen, not from Engine Information Plate. For example, a new ECM has the engine serial number programmed to 0XX00000. If ET indicates the Engine Serial Number is 0XX00000, this serial number must be used to obtain Factory Passwords, not the one on the Engine Information Plate. Verify all information on the ET screen is what was provided to Caterpillar to obtain the password. - Information was obtained from the ECM being programmed. DO NOT obtain information from the old (or another) ECM to use Factory passwords on a replacement ECM. - **All** characters in the ECM and/or ET serial number have been supplied.
3. Error entering Password.	• Verify correct passwords were entered (upper case only). Also check each character in password for accuracy (for instance I vs. 1, Z vs. 2, 0 vs. O, etc). • Turn ignition key switch OFF, then retry. **NOTE:** Refer to “Example Factory Password ECAP Screen” below. Verify the information recorded for a request to obtain a password is **exactly** as displayed on the Service Tool screen. • If checking passwords does not correct the problem, change a Customer Parameter from its current value to another value and back. Then revert back to the screen and proceed to obtain Factory Passwords again. **NOTE:** Changing a parameter as described above changes the Total Tattletale. The changed Tattletale will require a new password.
4. Error entering Reason Code.	• Verify correct Reason Code from Factory Password Screen was entered. Do not guess at the reason code, this must be obtained from the ET. Reason Codes are assigned for specific purposes and are not interchangeable. **NOTE:** the information must be entered **exactly** as it appears on the Service Tool Screen.

PA-15: Check Engine Lamp Is Malfunctioning

• **Probable root causes:**	• **Perform the following tests:**
1. Intermittent diagnostic codes.	• Check for logged and active diagnostic codes with ET.
2. Burned out bulb/machine lamp circuit problem (for lamp not coming ON).	• **Turn the ignition key ON, engine OFF.** - the Check Engine Lamp should come ON and then turn OFF (it will continue to flash if there is an Active Diagnostic Code).
3. For Check Engine Lamp continuously flashing - Diagnostic Enable Switch shorted.	• If the Check Engine Lamp does not operate as indicated above, check bulb, remove the Check Engine Lamp pin (pin-22) from the ECM 40-Pin connector and connect to the Ground Stud while observing the lamp with the ignition key switch in the ON position. If it comes ON, check the ECM power and ground connections. For further assistance, refer to "PB-13: Check Engine, Crank Without Inject, or Starting Aid Lamp Test" on page D-60.
4. Machine Harness is shorted (for Check Engine Lamp/Service Engine Soon Lamp continuously ON, not flashing).	• Monitor the lamp while removing the Check Engine pin (pin-22) from the ECM 40-Pin Engine Harness Connector (or disconnect the ECM 40-Pin Connector P1). If the lamp remains ON while the pin is removed from the ECM, there is a short circuit in the machine harness.

PA-16: Engine Will Not Crank

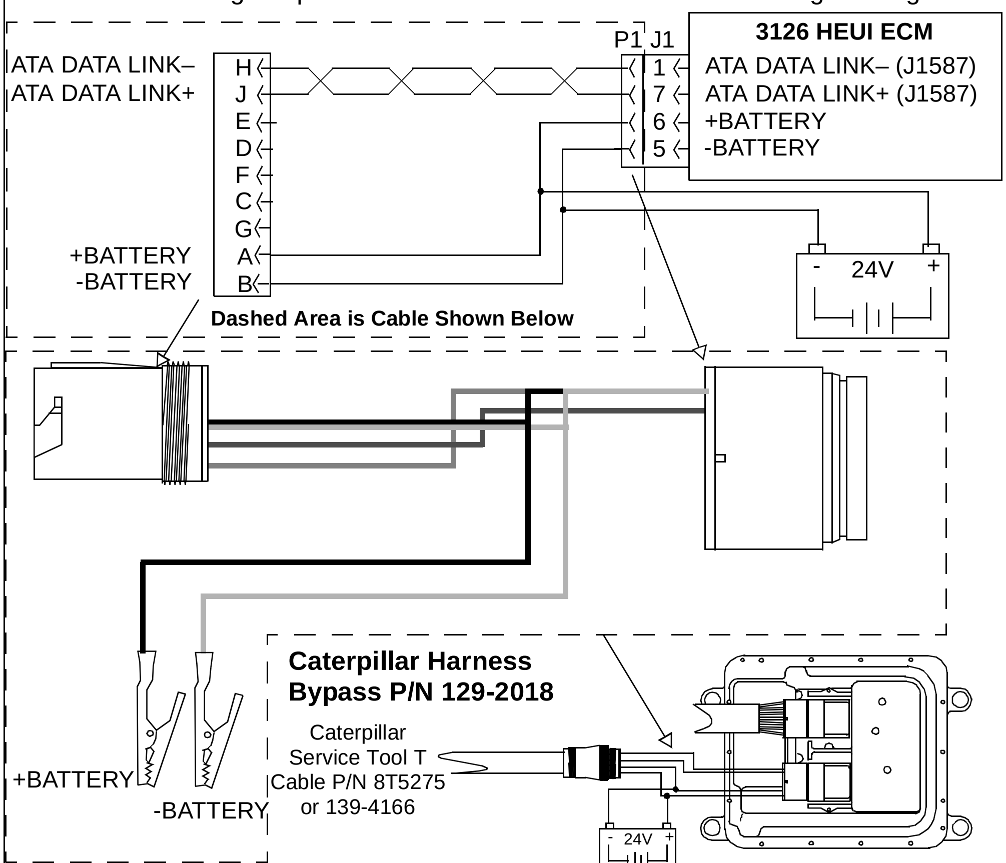
• Probable root causes:	• Perform the following tests:
	NOTE: These are NOT electronic problems with the Engine Control System. For more details on the following tests, refer to the Systems Operation, Testing and Adjusting Manual.
1. Batteries	• Charge batteries (refer to Special Instruction SEHS7633, for Battery Test Procedure). • Load test batteries (refer to Special Instruction SEHS9249, for Use Of 4C4911 Battery Load Tester).
2. Starting circuit problem (in machine wiring)	• Check machine wiring to starting motor solenoid. • Check engine start switch, switch power relay, etc.
3. Starting Motor solenoid	• Inspect starting motor cables for damage or loose connections. • Remove and clean starting motor cables and connections if corroded. • Test starting motor solenoid operation. Refer to Systems Operation, Testing and Adjusting Manual.
4. Starting Motor	• Test starting motor operation. Refer to Systems Operation, Testing and Adjusting Manual.
5. Engine accessory	• Remove and inspect engine accessories that may lock up the engine (Air Compressor, Power Steering Pump, Oil Pump, etc).
6. Hydraulic cylinder lock	• Check for fluid in cylinders by removing individual injectors.
7. Internal Engine Problem	• Timing Pin left in flywheel housing after setting valve lash. • Attempt to manually turn the engine using the 9S9082 Turning Tool. • Disassemble engine to inspect for internal components that may be seized, broken, bent, etc. Refer to Disassembly & Assembly Manual.
8. Flywheel ring gear	• Remove and inspect flywheel ring gear for damage.
9. Transmission or Power Take-Off problem	• Ensure free movement of driveline.

PA-17: Engine Cranks But Will Not Start

• Probable root causes:	• Perform the following tests:
1. Crank Without Inject Inputs	• Make sure Crank Without Inject is Disabled. Refer to PB-17.
2. Low Oil, Out of Fuel, Air in the High Pressure Oil System.	• Check the engine oil level. Engine oil feeds the high pressure hydraulic pump. • Make sure the engine is not out of fuel. • If the engine has been recently worked on, air in the High Pressure Oil System. Only after opening/working on the High Pressure Oil System. - Crank the engine for up to five 30 second cycles to purge the air from the oil system.
3. ECM to Service Tool Communications check	**NOTE:** A new ECM has an unprogrammed Personality Module, and will cause this symptom. Accessing “ECM Status” in the FLASH PC Program without following this request with programming the Personality Module may also cause the engine to not start or communicate. Cycling the ignition key switch OFF, then ON will correct this problem. • Connect ET. Ensure the ignition key switch is in the ON position. Attempt to access “Truck Engine Functions”. If ET indicates the ECM will not communicate, proceed to next item. If the ECM communicates, proceed to item 7.

PA-17: Engine Cranks But Will Not Start (Continued)

• Probable root causes:	• Perform the following tests:
4. Electrical power supply to ECM	• Check the ECM Power and Ground connections. Verify that the ECM is receiving battery voltage when the ignition key switch is turned ON. Wire a bypass as indicated in **STEP 4** of “PB-11: ECM Battery Circuits Test” on page D-48.
5. Unprogrammed Personality Module in a New ECM or ECM.	**NOTE:** A new ECM has an unprogrammed Personality Module in it. The engine will not start or communicate until the Personality Module is Flashed into the ECM. • If the ECM still will not communicate and the engine will not start, temporarily install a new ECM. Flash Program the same Personality Module into the new ECM. Test to verify that the ECM will communicate and the engine starts. If the engine starts, the old ECM is bad. If the engine does not start the problem is elsewhere.
6. Incorrect Engine Software	• Connect ET and verify there is not an active 252-11 Incorrect Engine Software (59) diagnostic code. If the diagnostic code is present, refer to “PC-30: ECM Memory Test” on page D-94.
7. Engine Speed/Timing Signal	• Observe the engine rpm with the ET Status Screen while cranking the engine.



• If the Service tools displays 0 rpm while cranking the engine, there is a problem in the Speed/Timing Sensor circuit. Refer to “PC-31: Engine Speed/Timing Circuit Test” on page D-98. If engine rpm is present, the electronics are OK. Proceed to the next item.

PA-17: Engine Cranks But Will Not Start (Continued)

• Probable root causes:	• Perform the following tests:
8. Injection Actuation Pressure System	• Crank engine while monitoring the Injection Actuation Pressure and Injection Actuation Control Valve Output. If the Injection Actuation Pressure is reaching **at least** 725 psi (5 MPa) the problem is not in the High Pressure Oil System. • Connect ET and check for a 164-11 Injection Actuation Pressure System Fault Diagnostic EVENT Code. If a 164-11 has been recently logged, refer to "PC-38: Injection Actuation Pressure System Test" on page D-140. • Injection Actuation Pressure Sensor indicating a higher than actual pressure. Disconnect the Injection Actuation Pressure Sensor, and then crank the engine. If the engine starts, refer to "PC-36: Injection Actuation Pressure Sensor Test" on page D-130.
9. Fuel supply - low pressure - poor fuel quality	• Monitor exhaust for smoke while cranking. If smoke is not present, there may be a fuel supply problem. • Check fuel quality. Refer to the Truck Performance and Driveability Diagnostic Guide, LEBT3477. • Check Fuel Pressure. Check to ensure fuel system is primed. Check for restricted fuel supply lines and fuel filters. In temperatures below 32°F (0°C), check for congealed fuel (wax).
10. Combustion problem	• Check for combustion problems (outside temperatures too cold or a mechanical problem). Check for proper operation of the Engine Coolant and Inlet Air Heater in cold temperatures.

PA-18: Engine Misfires, Runs Rough Or Is Unstable

• Probable root causes:	• Perform the following tests:
NOTE: If the problem is intermittent and cannot be recreated, refer to "PA-21: Intermittent Low Power Or Power Cutouts" on page D-37.	**NOTE:** If the problem only occurs under certain conditions (high rpm, full load, engine operating temperature, etc), test the engine under those conditions. Troubleshooting the symptoms under other conditions can give misleading results.
1. Individual cylinder malfunction	• Inspect ECM Connector J2/P2 for full connection and corrosion. Connect ET and cut-out each cylinder to isolate the misfiring cylinder(s). If it can be isolated to a specific cylinder(s), refer to "PC-33: Injector Solenoids Circuit Test" on page D-108.
2. Fuel supply - low pressure - combustion gas/air in fuel - poor fuel quality	• Check fuel quality. Refer to the Truck Performance and Driveability Diagnostic Guide, LEBT3477. • Inspect fuel system and check fuel pressure or for air in fuel. Refer to Systems Operation, Testing and Adjusting Manual.
3. Low Injection Actuation Pressures	• Check Engine Oil Level to ensure the engine is not low on oil. • Connect ET and check for a 164-11 Injection Actuation Pressure System Fault Diagnostic EVENT Code. If a 164-11 has been recently logged, refer to "PC-38: Injection Actuation Pressure System Test" on page D-140.
4. Throttle Position Sensor signal (if the problem does not occur while using the Engine Speed Control Switch)	• Use the Engine Speed Control Switch to operate the engine in High Idle mode. - If the engine is stable using the Engine Speed Control Switch to control engine rpm, but unstable using the throttle sensor, connect ET and monitor the throttle position status. If it is unstable, refer to "PB-12: Throttle Position Sensor Circuit Test" on page D-53.
5. Valve Lash Adjustment	• Refer to the Systems Operation, Testing and Adjusting Manual.

PA-19: Consistent Low Power or Poor Response To Accelerator

• Probable root causes:	• Perform the following tests:
1. Cold Mode Operation (Normal operation, if the problem occurs only after start-up in cold weather.)	• Monitor any of the ET Status screens to verify the engine has shifted out of Cold Mode. An Active Cold Mode is indicated in the upper corner of any Status Screen. During Cold Mode engine power maybe limited.
2. Electronic System problem	• Monitor “Fuel Pos”, “Rated Fuel Pos”, and “FRC Fuel Pos”, on ET. These three parameters should be as follows **while the machine is operating under full load**. **“Fuel Pos” = “Rated Fuel Pos”** **AND** **“Fuel Pos” is less than “FRC Fuel Pos”** • If the three parameters are as indicated above, the Electronics are operating correctly. If these three parameters are not as indicated check the following. • Monitor Boost Pressure on the ET status screen for normal operation. Turn the ignition key ON, engine OFF, and check the Boost Pressure on an ET status screen - with the engine OFF it should indicate 0 psi (0 kPa). • Monitor the Throttle Position status. Operate the engine to high idle with the machine in neutral. If the engine can not reach programmed Top Engine Limit, check the Throttle Duty Cycle to verify it is within calibration (75 to 90 percent at high idle). If throttle position is unstable when it should not be, check the Throttle Duty Cycle while slowly operating the accelerator pedal to verify it is within calibration (10 to 22 percent at low idle, 75 to 90 percent at high idle), and the duty cycle changes along with pedal position. If a problem with the Throttle Sensor is suspected, refer to “PB-12: Throttle Position Sensor Circuit Test” on page D-53. • Monitor the vehicle speed signal and verify accuracy compared to actual speed. If a problem is discovered, refer to “PB-14: Vehicle (Machine) Speed Circuit Test” on page D-66.
3. Fuel supply - low pressure - combustion gas/air in fuel - poor fuel quality	• Check fuel quality. Refer to the Truck Performance and Driveability Diagnostic Guide, LEBT3477. • Inspect fuel system, check fuel pressure and for air in fuel, and fuel quality. Refer to Systems Operation, Testing and Adjusting Manual.
4. Air-To-Air Aftercooler Core Leak Test	• Refer to Systems Operation, Testing and Adjusting Manual.
5. Air inlet or exhaust system restrictions, or air system leaks	• Check air inlet and exhaust systems for restrictions and leaks. Refer to Systems Operation, Testing and Adjusting Manual.
6. Individual cylinder malfunction	• Inspect ECM Connector J2/P2 for full connection and corrosion. Connect ET and cut-out each cylinder to isolate the misfiring cylinder(s). If it can be isolated to a specific cylinder(s), refer to “PC-33: Injector Solenoids Circuit Test” on page D-108.
7. Low Injection Actuation Pressures	• Check Engine Oil Level to ensure the engine is not low on oil. • Connect ET and check for a 164-11 Injection Actuation Pressure System Fault Diagnostic EVENT Code. If a 164-11 has been recently logged, refer to “PC-38: Injection Actuation Pressure System Test” on page D-140.

PA-20: Intermittent Engine Shutdowns

• Probable root causes:	• Perform the following tests:
1. Battery power or ground to ECM (machine wiring)	• Check for correct installation of 40-Pin ECM Connectors J1/P1 and J2/P2, Engine Speed/Timing Sensor Connectors J9/P9 and J4/P4. • Check ET for - 168-02 Intermittent Battery (51) Diagnostic Code. • Follow battery wires from ECM back to the battery compartment. Inspect these wires and the power relay, usually mounted in or near the battery compartment. • Check the ECM Power and Ground connections If a problem is suspected, wire a bypass as indicated in **STEP 4** of "PB-11: ECM Battery Circuits Test" on page D-48. • If the problem seems to occur only after the engine is warmed up and disappears after the machine has been allowed to cool, the circuit breakers may be tripping because of heat. Check to ensure that the circuit breakers on the machine are an automatically resetting type.
2. Fuel supply - low pressure - poor fuel quality	• Inspect fuel system and check fuel pressure. Refer to Systems Operation, Testing and Adjusting Manual. • Check fuel quality. Refer to the Truck Performance and Driveability Diagnostic Guide, LEBT3477.
3. Erratic, Low Injection Actuation Pressures	• Check Engine Oil Level to ensure the engine is not low on oil. • Connect ET and check for a 164-11 Injection Actuation Pressure System Fault Diagnostic EVENT Code. If a 164-11 Diagnostic EVENT Code has been recently logged, refer to "PC-38: Injection Actuation Pressure System Test" on page D-140.
4. ECM	• Refer to "PC-30: ECM Memory Test" on page D-94.

PA-21: Intermittent Low Power Or Power Cutouts

• Probable root causes:	• Perform the following tests:
1. Poor electrical connections	• Check Machine Harness and connectors (refer to “PB-10: Inspecting Electrical Connectors” on page D-43).
2. Battery power or ground to ECM (machine wiring)	• Check ET for 168-02 Intermittent Battery (51) Diagnostic Code. • Check the ECM Power and Ground connections. - If a problem is suspected, wire a bypass as indicated in “Step 4” Bypass Machine Wiring Harness for Testing” on page D-52 of “PB-11: ECM Battery Circuits Test”.
3. Air supply/low boost	• Monitor “Fuel Pos”, “Rated Fuel Pos”, and “FRC Fuel Pos”, on ET. These three parameters should be as follows **while the machine is operating under full load.** **“Fuel Pos” = “Rated Fuel Pos”** **AND** **“Fuel Pos” is less than “FRC Fuel Pos”** • If the three parameters are as indicated above, the Electronics are operating correctly. If these three parameters are not as indicated check the following. • Monitor Boost Pressure on the ET status screen for normal operation. Turn the ignition key ON, engine OFF, and check the Boost Pressure on ET status screen - with the engine OFF it should indicate 0 psi (0 kPa).
4. Throttle Position Sensor signal (if the problem does not occur while using the Engine Speed Control Switch)	• Use the Engine Speed Control Switch to establish the engine speed. If the engine is stable using the Engine Speed Control Switch, but unstable using the accelerator pedal, refer to “PB-12: Throttle Position Sensor Circuit Test” on page D-53. • If the engine is stable using the Engine Speed Control Switch to control engine rpm, but not the throttle sensor, connect ET and monitor the Throttle Position status. Operate the engine to high idle with the machine in Neutral. If the engine can not reach programmed Top Engine Limit, check the Throttle Duty Cycle to verify it is within calibration (75 to 90 percent at high idle). If throttle position is unstable when it should not be, check the Throttle Duty Cycle while slowly operating the accelerator pedal to verify it is within calibration (10 to 22 percent at low idle, 75 to 90 percent at high idle), and the duty cycle changes along with pedal position. If a problem with the Throttle Sensor is found, refer to “PB-12: Throttle Position Sensor Circuit Test” on page D-53, in this manual.
5. Fuel Supply	• Check fuel lines for restrictions, fuel/water separator, and fuel tanks for foreign objects which may block fuel supply.
6. Erratic, Low Injection Actuation Pressures	• Check Engine Oil Level to ensure the engine is not low on oil. • Connect ET and check for a 164-11 Injection Actuation Pressure System Fault Diagnostic EVENT Code. If a 164-11 Diagnostic EVENT Code has been recently logged, refer to “PC-38: Injection Actuation Pressure System Test” on page D-140.

PA-22: Excessive Black Smoke

• Probable root causes:	• Perform the following tests:
1. Air inlet restriction	• Check air inlet and exhaust systems for restrictions, refer to Systems Operation, Testing and Adjusting Manual.
2. Incorrect valve adjustment	• Refer to Systems Operation, Testing and Adjusting Manual.
3. Faulty unit injector	• Inspect ECM Connector J2/P2 for full connection and corrosion. Connect ET and cut-out each cylinder to isolate the misfiring cylinder(s). If it can be isolated to a specific cylinder(s), refer to Systems Operation, Testing and Adjusting Manual.
4. Boost Pressure Sensor signal	• Monitor “Fuel Pos”, “Rated Fuel Pos”, and “FRC Fuel Pos”, on ET. These three parameters should be as follows **while the machine is operating under full load.** **“Fuel Pos” equal to “Rated Fuel Pos”** **AND** **“Fuel Pos” is less than “FRC Fuel Pos”** • Fuel Pos should be limited to FRC until Boost Pressure is up to a predetermined level. If the three parameters are as indicated above, the Electronics are operating correctly. If these three parameters are not as indicated check the following, • Monitor Boost Pressure on the ET status screen for normal operation. Turn the ignition key ON, engine OFF, and check the Boost Pressure on ET status screen - with the engine OFF it should indicate 0 psi (0 kPa).
5. Personality Module	• Connect ET and check to ensure the correct Personality Module is installed compared to the engine configuration.

PA-23: Excessive White Smoke

• Probable root causes:	• Perform the following tests:
1. Normal operation (Cold outside temperatures)	• The engine may smoke briefly under cold conditions if the brake or clutch have been depressed, because the ECM will exit Cold Mode briefly (to allow an Automatic Transmission to be put in gear). Cold Mode will gradually return if the Coolant Temperature is below 64°F (17°C).
2. Fuel supply - low pressure - combustion gas/air in fuel - poor fuel quality	• Check fuel quality. Refer to the Truck Performance and Driveability Diagnostic Guide, LEBT3477. • Inspect fuel system and check fuel pressure. Refer to Systems Operation, Testing and Adjusting Manual. • Check for air in fuel. Refer to Systems Operation, Testing and Adjusting Manual. • Incorrect fuel blend.
3. Oil Temperature or Intake Manifold Air Temperature Sensor Circuit	• Connect ET and check for Oil Temperature or Intake Manifold Air Temperature Sensor Diagnostic Codes. Monitor Oil Temperature Sensor and Intake Manifold Air Temperature Status on ET. If an Active Open or Short Circuit Diagnostic Code is detected, refer to “PC-12: Engine Sensor Open or Short Circuit Test” on page D-121.
4. Faulty unit injector	• Inspect ECM Connector J2/P2 for full connection and corrosion. Connect ET and cut-out each cylinder to isolate the misfiring cylinder(s). If it can be isolated to a specific cylinder(s), refer to Systems Operation, Testing and Adjusting Manual.
5. Combustion problem	• Check for combustion problems (too cold or mechanical problem).

PA-23: Excessive White Smoke (Continued)

6. Inlet Air Heater Malfunction	• If the Inlet Air Heater fails to come ON in cold weather white smoke could result. Check the Coolant and Intake Air Temperature Sensors through ET, and Inlet Air Heater Grid, Inlet Air Heater Relay, and wiring.
7. Air inlet restriction	• Check air inlet and exhaust systems for restrictions, refer to Systems Operation, Testing and Adjusting Manual.

PA-24: Can Not Reach Top Engine RPM

• Probable root causes:	**• Perform the following tests:**
	• If the problem occurs only under load, refer to "PA-19: Consistent Low Power or Poor Response To Accelerator" on page D-35.
1. Cold Mode Operation (Normal operation, if the problem occurs only after start-up in Cold weather.)	• Monitor any of the ET Status screens to verify the engine has shifted out of Cold Mode. An Active Cold Mode is indicated in the upper corner of any Status Screen.
2. Throttle Position Sensor signal	• Monitor the Throttle Position status. Operate the engine to high idle with the machine in neutral. If the engine can not reach Top Engine Limit check the Throttle Duty Cycle to verify it is within calibration (75 to 90 percent at high idle). If a problem with the Throttle Sensor is suspected, refer to "PB-12: Throttle Position Sensor Circuit Test" on page D-53.
3. Machine speed signal	• Monitor the machine speed signal and verify accuracy compared to actual speed. If a problem is discovered, refer to "PB-14: Vehicle (Machine) Speed Circuit Test" on page D-66.
4. Fuel supply: - low pressure - poor fuel quality	• Check fuel quality. Refer to the Truck Performance and Driveability Diagnostic Guide, LEBT3477. • Inspect fuel system and check fuel pressure. Refer to Systems Operation, Testing and Adjusting Manual.

PA-25: Can Not Reach Machine Speed Limit

• Probable root causes:	• Perform the following tests:
1. Self-Deployable / Earthmoving Switch Position.	• Verify the Earthmoving/Self Deploy Mode Switch is in the correct position. Use ET to verify switch operation.
2. Cold Mode Operation (Normal operation, if the problem occurs only after start-up in Cold weather.)	• Monitor any of the ET Status screens to verify the engine has shifted out of Cold Mode. An Active Cold Mode is indicated in the upper corner of any Status Screen. During Cold Mode the engine power is limited, preventing the machine from reaching the top machine speed under heavy loads.
3. Electronic System problem	• Monitor “Fuel Pos”, “Rated Fuel Pos”, and “FRC Fuel Pos”, on the ET. These three parameters should be as follows **while the machine is operating under full load**. **“Fuel Pos” = “Rated Fuel Pos”** **AND** **“Fuel Pos” is less than “FRC Fuel Pos”** • If the three parameters are as indicated above, the Electronics are operating correctly. If these three parameters are not as indicated check the following. • Monitor Boost Pressure on the ET status screen for normal operation. Turn the ignition key ON, engine OFF, and check the Boost Pressure on ET status screen - with the engine OFF it should indicate 0 psi (0 kPa). • Monitor the Throttle Position status. Operate the engine to high idle with the machine in Neutral. If the engine can not reach Top Engine Limit, check the Throttle Duty Cycle to verify it is within calibration (75 to 90 percent at high idle). If throttle position is unstable when it should not be, check the Throttle Duty Cycle while slowly operating the accelerator pedal to verify it is within calibration (10 to 22 percent at low idle, 75 to 90 percent at high idle), and the duty cycle changes along with pedal position. If a problem with the Throttle Sensor is suspected, refer to “PB-12: Throttle Position Sensor Circuit Test” on page D-53. • Monitor the machine speed signal and verify accuracy compared to actual speed. If a problem is discovered, refer to “PB-14: Vehicle (Machine) Speed Circuit Test” on page D-66.
4. Fuel supply: - low pressure - poor fuel quality	• Check fuel quality. Refer to the Truck Performance and Driveability Diagnostic Guide, LEBT3477. • Inspect fuel system and check fuel pressure. Refer to Systems Operation, Testing and Adjusting Manual.

PA-26: Poor Acceleration or Response

• Probable root causes:	• Perform the following tests:
1. Boost Pressure Sensor signal	• Monitor “Fuel Pos”, “Rated Fuel Pos”, and “FRC Fuel Pos”, on the ET. These three parameters should be as follows **while the machine is operating under full load.** **“Fuel Pos” equal to “Rated Fuel Pos”** **AND** **“Fuel Pos” is less than “FRC Fuel Pos”** • Fuel Pos should be limited to FRC until Boost Pressure is up to a predetermined level. If the three parameters are as indicated above, the Electronics are operating correctly. If these three parameters are not as indicated check the following; • Monitor Boost Pressure on the ET status screen for normal operation. Turn the ignition key ON, engine OFF, and check the Boost Pressure on ET status screen - with the engine OFF it should indicate 0 psi (0 kPa).
2. Cold Mode Operation (Normal operation, if the problem occurs only after start-up in cold weather.)	• Monitor any of the ET Status screens to verify the engine has shifted out of Cold Mode. An Active Cold Mode is indicated in the upper corner of any Status Screen.
3. Individual cylinder malfunction	• Inspect ECM Connector J2/P2 for full connection and corrosion. Connect ET and cut-out each cylinder to isolate the misfiring cylinder(s). If it can be isolated to a specific cylinder(s), refer to Systems Operation, Testing and Adjusting Manual.
4. Personality Module	• Connect ET and check to ensure the correct Personality Module is installed compared to the engine configuration.
5. **Actual** Injection Actuation Pressure Less Than Desired Injection Actuation Pressure.	• Check the Injection Actuation Pressure from ET against the Desired Injection Actuation Pressure to verify that Desired Injection Actuation Pressure is being reached.
6. Mechanical Problems	• Refer to the Systems Operation, Testing and Adjusting Manual.

PA-27: Poor Fuel Consumption

• Probable root causes:	• Perform the following tests:
1. Machine operation	• Inspect the ECM Totals idle time for excessive idling. • Consider environmental conditions such as wind, snow, road condition, etc.
2. Fuel supply - poor fuel quality	• Check fuel quality. Refer to the Truck Performance and Driveability Diagnostic Guide, LEBT3477.
3. Air inlet or exhaust system restrictions	• Check air inlet and exhaust systems for restrictions and leaks, refer to Systems Operation, Testing and Adjusting Manual.

Troubleshooting With A Diagnostic Code

PB-10: Inspecting Electrical Connectors

System Operation

When to Use This Procedure

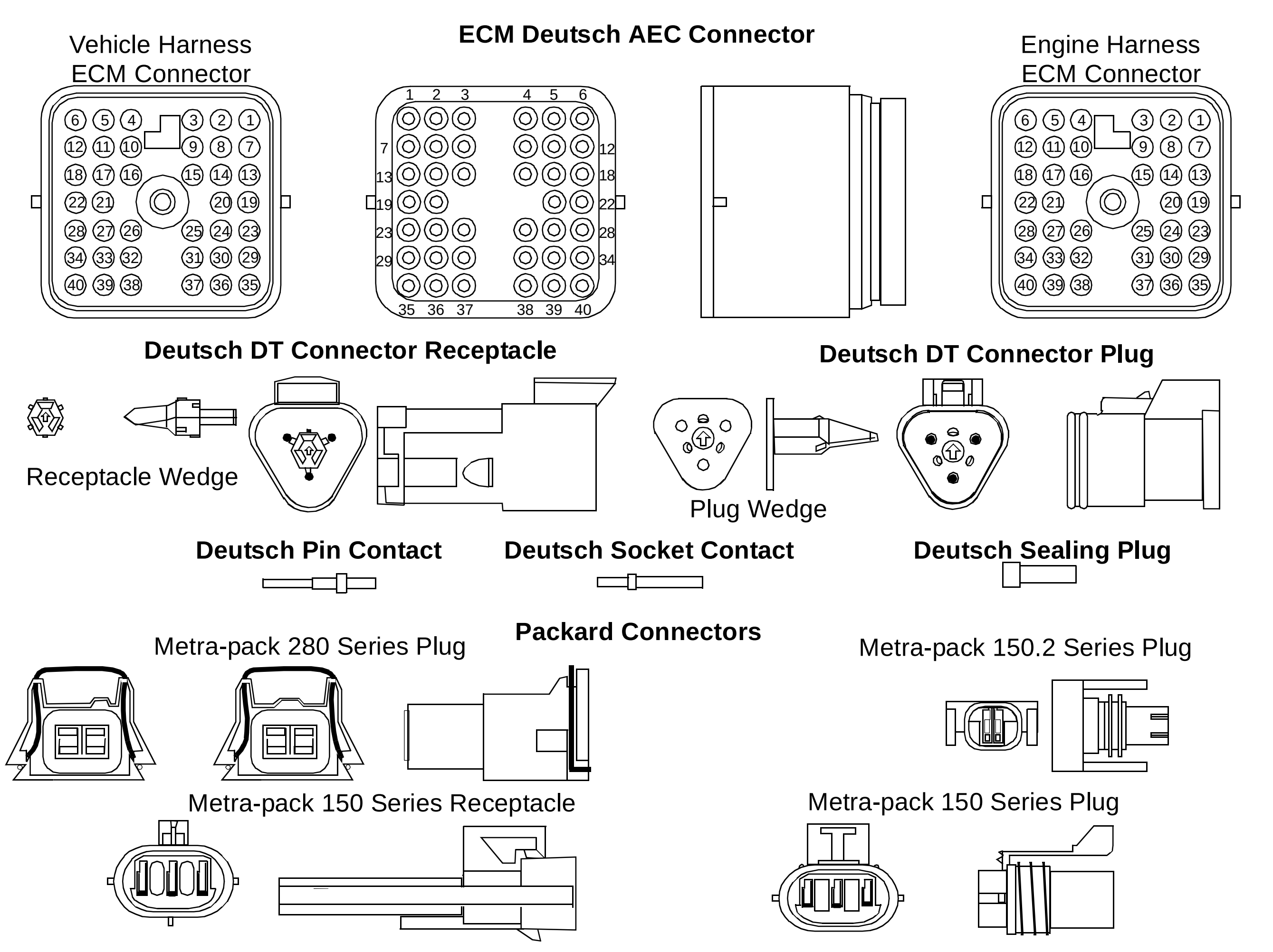
Use the following steps to help determine if the connector is the cause of the problem. If a problem is found in the electrical connector, repair the connector and verify that the problem has been fixed.

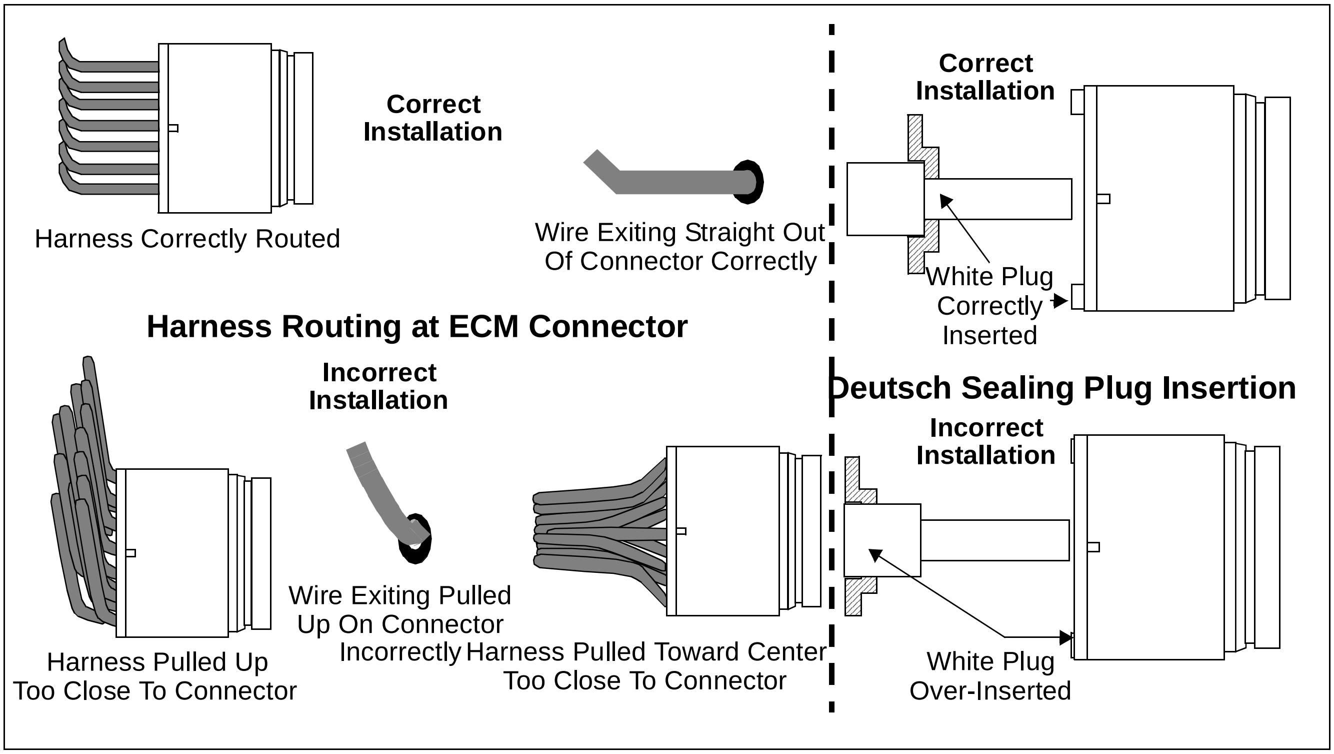
Background

Many of the Operational Procedures and Diagnostic Code Procedures in this troubleshooting guide will direct you to check a specific electrical connector. The Appendix D: Electronic Troubleshootings use a variety of Deutsch and Packard connectors.

Intermittent electrical problems are often caused by poor connections. Always check for an Active Diagnostic Code before breaking any connections and check again immediately after reconnecting the connector to see if the problem disappears. Simply disconnecting and then reconnecting connectors can sometimes solve a problem. If this occurs, likely causes are loose pins, improperly crimped pins or corrosion. Follow this procedure to thoroughly inspect the connectors to determine if connectors are the cause of the problem.

3126 HEUI Connectors

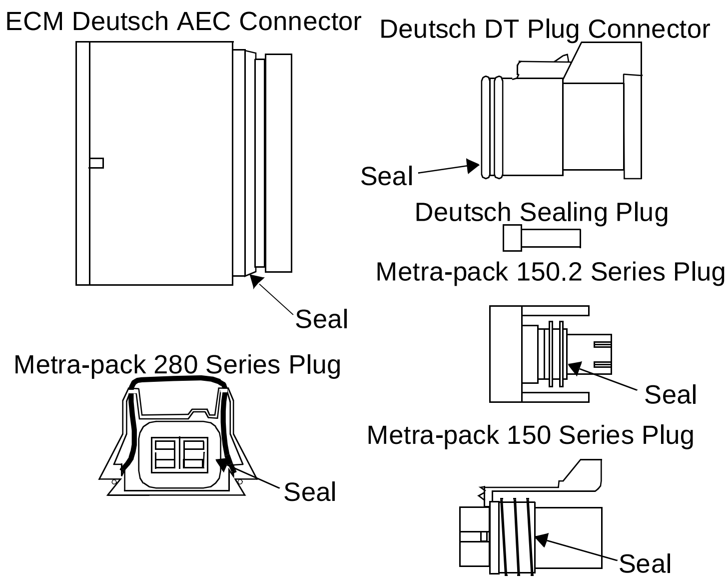


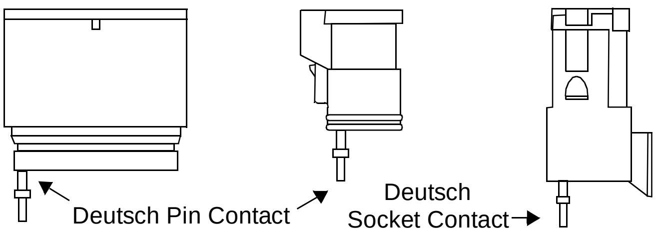


Functional Test

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 1: Check Deutsch "DT" Connector Locking, Deutsch "HD" connector Lock Ring, and Packard Connector Locking.		
• Ensure the connector is properly locked (clicked) together and the two halves cannot be pulled apart. • If inspecting a Packard Connector, make sure the sensor is latched on both sides. **• If any locking mechanism is cracked or broken on the connector or the connector will not lock, replace the connector.** **NOTE:** Packard Connectors cannot be serviced. If a Packard Connector requires service, replace the component or harness piece as required.	**OK** ⇒ **NOT OK** ⇒	Proceed to the next step. **Repair or replace as necessary.** STOP.
Step 2: Check ECM Connector "Allen Screw".		
• Ensure the Connector Bolt is properly tightened, but be careful not to over-tighten and break the bolt. If the bolt breaks, a 6V6703 bolt replacement is available to repair the ECM. **• Do not exceed 20 lb in (2.25 N•m) of torque on the ECM Connector Bolt when connecting the 40-Pin "AEC" connector to the ECM.**	**OK** ⇒ **NOT OK** ⇒	Proceed to the next step. **Repair or replace as necessary.** STOP.

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 3: Perform 10 pound (44.5 N) Pull Test on Each Pin/Wire.		
• Each pin and connector should easily withstand 10 pounds (44.5 N) of pull, and remain in the connector body. This test checks whether the wire was properly crimped in the pin or socket and whether the pin or socket was properly inserted into the connector. The “DT” connectors use an orange wedge to lock the pins in place. Check to see that the orange wedge is not missing and installed properly on the “DT” connectors. Repair as needed. **NOTE:** Pins should ALWAYS be crimped onto the wires using a Deutsch Crimp Tool. Do not solder pins or sockets. Use the 1U5804 Deutsch Crimp Tool.	**OK** ⇒ **NOT OK** ⇒	Proceed to the next step. **Repair or replace as necessary.** STOP.
Step 4: Monitor ET while Tugging on Wiring and Connectors.		
• If there is an active diagnostic code relating to the circuit, monitor the Service Tool Active Code screen while pulling on all harnesses and connectors that connect to the component with the Active code. If the Active code disappears while pulling on the harness, there is a problem in the wiring or a connector. • If there is no Active code, use the Service Tool Display Status to monitor the component status while tugging on the harnesses. If the reading changes erratically while tugging, there is a problem in the wiring or connector. • If there are no active codes and the driver is complaining about speed burps or engine cutouts, run the engine and listen for burps or cutouts while pulling on the wiring and connectors. If the engine burps or cuts out, there is a problem in the wiring or connector.	**OK** ⇒ **NOT OK** ⇒	Proceed to the next step. **Repair or replace as necessary.** STOP.
Step 5: Check Wires for Insulation Nicks or Abrasion.		
• Carefully inspect each wire for signs of abrasion, nicks, or cuts. Likely locations to check are anywhere the insulation is exposed, points where the wire rubs against the engine or a sharp point. • Check all harness hold down clamps to verify that the harness is properly clamped and the clamp is not compressing the harness. Pull the harness sleeves away to check for flattened wires where the clamp holds the harness.	**OK** ⇒ **NOT OK** ⇒	Proceed to the next step. **Repair or replace as necessary.** STOP.

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 6: Check connectors for moisture or corrosion.		
• Ensure the connector seals and white sealing plugs are in place. If **any** of the seals or plugs are missing, replace the seal, plug, or if necessary, the connector.  • Check all wiring harnesses to verify the harness does not make a sharp bend out of a connector. This will deform the connector seal and create a moisture entry path. • Thoroughly inspect ECM Connectors J1/P1 and J2/P2 for evidence of moisture entry. **NOTE:** It is normal to see some minor seal abrasion on the ECM Connector seals. Minor seal abrasion will not cause moisture entry. • If moisture or corrosion is evident in the connector, the source of the moisture entry must be found and repaired or the problem will reoccur. Simply drying the connector will not fix the problem. Likely moisture entry paths are missing or improperly installed seals, nicks in exposed insulation, or unmated connectors. Moisture can also travel or “wick” from one connector through the inside of a wire to the ECM Connector. If moisture is found in the ECM connector, thoroughly check all connectors and wires on the harness that connects to the ECM. The ECM is not the source of the moisture. Do not replace an ECM if moisture is found in either ECM connector. **NOTE:** If corrosion is evident on pins, sockets or the connector itself, use **only** denatured alcohol to clean/remove the corrosion with a cotton swab or a soft brush. Do not use any cleaners that contain 1,1,1 trichloro-ethylene as this may damage the connector. • **All connectors/seals should be completely mated/inserted, and the harness/wiring should be free of abrasion or pinch points.**	**OK** ⇒ **NOT OK** ⇒	Proceed to the next step. **Repair or replace wiring or connectors as necessary.** Ensure all seals are properly in place and connectors completely mated. Verify the repair eliminates the problem. Run the engine for several minutes and check again for moisture If moisture reappears, it is wicking into the connector. Even if the moisture entry path is repaired, it may be necessary to replace the wires that have moisture wicking through them as the wires may have moisture trapped inside the insulation.

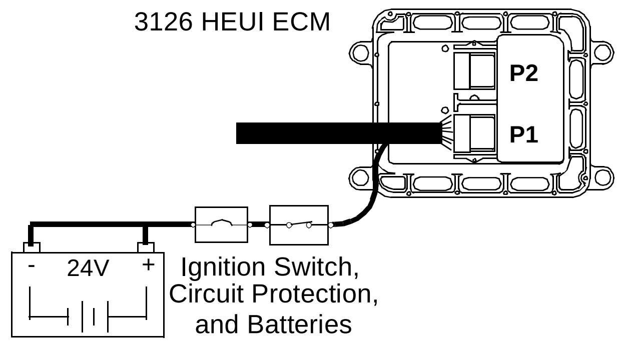
TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 7: Inspect Connector Pins and Sockets.		
• Verify that pins and sockets are not damaged. Verify proper alignment and location of pins in the connector.	**OK** ⇒	Proceed to the next step.
	NOT OK ⇒	**Repair or replace as necessary.** STOP.
Step 8: Check Individual Pin Retention into the Socket.		
• This is especially important for intermittent problems. Using a new pin, insert the pin into each socket one at a time to check for a good grip on the pin by the socket. Repeat for each pin on the mating side of the connector, using a new socket for the test. The terminal contact (pin or socket) should stay connected if held as shown below. 	**OK** ⇒	STOP.
	NOT OK ⇒	**Repair or replace as necessary.** STOP.

PB-11: ECM Battery Circuits Test

System Operation

When to Use This Procedure

This procedure tests whether proper voltage is supplied to the ECM by machine wiring. Use this procedure if a 168-02 Intermittent Battery (51) Diagnostic Code is Logged or Active, or anytime you suspect the ECM is not receiving battery supply voltage.



Background

The ECM receives power through ignition switched wiring.

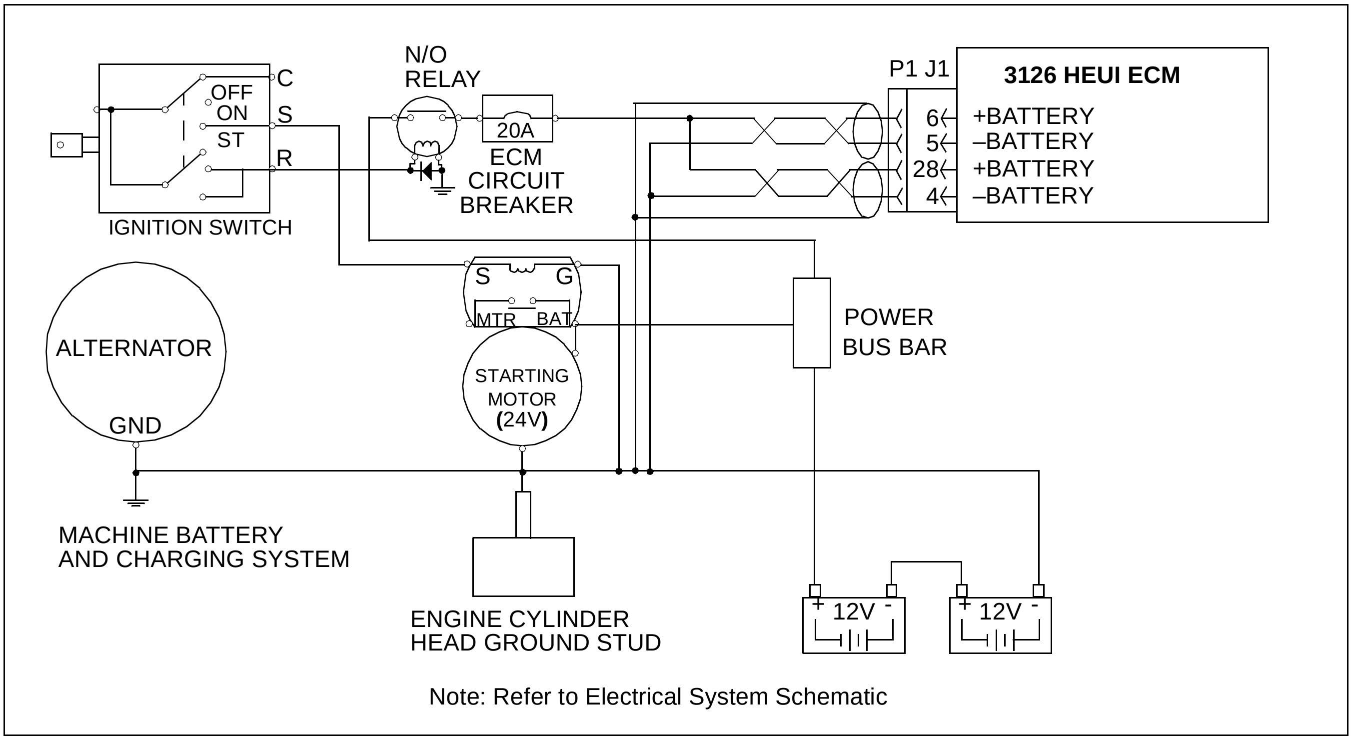
The cause of an intermittent power supply to the ECM can occur on either the positive (+Battery) or negative (-Battery) side. The -Battery side is routed from the ECM to the battery.

The ignition switched +Battery is provided when the ignition switch is in the ON position. Ignition switched +Battery is usually routed through a power relay located in the battery compartment. The power relay is activated when the ignition switch is in the ON position.The ignition switched battery connection is required before the ECM will be able to run, control and monitor the engine.

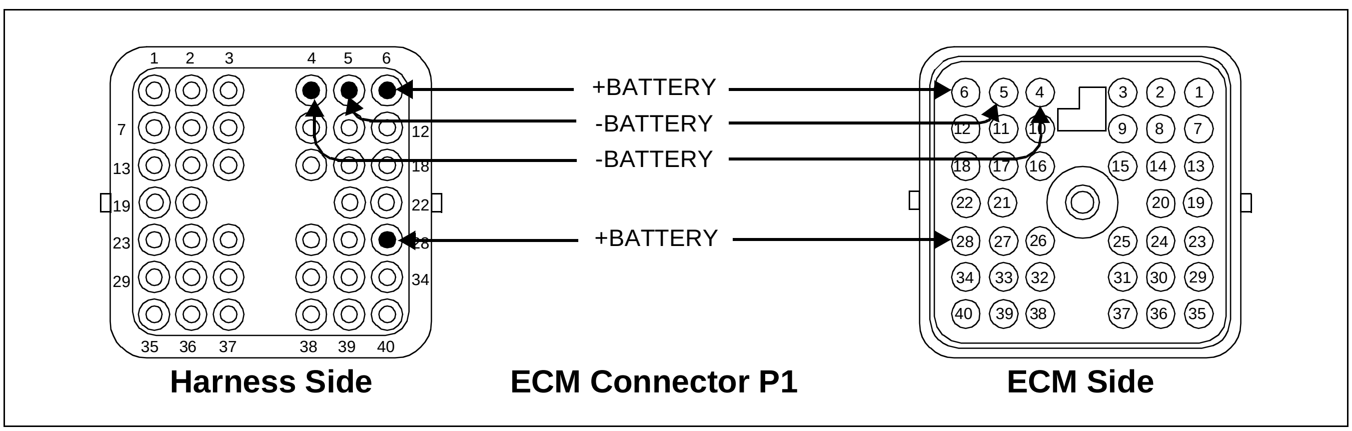
The battery wires are a twisted shielded pair. The shield should be connected to the -Battery at the batteries, not the ECM. If the battery lines require repair, ensure they are replaced with twisted shielded pair wiring.

For intermittent problems that could be caused by machine wiring (such as intermittent shutdowns) **temporarily** bypassing the machine wiring may be an effective means of determining the root cause. If symptoms disappear with the wiring bypassed, machine wiring was the cause. A means of bypassing machine wiring is explained in **Step 4 on page D-52**.

Schematic



ECM Pin Locations



Diagnostic Codes

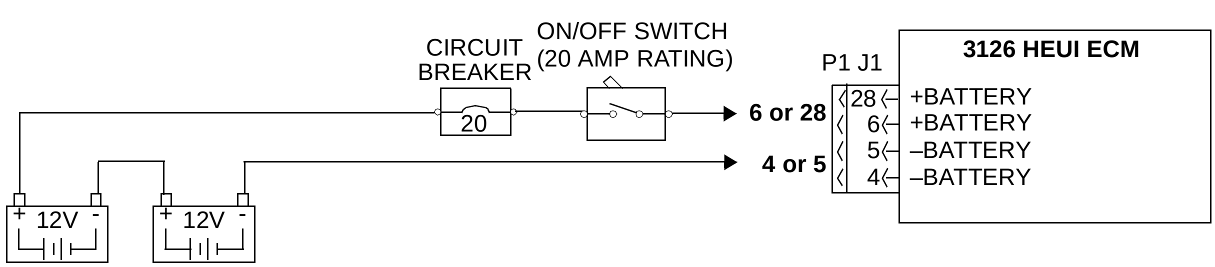
PID-FMI and Description of Code:	Systems Response:	Troubleshooting:
168-02 Low or Intermittent Battery Power to the ECM (51) Indicates the battery circuit to the ECM has either an intermittent or low battery condition while the engine is running. If battery voltage disappears without returning, the ECM will not log this diagnostic code and the engine will shutdown.	**Engine Response -** The engine may experience engine rpm “burps”, intermittent and/or complete engine shutdowns while the conditions causing this diagnostic code are present.	Proceed with procedure PB-11.

Functional Test

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 1: Check Electrical Connectors and Wiring.		
• Thoroughly inspect ECM Machine Harness Connector J1/P1 and the connections to the power relay in the battery compartment. (Refer to procedure “PB-10: Inspecting Electrical Connectors” on page D-43 for details on inspecting connectors.) • Perform 10 pound (44.5 N) pull test on each of the wires in the ECM Connector associated with the switched +Battery and -Battery connections. • Check ECM Connector (Allen screw) for proper torque. • Check the harness and wiring for abrasion and pinch points from the sensor back to the ECM. **• All connectors/pins/sockets should be completely mated/inserted, and the harness/wiring should be free of corrosion, abrasion or pinch points.**	**OK** ⇒ **NOT OK** ⇒	Proceed to the next step. **Repair or replace wiring or connectors as necessary.** Ensure all seals are properly in place and connectors completely mated. Verify the repair eliminates the problem. STOP.
Step 2: Check Batteries.		
• Turn the Ignition Switch ON, engine OFF. • Measure no-load battery voltage at the battery posts. **• Is the voltage at the batteries at least 24.4 volts DC?**	**YES** ⇒ **NO** ⇒	Proceed to the next step. **Charge the batteries.** Repair the charging system, if necessary. STOP.

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 3: Check Battery Voltage at ECM.		
• Turn the Ignition Switch OFF. • Disconnect Machine Harness Connector P1 from ECM Connector J1 and insert a 40-Pin Breakout T in series, or if Signal Reading Probes are available and ECM Machine Harness Connector P1 is accessible (without disconnecting), insert probes into pin-6 (+Battery) and pin-5 (-Battery). • Turn the Ignition Switch ON, engine OFF. • Measure the voltage between Machine Harness Connector P1 pin-6 (+Battery) and pin-5 (-Battery) with the ignition switch in the ON position. • Measure the voltage from Machine Harness Connector P1 pin-28 (+Battery) to pin-4 (-Battery) with the ignition switch in the ON position. **• Is the voltage within 1 volt DC of the measurement taken at the batteries for both measurements?**	**YES ⇒** **NO ⇒**	**The ECM is currently receiving the correct voltage.** If intermittent problems with battery voltage are suspected, proceed to 4 on page D-52. Otherwise, STOP. **There is excessive resistance in the harness. Repair or replace wiring or connectors as necessary.** STOP.

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 4: Bypass Machine Wiring Harness for Testing.		
NOTE: This bypass is for **TEST PURPOSES ONLY.** It may be left on the machine temporarily to test whether intermittent problems are due to interruptions in battery power to the ECM. Since this will also bypass any engine protection devices, **obtain approval from the owner before releasing the machine with this bypass installed.** The added switch is installed in parallel with the ignition switch. Either one will turn power ON, and both must be OFF to turn all power off and shut down the engine. • Turn the ignition OFF, engine OFF. • Build a bypass circuit as shown **below,** using #14 AWG wire. • Connect the battery end of the bypass DIRECTLY to the battery posts. • Remove pin-6 (+Battery) or pin-28 (+Battery) and pin-4 (-Battery) or pin-5 (-Battery) from the Machine Harness Connector P1. • Insert the other end of the bypass into Machine Harness Connector P1 pin-6 (+Battery) or pin-28 (+Battery) and pin-4 (-Battery) or pin-5 (-Battery). • Install the temporary switch in the cab. It will take place of the normal ignition switch during testing. • **Does the bypass eliminate the problem?** • After tests are complete, restore all wiring to original condition.	**YES ⇒** **NO ⇒**	**If symptoms disappear with the bypass installed, but return when it is removed, the problem is in the machine wiring supplying power to the ECM.** Repair as needed. STOP. **If the symptoms continue even with the bypass installed and the bypass switch is ON, the problem is in the engine system.** Continue with the procedure in this manual that best describes the symptoms. STOP.



Battery Bypass

PB-12: Throttle Position Sensor Circuit Test

System Operation

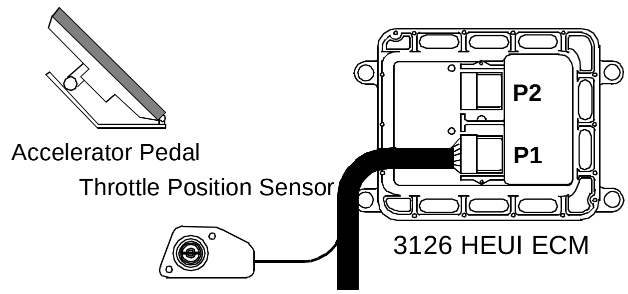
When to Use This Procedure

Use this procedure if a 91-08 Invalid Throttle Signal (32), 91-13 Throttle Sensor Calibration (28), 41-03 8 Volt Supply Above Normal (21), or 41-04 8 Volt Supply Below Normal (21) Diagnostic Code is indicated, or if the Throttle Position Sensor is suspected of improper operation.

Background

The Throttle Position Sensor is used to provide a throttle signal to the ECM. Sensor output is a constant frequency signal with a pulse width that varies with throttle position. This output signal is referred to as either “Duty Cycle” or a “Pulse Width Modulated” (PWM) signal and is expressed as a percentage between 0% and 100%.

The Throttle Position Sensor is attached directly to the accelerator pedal assembly and requires no adjustment. The sensor will produce a “Duty Cycle” of 10% to 22% at low idle and 75% to 90% at full throttle. The percent duty cycle is translated in the ECM into throttle position of 3% to 100%.

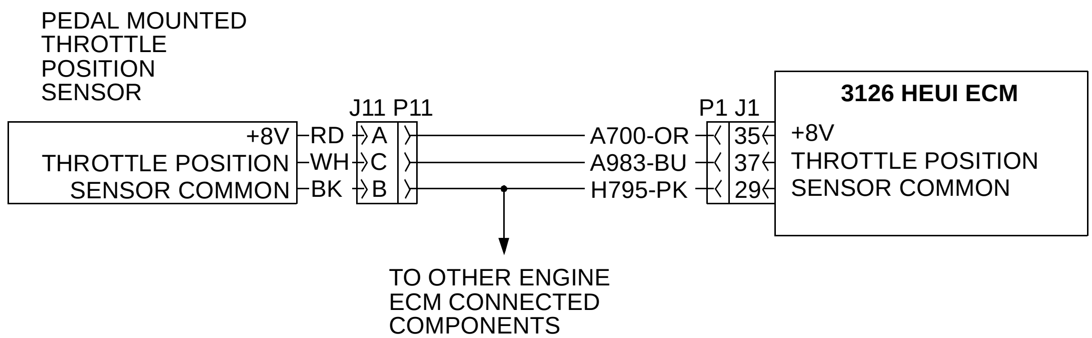


The Throttle Position Sensor is powered by the ECM supplied + 8V from connector P1 pin-35 to pin-A of the throttle sensor connector. The pedal mounted sensor can be replaced separately from the accelerator pedal assembly.

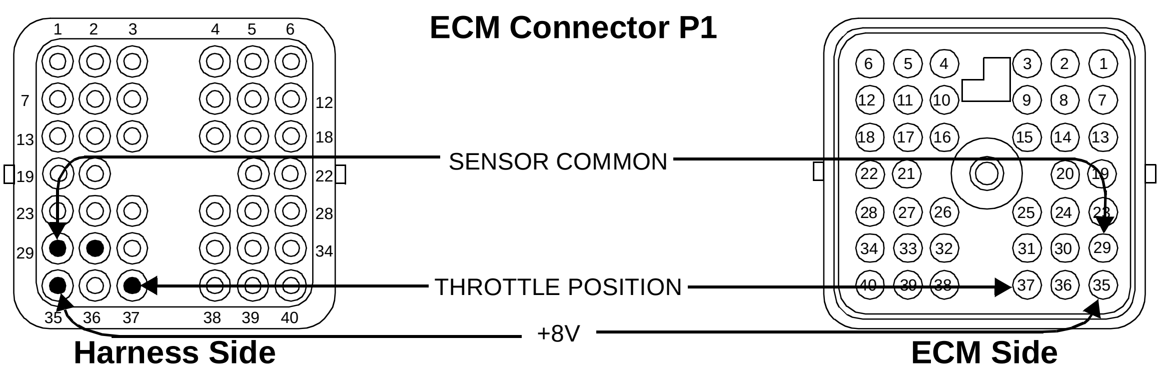
An incorrectly calibrated pedal mounted throttle position sensor assembly cannot be adjusted, the accelerator pedal assembly must be replaced.

The ECM may also not respond to the Throttle Position Sensor if there is an Active 253-02 Check Customer or System Parameters (56) Diagnostic Code under some conditions. Proceed to “PC-30 ECM Memory Test” on page D-94 if there is an Active 253-02 Check Customer or System Parameters (56) Diagnostic Code.

Schematic: +8V Pedal Mounted Throttle Position Sensor



ECM Pin Locations



Diagnostic Codes

PID-FMI and Description of Code:	Systems Response:	Troubleshooting:
41-03 8 Volt Supply Above Normal (21) The accelerator pedal throttle position sensor supply voltage is higher than it should be.	**Engine Response -** An active diagnostic code may not cause any noticeable affect on engine response unless the voltage is significantly above or below 8 volts.	Proceed with procedure PB-12.
41-04 8 Volt Supply Below Normal (21) The accelerator pedal throttle position sensor supply voltage is lower than it should be.		
91-08 Invalid Throttle Signal (32) The ECM is not receiving a correct throttle signal.	**Electronic System Response -** The ECM returns the engine to low idle as soon as the problem is detected. The diagnostic code is only logged if the engine is running. **Service Tool Display or Lamps -** Service Tool will indicate 0% throttle position while the diagnostic code is Active regardless of the accelerator pedal assembly position. **Engine Response -** The engine will remain at low idle while the diagnostic code is active.	This diagnostic code is most likely caused by an open circuit in the throttle position signal circuit, or voltage supply circuit. Proceed with procedure PB-12.
91-13 Throttle Sensor Calibration (28) The throttle signal is less than 5% or more than 95%.	**Electronic System Response -** The ECM returns the engine to low idle as soon as the problem is detected. **Service Tool Display or Lamps -** Service Tool will indicate 0% throttle position while the diagnostic code is Active. **Engine Response -** The engine will remain at low idle while the diagnostic code is active.	Proceed with procedure PB-12.

Functional Test

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 1: Check Electrical Connectors and Wiring.		
• Thoroughly inspect ECM Machine Harness Connector J1/P1, the bulkhead connector, and the Throttle Position Sensor Connector. (Refer to procedure "PB-10: Inspecting Electrical Connectors" on page D-43 for details on inspecting connectors.) • Perform 10 pound (44.5 N) pull test on each of the wires in the ECM Connector associated with the Throttle Position Sensor. • Check ECM Connector (Allen screw) for proper torque. • Check the harness and wiring for abrasion and pinch points from the sensor back to the ECM. • **All connectors/pins/sockets should be completely mated/inserted, and the harness/wiring should be free of corrosion, abrasion or pinch points.**	OK ⇒	Proceed to the next step if inspecting the throttle position signal circuit for **Active diagnostic codes 91-08, or 91-13.** Proceed to Step 4 on page D-56 if inspecting the **+8V supply for Active codes 41-03 or 41-04.**
	NOT OK ⇒	**Repair or replace wiring or connectors as necessary.** Ensure all seals are properly in place and connectors completely mated. Verify the repair eliminates the problem. STOP.
Step 2: Check Throttle Position Sensor Reading.		
• Connect ET at the Cab Data Link Connector. **NOTE:** Performing certain steps within this procedure requires a multimeter capable of determining PWM duty cycle. • Turn the ignition switch ON, engine OFF. • Observe Throttle Position Sensor reading on the **"Monitor Throttle Position Sensor Signal"** screen of the Service Tool. The screen is under the Calibrate/Monitor Sensors function. • **Is the DUTY CYCLE between 10% and 22% with the accelerator pedal assembly in the low idle position and increasing to between 75% and 90% with the throttle assembly in the high idle position?**	YES ⇒	**The Throttle Position sensor is currently operating correctly.** Start the engine and depress and release the throttle while monitoring the ET Throttle Position status. STOP.
NOTE: When the ECM automatically calibrates (auto-cal) new duty cycle values for the low idle and high idle throttle positions, it assumes 22% at low idle and 75% for the high idle **duty cycle**. As a result, you may notice the "Throttle Pos" status reaches 100% throttle position well before the accelerator pedal is fully depressed, this is normal. Following some cycling of the accelerator pedal to the high idle position, the ECM will adjust its calibration automatically, provided the high idle stop position is within the 75% to 90% duty cycle range, and the low idle is in the 10% to 22% duty cycle range. During normal operation you may also notice it requires more accelerator pedal movement for the "Throttle Pos" status to increase above 3% than you think it should, and observe the status reaches the 100% value prior to the limit of the high idle position before you think it should. This is done to ensure the throttle reaches these two critical points for engine operation.	NO ⇒	**The Throttle Position Sensor circuit is not operating correctly. Proceed to the next step.**

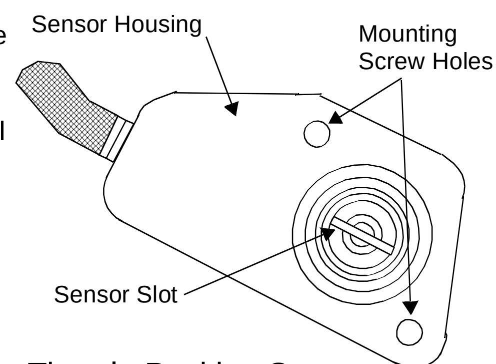
TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 3: Check Throttle Position Sensor Supply Voltage at the sensor. • Install 3-Pin Breakout T at the Throttle Position Sensor connector J11/P11. • Turn the ignition switch ON, engine OFF. • Measure voltage at pin-A (+V) with reference to pin-B (Sensor Common). • The voltage should be between 7.5 and 8.5 volts DC. **• Is the voltage within the indicated range?**	**YES ⇒** **NO ⇒**	**The Throttle Position Sensor is receiving the correct voltage.** Proceed to Step 6 on page D-57. **The sensor is not receiving correct voltage.** Proceed to the next step.
Step 4: Disconnect Throttle Position Sensor while Monitoring Active Codes. • Access the Active Diagnostic Code screen of ET. **Verify either a 41-03 8 Volt Supply Above Normal (21) or 41-04 8 Volt Supply Below Normal (21) Diagnostic Code are Active before proceeding.** • Monitor the Active Diagnostic Code screen while disconnecting and reconnecting the Throttle Position Sensor. **• Is the 41-03 8 Volt Supply Above Normal (21) or 41-04 8 Volt Supply Below Normal (21) Diagnostic Code still Active after the sensor is disconnected?**	**YES ⇒** **NO ⇒**	**Ensure the Throttle Sensor is reconnected.** Proceed to the next step. **Replace the throttle position sensor.** Ensure the +8V Diagnostic Code is cleared, and the problem is resolved. STOP.

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 5: Disconnect Throttle Position Sensor Supply Pins at the ECM.		
• Turn the ignition switch OFF, engine OFF. • Remove pin-35 (+ 8V) and pin-29 (Sensor Common) from Machine Harness Connector P1 (disconnect ECM Machine Harness Connector J1/P1 if necessary). • Reconnect ECM Machine Harness Connector J1/P1. • Turn the ignition switch ON, engine OFF. • Use ET to verify the code is still Active. • **Is the 41-03 8 Volt Supply Above Normal (21) or 41-04 8 Volt Supply Below Normal (21) Diagnostic Code still Active after the sensor power pins are disconnected?**	**YES** ⇒ **NO** ⇒	**Check the battery voltage from pin-6 (+Battery) to pin-5 (-Battery) at ECM Connector J1/P1 and verify it is 22 to 27 VDC. Check the battery voltage from pin-28 (+Battery) to pin-4 (-Battery) at Connector J1/P1 and verify it is 22 to 27 VDC.** If the voltages are as indicated, **temporarily install another ECM**. If the problem is corrected with the new ECM, and returns when the old ECM is connected, replace the ECM. **There is a problem in the wiring between the ECM and the throttle sensor.** Reconnect the removed wires one at a time while watching to verify the code reappears, first pin-29 and then pin-35 to determine which is causing the problem and repair/replace as necessary. STOP.
Step 6: Check Throttle Position Sensor Duty Cycle at the Sensor.		
• Turn the ignition switch OFF, engine OFF. • Remove Throttle Position Signal wire (pin-C) from Connector P11, Machine Harness half of the Throttle Position Sensor Connector. • Connect a 3-Pin Breakout T to the Throttle Position Sensor Connector and Harness Connector. • Turn the ignition switch ON, engine OFF. • Use a multimeter capable of measuring DUTY CYCLE to measure the DUTY CYCLE between pin-C and pin-B of the Breakout T. **Is the DUTY CYCLE between 10% and 22% with the accelerator pedal released and between 75% and 90% with the accelerator pedal fully depressed?**	**YES** ⇒ **NO** ⇒	**Insert Pin-C into the Machine Harness Connector. The Throttle Position Sensor is working correctly.** Proceed to Step 8 on page D-59. **Leave the PWM Probe Connected to the Breakout T. Reinsert the wire (pin-C) into the Machine Harness Connector.** The Throttle Position Sensor or the Accelerator Pedal Assembly is faulty. Proceed to the next step.

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 7: Remove Sensor from Throttle Assembly.		
• Turn the ignition switch OFF, engine OFF. • Remove the Pedal Mounted Sensor from the Accelerator Pedal Assembly. Note the sensor orientation in the accelerator pedal assembly, and the sensor pigtail routing prior to sensor removal. • Turn the ignition switch ON, engine OFF. • Use a multimeter capable of measuring DUTY CYCLE to measure the DUTY CYCLE output of the Throttle Position Sensor with the sensor slot released, and advanced (use a screwdriver in the dial slot, refer to the following illustration) to the maximum position. **• With the sensor removed from the Accelerator Pedal Assembly, is the pedal mounted sensor DUTY CYCLE 10% or less with the slot released, and does it increase to 90% or more with the slot in the maximum position?** **NOTE:** With the sensor removed from the Accelerator Pedal Assembly a Diagnostic Code, 91-13 Check Throttle Position Adjustment (28), may be generated. This is normal, but should disappear when the sensor is properly assembled into the Pedal Assembly.	**YES ⇒** **NO ⇒**	**The Throttle Position Sensor is working correctly.** Replace the Accelerator Pedal Assembly. **Clear any codes caused by this procedure.** **The Pedal Mounted Throttle Position Sensor is faulty.** Check the Accelerator Pedal Assembly to ensure it is not causing sensor damage. If so, replace the Accelerator Pedal Assembly. If the Pedal Assembly appears OK, replace the Throttle Sensor as shown in the illustration. STOP.

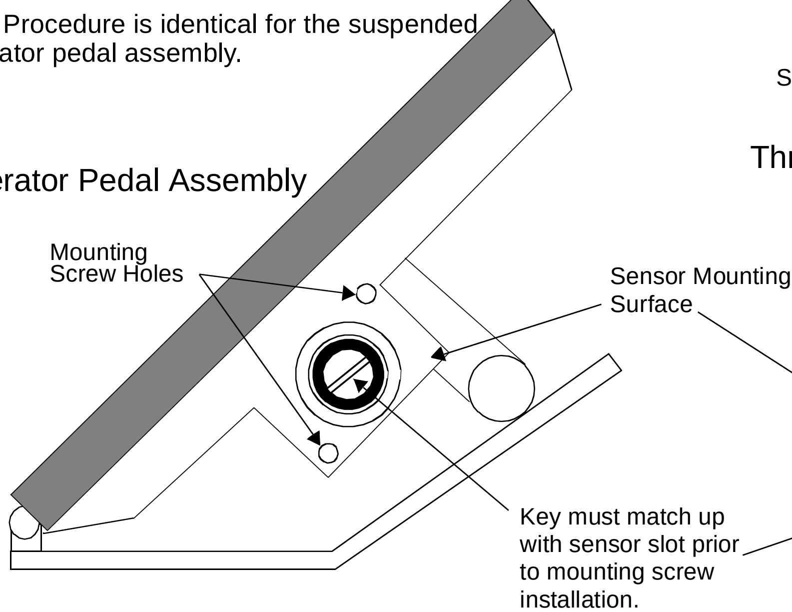
1. Mate sensor to accelerator pedal assembly. Key must match up with the sensor slot. Check the sensor housing for a flush fit to the pedal assembly mounting surface. (This insures slot on sensor has mated correctly with the pedal assembly key.)
2. Ensure the sensor is oriented the same as it was prior to removal to insure sensor harness pigtail is routed correctly.
3. Line up screw holes and install mounting screws.

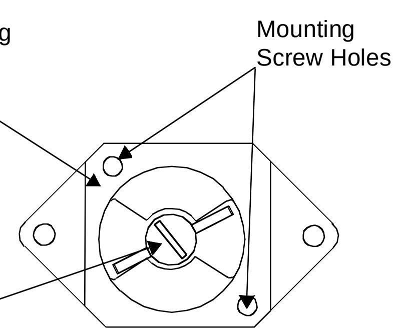
NOTE: Procedure is identical for the suspended accelerator pedal assembly.



Throttle Position Sensor

Accelerator Pedal Assembly





Throttle Block Assembly

<table>
<tr><th>TEST STEP</th><th>RESULT</th><th>DIAGNOSIS/ACTION</th></tr>
<tr><td>Step 8: Check Throttle Sensor Duty Cycle at ECM.
• Turn the ignition switch OFF, engine OFF.
• Disconnect Machine Harness Connector P1 if necessary to remove the throttle position signal pin as described below.
- Remove the Throttle Position wire (pin-37) from the Machine harness side (P1) of ECM Machine Harness Connector J1/P1.
• Reconnect Machine Harness Connector P1 to the ECM.
• Turn the ignition switch ON, engine OFF.
• Use a multimeter capable of measuring DUTY CYCLE to measure the DUTY CYCLE output of the Throttle Position Sensor while moving the sensor assembly from low idle to the maximum.
• Is the DUTY CYCLE between 10% and 22% with the accelerator pedal released and increased to between 75% and 90% with the accelerator pedal fully depressed?
• Turn the ignition switch OFF, engine OFF.
• Reinsert pin-37 into the 40-Pin ECM Machine Harness Connector J1/P1.</td><td>YES ⇒

NO ⇒</td><td>An acceptable throttle sensor signal is reaching the ECM. Check to ensure the ECM is receiving proper battery voltage. If so, temporarily replace the ECM with another. If the problem disappears with the new ECM, and returns with the old ECM, replace the old ECM.

There is a problem with the throttle sensor signal wire in the Machine wiring harness. Proceed to the next step.</td></tr>
<tr><td>Step 9: Route Supply Bypass Wires to the Throttle Sensor.
• Turn the ignition switch OFF, engine OFF.
• Remove pin-37 (Throttle Position) from Machine Harness Connector P1.
• Remove pin-C (Throttle Position) from the Throttle Position Sensor Connector.
• Route new wiring from the ECM to the Throttle Position Sensor.
• Turn the ignition switch ON, engine OFF.
• Check the Throttle Sensor Duty Cycle on ET while moving the throttle assembly over the full range.
• Is the DUTY CYCLE between 10% and 22% with the accelerator pedal released and increased to between 75% and 90% with the accelerator pedal fully depressed?</td><td>YES ⇒

NO ⇒</td><td>Permanently install the wiring.

Double check the wiring, the ECM Connector J1/P1 and the Sensor Connector. Repeat Step 4 on page D-56 and Step 5 on page D-57 if necessary.</td></tr>
</table>

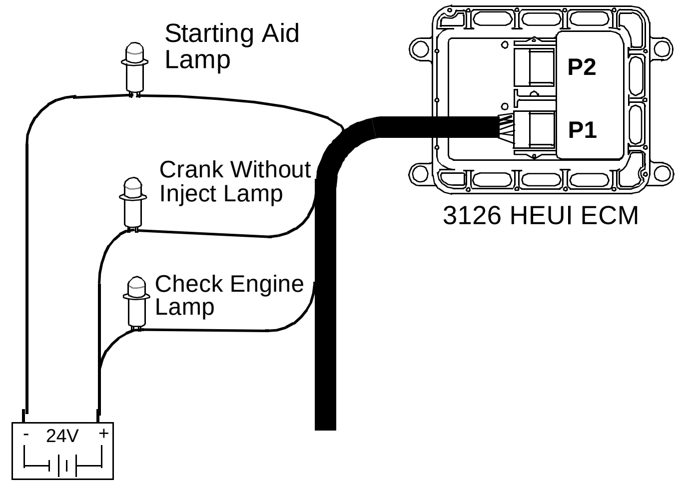
PB-13: Check Engine, Crank Without Inject, or Starting Aid Lamp Test

System Operation

When to Use This Procedure

Use the following information to help determine if the Check Engine, Crank Without Inject, or Starting Aid Lamps are operating or when troubleshooting a lamp diagnostic code.

If the Blackout Light Switch is in the OFF position or a Blackout mode position, the Check Engine, Crank Without Inject, and Starting Aid Lamps will be kept OFF. When the Blackout Light Switch is in the Stop Light or Service Drive position, the Check Engine, Crank Without Inject, and Starting Aid Lamps will turn on for five seconds when the ignition switch is turned to the ON position. Afterwards, the Check Engine, Crank Without Inject, and Starting Aid Lamps illuminate when certain diagnostic conditions exist. All lamps will be OFF when the ignition switch is turned OFF.



Check Engine Lamp

The Check Engine Lamp is often referred to as the Diagnostic Lamp. This Lamp is used to indicate the existence of an Active diagnostic code and may be used to read Diagnostic Flash Codes.

While the Diagnostic Enable Switch is set to the Check Engine Mode, the Lamp will turn ON for a minimum of five seconds any time a fault condition exists. It will continue to flash ON for five seconds, and then blink OFF, flash ON for five seconds, etc, as long as the fault condition exists.

While the Diagnostic Enable Switch is set to the Flashing Code Mode, a two digit code is flashed for each ACTIVE diagnostic code. The Flash Code is determined from the number of times the Check Engine Lamp blinks. The lamp will blink for the first digit of the flash code, pause five seconds, and then blink for the second digit.

NOTE: If the Check Engine/Diagnostic Lamp continually flashes diagnostic flash codes (without operator prompting) the Diagnostic Enable J1/P1 pin-38 is most likely short circuited to ground.

Crank Without Inject Lamp

The Crank Without Inject Lamp is illuminated to indicate fuel injection is disabled at the Crank Without Inject plug. This prevents unnecessary troubleshooting when injection is disabled with the Crank Without Injection Inputs.

Starting Aid Lamp

The Starting Aid Lamp is illuminated to indicate if the Air Inlet Heater is ON or if ether is being injected.

Electrical Connection of Lamps

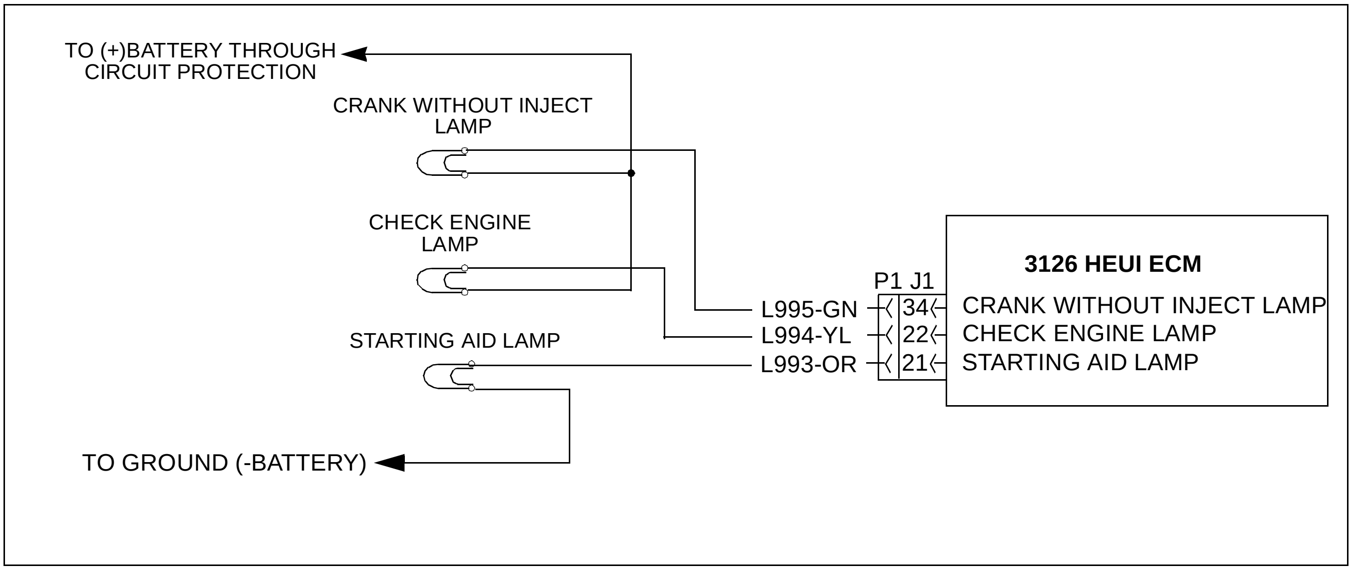
One terminal of the Check Engine Lamp the and Crank Without Inject Lamp must be connected to battery voltage through machine wiring. The other terminal is connected to the ECM at ECM Machine Harness Connector J1/P1 pin-22 (Check Engine Lamp) or pin-34 (Crank Without Inject Lamp). The ECM provides a path to ground to turn these lamps ON.

One terminal of the Starting Aid Lamp must be connected to ground through machine wiring. The other terminal is connected to the ECM at ECM Machine Harness Connector J1/P1 pin-21. The ECM provides voltage to turn this lamp ON.

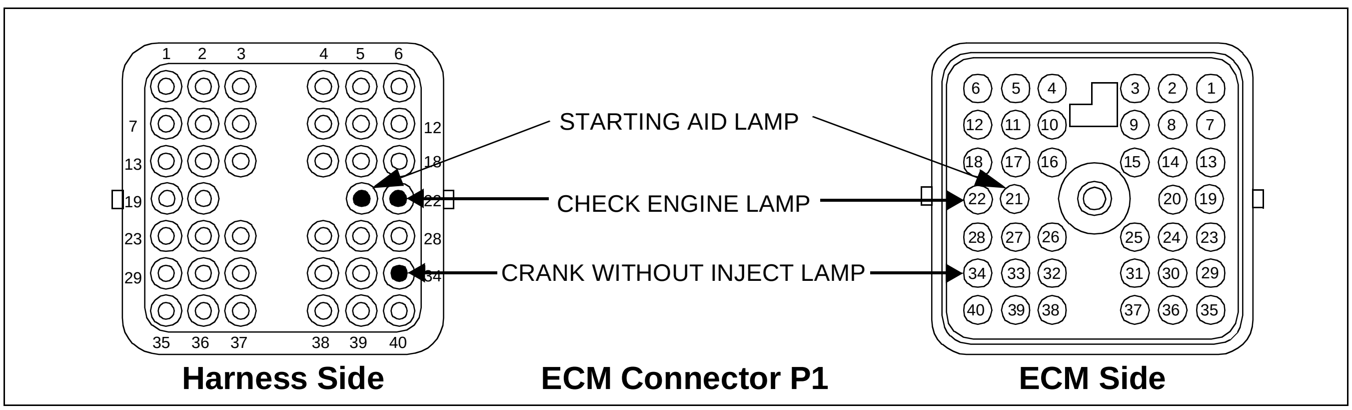
Diagnostic Codes

PID-FMI and Description of Code:	Systems Response:	Troubleshooting:
129-05 Check Engine Lamp Open Circuit Indicates the circuit from the Check Engine Lamp to the ECM is open or shorted to ground.	**Electronic System Response -** A diagnostic code is generated. The Check Engine Lamp may or may not be illuminated	Proceed with procedure PB-13.
129-06 Check Engine Lamp Short Circuit Indicates the circuit from the Check Engine Lamp to the ECM is shorted to +Battery.		
132-05 Starting Aid Lamp Open Circuit (89) Indicates the circuit from the Starting Aid Lamp to the ECM is open or shorted to +Battery.	**Electronic System Response -** A diagnostic code is generated and the Check Engine Lamp is illuminated (if the Blackout Light Switch is OFF).	
132-06 Starting Aid Lamp Short Circuit (89) Indicates the circuit from the Starting Aid Lamp to the ECM is shorted to ground.		
133-05 Crank Without Inject Lamp Open Circuit (91) Indicates the circuit from the Crank Without Inject Lamp to the ECM is open or shorted to ground.		
133-06 Crank Without Inject Lamp Short Circuit (91) Indicates the circuit from the Crank Without Inject Lamp to the ECM is shorted to +Battery.		

Schematic:

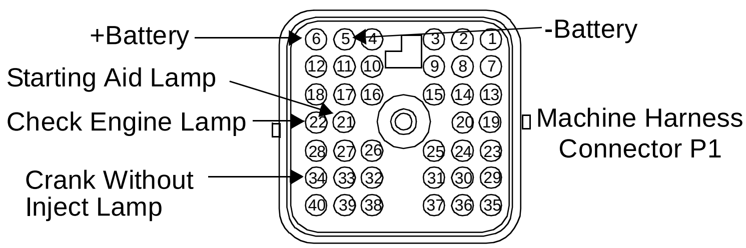


ECM Pin Locations



Functional Test

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 1: Check Electrical Connectors and Wiring.		
• Thoroughly inspect ECM Machine Harness Connector J1/P1, the bulkhead connector, and the Check Engine, Crank Without Inject, and Starting Aid Lamps pins in the Connectors. (Refer to procedure “PB-10: Inspecting Electrical Connectors” on page D-43 for details on inspecting connectors.) • Perform 10 pound (44.5 N) pull test on each of the wires in the ECM Connector associated with the Check Engine, Crank Without Inject, or Starting Aid Lamp. • Check ECM Connector (Allen screw) for proper torque. • Check the harness and wiring for abrasion and pinch points from the sensor back to the ECM. • **All connectors/pins/sockets should be completely mated/inserted, and the harness/wiring should be free of corrosion, abrasion or pinch points.**	**OK** ⇒ **NOT OK** ⇒	Proceed to the next step. **Repair or replace wiring or connectors as necessary.** Ensure all seals are properly in place and connectors completely mated. Verify the repair eliminates the problem. STOP.
Step 2: Check for Normal Operation of the Lamp.		
For the Check Engine/Service Engine Soon Lamp, • Turn the Blackout Light Switch to the Service Drive position. • While observing the Check Engine, Crank Without Inject, and Starting Aid Lamps, turn the ignition switch ON, engine OFF. The lamps should turn ON for five seconds and turn OFF if no diagnostic conditions are present. • **Do the Lamps turn ON and OFF as indicated?**	**YES** ⇒ **NO** ⇒	**The lamps appear to be operating correctly at this time.** STOP. Use ET to verify the Blackout Status is OFF. Refer to PB-15: Blackout, Diagnostic Enable, Engine Speed Control, and Starting Aid Switch Circuit Test. If problem is not resolved, Proceed to the next step.

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 3: Test the Lamp Circuit.		
• Disconnect ECM Machine Harness Connector J1/P1. • Fabricate a jumper wire 4 inches (100 mm) long with a Deutsch Pin crimped to both ends.  • **Check Engine Lamp or Crank Without Inject Lamp:** Insert the jumper into the suspect lamp socket of connector P1 socket-22 (Check Engine Lamp) or socket-34 (Crank Without Inject Lamp). Connect the other side of the jumper wire to the -Battery pin-5. • **Starting Aid Lamp:** Insert the jumper into the suspect lamp socket of connector P1 socket-21 (Starting Aid Lamp). Connect the other side of the jumper wire to the +Battery pin-6.  • Turn the ignition switch ON, engine OFF. • Insert and remove the jumper wire while watching the lamp. • **Does the Lamp turn ON while the jumper is connected to both sockets, and turn OFF when the jumper is removed from one of the sockets?**	**YES ⇒** **NO ⇒**	**The lamp circuit is functioning properly.** Proceed to the next step. **For the lamp not coming ON, The machine lamp circuit is not functioning properly.** Most likely the lamp is burned out or there is a problem in the wiring from the cab to either the ECM or the +Battery / Ground connection. Repair as required.

<table>
<tr><th>TEST STEP</th><th>RESULT</th><th>DIAGNOSIS/ACTION</th></tr>
<tr><td>Step 4: Check ECM Operation of the Lamp.</td><td rowspan="2">YES ⇒

NO ⇒</td><td rowspan="2">The ECM is operating correctly. There is a problem in the machine wiring or the lamp.

Temporarily install another ECM. Repeat this test step. If the problem is resolved with the new ECM, install the old ECM to verify the problem returns with the ECM. If the new ECM works and the old one did not, replace the ECM.</td></tr>
<tr><td>

• Insert a 40-Pin Breakout T at ECM Machine Harness Connector J1/P1.

• Connect one of the probes of a voltage test lamp to pin-5 (-Battery) and the other probe to pin-6 (+Battery) of the Breakout T.

• Turn the Blackout Light Switch to the Service Drive position.

• Turn the ignition switch ON, engine OFF. The test lamp should turn ON with the ignition switch ON. If it does not, either the test lamp or wiring to the ECM is faulty. Continue with this step if the lamp turns ON as expected.

For the Check Engine or Crank Without Inject Lamp,

• Leave the voltage test lamp probe connected to pin-6 (+Battery).

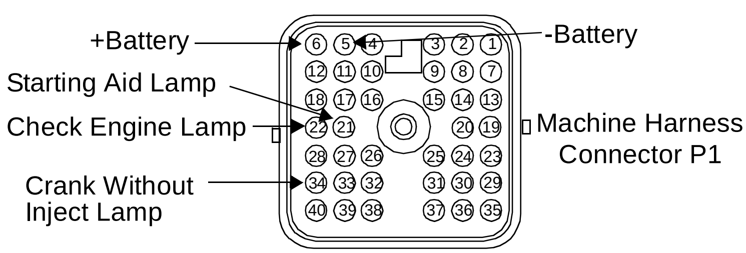
• Connect the other probe of the test lamp to pin-22 (Check Engine Lamp) or socket-34 (Crank Without Inject Lamp) of the 40-Pin T.

For the Starting Aid Lamp,

• Leave the voltage test lamp probe connected to pin-5 (-Battery).

• Connect the other probe of the test lamp to pin-21 (Starting Aid Lamp) of the 40-Pin Breakout T.

• While watching the voltage test lamp, turn the ignition switch ON (engine OFF). The test lamp should turn ON for five seconds and turn OFF (unless a diagnostic condition is present).



• **Does the Lamp turn ON and OFF as indicated?**

</td></tr>
</table>

PB-14: Vehicle (Machine) Speed Circuit Test

System Operation

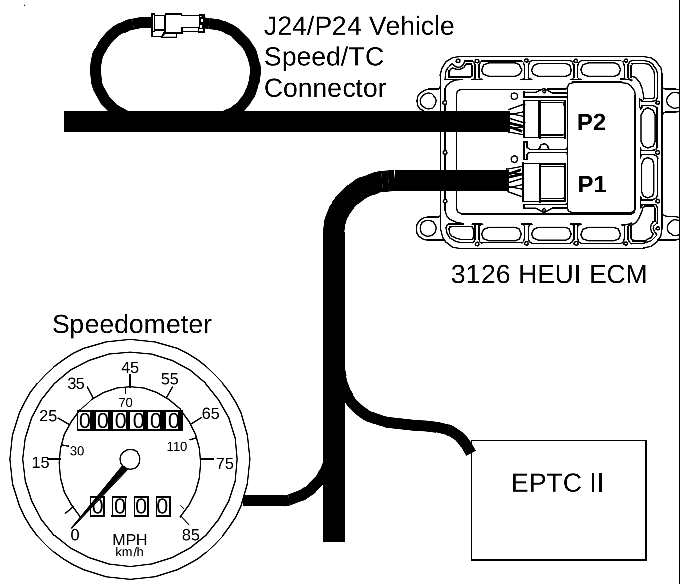
When to Use This Procedure

Use this procedure to troubleshoot for Active or easily repeated diagnostic fault codes associated with the vehicle speed circuit.

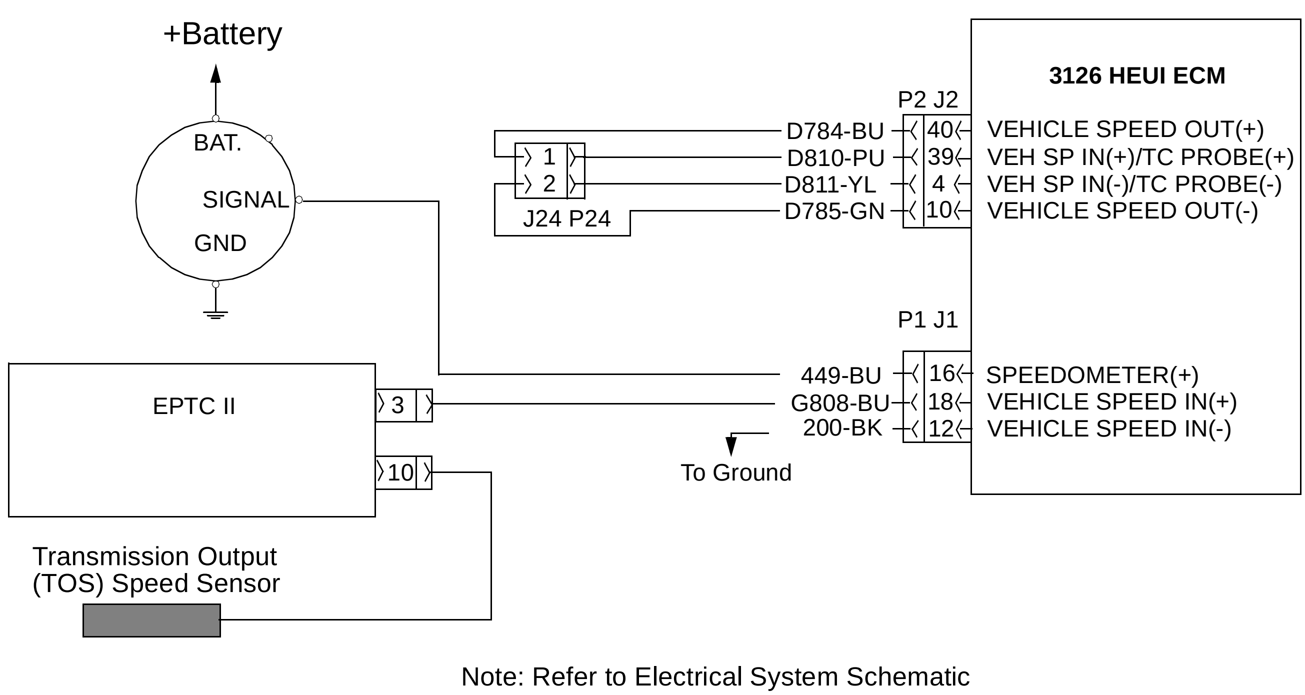
Background

The vehicle (machine) speed circuit consists of the vehicle speed source, the speedometer, and associated wiring. The vehicle speed source is from EPTC II which has a sensor that detects movement of teeth on the output shaft of the transmission. The ECM converts the signal from the vehicle speed source and sends it to the vehicle speedometer. Connector J24/P24 must remain connected during normal operation or the ECM speed signal will be lost.

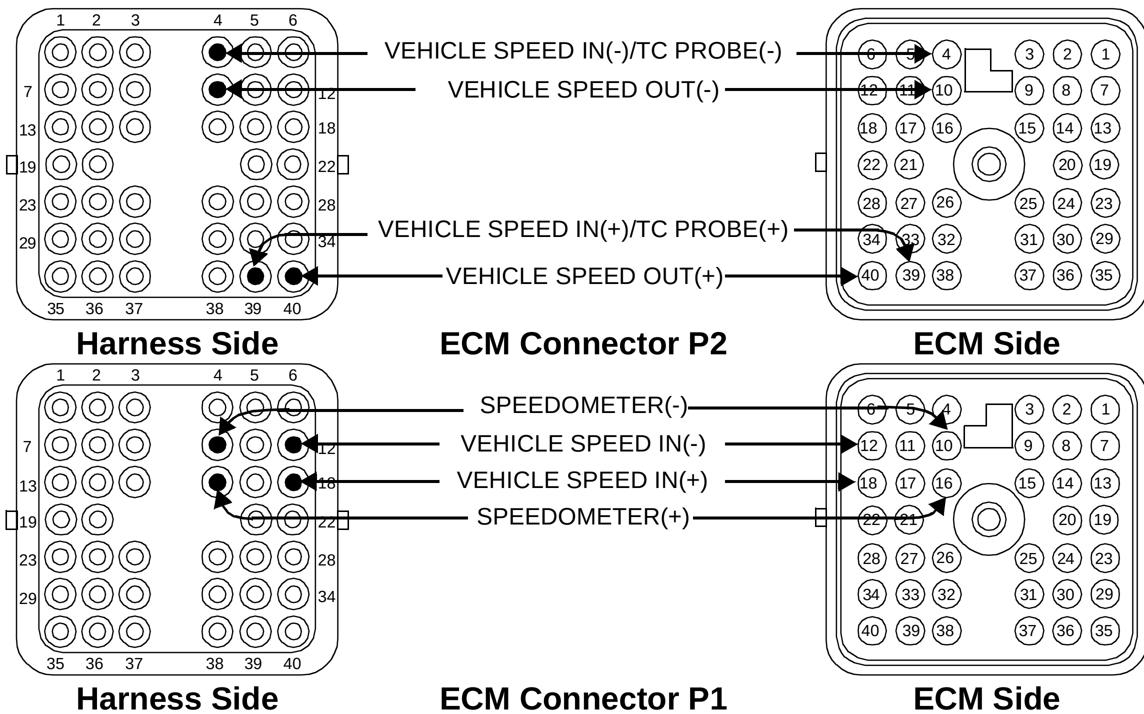
The vehicle speed signal has a frequency that is directly proportional to vehicle speed and is set to 59,742 pulses per mile.



Schematic- EPTC II Providing Vehicle Speed to Engine ECM



ECM Pin Locations



Diagnostic Codes

PID-FMI and Description of Code:	Systems Response:	Troubleshooting:
84-01 Loss of Vehicle Speed Signal (31) The ECM does not detect vehicle speed when conditions indicate vehicle speed should be present.	**Electronic System Response -** The diagnostic code is logged. **NOTE:** On rare occasions, a fuel system restriction or other fuel problem has been known to cause this diagnostic code. This situation exists because the injectors are unable to provide sufficient fuel to achieve desired rpm under normal load conditions. Because the ECM cannot reach desired rpm under normal load conditions it suspects the vehicle is under a load which can/should only occur when the vehicle is moving.	If the problem occurs while the vehicle is not moving, check the fuel pressure to ensure a fuel system restriction is not the cause. Otherwise, proceed with procedure PB-14.

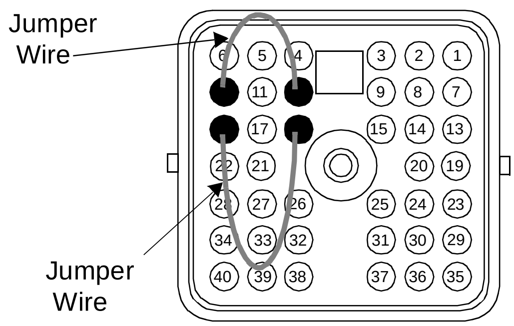
Functional Test

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 1: Check Electrical Connectors and Wiring.		
• Thoroughly inspect ECM Connectors J1/P1, J2/P2, Vehicle Speed/TC Connector J24/P24, and the bulkhead connector, and the Vehicle Speed pins in the Connectors. Check EPTC II connectors and the TOS Sensor connections. (Refer to procedure “PB-10: Inspecting Electrical Connectors” on page D-43 for details on inspecting connectors.) • Perform 10 pound (44.5 N) pull test on each of the wires in the ECM Connector associated with the Vehicle Speed Sensor. • Check ECM Connector (Allen screw) for proper torque. • Check the harness and wiring for abrasion and pinch points from the sensor back to the ECM. • **All connectors/pins/sockets should be completely mated/inserted, and the harness/wiring should be free of corrosion, abrasion or pinch points.**	**OK** ⇒ **NOT OK** ⇒	Proceed to the next step. Repair or replace wiring or connectors as necessary. **Ensure all seals are properly in place and connectors completely mated. Verify the repair eliminates the problem.** STOP.
Step 2: Check EPTC II for Transmission Output Speed (TOS) Diagnostic Codes.		
• Turn the ignition switch OFF, engine OFF. • Connect ET to the **EPTC II Transmission Control** service tool connector. • Road test the machine. • Verify correct operation of the Transmission Output Speed Sensor. Check for diagnostic codes (CID 701). Refer to the EPTC II Service Manual for details. • **Is the EPTC II Transmission Output Speed Sensor circuit functioning correctly?**	**YES** ⇒ **NO** ⇒	Proceed to the next step. **There is a problem in the EPTC II speed circuit.** Repair as required. Refer to the Electrical System Schematic and the EPTC II Service Manual for details.
Step 3: Check ECM Vehicle Speed Status With ET.		
• Road test the machine. Compare the vehicle speed on ET status screen against the speedometer, and against actual vehicle speed as measured by a follow vehicle or a stopwatch. • Monitor the vehicle speed status on ET while parked, engine running. • Operate (cycle them ON/OFF) various electrical devices in the vehicle while monitoring the vehicle speed. • Rev engine rpm up and down a few times. • **Does the ET status screen and speedometer agree with the actual speed?** **NOTE:** If operation of a specific electrical device or if accelerating engine rpm produces a vehicle speed problem, there is an electrical noise problem. Check for proper grounding and verify speed signal wiring is routed away from noise sources.	**YES** ⇒ **Service Tool Vehicle Speed NOT OK** ⇒ **Service Tool Status OK, Speedometer NOT OK** ⇒	**There is not a vehicle speed problem at this time.** STOP. Proceed to the next step. Proceed to Step 8.

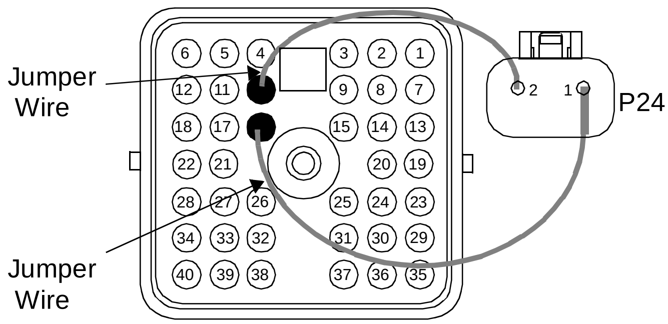
<table>
<tr><th>TEST STEP</th><th>RESULT</th><th>DIAGNOSIS/ACTION</th></tr>
<tr><td>Step 4: Check ECM and Engine Harness Using the ET Special Test.</td><td rowspan="2">YES ⇒

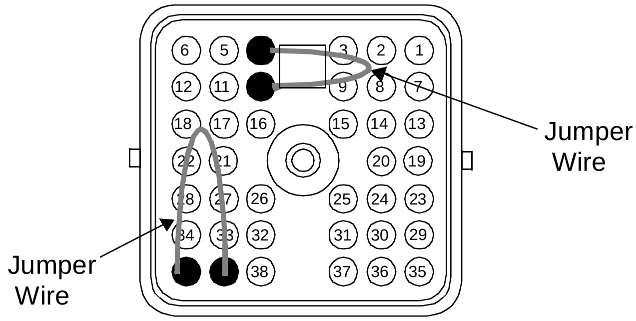
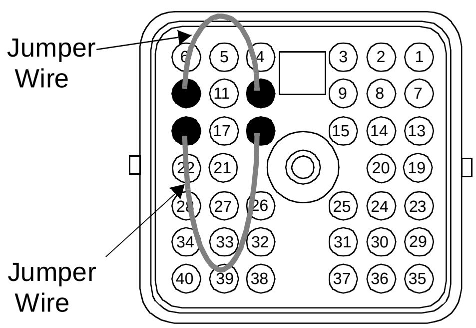
NO ⇒</td><td rowspan="2">The ECM is operating correctly. The problem is in the Vehicle Speed Signal harness between the ECM and EPTC II. Repair as necessary. Remove all jumpers, the Breakout T, and reconnect wires to pin-10, pin-12, pin-16, and pin-18 in Connector P1. STOP.

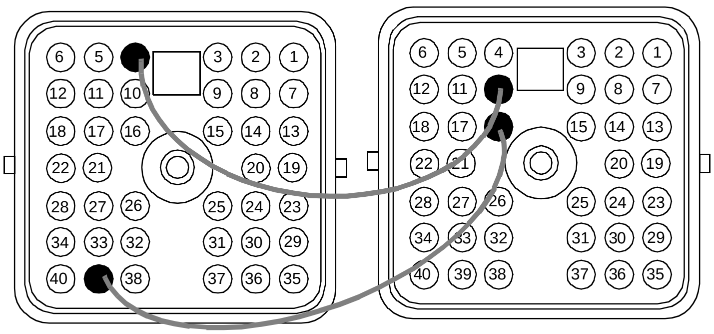
Leave the Breakout T in place and remove jumper wires. Proceed to the next step.</td></tr>
<tr><td>• Turn the ignition switch OFF, engine OFF.
• Make two wire jumpers 24 inches (600 mm) long with Deutsch pins on both ends.
Deutsch Pin Contact Deutsch Pin Contact

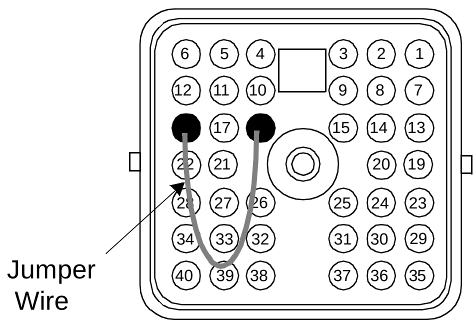
• Disconnect ECM Connector J1/P1.
• Remove terminals pin-10 (Speedometer-), pin-16 (Speedometer+), pin-12 (Vehicle Speed In-), and pin-18 (Vehicle Speed In+) from Connector P1.
• Connect a 40-Pin Breakout T to ECM Connector J1 and connect P1 to the Breakout T.


40-Pin Breakout T
@ J1/P1 Harness Connector
• Install one jumper into the Breakout T pin-12 (Vehicle Speed In-) and pin-10 (Speedometer-). Install the other jumper into the Breakout T pin-18 (Vehicle Speed In+) and pin-16 (Speedometer+).
• Turn the ignition switch ON, engine OFF.
• Install ET and access the 55 mph VSP/Speedometer Test.
• Start the test and then check the vehicle speed on the vehicle speed status screen.
• Does ET indicate a constant vehicle speed with the jumper from the Speedometer circuits connected to the ECM Vehicle Speed Inputs?</td></tr>
</table>

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 5: Check ECM and Engine Harness from ECM to P24 Using the ET Special Test.		
• Turn the ignition switch OFF, engine OFF. • A Breakout T should already have been installed at ECM Connector J1/P1. • Disconnect Connector P24/J24.  **40-Pin Breakout T @ J1/P1 Harness Connector** • Install one jumper from pin-2 (Vehicle Speed In-) of P24 to pin-10 (Speedometer-) of the Breakout T. Install the other jumper from pin-1 (Vehicle Speed In+) of P24 to pin-16 (Speedometer+) of the Breakout T. • Turn the ignition switch ON, engine OFF. • Install ET and access the 55 mph VSP/Speedometer Test. • Start the test and then check the vehicle speed on the vehicle speed status screen. **• Does ET indicate a constant vehicle speed with the jumper from the Speedometer circuits connected to the ECM Vehicle Speed Inputs?**	**YES ⇒** **NO ⇒**	**Leave the Breakout T in place and remove jumper wires.** Reconnect Connector J24/P24. Proceed to the next step. **Leave the Breakout T in place and remove jumper wires.** Reconnect Connector J24/P24. Proceed to Step 7 on page D-72.

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 6: Check ECM Using Service Tool Special Test.		
• Turn ignition switch OFF, engine OFF. • Disconnect ECM Connector J2/P2. Connect a 40-pin Breakout T to J2 only.  **40-Pin Breakout T** **J2/P2 Harness Connector** • Install a jumper from pin-4 (Veh Sp In-/TC Probe-) to pin-10 (Vehicle Speed Out-) of the Breakout T connected at Connector J2. • Install another jumper from pin-39 (Veh Sp In+/TC Probe+) to pin-40 (Vehicle Speed Out+) of the Breakout T connected at Connector J2.  **40-Pin Breakout T** **J1/P1 Harness Connector** • A Breakout T should already have been installed at ECM Connector J1/P1. Install one jumper into Breakout T pin-12 (Vehicle Speed In-) and pin-10 (Speedometer-). Install the other jumper into Breakout T pin-18 (Vehicle Speed In+) and pin-16 (Speedometer+). • Turn ignition switch ON, engine OFF. • Install ET and access the 55 mph VSP/Speedometer Test. • Start the test and then check the vehicle speed on the vehicle speed status screen. **• Does ET indicate a constant vehicle speed with the jumper from the Speedometer circuits connected to the ECM Vehicle Speed Inputs?**	**YES ⇒** **NO ⇒**	**The ECM is operating correctly.** Remove all jumpers and the Breakout T. Replace the wiring from P2 to J24. **Double check the jumper wires to ensure they were installed correctly.** Temporarily install another ECM. Repeat this test step. If the problem is resolved with the new ECM, install the old ECM to verify the problem returns with the ECM. If the new ECM works and the one on the engine did not, replace the ECM. STOP.

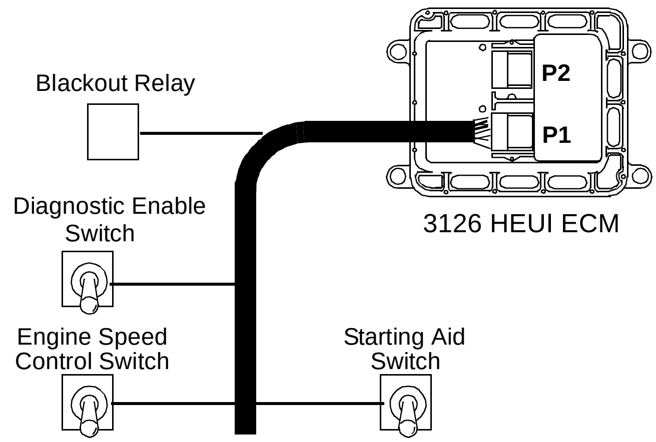
TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 7: Check ECM Using Service Tool Special Test.		
• Turn ignition switch OFF, engine OFF. • Disconnect ECM Connector J2/P2. • Connect a 40-Pin Breakout T to J2 only. A Breakout T should already have been installed at ECM Connector J1/P1.  **40-Pin Breakout T J2/P2 Harness Connector** **40-Pin Breakout T J1/P1 Harness Connector** • Install one jumper from pin-4 (Vehicle Speed In-) of the Breakout T connected at J2 to pin-10 (Speedometer-) of the Breakout T connected at J1/P1. Install the other jumper from pin-39 (Vehicle Speed In+) of the Breakout T connected at J2 to pin-16 (Speedometer+) of the Breakout T connected at J1/P1. • Turn ignition switch ON, engine OFF. • Install ET and access the 55 mph VSP/Speedometer Test. • Start the test and then check the vehicle speed on the vehicle speed status screen. **• Does ET indicate a constant vehicle speed with the jumper from the Speedometer circuits connected to the ECM Vehicle Speed Inputs?**	**YES** ⇒ **NO** ⇒	**The ECM is operating correctly.** Remove all jumpers and the Breakout T. Replace the wiring from P2 to P24. **Temporarily install another ECM.** Repeat this test step. If the problem is resolved with the new ECM, install the old ECM to verify the problem returns with the ECM. If the new ECM works and the one on the engine did not, replace the ECM. STOP.
Step 8: Check ECM Connection To The Speedometer.		
• Inspect ECM Connector J1/P1 and verify connections between pin-16 (Speedometer +) and the speedometer Signal terminal. Turn ignition switch ON, engine OFF. • Install ET and access the 55 mph VSP/Speedometer Test. • Start the test and then check the vehicle speed on the speedometer. **• Does the speedometer indicate a constant vehicle speed with the Service Tool Special Test active?**	**YES** ⇒ **NO** ⇒	**The ECM, speedometer, and the wiring are OK.** STOP. Proceed to the next step.

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 9: Check ECM Using Service Tool Special Test. • Turn the ignition switch OFF, engine OFF. • Disconnect ECM Connector J1/P1. • Remove terminal pin-16 (Speedometer+) from Connector P1. • Connect a 40-Pin Breakout T to ECM Connector J1 and connect P1 to the Breakout T.  **40-Pin Breakout T J1/P1 Harness Connector** • Install a jumper into Breakout T pin-18 (Vehicle Speed In+) and pin-16 (Speedometer+). • Turn the ignition switch ON, engine OFF. • Install ET and access the 55 mph VSP/Speedometer Test. Start the test and then check the vehicle speed on the vehicle speed status screen. **• Does ET indicate a constant vehicle speed with the jumper from the Speedometer circuits connected to the ECM Vehicle Speed Inputs?**	**YES ⇒** **NO ⇒**	**The ECM speedometer circuit is operating correctly.** The problem is in the speedometer or the wiring between the speedometer and ECM. Repair as necessary. Remove all jumpers and the Breakout T. **Temporarily install another ECM.** Repeat this test step. If the problem is resolved with the new ECM, install the old ECM to verify the problem returns with the ECM. If the new ECM works and the one on the engine did not, replace the ECM. STOP.

PB- 15: Blackout Light, Diagnostic Enable, Engine Speed Control, and Starting Aid Switch Circuit Test

When to Use This Procedure

Use this procedure to determine if the Blackout Light, Diagnostic Enable, Engine Speed Control, and Starting Aid Switches are operating correctly.



Blackout Input:

The Blackout Light Switch is provided for activation control of all lamps on the machine. The Blackout Relay is controlled by the Blackout Light Switch and machine wiring. The ECM monitors the Blackout Relay status and keeps the Check Engine, Crank Without Inject, or Starting Aid Lamp from illuminating when the Blackout input J1/P1 pin-14 is open, and enables the lamps when the input is grounded.

Diagnostic Enable Switch:

The Diagnostic Enable Switch Input is set to the Check Engine Mode when input J1/P1 pin-19 is open. The Lamp will turn ON for a minimum of five seconds any time a fault condition exists. It will continue to flash ON for five seconds, and then blink OFF, flash ON for five seconds, etc, as long as the fault condition exists.

The Diagnostic Enable Switch is set to the Flashing Code Mode when input J1/P1 pin-19 is grounded. A two digit code is flashed for each ACTIVE diagnostic code. The Flash Code is determined from the number of times the Check Engine Lamp blinks. The lamp will blink for the first digit of the flash code, pause five seconds, and then blink for the second digit.

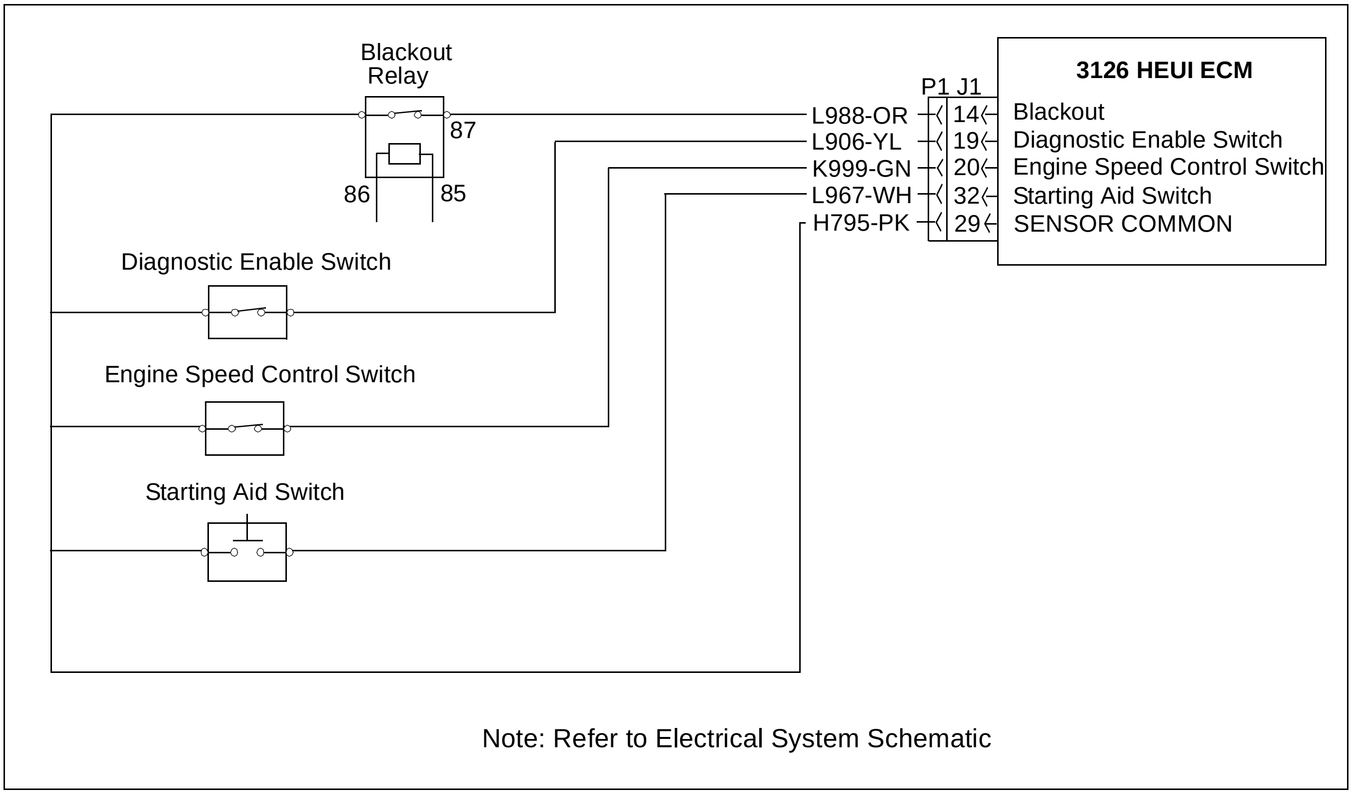
Engine Speed Control Switch:

The desired engine speed is set to 2400 rpm when J1/P1 pin-20 (Engine Speed Control) is grounded. When the input is open, engine speed is determined by the Throttle Position Sensor.

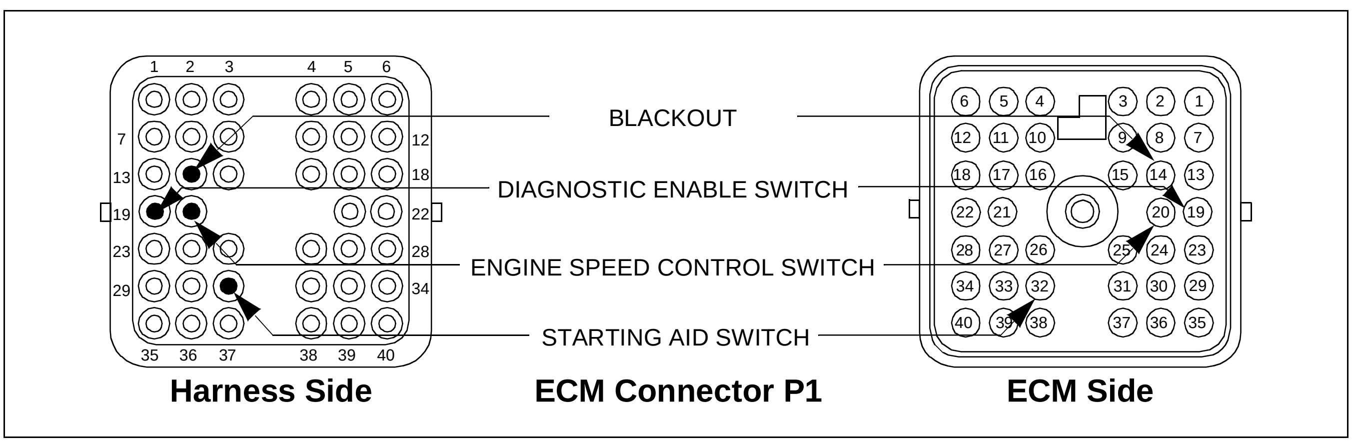
Starting Aid Switch:

The Starting Aid Switch allows the operator to activate the ether start aid. One 2.25 cm^3 shot of ether is injected each time J1/P1 pin-32 (Starting Aid Switch) is grounded provided engine speed is below 1000 rpm, coolant temperature is below 40 °C (104 °F), and Inlet Manifold Air Temperature is below 0 °C (32 °F).

Schematic - ECM Switch Inputs



ECM Pin Locations



Functional Test

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 1: Check Electrical Connectors and Wiring.		
• Thoroughly inspect ECM Connector J1/P1 and the bulkhead connectors. (Refer to “PB-10: Inspecting Electrical Connectors” on page D-43 for details on inspecting connectors.) • Perform 10 pound (44.5 N) pull test on each of the wires in the ECM Connector associated with the Blackout, Diagnostic Enable, Engine Speed Control, and Starting Aid Switches. • Check ECM Connector (Allen screw) for proper torque. • Check the harness and wiring for abrasion and pinch points from the sensor back to the ECM. • **All connectors/pins/sockets should be completely mated/inserted, and the harness/wiring should be free of corrosion, abrasion or pinch points.**	**OK** ⇒ **NOT OK** ⇒	Proceed to the next step. **Repair or replace wiring or connectors as necessary.** Ensure all seals are properly in place and connectors completely mated. Verify the repair eliminates the problem. STOP.
Step 2: Check Switch Status On ET.		
• Connect ET and turn the ignition switch ON, engine OFF. • Operate the Blackout Light Switch while observing the Blackout status on ET. • Operate the Diagnostic Enable switch while observing the Diagnostic Switch status on ET. • Operate the Engine Speed Control switch while observing the Engine Speed Control Switch status on ET. • Depress and release the Starting Aid Switch while observing the Starting Aid Switch status on ET. **NOTE:** The Starting Aid Switch is a momentary switch. Depress and hold it in position for the switch status ON, release the switch for OFF. • **Does the status of each switch displayed on ET change appropriately as each switch is operated?**	**YES** ⇒ **NO** ⇒	**The switches are operating normally.** STOP. **The ECM is not reading the switch status change.** Proceed to the next step.

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 3: Check ECM Switch Circuit.		
• Turn the ignition switch OFF, engine OFF. • Disconnect the Machine Harness Connector P1 from the ECM. • Remove the wire for the suspect switch from the Machine Harness Connector P1, socket-14 (Blackout Light Switch), socket-19 (Diagnostic Enable Switch), socket-20 (Engine Speed Control Switch), or socket-32 (Starting Aid Switch). • Connect a 40-Pin Breakout T to the ECM Connector J1 and the Machine Harness Connector P1. • Make a jumper wire (4 inches, 100 mm long) with Deutsch pins on **both** ends. • Insert the wire jumper pin into the suspect switch socket of Breakout T socket-14 (Blackout Light Switch), socket-19 (Diagnostic Enable Switch), socket-20 (Engine Speed Control Switch), or socket-32 (Starting Aid Switch). Connect the other end of the jumper to ECM Connector P1 socket-29 (Sensor Common) of the Breakout T. • Install ET and turn the ignition switch ON, engine OFF. • Slowly remove and insert the jumper from pin-29 (SENSOR COMMON) while monitoring the ET switch status screen. • **Does the status of each switch change as the jumper is removed and inserted?**	**YES ⇒** **NO ⇒**	**The ECM is functioning properly.** Proceed to the next step. **The ECM is NOT functioning properly.** Temporarily install another ECM. **Repeat this test step.** If the problem is resolved with the new ECM, install the old ECM to verify the problem returns with the ECM. If the new ECM works and the old one did not, replace the ECM.
Step 4: Insert Jumper at Switch.		
• Turn the ignition switch OFF, engine OFF. • Make a wire jumper (4 inches, 100 mm long) without insulation on **both** ends. **Insulation Removed** **Insulation Removed**  • Locate the suspect switch in the machine. If troubleshooting the Blackout input, locate the Blackout Relay. • Disconnect the switch (or relay) from the Machine harness. • Insert the wire jumper between the two terminals for the switch in the harness (or the normally open contacts of the relay). • Install ET and turn the ignition switch ON, engine OFF. • Slowly remove and insert the jumper wire from between the terminals while monitoring the ET switch status screen. • **Does the status change as the jumper is removed and inserted?**	**YES ⇒** **NO ⇒**	**Repair or replace the faulty switch or relay circuit.** STOP. **There is a problem in the harness between the switch and the ECM.** Repeat this step at the bulkhead connector to isolate the problem. Refer to Electrical System Schematic. Repair as required. STOP.

PB-17: Crank Without Inject Inputs Circuit Test

System Operation

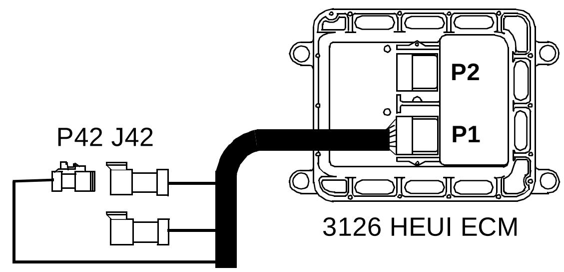
When to Use This Procedure

Use this procedure to determine if the Crank Without Inject Inputs to the ECM are functioning properly or to troubleshoot a 266-02 diagnostic code.

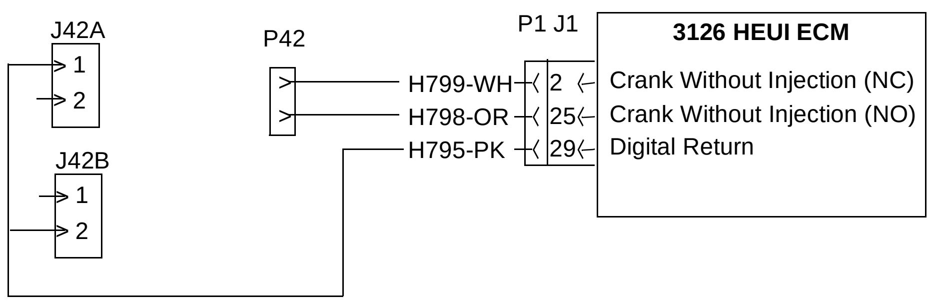
Background

The Crank Without Inject Inputs are provided to allow a service technician to crank the engine and have the engine NOT start. The Crank Without Inject Lamp is illuminated when injection is disabled by the Crank Without Inject Inputs, provided the Blackout Light Switch is in the Stop Light or Service Drive position.

When the normally closed Crank Without Inject Input (NC) J1/P1 pin-2 is shorted to ground and the normally open Crank Without Inject Input (NO) J1/P1 pin-25 is open, injection is enabled and the engine is allowed to start. When the Crank Without Inject Input (NC) J1/P1 pin-2 is open and the Crank Without Inject Input (NO) J1/P1 pin-25 is shorted to ground, injection is disabled and the engine is NOT allowed to start. If both Crank Without Inject Input (NC) and Crank Without Inject Input (NO) are open or shorted to ground, a 266-02 diagnostic code is generated and the engine is allowed to start.

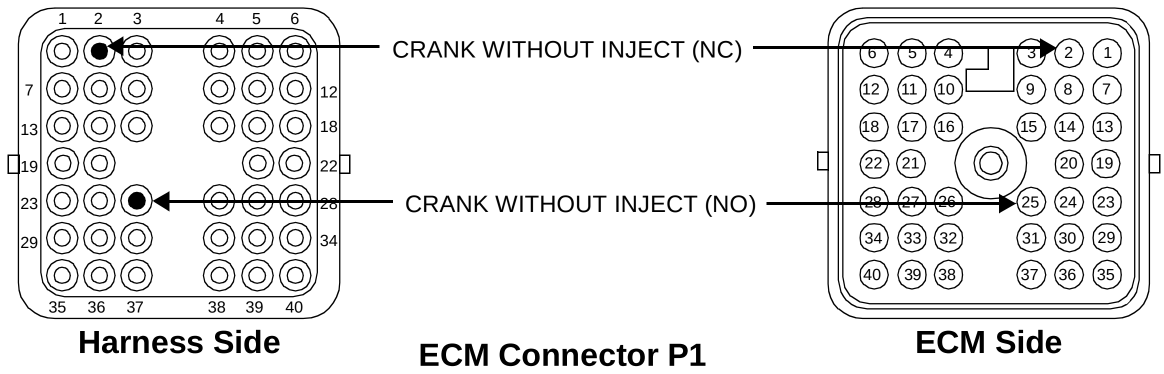


Schematic



Note: Connect P42 to J42A for normal operation, Connect P42 to J42B to disable injection.

ECM Pin Locations



Diagnostic Codes

PID-FMI and Description of Code:	Systems Response:	Troubleshooting:
262-02 Crank Without Inject Inputs Incorrect Both Crank Without Inject Input (NC) and Crank Without Inject Input (NO) are open or shorted to ground.	**Electronic System Response -** The diagnostic code is logged in memory. **Engine Response -** Fuel Injection is enabled.	Proceed with PB-17: Crank Without Inject Inputs Circuit Test.

Functional Test

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 1: Check Electrical Connectors and Wiring.		
• Thoroughly inspect ECM Connector J1/P1, J42/P42 and the bulkhead connectors. (Refer to procedure “PB-10: Inspecting Electrical Connectors” on page D-43 for details on inspecting connectors.) • Perform 10 pound (44.5 N) pull test on each of the wires in the ECM Connector associated with the Crank Without Inject Inputs. • Check ECM Connector (Allen screw) for proper torque. • Check the harness and wiring for abrasion and pinch points from the sensor back to the ECM. • **All connectors/pins/sockets should be completely mated/inserted, and the harness/wiring should be free of corrosion, abrasion or pinch points.**	**OK** ⇒ **NOT OK** ⇒	Proceed to the next step. **Repair or replace wiring or connectors as necessary.** Ensure all seals are properly in place and connectors completely mated. Verify the repair eliminates the problem. STOP.

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 2: Check Input Status On ET.		
• Install an ET. • Connect P42 to J42A. • Turn the ignition switch to the ON position, engine OFF • Observe the Crank Without Inject Input Status on ET. • Connect P42 to J42B. • Observe the Crank Without Inject Input Status on ET. **• Does the Shutdown Input status indicate “DISABLED” with P42 and J42A connected, and “ENABLED” with P42 and J42B connected?**	**YES** ⇒ **NO** ⇒	**The switches are operating normally.** STOP. **The ECM is not reading the switch status change.** Proceed to the next step.
Step 3: Check ECM Input Circuit.		
• Turn the ignition switch OFF. • Install a 40-Pin Breakout T in between ECM Machine Harness Connector J1/P1. • Make a jumper wire (4 inches, 100 mm long) with Deutsch pins on **both** ends. **Deutsch Pin Contact** **Deutsch Pin Contact**  • Remove socket-2 (Crank Without Inject N.C.)and socket-25 (Crank Without Inject N.O.) from the ECM Connector P1. • Insert the wire jumper into P1 socket-2 (Crank Without Inject N.C.) and P1 socket-29 (Digital Return) of the Breakout T. • Turn the ignition switch to the ON position, engine OFF. • Observe the Crank Without Inject Input Status on the Electronic Service Tool. • Remove the wire jumper and insert it into P1 socket-25 (Crank Without Inject N.C.) and P1 socket-29 (Digital Return) of the Breakout T. • Observe the Crank Without Inject Input Status on ET. **• Does the Crank Without Inject Input status indicate “DISABLED” with the wire jumper inserted into P1 socket-2 and P1 socket-29 of the Breakout T, and “ENABLED” with the wire jumper inserted into P1 socket-25 and P1 socket-29 of the Breakout T?**	**YES** ⇒ **NO** ⇒	**The ECM is functioning properly.** Proceed to the next step. **The ECM is not functioning properly.** Temporarily connect another ECM and repeat this test. If the problem is resolved, replace the ECM. STOP.

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 4: Jumper Inputs To Ground at Connector P42.		
• Turn the ignition switch OFF, engine OFF. • Remove Breakout T and reinsert wires into P1. • Use the jumper wire (4 inches, 100 mm long) with Deutsch pins on **both** ends.  • Insert one end of the wire jumper pin into P42 socket-2 (H799-WH) Connect the other end of the wire jumper to engine ground. Verify engine ground connection with an ohmmeter. • Turn the ignition switch to the ON position, engine OFF. • Observe the Crank Without Inject Input Status on ET. • Remove wire jumper from P42 socket-2 (H799-WH) and insert it into P42 socket-1 (H798-OR). • Observe the Crank Without Inject Input Status on ET. **• Does the Crank Without Inject Input status indicate “DISABLED” with the wire jumper inserted between P42 socket-2 and ground, and “ENABLED” with the wire jumper inserted into P42 socket-1 and ground?**	**YES** ⇒ **NO** ⇒	**There is a problem in the harness between J42A or J42B and the ECM.** Repair as needed. STOP. **There is a problem in the harness between P42 and the ECM.** Repair as needed. STOP.

PB-18: Rating Select Inputs Circuit Test

System Operation

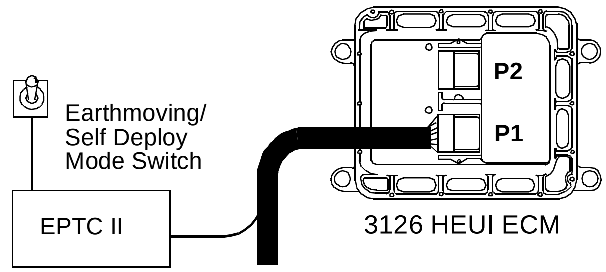
When to Use This Procedure

Use this procedure to determine if the Rating Select Inputs to the ECM are functioning properly or to troubleshoot a 35-11 diagnostic code.

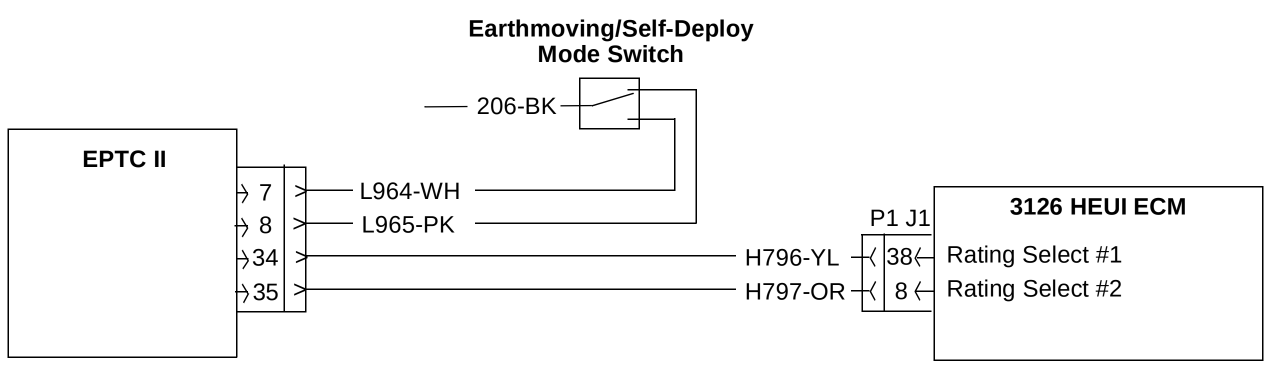
Background

The Rating Select Inputs allow the EPTC II Transmission Control to select one of two engine horsepower ratings: Self Deploy and Earthmoving. This provides performance and driveability improvements without exceeding the transmission and drive axle torque capacities.

When J1/P1 pin-38 is shorted to ground and J1/P1 pin-8 is open, the higher rating (Self Deploy Mode) is selected. When J1/P1 pin-38 is open and J1/P1 pin-8 is shorted to ground, the lower rating (Earthmoving Mode) is selected. If both J1/P1 pin-38 and J1/P1 pin-8 are open or shorted to ground, a 35-11 diagnostic code is generated and the engine rating defaults to the lower Earthmoving Mode rating.

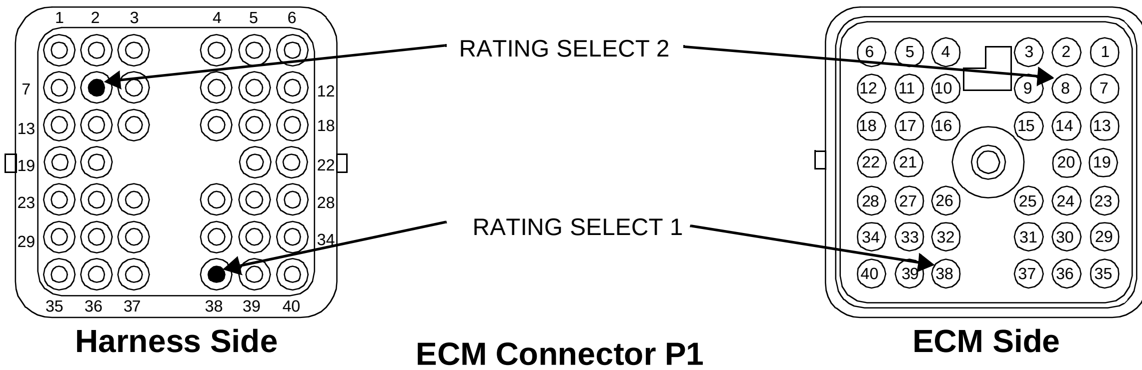


Schematic



Note: Refer to Electrical System Schematic

ECM Pin Locations



Diagnostic Codes

PID-FMI and Description of Code:	Systems Response:	Troubleshooting:
35-11 EPTC II Rating Select Inputs are Incorrect Both Rating Select Inputs are open or shorted to ground.	**Electronic System Response -** The diagnostic code is logged in memory. **Engine Response -** The engine rating defaults to the lower horsepower Earthmoving Mode	Proceed with PB-18: Horsepower Rating Select Inputs Circuit Test.

Functional Test

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 1: Check Electrical Connectors and Wiring.		
• Thoroughly inspect ECM Connector J1/P1, EPTC II Connectors and the bulkhead connectors. (Refer to procedure “PB-10: Inspecting Electrical Connectors” on page D-43 for details on inspecting connectors.) • Perform 10 pound (44.5 N) pull test on each of the wires in the ECM and EPTC II Connectors associated with the EPTC II Rating Select Inputs. • Check ECM Connector (Allen screw) for proper torque. • Check the harness and wiring for abrasion and pinch points from the sensor back to the ECM. • **All connectors/pins/sockets should be completely mated/inserted, and the harness/wiring should be free of corrosion, abrasion or pinch points.**	**OK** ⇒ **NOT OK** ⇒	Proceed to the next step. **Repair or replace wiring or connectors as necessary.** Ensure all seals are properly in place and connectors completely mated. Verify the repair eliminates the problem. STOP.

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 2: Check Input Status On ET.		
• Install an ET. • Turn the ignition switch to the ON position, engine OFF • Set the Earthmoving/Self-Deploy Mode Switch to the Self Deploy position. • Observe the Rating Select status on ET. • Set the Earthmoving/Self-Deploy Mode Switch to the Earthmoving position. • Observe the Rating Select status on ET. **• Does the Rating Select Switch #1 status indicate “ON” and the Rating Select Switch #2 indicate “OFF” with the Earthmoving/Self-Deploy Mode Switch in the Self-Deploy position?** **• Does the Rating Select Switch #1 status indicate “OFF” and the Rating Select Switch #2 indicate “ON” with the Earthmoving/Self-Deploy Mode Switch in the Earthmoving position?**	**YES** ⇒ **NO** ⇒	**The switches are operating normally.** STOP. **The ECM is not reading the switch status change.** Proceed to the next step.
Step 3: Check ECM Input Circuit.		
• Turn the ignition switch OFF. • Install a 40-Pin Breakout T in between ECM Machine Harness Connector J1/P1. • Make a jumper wire (4 inches, 100 mm long) with Deutsch pins on **both** ends. **Deutsch Pin Contact** **Deutsch Pin Contact**  • Remove terminals socket-38 (Rating Select #1) and socket-8 (Rating Select #2) from the ECM Connector P1. • Insert the wire jumper into P1 socket-38 (Rating Select #1) and P1 socket-29 (Digital Return) of the Breakout T. • Turn the ignition switch to the ON position, engine OFF. • Observe the Rating Select status on ET. • Remove the wire jumper and observe the Rating Select status on ET. • Insert the jumper into P1 socket-8 (Rating Select #2) and P1 socket-29 (Digital Return) of the Breakout T. • Observe the Rating Select status on ET. **• Does the Rating Select Switch #1 status indicate “ON” with the with the wire jumper inserted into P1 socket-38 and P1 socket-29 of the Breakout T, and “OFF” with the wire jumper removed?** **• Does the Rating Select Switch #2 status indicate “ON” with the with the wire jumper inserted into P1 socket-8 and P1 socket-29 of the Breakout T, and “OFF” with the wire jumper removed?**	**YES** ⇒ **NO** ⇒	**The ECM is functioning properly.** Proceed to the next step. **The ECM is not functioning properly.** Temporarily connect another ECM and repeat this test. If the problem is resolved, replace the ECM. STOP.

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 4: Jumper Inputs To Ground at EPTC II.		
• Turn the ignition switch OFF, engine OFF. • Remove Breakout T and reinsert wires into P1. • Remove wires H796-YL and H797-OR from the EPTC II connector. • Connect loose wire H796-YL to engine ground. Verify engine ground connection with an ohmmeter. • Turn the ignition switch to the ON position, engine OFF. • Observe the Rating Select status on ET. • Disconnect H796-YL to engine ground. Connect loose wire H797-OR to engine ground. • Observe the Rating Select status on ET. • **Does the Rating Select Switch #1 status indicate “ON” with the with wire H796-YL shorted to ground and “OFF” with wire H796-YL open?** • **Does the Rating Select Switch #2 status indicate “ON” with the with wire H797-OR shorted to ground and “OFF” with wire H797-OR open?**	**YES** ⇒ **NO** ⇒	**There is a problem with the signal from EPTC II.** Check Earthmoving/Self-Deploy Mode Switch, and EPTC II harness. Repair as needed. Refer to the EPTC II Service Manual. STOP. **There is a problem in the harness between EPTC II and the ECM.** Repair as necessary. STOP.

PB-20: Tachometer Circuit Test

System Operation

When to Use This Procedure

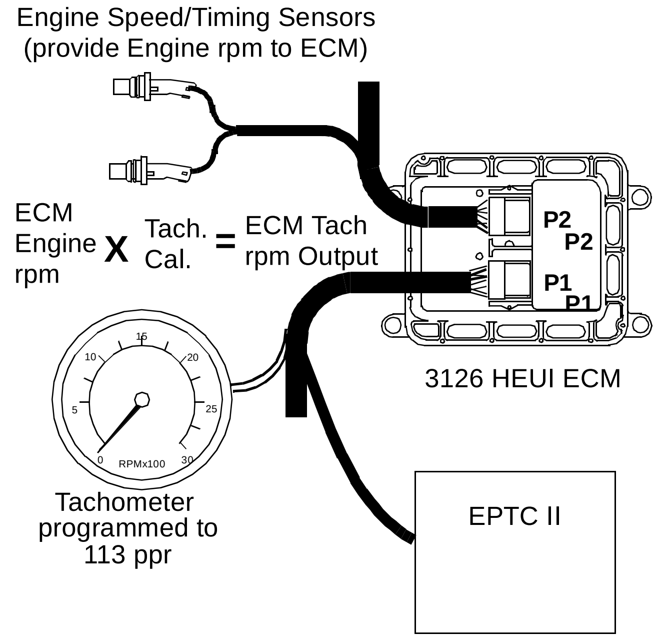
Use this procedure if a problem with the tachometer circuit is suspected.

Background

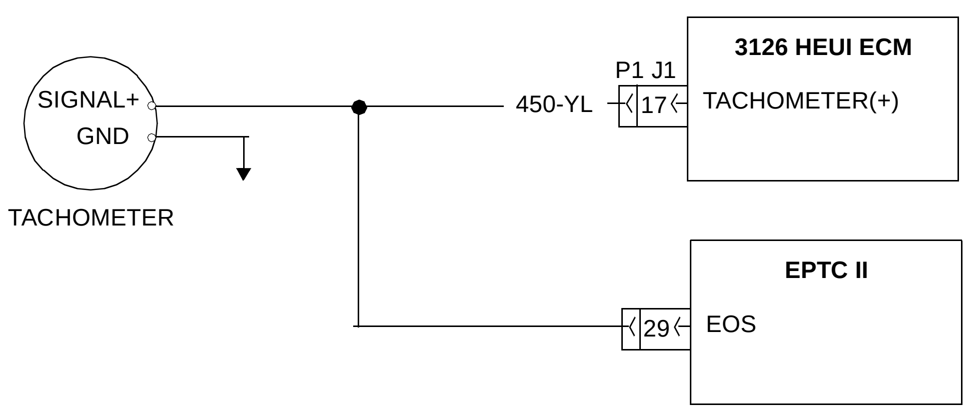
The tachometer circuit consists of the tachometer and transmission control (EPTC II) connected to the ECM with ECM Connector J1/P1, and associated wiring. The ECM engine speed signal is provided by the Engine Speed/Timing Sensors. The ECM converts the signal from the Speed/Timing Sensors into engine rpm in pulses per revolution (ppr) before sending a signal out to the tachometer and EPTC II. The ECM tachometer signal is programmed for 113 pulses per revolution.

The most likely source of a tachometer circuit problem is the machine wiring, then the tachometer, and least likely is the ECM.

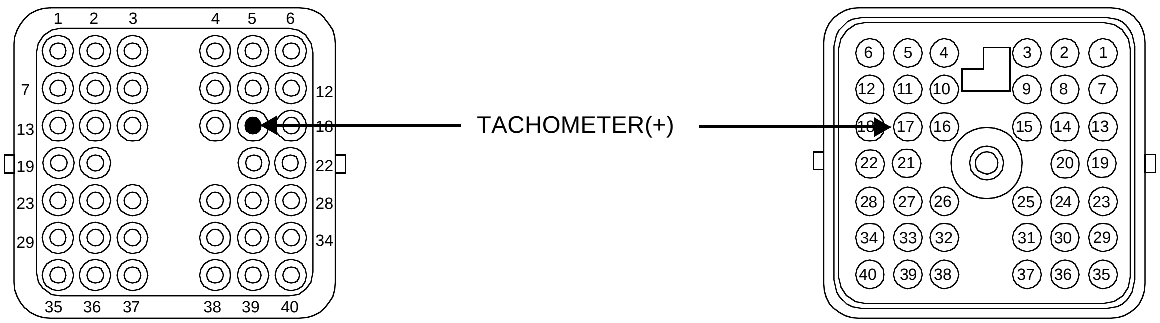
NOTE: Do not disturb the Engine Speed/Timing Sensors to troubleshoot a tachometer circuit problem. If there is a problem associated with the Speed/Timing Sensors, refer to procedure “PC-31: Engine Speed/Timing Circuit Test” on page D-98 to troubleshoot. Any problem associated with the Speed/Timing Sensor will be apparent because of engine operation with a Engine Speed/Timing Sensor Diagnostic Code present. There are no diagnostic codes associated with the tachometer circuit.



Schematic



ECM Pin Locations



Harness Side ECM Connector P1 ECM Side

Functional Test

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 1: Check Electrical Connectors and Wiring.		
• Thoroughly inspect ECM Connector and the bulkhead connector, and the EPTC II and Tachometer pins in the Connectors. (Refer to procedure “PB-10: Inspecting Electrical Connectors” on page D-43 for details on inspecting connectors.) • Perform 10 pound (44.5 N) pull test on each of the wires in the ECM Connector associated with the Tachometer Sensor. • Check ECM Connector (Allen screw) for proper torque. • Check the harness and wiring for abrasion and pinch points from the sensor back to the ECM. • **All connectors/pins/sockets should be completely mated/inserted, and the harness/wiring should be free of corrosion, abrasion or pinch points.**	**OK** ⇒ **NOT OK** ⇒	Proceed to the next step. **Repair or replace wiring or connectors as necessary.** Ensure all seals are properly in place and connectors completely mated. Verify the repair eliminates the problem. STOP.
Step 2: Determine The Type Of Tachometer Problem.		
• Install ET at the cab Service Tool Connector. • Start the engine. • Compare engine rpm on the ET display against rpm displayed on the tachometer. • **Does the ET and tachometer readings agree?**	**YES** ⇒ **NO** ⇒	**There is not a tachometer problem at this time.** STOP. **If the tachometer does not indicate any engine speed,** proceed to the next step. **If the tachometer indicates an engine speed significantly different from the ET engine speed,** most likely the wrong tachometer is installed.

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 3: Check ECM Tachometer Signal Using ET Special Test.		
• Turn the ignition key ON, engine OFF. • Connect ET to the Cab Data Link connector. • Access the Tachometer Circuit Test under the Interactive Diagnostic Special Test menu of the Service Tool. • Begin the test while monitoring the dash Tachometer. • **Does the dash Tachometer indicate approximately 1500 rpm?**	**YES** ⇒ **NO** ⇒	**The ECM and Tachometer are OK.** STOP. **If the Tachometer does not indicate an engine rpm, or is erratic,** proceed to the next step.
Step 4: Check ECM Tachometer Signal.		
• Disconnect the ECM Machine Harness Connector J1/P1. • Remove pin-11 (Tachometer-) and pin-17 (Tachometer+) from the Machine Harness Connector P1. • Install a 40-Pin Breakout T between Connectors J1 and P1. • Fabricate two jumper wires (4 inches, 100 mm long) with a Deutsch Pin crimped to one end of each.  • Insert the two jumper wires into pin-11 (Tachometer-) and pin-17 (Tachometer+) of the Breakout T. • Start the engine and allow it to idle at a constant rpm. • Use a multimeter capable of measuring duty cycle to measure duty cycle between the two jumpers with the engine running at a constant rpm. • **Does the multimeter indicate a duty cycle from 30% to 70% between the Tachometer pins while the engine is running?**	**YES** ⇒ **NO** ⇒	**The ECM Tachometer Output is OK.** Connect the tachometer lines to the ECM and tachometer. Proceed to the next step. **Temporarily install another ECM. Repeat this test step.** If the problem is resolved with the new ECM, install the old ECM to verify the problem returns with the ECM. If the new ECM works and the old one did not, replace the ECM.
Step 5: Check ECM Connection to the Tachometer.		
• Find the Tachometer Signal connections to the tachometer. • Disconnect the wire from the ECM to the tachometer and check for continuity from the pin at the tachometer through the harness to the ECM Connector P1 pin-17 (Tachometer+). • **Are the ECM to tachometer wires undamaged?**	**YES** ⇒ **NO** ⇒	**The wiring is OK.** Connect the tachometer lines to the ECM and tachometer. Check the +Battery and -Battery connections to the tachometer, including fuses/circuit protection. If the Tachometer is receiving battery voltage, but not working, replace the Tachometer. STOP. **The wiring is damaged.** Repair the wiring. STOP.

PB-21: ATA (SAE J1587/1708) Data Link Circuit Test

System Operation

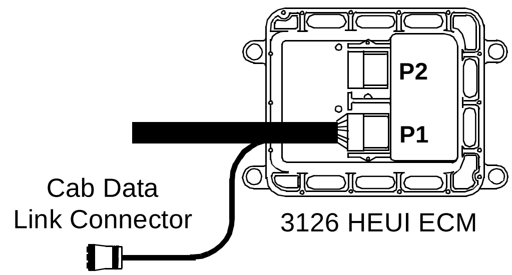
When to Use This Procedure

Use this procedure if the Electronic Service Tool will not power up or communicate through the ECM with the cab mounted data link.

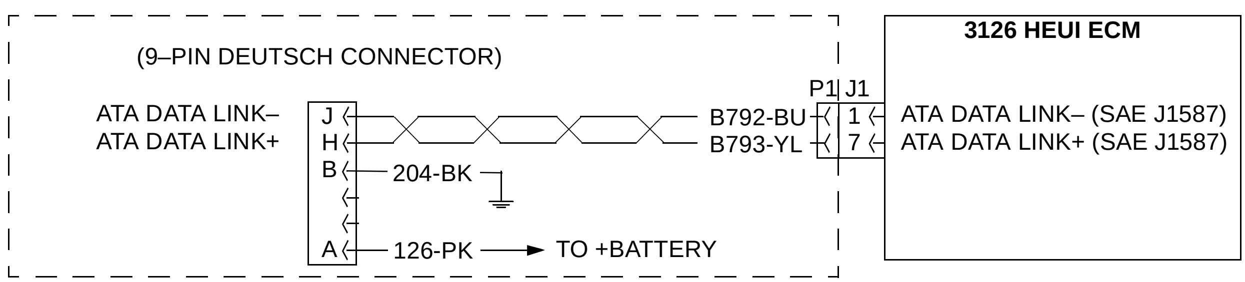
Background

The ATA Data Link is used to communicate ECM information to Electronic Service Tools. The ECM provides two ATA Data Link connection pins from ECM Machine Harness Connector J1, pin-1, SAE J1587 ATA Data Link(-) and pin-7, SAE J1587 ATA Data Link(+). A twisted pair cable from the ECM to the Cab Data Link Connector is provided for connection to Electronic Service Tools.

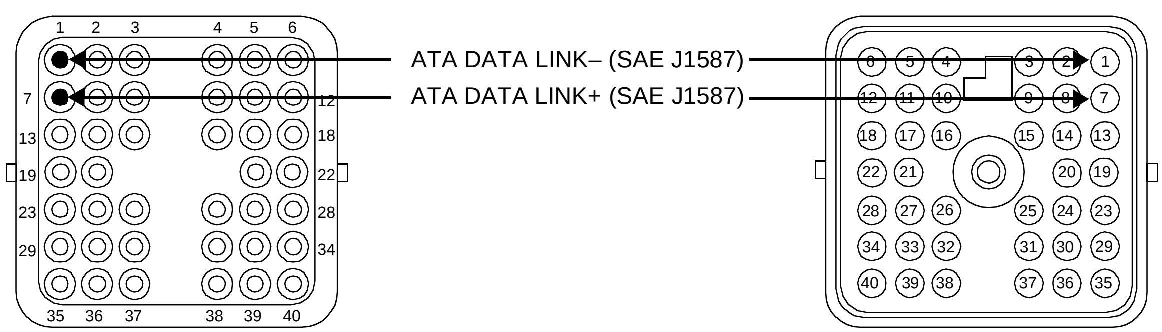
NOTE: The ECM does not provide the power and ground connections to the Cab Data Link Connector.



Schematic



ECM Pin Locations

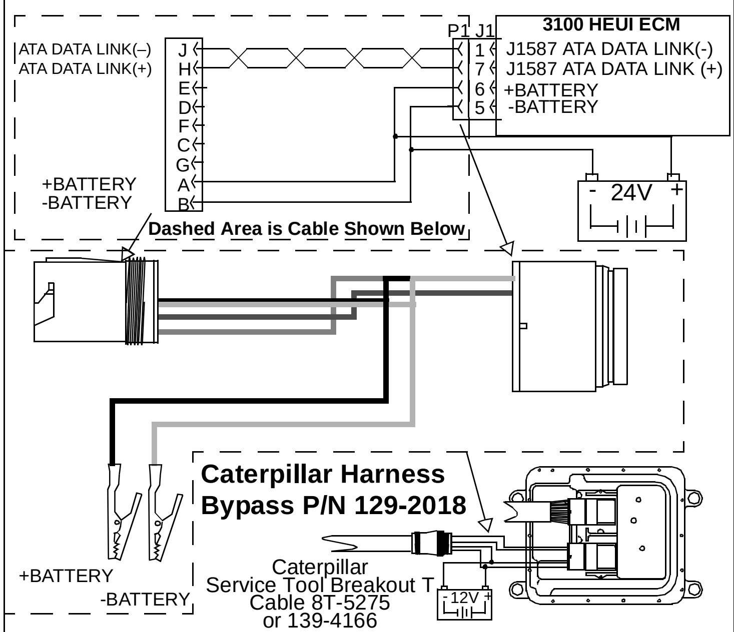


Harness Side **ECM Connector P1** **ECM Side**

Functional Test

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 1: Check Electrical Connectors and Wiring.		
• Thoroughly inspect ECM Machine Harness Connector J1/P1, Cab Data Link Connector, the bulkhead connector, ET Connectors and Cables, and the ATA Data Link pins in the Connectors. (Refer to procedure "PB-10: Inspecting Electrical Connectors" on page D-43 for details on inspecting connectors.) • Perform 10 pound (44.5 N) pull test on each of the wires in the Connectors associated with the ATA Data Link. • Check ECM Connector (Allen screw) for proper torque. • Check the harness and wiring for abrasion and pinch points from the sensor back to the ECM. • **All connectors/pins/sockets should be completely mated/inserted, and the harness/wiring should be free of corrosion, abrasion or pinch points.**	**OK** ⇒ **NOT OK** ⇒	Proceed to the next step. **Repair or replace wiring or connectors as necessary.** Ensure all seals are properly in place and connectors completely mated. Verify the repair eliminates the problem. STOP.
Step 2: Determine the Type of Data Link Problem.		
• Install ET at Cab Data Link Connector using the appropriate harness adapter. • Start the engine. • **Does ET come ON without any error messages?** **NOTE:** If the engine starts, then the ECM is OK and the problem is in the data link wiring or other devices connected to the data link.	**YES** ⇒ **NO** ⇒	**There is not an ATA Data Link problem at this time.** STOP. **If ET does NOT come ON,** ensure the ignition switch is in the ON position so the ECM is receiving battery power. If it is, proceed to the next step. **If ET indicates "Unable to Communicate",** ensure the ignition switch is in the ON position. The ECM should be receiving battery power. If it is, proceed to Step 5 on page D-91.
Step 3: Check Battery Voltage Coming To Cab Data Link Connector.		
• Turn the ignition switch ON, engine OFF. • Measure the voltage between +Battery (pin-A) and -Battery (pin-B) of the Service Tool Connector. • **Is the voltage above 22 VDC?**	**YES** ⇒ **NO** ⇒	**The Cab Data Link Connector is currently receiving the correct voltage.** Proceed to the next step. **The Cab Data Link Connector is not receiving the correct voltage.** Inspect the wiring and fuses to the Connector. Repair, replace, as necessary. STOP.

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 4: Change ET Components. • If another machine is available with a Caterpillar Electronic Engine, connect ET to the other machine using the same cables. • Turn the ignition switch ON, engine OFF. **• Does ET operate correctly in the other machine?** • If another machine is not available, - Locate a **complete, different** set of Service Tool Cables. • Connect ET to the Cab Data Link using the different set of cables. • Turn the ignition switch ON, engine OFF. • If changing cables allows ET to operate properly, replace (one at a time) the pieces from the old cable set into the one that does operate and re-power ET each time to determine which piece is faulty. • If changing cables does not allow ET to work, connect another (different) ET equipped laptop computer and/or Communications Adapter (if available). • Turn the ignition switch ON, engine OFF. **• Does the Communications Adapter, ET, and the cables check OK?**	**YES** ⇒ **NO** ⇒	Proceed to the next step. **Send the faulty Electronic Service Tool in for repair.**
Step 5: Check Battery Voltage at ECM. • Disconnect ECM Machine Harness Connector J1/P1 and insert a 40-Pin Breakout T in series, or if Signal Reading Probes are available and ECM Connector P1 is accessible (without disconnecting), insert probes into pin-6 (+Battery) and pin-5 (-Battery). • Turn the ignition switch ON, engine OFF. • Measure the voltage between ECM Connector P1 pin-6 (+Battery) and pin-5 (-Battery). • Crank the engine. • Measure the voltage between pin-6 (+Battery) and pin-5 (-Battery) while cranking the engine. **• Is the voltage above 22 VDC with the ignition switch ON and does it remain above 6.0 volts DC while cranking?**	**YES** ⇒ **NO** ⇒	**The ECM is currently receiving the correct voltage.** Proceed to the next step. **The ECM is not receiving the correct voltage.** Ensure there is not an aftermarket engine protection switch overriding battery power to the ECM. If not, proceed to "PB-11: ECM Battery Circuit Test" on page D-48.

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 6: Connect Electronic Service Tool Directly to ECM.		
• Turn the ignition switch OFF, engine OFF. • Disconnect ECM Machine Harness Connector J1/P1. • Remove pin-1 (ATA J1587 Data Link-) pin-7 (ATA J1587 Data Link+) from ECM Machine Harness Connector J1. • Install a 40-Pin Breakout T and connect ECM Machine Harness Connector P1. • Make four jumper wires (4 inches, 100 mm long) with a Deutsch pin and socket on either end. • Insert the two jumper wires into the Breakout T pin-1 (ATA J1587 Data Link-) and pin-7 (ATA J1587 Data Link+). • Connect the first jumper from the Breakout T Connector pin-1 (ATA Data Link-) to the Electronic Service Tool Connector Cable (ATA Data Link-) pin-H of Caterpillar 9-Pin Service Tool Cables. Connect the second jumper from the Breakout T Connector pin-7 (ATA Data Link+) to the Electronic Service Tool Connector Cable (ATA Data Link+) pin-J.  • Turn the ignition switch ON, engine OFF. • **Does the Electronic Service Tool operate correctly?**	**YES** ⇒	**There is a problem in the machine wiring, or another device in the machine is causing problems on the data link.** Reinsert the two data link lines into ECM Connector P1. Determine the device causing the problem.
	NO ⇒	Proceed to the next step.

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 7: Connect Electronic Service Tool and ECM to Another Battery.		
• Jumper Electronic Service Tool Connector Cable +Battery pin (pin-A of Caterpillar 9-Pin Service Tool Cables) and -Battery pin (pin-B of Caterpillar 9-Pin Service Tool Cables) to a known good battery source. • Turn the ignition switch ON, engine OFF. • **Does ET operate correctly?**	**YES** ⇒ **NO** ⇒	Proceed to “PB-11: ECM Battery Circuit Test” on page D-48 to repair the Battery Circuit to the ECM. **Temporarily install another ECM. Repeat this test step.** If the problem is resolved with the new ECM, install the old ECM to verify the problem returns with the ECM. If the new ECM works and the old one did not, replace the ECM.

PC-30: ECM Memory Test

System Operation

When to Use This Procedure

Use this procedure if Diagnostic Code 252-11 Incorrect Engine Software (59), or 253-02 Check Customer or System Parameters (56) is present, or if the integrity of the Customer or System Parameters in the ECM or Engine Lifetime Totals Data is questionable.

Background

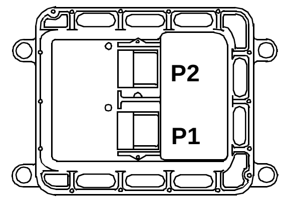
The Electronic Control Module (ECM) is the computer which controls the Caterpillar Electronic Diesel Engine. The Personality Module contains the software which controls how the computer (ECM) behaves.

The Personality Module consists of all of the **software**, or **instructions** for the ECM to do its job. Because of this, updating the Personality Module to a different version may cause some engine functions to behave in a different manner.

Performance Maps define fuel rate, timing, etc., for various operating conditions to achieve optimum performance while meeting emissions requirements. These are programmed into the Personality Module at the factory only.

The ECM consists of a **microprocessor,** to perform the computing necessary to perform the functions of governing, controlling timing, generating diagnostic codes, communicating with service tools, etc. The microprocessor reads its instructions from the software in the Personality Module.

3126 HEUI ECM



Programmable Parameters are stored in permanent memory. Refer to the “P-2.0: Programming Parameters” on page D-18 for details on the parameter functions.

Logged Diagnostics are stored by the ECM into memory so a permanent record of the diagnostic code is retained.

Input Circuits to filter electrical noise for sensor signals and to protect internal circuits from potentially damaging voltage levels.

Output Circuits to provide the voltages necessary to energize lamps or injector solenoids as the microprocessor chooses.

Power Circuits to provide clean stable electrical power to internal circuits and external sensors.

Diagnostic Codes

PID-FMI and Description of Code:	Systems Response:	Troubleshooting:
252-11 Incorrect Engine Software (59) The Personality Module installed is for a different engine than the Personality Module it replaced. **NOTICE** **Do not attempt to program a 3116 Personality Module into a 3126 engine. Serious engine damage may occur when the engine is started.**	**Electronic System Response -** The ECM will not allow the engine to start. **Engine Response -** The engine will not start.	Proceed with procedure PC-30.
253-02 Check Customer or System Parameters (56) A parameter requiring programming has not been programmed.	**Electronic System Response -** The fault is displayed only, not logged. If the Personality Module code of the new Personality Module does not match the code of the old Personality Module, the engine is limited to low idle. If the rating number has not been programmed, the ECM limits the engine to 120 hp (89.5 kW). On initial power up of a new ECM, the following five parameters must be programmed to avoid this code: **1.** Full Load Setting (FLS) **2.** Full Torque Setting (FTS) **Engine Response -** The ECM will limit the engine to low idle if the parameter is FLS or FTS, or limit power if the parameter is Rating Number.	Proceed with procedure PC-30.

Functional Test

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 1: Check Electrical Connectors and Wiring.		
• Thoroughly inspect ECM Connector J2/P2 and the battery connections. (Refer to procedure "PB-10: Inspecting Electrical Connectors" on page D-43 for details on inspecting connectors.) • Perform 10 pound (44.5 N) pull test on each of the wires in the ECM Connector associated with the +Battery, -Battery, and ATA Data Link connections. • Check ECM Connector (Allen screw) for proper torque. • Check the harness and wiring for abrasion and pinch points from the sensor back to the ECM. • **All connectors/pins/sockets should be completely mated/inserted, and the harness/wiring should be free of corrosion, abrasion or pinch points.**	**OK ⇒**	If troubleshooting a **252-11 Incorrect Engine Software (59) Diagnostic Code.** Proceed to Step 2 on page D96. If troubleshooting a **253-02 Check Customer or System Parameters (56) Diagnostic Code,** proceed to Step 3 on page D-97. If troubleshooting **because of scramble parameters or data,** proceed to Step 3 on page D-97.
	NOT OK ⇒	**Repair or replace wiring or connectors as necessary.** Ensure all seals are properly in place and connectors completely mated. Verify the repair eliminates the problem. STOP.
Step 2: Check ECM Personality Module Part Number with ET.		
• Install ET at Cab Data Link Connector. • Turn the ignition switch ON, engine OFF. • Read Customer Specified Parameters (refer to "P-2.0: Programming Parameters" on page D-18 if necessary), especially the Personality Module Part Number. • Ensure the Personality Module Part Number agrees with the engine arrangement as built at the factory (injectors, turbo, etc). • **Is the correct Personality Module installed in the ECM for the engine?**	**YES ⇒**	**If the correct Personality Module has been installed but there is an active 252-11 Diagnostic Code**, clearing this code requires Factory Passwords and resetting the Personality Module Code to zero.
	NO ⇒	**Reprogram the ECM with the correct Personality Module.** Refer to the section on Personality Module Programming.

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 3: Use ET to Determine Parameters Requiring Programming.		
• Install ET at Cab Data Link Connector (if not already installed). • Turn the ignition switch ON, engine OFF. • Check the Active diagnostic codes. Note any parameters listed in the 253-02 Check Customer or System Parameters (56). • **Will the ECM allow programming of the parameters listed under the 253-02 Check Customer or System Parameters (56) Code in the Active Diagnostic Code Screen?**	**YES** ⇒	**Ensure the cause of all diagnostic codes is repaired.** STOP.
	NO ⇒	**Temporarily install another ECM.** Ensure it will allow programming of the Parameters. If it does not, the old ECM is OK. Something is wrong in the machine wiring. Check the battery supply to the ECM.
Step 4: Use ET to Review Parameters and Data.		
• Install ET at Cab Data Link Connector (if not already installed). • Turn the ignition switch ON, engine OFF. • Check the Active and Logged diagnostic codes. • Review the Customer and System Parameters. • Review the Engine Lifetime Totals. • **Are the parameters and totals scrambled?**	**YES** ⇒	**Try to reprogram the suspect parameter(s).** If the ECM does not maintain the parameters, Temporarily install another ECM ensure it will allow programming of the Parameters. If it does not, the old ECM is OK. Something is wrong in the machine wiring. Check the battery supply to the ECM.
	NO ⇒	**The ECM is OK.** STOP.

PC-31: Engine Speed/Timing Circuit Test

System Operation

When to Use This Procedure

Use this procedure to troubleshoot the system only when there is an Active, easily repeated diagnostic code associated with either of the Engine Speed Timing Circuits, or if referred from the section “Troubleshooting Without a Diagnostic Code”.

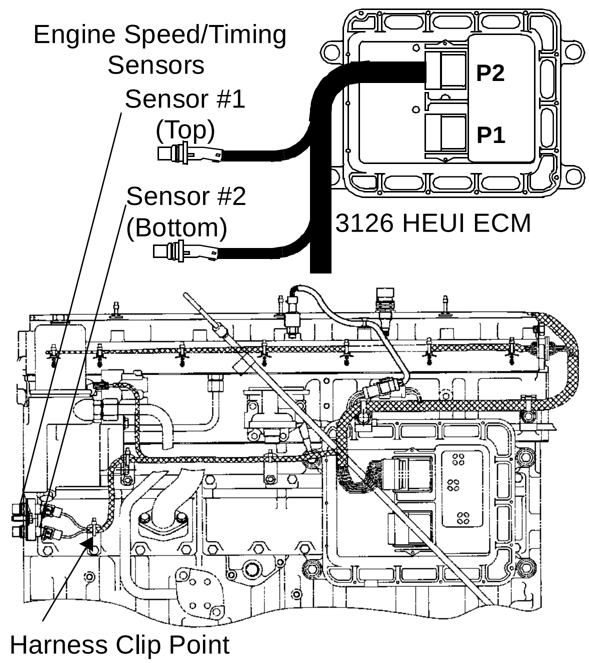
Background

The engine uses two Engine Speed/Timing Sensors, both detecting engine speed and timing reference from a unique pattern on the camshaft gear. The ECM counts the time between pulses created by the sensor as the camshaft gear rotates to determine rpm. The ECM memorizes the pattern of the pulses and compares the signal pattern to the expected pattern to determine crankshaft position. After locating No. 1 cylinder, the ECM triggers each injector in the correct firing order and at the correct time. The actual timing and duration of each injection is determined based on engine rpm and load. A loss of signal from one of the sensors will not cause noticeable engine operation changes. The loss of the signal from both sensors will result in the ECM terminating injection and shutting down the engine, or preventing it from starting.

Both sensors are magnetic sensors with an integral connector. **They must be serviced as a pair. If one requires replacement, they must both be replaced.** The two sensors are not interchangeable, do not switch sensor positions. The Top Sensor (Sensor #1) must be connected to the engine harness with the black harness connector and the Bottom Sensor (Sensor #2) must be connected to the grey harness connector. If the sensors are replaced, a timing calibration is NOT necessary for the 3126 HEUI engine. **Timing calibration is only necessary after replacing an ECM.**

The sensors are connected to the ECM through the Engine Harness Connector P2/J2 pin-8 (ENG SP/TMG #1+), pin-9 (ENG SP/TMG #1-), pin-3 (ENG SP/TMG #2+), and pin-15 (ENG SP/TMG #2-).

If an ECM replacement is required, the ECM parameters and timing calibration can be transferred from the suspect ECM to the replacement ECM and timing calibration would NOT be necessary. This feature requires Caterpillar Electronic Technician (ET) and is only possible if the existing ECM can communicate with Caterpillar Electronic Technician (ET).

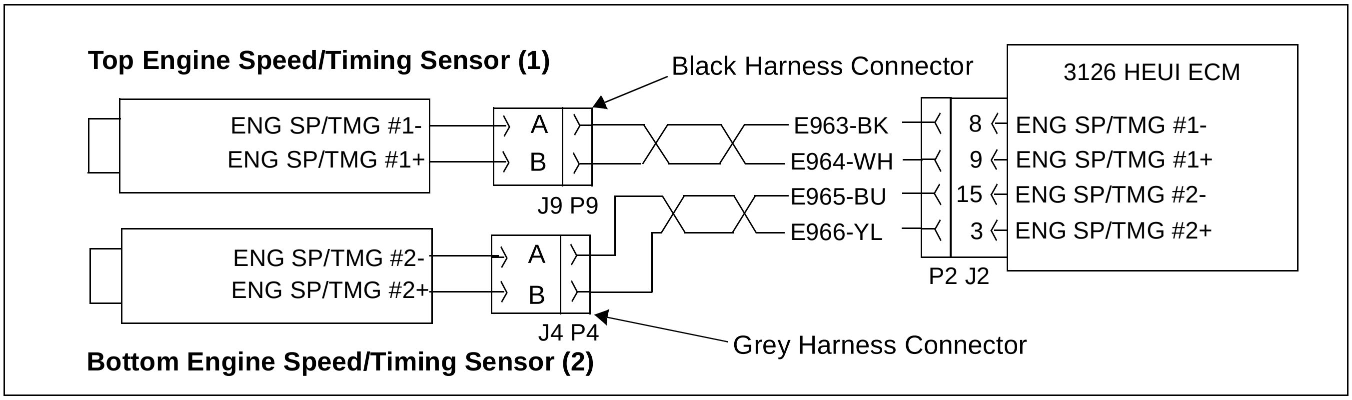


Left Side View 3126 HEUI Engine

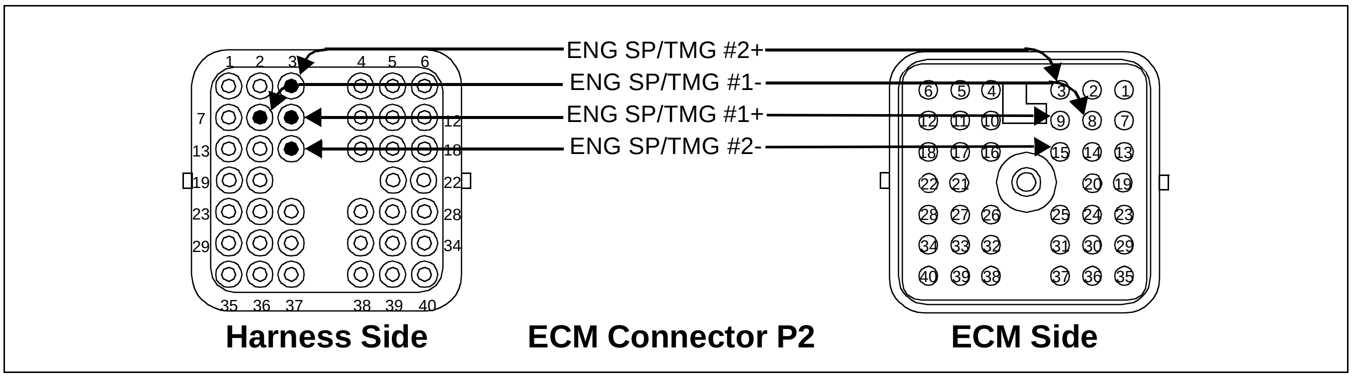
When installing the sensors:

1. Lubricate the O-rings with oil.
2. Check to ensure both sensors have connector face seals inside the connector body. If a seal is damaged or missing, use a 126-5011 replacement seal.
3. Check to ensure both sensors are fully seated into the engine before tightening the bracket bolt.
4. Check to ensure the connector is latched on both sides.
5. Check to ensure the harness is attached to the harness clip indicated in the Left Side View above.

Schematic



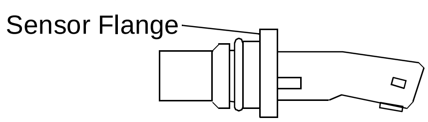
ECM Pin Locations



Diagnostic Codes

PID-FMI and Description of Code:	Systems Response:	Troubleshooting:
64-02 Loss of RPM Signal on Engine Speed/Timing Sensor #2 (34) The Speed/Timing signal for Engine Speed/Timing Sensor #2 is lost and then returns (intermittent). **64-08 Engine Speed without Pattern on Engine Speed/Timing Sensor #2 (34)** The Speed/Timing signal for Engine Speed/Timing Sensor #2 indicates rpm but the timing pattern is lost. **64-11 No Pattern on Engine Speed/Timing Sensor #2 (34)** The Speed/Timing signal for Engine Speed/Timing Sensor #2 is lost.	**Electronic System Response -** ECM uses the engine speed/timing signal from Engine Speed/Timing Sensor #1. The Check Engine Lamp will not be ON for this code unless the code has been Active for 10 hours. The code is logged. **Engine Response -** There should not be noticeable changes in engine response unless both Engine Speed/Timing Sensors are indicating problems which could shut the engine down.	Proceed with procedure PC-31: if the code is Logged or Active.
190-02 Loss of RPM Signal on Engine Speed/Timing Sensor #1 (34) The Speed/Timing signal for Engine Speed/Timing Sensor #1 is lost and then returns (intermittent). **190-08 Engine Speed without Pattern on Engine Speed/Timing Sensor #1 (34)** The Speed/Timing signal for Engine Speed/Timing Sensor #1 indicates rpm but the timing pattern is lost. **190-11 No Pattern on Engine Speed/Timing Sensor #1 (34)** The Speed/Timing signal for Engine Speed/Timing Sensor #1 is lost.	**Electronic System Response -** ECM uses the engine speed/timing signal from Engine Speed/Timing Sensor #1. The Check Engine Lamp will not be ON for this code unless the code has been Active for 10 hours. The code is logged. **Engine Response -** There should not be noticeable changes in engine response unless both Engine Speed/Timing Sensors are indicating problems which could shut the engine down.	Proceed with procedure PC-31: if the code is Logged or Active.

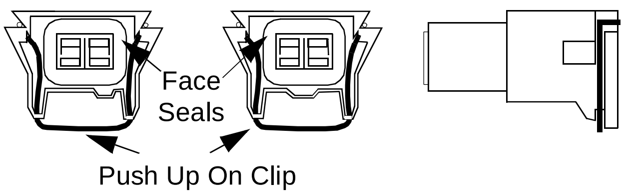
Functional Test

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 1: Connect ET and Note All Active and Logged Diagnostic Codes.		
• Connect ET to the Cab Data Link Connector. • Turn the ignition switch ON, engine OFF. • **Is one of the following diagnostic codes logged or active:** - 64-02 Loss of RPM Signal on Engine Speed/Timing Sensor #2 (34) - 64-08 Engine Speed without Pattern on Engine Speed/Timing Sensor #2 - 64-11 No Pattern on Engine Speed/Timing Sensor #2 (34) - 190-02 Loss of RPM Signal on Engine Speed/Timing Sensor #1 (34) - 190-08 Engine Speed without Pattern on Engine Speed/Timing Sensor #1 (34) - 190-11 No Pattern on Engine Speed/Timing Sensor #1 (34) **NOTE:** If the diagnostic code is logged, but is not Active, run the engine until it is at normal operating temperature. The problem may only occur when the engine is at the normal operating temperature.	**YES** ⇒ **NO** ⇒	**There is an Active or Logged diagnostic code for either of the Engine Speed Timing sensors.** Proceed to Step 3 on page D-102. **If none of the codes listed are active or logged and the engine is not running properly refer to "Troubleshooting Without a Diagnostic Code" on page D-23. If referred here because engine rpm is not indicated on an ET from the "Troubleshooting Without a Diagnostic Code" section, proceed to the next step.**
Step 2: Check Sensors and Bracket Installation.		
• To ensure proper operation, the sensor flange should be flush against the engine.  • **Inspect the bracket to ensure the installation allows the sensor flange to be flush against the engine, and the bracket should not be bent.**	**OK** ⇒ **NOT OK** ⇒	**The sensor and bracket were properly installed.** Proceed to the next step. Loosen the bolt holding the sensor bracket to the engine. Seat the sensors and tighten the bolt. If the sensors will not seat, repair or replace the sensors as necessary. Make sure the problem is corrected. STOP.

<table>
<tr><th>TEST STEP</th><th>RESULT</th><th>DIAGNOSIS/ACTION</th></tr>
<tr><td>Step 3: Measure the Sensor Resistance Through the Engine Harness.</td><td></td><td></td></tr>
<tr><td>• Turn the ignition switch OFF, engine OFF.
• Thoroughly inspect ECM Engine Harness Connector J2/P2. (Refer to “PB-10: Inspecting Electrical Connectors” on page D-43 for details on inspecting connectors.)
• Perform 10 pound (44.5 N) on ECM Engine Harness Connector P2 pin-3, pin-8, pin-9, and pin-15.
• Check ECM Connector (Allen screw) for proper torque.
• Repair the harness or connector if a problem is found.
• If the harness and connector are OK, disconnect Engine Harness ECM Connector J2/P2.
• Use a multimeter to measure the sensor resistance (Ohms -Ω) from Engine Harness Connector P2 as indicated below. Move the Engine Speed/Timing Harness (pull/shake on the wires, especially directly behind the sensors) while taking a measurement to check for an intermittent open or short circuit.
• Sensor #1 - the resistance from P2 pin-9 (ENG SP/TMG #1+) to P2 pin-8 (ENG SP/TMG #1-) should measure from 75.0 to 230.0 Ohms (Ω).
• Sensor #2 - the resistance from P2 pin-3 (ENG SP/TMG #2+) to P2 pin-15 (ENG SP/TMG #2-) should measure from 600 to 1800 Ohms (Ω).</td><td>OK ⇒

NOT OK ⇒</td><td>The engine harness and sensor does not indicate a short or open circuit. Proceed to Step 5 on page D-104.

The sensor resistance is not within the acceptable range when measured through the engine harness. Proceed to the next step.</td></tr>
</table>

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 4: Measure the Sensor Resistance at the Sensor.		
• Turn the ignition switch OFF, engine OFF. • Check the harness and wiring for abrasion and pinch points from the sensor back to the ECM. • Make sure the Top Sensor (Engine Speed/Timing Sensor #1) is connected to the Black Harness Connector and the Bottom Sensor (Engine Speed/Timing Sensor #2) is connected to the Grey Harness Connector. • Disconnect the suspect sensor from the engine harness as described below. • To disconnect the speed/timing sensors: - push up on metal clip under the sensor connector (**do not pry metal clip off of the connector**).  • Thoroughly inspect ECM Engine Harness Sensor Connectors J9/P9 or J4/P4. (Refer to “PB-10: Inspecting Electrical Connectors” on page D-43 for details on inspecting connectors.) • Connect a 122-8840 Engine Speed Timing Sensors Harness Section to the sensors on the engine for this measurement, or if none is available, it may be easier to remove the sensors from the engine. • Use a multimeter to measure the sensor resistance (Ohms -Ω) from the Sensor Connector. • **Sensor #1 -** the resistance from J9 pin-B (ENG SP/TMG #1+, white wire) to J9 pin-A (ENG SP/TMG #1-, black wire) should measure from 75.0 to 230.0 Ohms (Ω). J9 is the top sensor connector (connects to the black harness connector). • **Sensor #2 -** the resistance from J4 pin-B (ENG SP/TMG #2+, yellow wire) to J4 pin-A (ENG SP/TMG #2-, blue wire) should measure from 600 to 1800 Ohms (Ω)**.** J4 is the bottom sensor connector (connects to the grey harness connector). **NOTE:** Timing calibration is not necessary following replacement of the speed/timing sensors on a 3126 HEUI engine.	**OK** ⇒ **NOT OK** ⇒	**The sensor resistance is correct.** If a 122-8840 Engine Speed Timing Sensors Harness Section was installed, leave it in place. Proceed to the next step. The sensor resistance is out of range, obtain new sensors. **Before installing the new sensors, measure the resistance of the new sensors as outlined in this procedure using the same test setup (test harness, multimeter and meter settings).** If the new sensor readings are out of range, check the test harness, and multimeter. Recheck the original sensors. If the new sensors are in range install the new sensors in the engine. **NOTE:** When installing the sensors, refer to “When Installing the Sensors” on page D-98.

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 5: Install Engine Speed/Timing Bypass Harness.		
• Ensure the ignition switch is OFF, engine is OFF. • Disconnect Engine Harness ECM Connector J2/P2 (If not already disconnected). • Install a 122-8840 Engine Speed Timing Sensors Harness Section. Connect the Harness section to the sensors and ECM. **Make sure the yellow Harness wire connects to pin-3, black wire to pin-8, white wire to pin-9, and blue wire to pin-15 of the ECM Engine Harness Connector P2.** • Reconnect the Engine Harness Connector J2/P2. • Start the engine to determine if the bypass harness repairs the problem. **• Is the problem corrected with the bypass installed?**	**YES ⇒** **NO ⇒**	**Permanently install a 122-8840 Engine Speed Timing Sensors Harness Section.** Clip the new harness in the same locations as the original harness. STOP. **Double check to verify the correct pins have been installed in the correct location of the ECM Engine Harness Connector P2. If the temporary harness was installed correctly, install the original harness.** Proceed to the next step.
Step 6: Check ECM.		
• Turn the ignition switch OFF, engine OFF. • Temporarily install another ECM. • Start the engine and run it to repeat the conditions when the problem occurs. Determine if the problem is corrected with the replacement ECM. • If the problem does not recur with the replacement ECM, reinstall the suspect ECM and ensure the problem returns. **• Does the problem stay with the suspect ECM?**	**YES ⇒** **NO ⇒**	**If the replacement ECM works and the suspect ECM does not,** replace the ECM. **Replace the speed/timing sensors and ensure the problem is corrected.** STOP.

PC-32: Engine Speed/Timing Calibration

System Operation

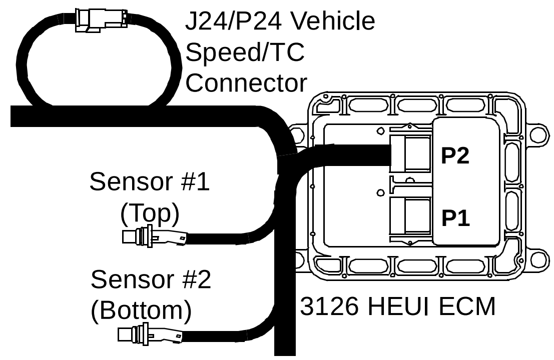
When to Use This Procedure

Use this procedure if Diagnostic Code 22-13 Check Timing Sensor Calibration (42) is Active. This code occurs only with a new ECM before the ECM has had a timing calibration performed. It is important to perform the calibration before permanently installing the ECM to allow access and installation of the Timing Probe into the timing calibration port in the flywheel.

Background

The Electronic Control Module (ECM) requires the timing calibration to determine the relative location of the timing wheel to the actual cam top center location. This is necessary for the engine to operate correctly for emissions.

NOTE: A timing calibration is ONLY REQUIRED following an ECM replacement, not after replacing the Speed/Timing Sensors. Also, performing a timing calibration to improve performance is unnecessary and will not improve performance unless a 22-13 Diagnostic Code is the reason for the calibration.



If an ECM replacement is required, the ECM parameters and timing calibration can be transferred from the suspect ECM to the replacement ECM and Timing calibration would NOT be necessary. This feature requires Caterpillar Electronic Technician (ET) and is only possible if the existing ECM can communicate with Caterpillar Electronic Technician (ET).

Diagnostic Codes

PID-FMI and Description of Code:	Systems Response:	Troubleshooting:
22-13 Check Timing Sensor Calibration (42) The ECM has been replaced and the Engine Speed/Timing Sensors have not been calibrated.	**Electronic System Response -** The ECM will use default timing. **Engine Response -** The engine will not be operating with calibrated timing.	Proceed with procedure PC-32.

Functional Test

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 1: Install the Timing Adapter Group. • Turn the ignition switch OFF, engine OFF. • Remove the timing calibration plug from in front of the flywheel housing on the rear right side of the engine. • Install the Timing Probe Adapter Sleeve into the hole for the plug.	**OK** ⇒	Proceed to the next step.
Step 2: Install 6V2197 Timing Probe on Engine. • Put a 2D-6392 O-Ring Seal on the end of the Magnetic Pickup Sensor (a small amount of clean engine oil will allow the seal slide onto the sensor more easily). • Push the sensor through the adapter until it comes in contact with the outermost portion of the flywheel timing calibration ring and move the O-Ring seal down against the adapter. • Withdraw the sensor 0.04 in. (1.0 mm) and hand tighten the nut on the adapter sleeve to secure the magnetic pickup in place. • Disconnect Vehicle Speed/TC Calibration Connector J24/P24. • Connect the 6V2197 Timing Probe to the 7X1695 Deutsch DT Timing Harness Adapter. **• Do not connect the DT Timing Harness Adapter to the Vehicle Speed/TC Probe Connector P24 until you are ready to perform the timing calibration. Connect cable for magnetic pickup to the magnetic pickup sensor.** **NOTE:** If the Timing Probe is connected to the Vehicle Speed/TC Connector when ET is not in the “Monitor/Calibrate Timing” Screen, Vehicle Speed Diagnostic Codes will result.	**OK** ⇒	Proceed to the next step.
Step 3: Start Engine and Warm to Operating Temperature. • Start the engine and run at low idle until the engine has warmed up enough to exit Cold Mode operation. An ET status screen will display COLD MODE in the upper corner when Cold Mode operation exists. The engine will change idle from Cold Mode idle (1000 rpm) to the programmed low idle rpm when out of Cold Mode. • Check for ACTIVE diagnostic codes. Use the procedures in this manual to troubleshoot and repair any ACTIVE diagnostic codes before attempting a calibration check.The engine must not have any diagnostic fault conditions present during timing calibration [other than 22-13 Timing Sensor Calibration (42)]. • Following warm up, set Engine Speed to 1100 rpm using the throttle. **NOTE:** The Engine speed must be steady and within the 1000 to 1200 rpm range to perform a timing calibration.	**OK** ⇒	Proceed to the next step.

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 4: Connect ET.		
• Connect ET to the Cab Data Link Connector. • After the engine has exited Cold Mode, select the "**Monitor/Calibrate Timing" Screen** on ET. **NOTE:** To perform a timing calibration, the engine rpm must be held as steady as possible at approximately 1100 rpm. Any major changes (greater than 100 rpm) will slow down the procedure and reduce accuracy. • Connect the 7X1695 Deutsch DT Adapter Harness for the 6V2197 Timing Probe to the 2-Pin Vehicle Speed/TC Connector P24. • Be certain all connections are made correctly. **NOTE:** If ET is not in the "Monitor/Calibrate Timing" screen with the probe connected, vehicle speed diagnostic codes will be generated.	**OK** ⇒	Proceed to the next step.
Step 5: Calibrate the Speed/Timing Sensors.		
• To calibrate the timing to the correct setting, press the Space Key on the ET keyboard and wait until ET indicates the timing is CALIBRATED. (First press of space bar will put "Timing Error" Bar on screen, second press Calibrates.) **NOTE:** If the ET display reads "COULD NOT CALIBRATE" timing, the electronic injection timing has not been set. Recheck the tool installation and tool operation and try again to calibrate electronic injection timing. If the crank and cam gears have been reassembled incorrectly (relative to each other), the engine will not calibrate. • **If timing calibration has been successfully completed, do not exit the** "**Monitor/Calibrate Timing" Screen on the ET until you have first disconnected the timing probe from the Vehicle Speed/TC Connector P24.**	**OK** ⇒ **NOT OK** ⇒	The Timing Calibration procedure was completed successfully. Proceed to the next step. If engine speed is unstable, verify that the engine speeds were kept stable (± 50 rpm) during testing. If engine speed was unstable or could not be controlled within ± 50 rpm because of mechanical or electrical factors, refer to "PA-18: Engine Misfires, Runs Rough Or Is Unstable" on page D-34**.** If all of the checks are OK but the timing still will not calibrate, check the Timing Probe and make sure it is not bent. **If it is not bent restart this procedure**.
Step 6: Disconnect Timing Probe and Then Exit "Monitor/Calibrate Timing" Screen.		
• Disconnect the Timing Probe from the Vehicle Speed/TC Connector P24. • Exit the ET "Monitor/Calibrate Timing" Screen (press previous screen key). **NOTE:** Exiting the ET "Monitor/Calibrate Timing" Screen will drop engine rpm to programmed low idle if PTO was used to maintain engine speed during calibration- this is normal.	**OK** ⇒	STOP. If the timing probe is installed following exit from the "Monitor/Calibrate Timing" Screen, Vehicle Speed Diagnostics will be generated and should be cleared.

PC-33: Injector Solenoids Circuit Test

System Operation

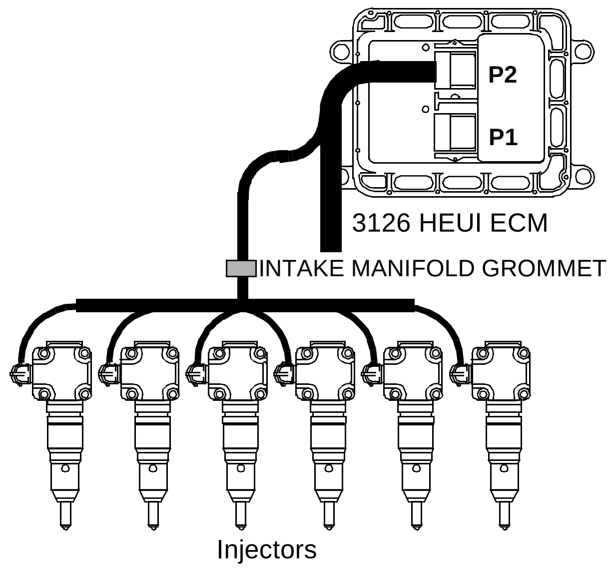
When to Use This Procedure

Use this procedure when there is an Active or easily repeated Diagnostic Code associated with an injector solenoid. It is important to perform this procedure when the injector is under similar conditions to when the problem occurs. Typically injector solenoid problems occur when the engine is at operating temperature and/or under vibration (heavy loads).

Background

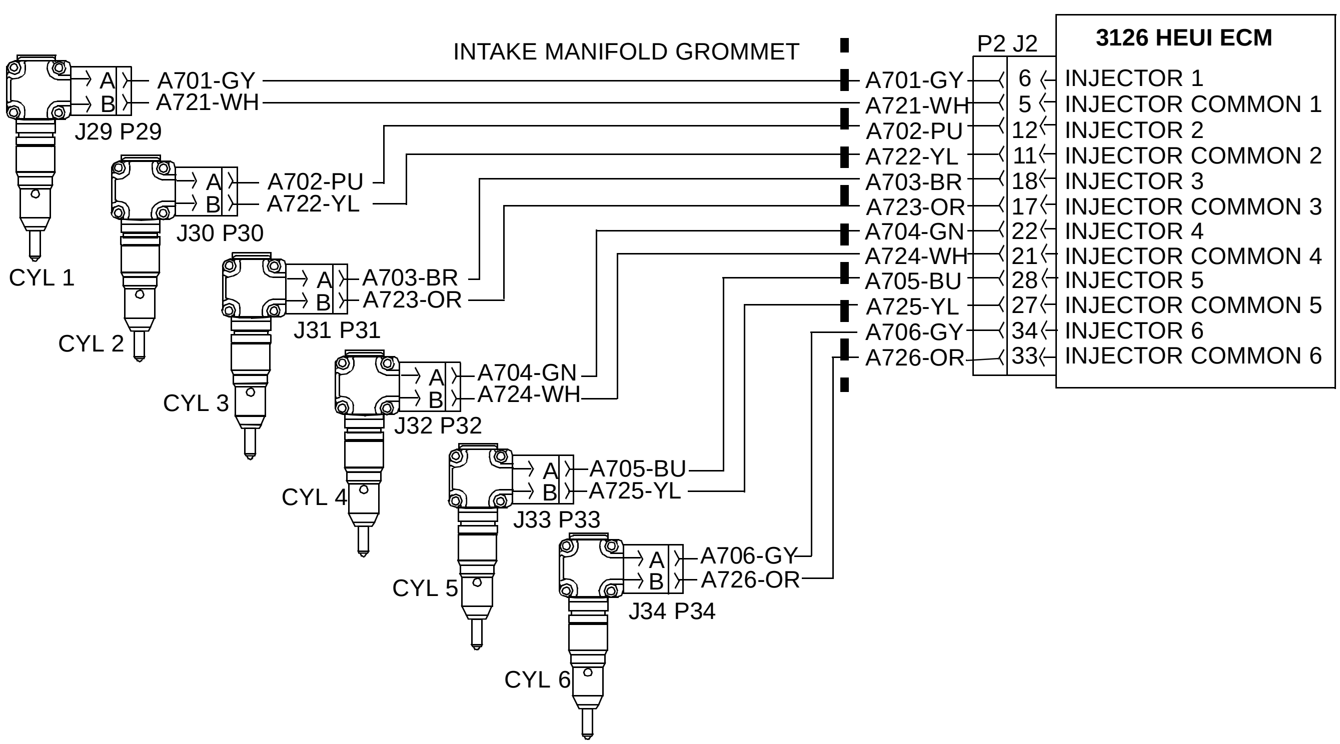
The engine has Hydraulic Electronic Unit Injectors, which are hydraulically actuated and electronically energized. The solenoid is mounted on top of the injector body along side the rocker return spring.

The injectors can be individually cut out while the engine is running to aid in troubleshooting misfire problems. The injector solenoids can also be actuated without the engine running using the ET Special Test to check for solenoid operation.

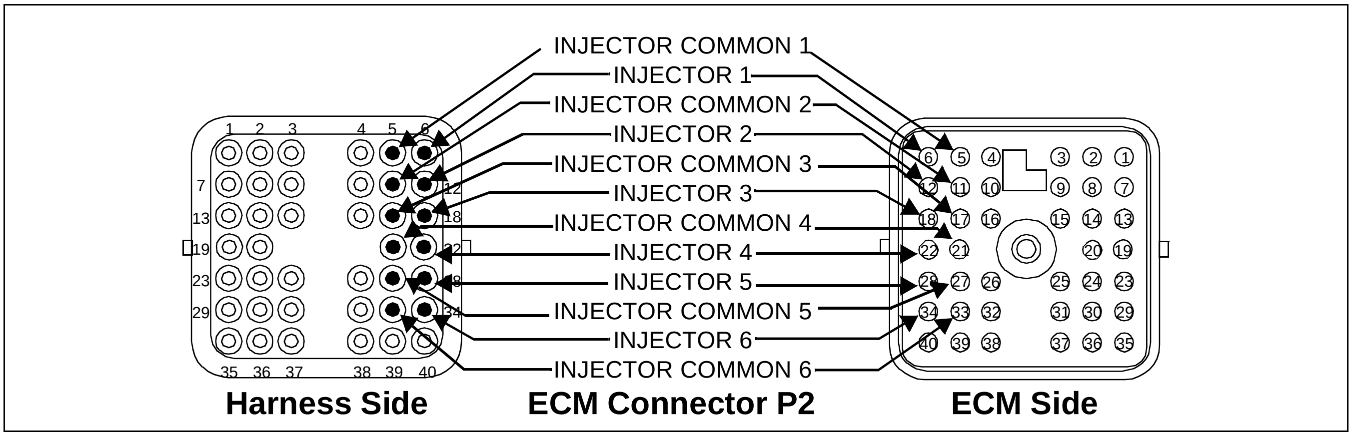


NOTE: The Injector Cutout Test will not help find leaks in the high pressure oil system.

Schematic



ECM Pin Locations



Diagnostic Codes

PID-FMI and Description of Code:	Systems Response:	Troubleshooting:
1-05 Cylinder 1 Open Circuit Fault (72) **2-05 Cylinder 2 Open Circuit Fault (72)** **3-05 Cylinder 3 Open Circuit Fault (73)** **4-05 Cylinder 4 Open Circuit Fault (73)** **5-05 Cylinder 5 Open Circuit Fault (74)** **6-05 Cylinder 6 Open Circuit Fault (74)** The ECM detects one of the following after attempting to actuate the injector solenoid. - An open circuit in the injector wiring. - An internal open circuit in the injector solenoid.	**Electronic System Response -** The ECM will turn the Check Engine Lamp ON and log the diagnostic code. The ECM skips two injections between attempts to actuate the injector. **Engine Response -** The engine will run without the affected injector. The engine may run rough and/or misfire under some conditions because the injector may not actuate while the conditions exist.	Proceed with procedure PC-33.
1-06 Cylinder 1 Short Circuit Fault (72) **2-06 Cylinder 2 Short Circuit Fault (72)** **3-06 Cylinder 3 Short Circuit Fault (73)** **4-06 Cylinder 4 Short Circuit Fault (73)** **5-06 Cylinder 5 Short Circuit Fault (74)** **6-06 Cylinder 6 Short Circuit Fault (74)** After attempting to actuate the Injector Solenoids the ECM has detected one of the following. - An electrical short circuit to ground (to the engine iron). - An internal injector solenoid electrical short circuit. - A short circuit to battery voltage.		

Functional Test

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 1: Check Electrical Connectors and Wiring.		
• Turn the ignition switch OFF, engine OFF	OK ⇒	Proceed to the next step.
WARNING **Ensure the ignition switch is OFF. Possible strong electrical shock hazard if the ignition switch is not turned OFF.**	NOT OK ⇒	**Repair or replace wiring or connectors as necessary.** Ensure all seals are properly in place and connectors completely mated. Verify the repair eliminates the problem. STOP.
• Thoroughly inspect ECM Engine Harness Connector J2/P2 and each of the Injector wires in the Connector. • Perform 10 pound (44.5 N) pull test on each of the wires in the ECM Connector associated with the Injector Solenoids. • Check ECM Connector (Allen screw) for proper torque. • Check the harness and wiring for abrasion and pinch points from the ECM back to the Intake Manifold Grommet. • **All connectors/pins/sockets should be completely mated/inserted, and the harness/wiring should be free of corrosion, abrasion or pinch points.**		
Step 2: Check for Logged Injector Solenoid Diagnostic Codes.		
• Connect ET at the Cab Data Link Connector. • Turn the ignition switch ON, engine OFF. • Access the screen displaying Logged Diagnostic Codes. • **Does the Service Tool indicate a logged 1-05, 1-06, 2-05, 2-06, 3-05, 3-06, 4-05, 4-06, 5-05, 5-06, 6-05, 6-06 Injector Solenoid Diagnostic Code?**	YES ⇒ NO ⇒	Proceed to Step 4 on page D-112. Proceed to the next step.
Step 3: Check Cylinder to Cylinder Variation of Injectors.		
• Connect ET at the Cab Data Link Connector. • Start the engine, allow the engine to warm up to normal operating temperature. • Access the cylinder cut out screen. • Set engine speed to 1800 rpm. • Do not fully load the engine. • Cut out individual cylinders, or begin the Automatic Cylinder Cutout Test while watching the “Fuel Pos” on the Service Tool screen or the dynamometer. • Check to verify if cutting out a specific cylinder causes little change in the “Fuel Pos” compared to cutting out the remaining cylinders. This may indicate a mechanical problem with the injector or cylinder. • **Does an Injector Solenoid Diagnostic Code occur as a result of this test?**	YES ⇒ NO ⇒	Proceed to the next step. **If no diagnostic codes are apparent, the injectors are electronically OK.** Refer to Systems Operation, Testing and Adjusting Manual, SENR6558.

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 4: Check Injector Solenoids Using Service Tool Injector Solenoid Test.		
• Start the engine, allow the engine to warm up to normal operating temperature. • Turn the ignition switch OFF, engine OFF. • Connect ET at the Cab Data Link Connector. • Turn the ignition switch ON, engine OFF. • After the engine is warmed to operating temperature, access and begin the Injector Solenoid Test on the Service Tool. The engine cannot be running to perform this test. **NOTE:** The test is in the Interactive Diagnostic Tests. Do not confuse it with the Cylinder Cutout Test. • Performing the Injector Solenoid Test through the cylinders a few times is sufficient. **• Do all injectors indicate OK, and click?** **NOTE:** If an injector indicates “OK”, **but does not click,** replace the injector.	**YES ⇒**	**There is not an electronic problem with the Injectors at this time.** STOP.
	NO ⇒	**Note the cylinders indicating OPEN and/or SHORT.** **For cylinders indicating a SHORT**, proceed to the next step. **For cylinders indicating an OPEN**, proceed to Step 6 on page D-113.
Step 5: Check ECM for Short Circuits Using the ET Injector Solenoid Test.		
• Turn the ignition switch OFF, engine OFF. **⚠ WARNING** **Ensure the ignition switch is OFF. Possible strong electrical shock hazard if the ignition switch is not turned OFF.** • Disconnect ECM Connector J2/P2 from the ECM and check for evidence of moisture entry. • Turn the ignition switch ON, engine OFF. • Access and begin the Injector Solenoid Test on the Service Tool. Performing the Injector Solenoid Test through the cylinders a few times is sufficient. **• Do all cylinders indicate OPEN with ECM Connector P2 disconnected from the ECM?** **NOTE:** With the ECM Connector J2/P2 disconnected all of the +5V Supplied sensor open circuit diagnostic codes and the Inlet Air Heater Open Circuit Code will be Active. This is normal. Clear all of these diagnostic codes after completing this Test Step.	**YES ⇒**	**Clear all diagnostic codes** and proceed to Step 7 on page D-114.
	NO ⇒	**Temporarily install another ECM. Repeat this test step.** If the problem is resolved with the new ECM, install the old ECM to verify the problem returns with the ECM. If the new ECM works and the old one did not, replace the ECM.

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 6: Check ECM for Open Circuit • Turn the ignition switch OFF, engine OFF. **WARNING** **Ensure the ignition switch is OFF. Possible strong electrical shock hazard if the ignition switch is not turned OFF.** • Disconnect ECM Connector J2/P2 from the ECM and check for evidence of moisture entry. Connect a 40-Pin Breakout T to the ECM (do not connect the Engine Harness Connector P2 to the Breakout T). • Use a jumper wire and short between the Injector socket and Injector Common socket for the same Injector of **STEP 4** which indicated an OPEN. • Turn the ignition switch ON, engine OFF. • Access and begin the Injector Solenoid Test on the ET. Performing the Injector Solenoid Test through the cylinders a few times is sufficient. **• Does the cylinder with the jumper wire installed indicate SHORT?** **NOTE:** With the ECM Connector J2/P2 disconnected all of the +5V Supplied sensor open circuit diagnostic codes and the Inlet Air Heater Open Circuit Code will be Active. All of the Injectors without a short circuit jumper installed will indicate an OPEN during the Injector Solenoid Test. This is normal. Clear all diagnostic codes after completing this Test Step.	**YES** ⇒ **NO** ⇒	**The ECM is OK.** Remove the Breakout T and connect ECM Connector J2/P2. Clear all diagnostic codes. Proceed to the next step. **Temporarily install another ECM. Repeat this test step.** If the problem is resolved with the new ECM, install the old ECM to verify the problem returns with the ECM. If the new ECM works and the old one did not, replace the ECM.

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 7: Check Injector Harness Under Valve Cover. • Turn the ignition switch OFF, engine OFF. **WARNING** **Ensure the ignition switch is OFF. Possible strong electrical shock hazard if the ignition switch is not turned OFF.** • Remove the Valve Cover of the problem Injector(s). **For an injector with an open circuit problem,** • Disconnect the Harness from the problem injector and remove the Injector wires from the ECM Engine Harness Connector P2. • Use a 127-6359 Injector Test Harness Assembly to bypass the disconnected Injector Harness. Connect a 127-6359 Injector Test Harness Assembly to the disconnected Injector Connector. Insert the two pins from the 127-6359 Injector Test Harness Assembly into the ECM Engine Harness Connector P2. • Turn the ignition switch ON, engine OFF. • Access and begin the Injector Solenoid Test on ET. • Performing the Injector Solenoid Test through the cylinders a few times is sufficient. • **Does the Injector still indicate an OPEN?** **For an injector with a short circuit problem,** • Disconnect the Harness from the problem injector. • Turn the ignition switch ON, engine OFF. • Access and begin the Injector Solenoid Test on ET. • Performing the Injector Solenoid Test through the cylinders a few times is sufficient. • **Did the disconnected Injector change to OPEN with the Harness disconnected?** **NOTE:** Ensure the seal is installed in the harness connector before connecting the harness to the injector. If the seal is missing, use a 123-1199 replacement seal.	**YES ⇒** **NO ⇒**	**Replace the faulty injector indicating the problem.** Restore the wiring to the proper injector(s). **Repeat this test step** to ensure problem is corrected. DO NOT replace valve cover until problem is resolved. Clear all diagnostic codes. STOP. **Replace the Injector Harness under the valve cover. Repeat this test step** to ensure problem is corrected. DO NOT replace valve cover until problem is resolved. Clear all diagnostic codes. STOP.

PC-34: +5V Sensor Voltage Supply Circuit Test

System Operation

When to Use This Procedure

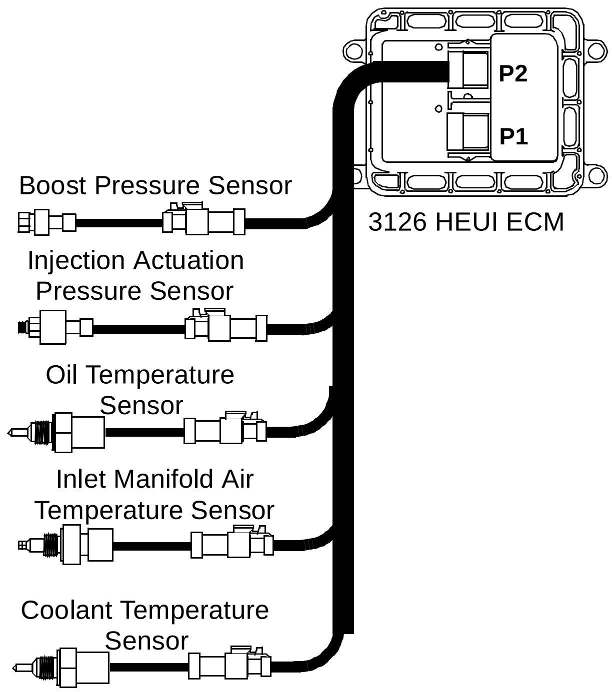
Use this procedure to troubleshoot the system only when there is an Active, or easily repeated 232-03 +5 Volt Supply Above Normal (21), or 232-04 +5 Volt Supply Below Normal (21) or if directed here by another troubleshooting procedure.

Background

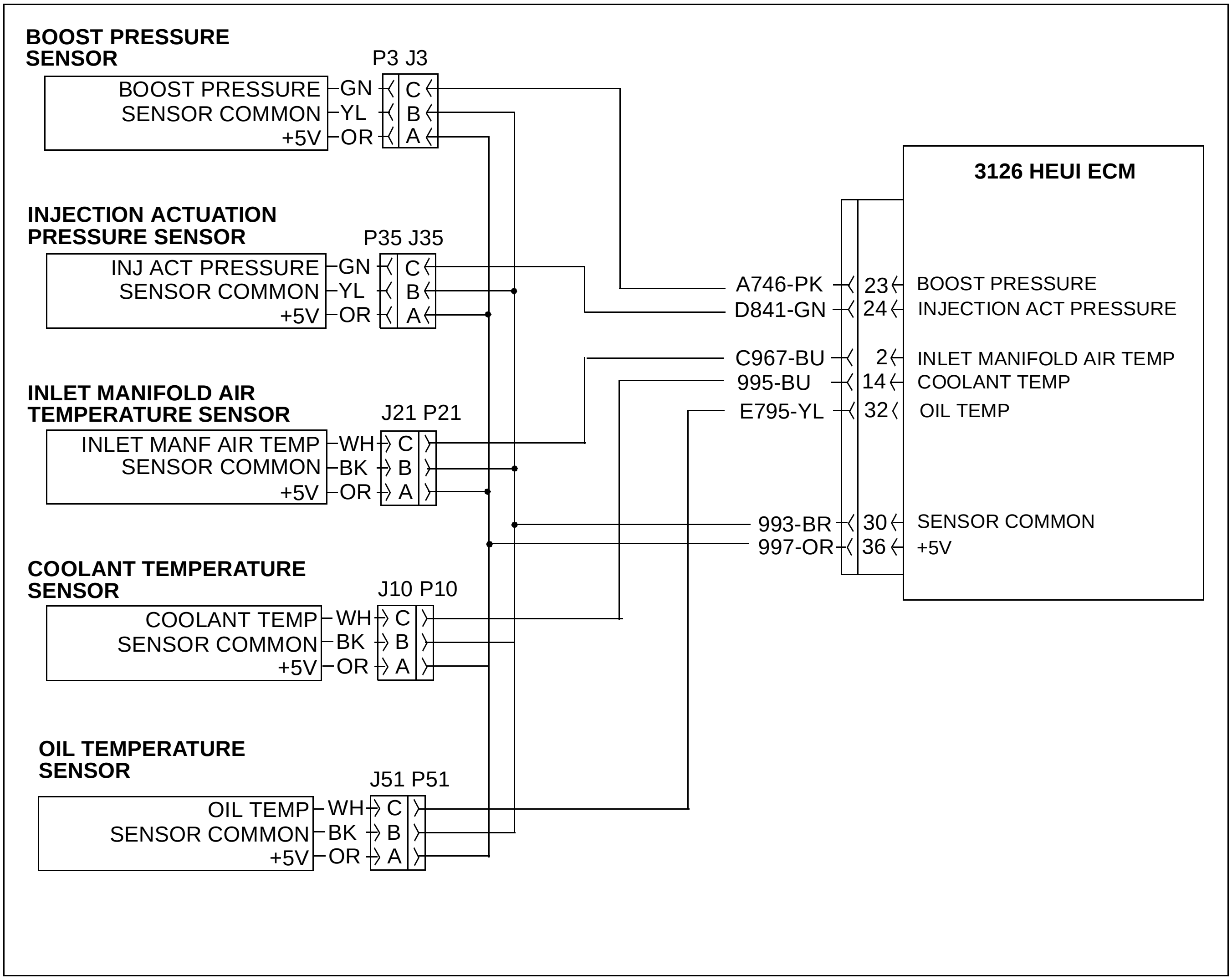
The Electronic Control Module (ECM) supplies the J10/P10 Oil Temperature, J21/P21 Inlet Manifold Air Temperature, J3/P3 Boost Pressure, and J35/P35 Injection Actuation Pressure Sensors with a regulated +5 volts DC from the same supply.

The +5V sensor supply is routed from the ECM through ECM Engine Harness Connector J2/P2 pin-36 to pin-A of each Engine Harness component. The supply voltage is 5.0 ± 0.5 volts DC.

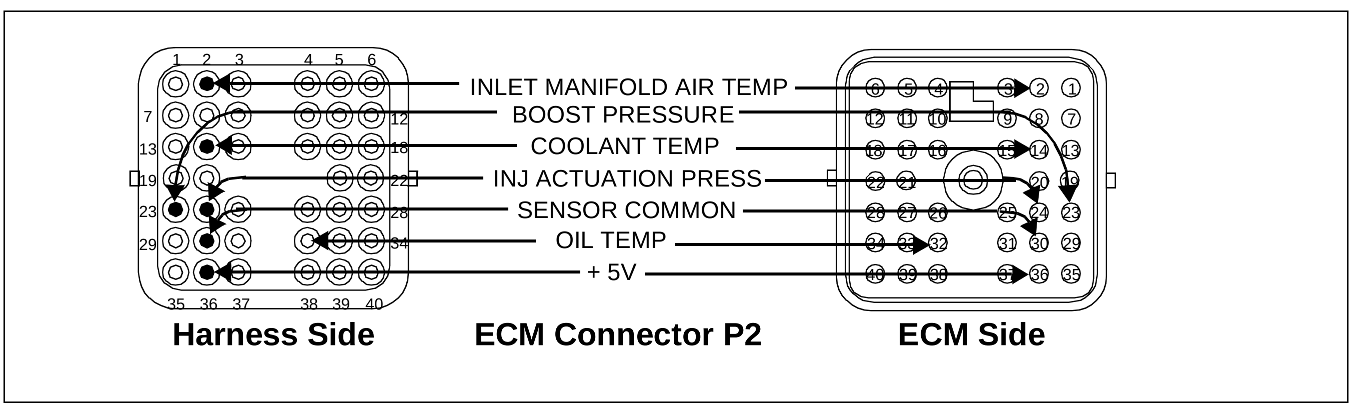
The +5V Short Circuit Diagnostic Code is most likely caused by a short or open circuit in the harness, next likely is a sensor, and the least likely, the ECM.



Schematic



ECM Pin Locations



Diagnostic Codes

<table>
<tr><th>PID-FMI and Description of Code:</th><th>Systems Response:</th><th>Troubleshooting:</th></tr>
<tr><td>232-03 5 Volt Supply Above Normal (21)
The supply voltage for all engine sensors (except Speed/Timing and Throttle Position) is exceeding normal level.</td><td rowspan="2">Electronic System Response - All Sensors powered by the supply are set to default values. All Diagnostic Codes for sensors powered by the supply are disabled while this diagnostic code is Active.
Service Tool Display or Lamps - ET will indicate sensor status approximately as indicated below.
- Boost Pressure = 0 psi (0 kPa).
- Coolant Temperature = 194°F (90°C).
- Oil Temperature = WARM MODE
- Inlet Manifold Air Temperature = 185°F (85°C).
- Injection Actuation Pressure = 1740 psi (12 MPa).
Engine Response - An Active diagnostic code may not cause any noticeable effect on engine response, or it may cause white smoke on start up, misfire during cold ambient temperatures or low power, depending on the operating conditions at the time the code occurs.</td><td rowspan="2">Proceed with procedure PC-34 if the diagnostic code is Active.</td></tr>
<tr><td>232-04 5 Volt Supply Below Normal (21)
The supply voltage for all engine sensors (except Speed/Timing and Throttle Position) is below normal level.</td></tr>
</table>

Functional Test

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 1: Check for Connector Damage.		
• Turn the ignition switch OFF, engine OFF. • Check ECM Connectors J1/P1 and J2/P2, J3/P3 (Boost Pressure), J10/P10 (Coolant Temperature), J21/P21 (Inlet Manifold Air Temperature), J35/P35 (Injection Actuation Pressure), and J51/P51 (Oil Temperature) Sensor Connectors for damage, corrosion, or abrasion. (Refer to procedure “PB-10: Inspecting Electrical Connectors” on page D-43 for details on inspecting connectors.) • Perform 10 pound (44.5 N) pull test on each of the wires in the ECM Connectors associated with the +5V Sensor Supply (pin-36) and Sensor Common (pin-30). • Check ECM Connector (Allen screw) for proper torque. • Check the harness and wiring for abrasion and pinch points from the sensor back to the ECM. • **All connectors/pins/sockets should be completely mated/inserted, and the harness/wiring should be free of corrosion, abrasion or pinch points.**	**OK** ⇒ **NOT OK** ⇒	Proceed to the next step. **Repair as required.** If the condition is NOT resolved, then proceed to the next step.
Step 2: Connect ET and Note All Active Diagnostic Codes.		
• Connect ET to the Cab Data Link Connector. • Turn the ignition switch ON, engine OFF. Wait at least 15 seconds for Diagnostic Codes to become Active. • **Is one of the following diagnostic codes Active or Logged?** - 232-03 5 Volt Supply Above Normal (21) - 232-04 5 Volt Supply Below Normal (21)	**YES** ⇒ **NO** ⇒	If either +5V diagnostic code is active proceed to the next step. If the +5V diagnostic code is logged ONLY proceed to Step 5 on page D-120. **+5V Supply operating correctly at this time.** STOP.

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 3: Disconnect the ECM Engine Harness Connector and Monitor +5V Code.		
• Install ET at the Cab Data Link Connector (if not already installed). • Turn the ignition switch OFF, engine OFF. • Disconnect ECM Engine Harness Connector (J2/P2). • Turn the ignition switch ON, engine OFF. • Access the Active Diagnostic Code screen on ET, and check for an ACTIVE +5V Sensor Supply Diagnostic Code (either 232-03 5 Volt Supply Above Normal [21] or 232-04 5 Volt Supply Below Normal [21]). • **Is the +5V Diagnostic Code Active with the Engine Harness Connector disconnected?** **NOTE:** When ECM Engine Harness Connector J2/P2 is disconnected and the ignition switch ON, Open Circuit diagnostic codes will be Active/Logged for all of the engine +5V Sensors and the Inlet Air Heater Relay Circuit. This is normal.	**YES ⇒** **NO ⇒**	**Disconnecting the Engine Harness Connector does not eliminate the Active +5V Sensor Diagnostic Code.** Temporarily install another ECM. Ensure the Engine Monitoring and Coolant Level Sensor are programmed the same as the old ECM. **Repeat this test step.** If the problem is resolved with the new ECM, install the old ECM to verify the problem returns with the ECM. If the new ECM works and the old one did not, replace the ECM. STOP. **The +5V Diagnostic Code is no longer Active when the harness is disconnected.** Either the harness or a sensor attached to the harness is causing the problem. Reconnect the ECM Engine Harness Connector. Proceed to the next step.

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 4: Disconnect +5V Sensors While Monitoring for Active Diagnostic Codes.		
• Install ET at the Cab Data Link Connector (if not already installed). • Turn the ignition switch ON, engine OFF. • Access the Active Diagnostic Code screen, and verify there is an ACTIVE +5V Sensor Supply Diagnostic Code [either 232-03 5 Volt Supply Above Normal (21), or 232-04 5 Volt Supply Below Normal (21)]. • Disconnect the following sensors and wait 30 seconds after each is disconnected while monitoring ET to verify if disconnection of a specific sensor deactivates the +5V Diagnostic Code. - Disconnect the Inlet Manifold Air Temperature Sensor. - Disconnect the Boost Pressure Sensor. - Disconnect the Coolant Temperature Sensor. - Disconnect the Oil Temperature Sensor. - Disconnect the Injection Actuation Pressure Sensor. • **Does the +5V Diagnostic Code remain Active?** **NOTE:** When the sensors are disconnected with the ignition switch ON, Open Circuit diagnostic codes will be Active/Logged when the +5V Diagnostic Codes are no longer Active. This is normal. Clear these diagnostic codes after this test step is completed.	**YES ⇒** **NO ⇒**	**Disconnecting the sensors does not make a difference.** The +5V Diagnostic Code is still active. The harness is the cause of the problem. Leave the sensors disconnected and proceed to the next step. **Disconnecting a specific sensor causes the +5V Diagnostic Code to not be Active.** Connect the sensor suspected of causing the problem. If the problem reappears, and then disappears following disconnection, replace the sensor. Clear all diagnostic codes. STOP.
Step 5: Check Engine Harness.		
• Turn the ignition switch OFF, engine OFF. • **Disconnect ECM Engine Harness Connector J2/P2, and verify ALL the +5V sensors attached to the Engine Harness are disconnected**, J3/P3 (Boost Pressure), J10/P10 (Coolant Temperature), J21/P21 (Inlet Manifold Air Temperature), J35/P35 (Injection Actuation Pressure), and J51/P51 (Oil Temperature) Sensor Connectors. • Use a multimeter and set it to measure resistance on the range closest to, but not less than, 20 Ohms (Ω). Measure from ECM Engine Harness Connector P2 pin-36 (+5V) to each of the sensor signal pins and sensor common pins at ECM Engine Harness Connector P2. Wiggle the harness during measurement to reveal any intermittent short condition. • **Does the resistance read more than 20 Ohms (20 Ω)?**	**YES ⇒** **NO ⇒**	**The +5V line is not shorted in the Engine Harness.** Ensure both ECM Connectors (J1/P1 and J2/P2) are connected. The problem is not apparent at this time. Clear all diagnostic codes. STOP. **The Engine Harness has a short circuit.** Replace the Engine Harness. Clear all diagnostic codes. STOP.

PC-35: Engine Sensor Open or Short Circuit Test

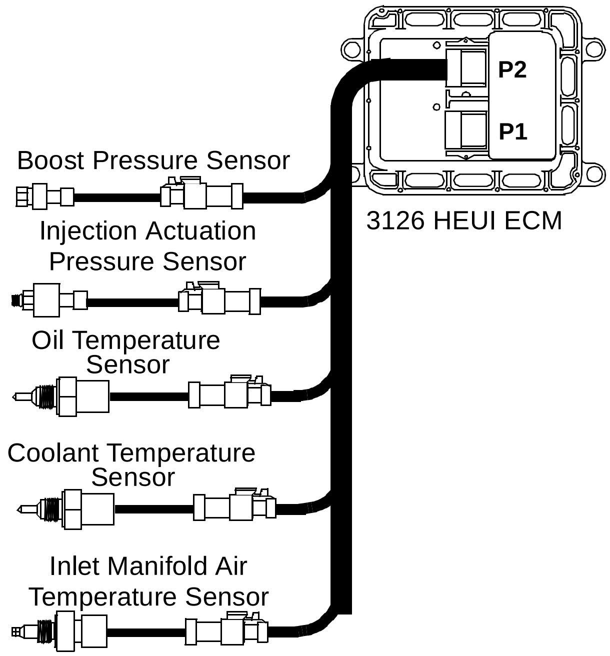
System Operation

When to Use This Procedure

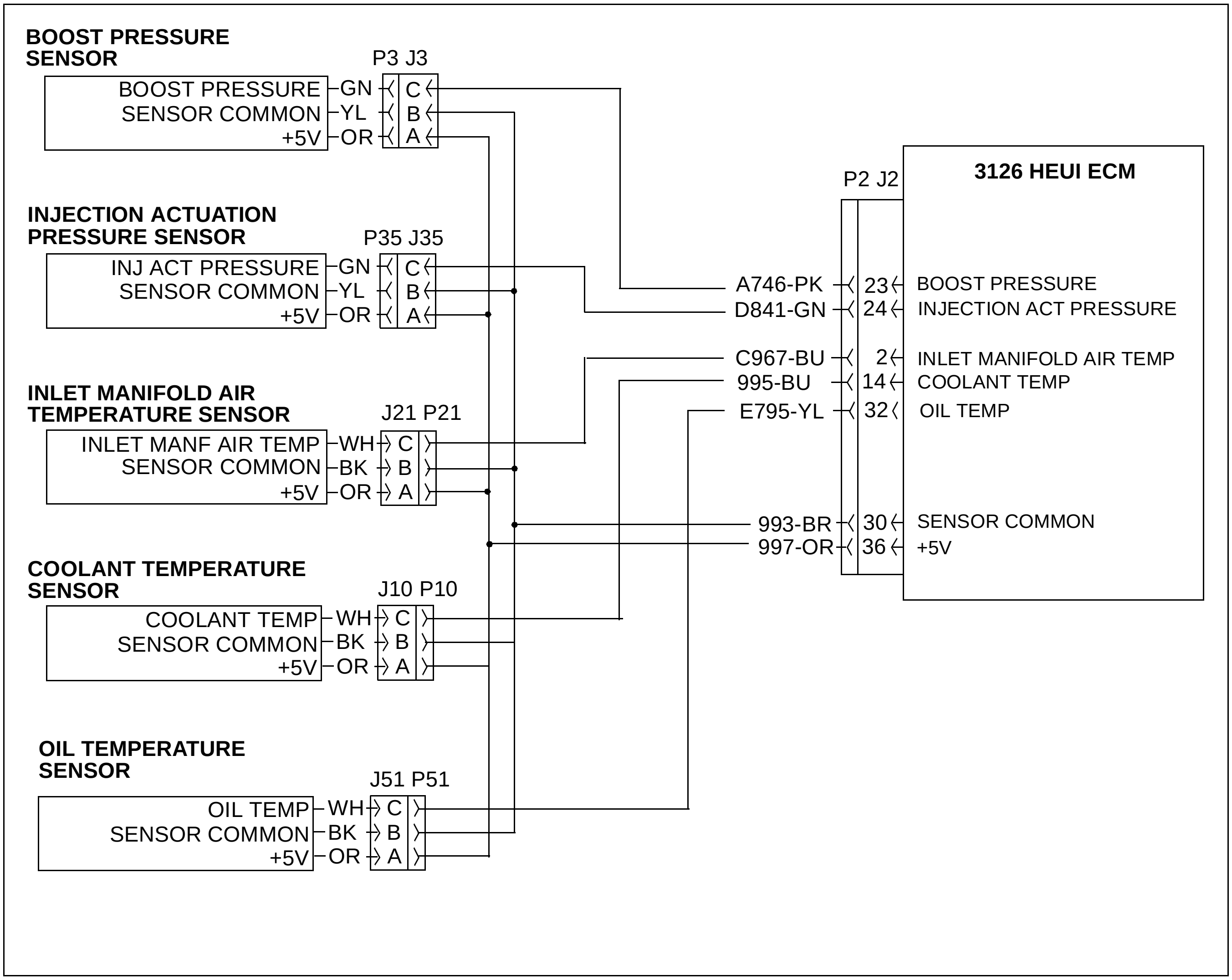
Use this procedure to troubleshoot the system only when there is an Active, or easily repeated Open or Short circuit diagnostic code associated with the Boost Pressure, Oil Temperature, Coolant Temperature, Injection Actuation Pressure, Inlet Manifold Air Temperature Sensor.

Background

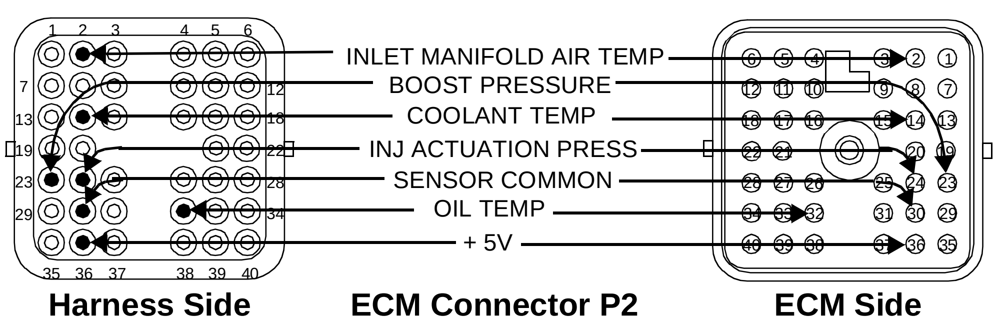
The troubleshooting procedure for the Boost Pressure, Oil Temperature, Coolant Temperature, Injection Actuation Pressure, Inlet Manifold Air Temperature Open and Short circuit diagnostic codes is identical. Each of these sensors is provided supply voltage from the ECM with Connector J2/P2 pin-36 (+5V) to the sensor connector pin-A. The Sensor Common connection for each of these sensors is also shared, provided from the ECM with Connector J2/P2 pin-30 (Sensor Common) to each sensor connector pin-B.



Schematic



ECM Pin Locations



Diagnostic Codes

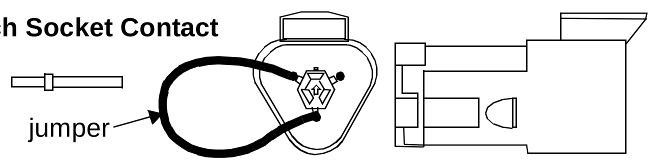
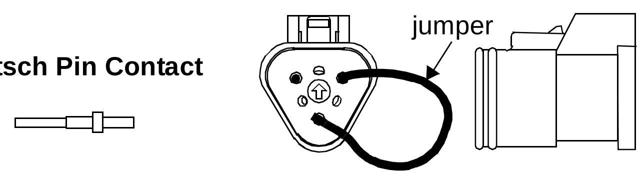
PID-FMI and Description of Code:	Systems Response:	Troubleshooting:
102-03 Boost Pressure Sensor Open Circuit (25) The Boost Pressure signal voltage is above acceptable range. **102-04 Boost Pressure Sensor Short Circuit (25)** The Boost Pressure signal voltage is below acceptable range.	**Electronic System Response -** Boost pressure is set to 0 psi (0 kPa). **Service Tool Display or Lamps -** ET will indicate 0 psi (0 kPa) while the diagnostic code is Active. **Engine Response -** The engine may experience low power when the diagnostic code is Active.	Proceed with procedure PC- 35 if the diagnostic code is Active.
105-03 Inlet Manifold Air Temperature Sensor Open Circuit (38) The Inlet Manifold Air Temperature signal voltage is above acceptable range. **105-04 Inlet Manifold Air Temperature Sensor Short Circuit (38)** The Inlet Manifold Air Temperature signal voltage is below acceptable range.	**Electronic System Response -** Inlet manifold air temperature is set to 185°F (85°C) while the diagnostic code is Active. Inlet Air Heater operation will continue, but the ECM will not consider Inlet Manifold Temperature while the code is Active. The Check Engine Lamp will **NOT** come ON unless this diagnostic code has been Active for one hour. **Engine Response -** On rare occasions the engine may emit white smoke on start-up and misfire during cold ambient air temperatures.	Proceed with procedure PC- 35 if the diagnostic code is Active.
110-03 Coolant Temperature Sensor Open Circuit (27) The Coolant Temperature signal voltage is above acceptable range. **110-04 Coolant Temperature Sensor Short Circuit (27)** The Coolant Temperature signal voltage is below acceptable range.	**Electronic System Response -** Coolant temperature is set to 194°F (90°C) while the diagnostic code is Active. Cold Mode timing is disabled and the Inlet Air Heater will come on for 7 minutes continuously and then cycle ON and OFF for 13 minutes while the code is Active. **Engine Response -** On rare occasions the engine may emit white smoke on start-up because Cold Mode is not active.	Proceed with procedure PC- 35 if the diagnostic code is Active.
164-03 Injection Actuation Pressure Open Circuit (15) The Injection Actuation Pressure Circuit voltage is exceeding normal levels. **164-04 Injection Actuation Pressure Short Circuit (15)** The Injection Actuation Pressure Circuit voltage is below normal levels.	**Electronic System Response -** +5V Engine Sensors is assumed to be 1,740 psi (12 MPa), the Injection Actuation Pressure Control Valve is set to a fixed position, and fuel is limited. The Injection Actuation Pressure Control Valve is set to a a fixed position. Fuel delivery is limited. **Engine Response -** The engine will be low on power and will run rough at idle.	Proceed with procedure PC- 35 if the diagnostic code is Active.

PID-FMI and Description of Code:	Systems Response:	Troubleshooting:
175-03 Oil Temperature Sensor Open Circuit (37) The Oil Temperature signal voltage is above acceptable range.	**Electronic System Response -** Oil temperature is set to a default temperature while the diagnostic code is Active. The engine will run in Warm Mode. **Engine Response -** The engine will be hard to start in cold weather and excessive white smoke may be present.	Proceed with procedure PC- 35 if the diagnostic code is Active.
175-04 Oil Temperature Sensor Short Circuit (37) The Oil Temperature signal voltage is below acceptable range.		

Functional Test

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 1: Connect ET and Note All Active Diagnostic Codes.		
• Connect ET to the Data Link Connector. • Turn the ignition switch ON, engine OFF. Wait at least 15 seconds for Codes to become Active. • **Check to see if one of the following diagnostic codes is Active.** - 102-03 Boost Pressure Sensor Open Circuit (25) - 102-04 Boost Pressure Sensor Short Circuit (25) - 105-03 Inlet Manifold Air Temp. Open Circuit (38) - 105-04 Inlet Manifold Air Temp. Short Circuit (38) - 110-03 Coolant Temp. Sensor Open Circuit (27) - 110-04 Coolant Temp. Sensor Short Circuit (27) - 164-03 Injection Actuation Pressure Open Circuit (15) - 164-04 Injection Actuation Pressure Short Circuit (15) - 175-03 Oil Temp. Sensor Open Circuit (37) - 175-04 Oil Temp. Sensor Short Circuit (37) • Code 232-03 +5V Supply Above Normal or 232-04 +5V Supply Below Normal (+5 V Sensor Supply Codes) **should not be Active.** • **Is one of the Codes listed Active?**	**YES** ⇒ **NO** ⇒	Proceed to the next step. **If the codes listed are Logged only and the engine is not currently running properly,** refer to “Troubleshooting Without a Diagnostic Code” on page D-23. **If either of the +5V Supply Codes are Active,** refer to procedure “PC-34: +5V Sensor Voltage Supply Circuit Test” on page D-115. **NOTE:** DO NOT perform this procedure until the +5V Supply procedure is completed.
Step 2: Check Electrical Connectors and Wiring.		
• Thoroughly inspect ECM Connector J2/P2 and the sensor connectors. (Refer to procedure “PB-10: Inspecting Electrical Connectors” on page D-43 for details on inspecting connectors.) • Perform 10 pound (44.5 N) pull test on each of the wires in the Sensor and ECM Connector associated with the active diagnostic code. • Check ECM Connector (Allen screw) for proper torque. • Check the harness and wiring for abrasion and pinch points from the sensor back to the ECM. • **All connectors/pins/sockets should be completely mated/inserted, and the harness/wiring should be free of corrosion, abrasion or pinch points.**	**OK** ⇒ **NOT OK** ⇒	**Verify the code is still active.** **If troubleshooting an Active Short Circuit Code**, proceed to the next step. **If troubleshooting an Active Open Circuit Code,** proceed to Step 4 on page D-126. **Repair or replace wiring or connectors as necessary.** Ensure all seals are properly in place and connectors completely mated. Verify the repair eliminates the problem. Clear all logged diagnostic codes. STOP.

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 3: Disconnect Sensor and Ensure an Open Circuit Diagnostic Code Becomes Active.		
• Turn the ignition switch OFF, engine OFF. • Disconnect the Sensor Connector of the Sensor with the Short Circuit diagnostic code. Ensure this is done with the ignition switch OFF. • Connect ET to the Cab Data Link Connector. • Turn the ignition switch ON, engine OFF. • Access the Active Diagnostic Code screen of ET. Check for an Active Open Circuit Diagnostic Code. • **Wait 15 seconds after disconnecting the sensor. Is an Open Circuit Diagnostic Code for the disconnected sensor Active?**	**YES ⇒**	**A Short Circuit code was Active before the sensor was disconnected, but an Open Circuit code became Active after the sensor was disconnected.** Thoroughly inspect the connector for moisture. Inspect the seals and connect the sensor. If the Short Circuit code reappears, the sensor or pigtail harness is the problem. **Temporarily replace the Sensor** (connect a sensor to the harness, but do not install into engine) and ensure the code is no longer Active. If the code disappears with a new sensor, replace the old sensor. Clear all logged diagnostic codes. STOP.
	NO ⇒	**There is a short circuit between the Sensor Harness Connector and the ECM.** Leave the sensor disconnected. Proceed to Step 6 on page D-128.
Step 4: Measure the Sensor Supply Voltage with a Voltmeter.		
• Turn the ignition switch OFF, engine OFF. • Disconnect the Sensor from the Engine Harness. • Connect a 3-Pin Breakout T to the Engine Harness **only**. • Turn the ignition switch ON, engine OFF. • Use a voltmeter on the DC setting and measure the voltage from pin-A (+5V) to pin-B (SENSOR COMMON). • **Does the DC voltage from pin-A to pin-B measure from 4.5 to 5.5 volts DC (VDC)?**	**YES ⇒**	**The sensor supply voltage is correct.** Remove the Breakout T. Proceed to the next step.
	NO ⇒	**The +5 V Sensor Supply voltage is out of range.** Refer to procedure “PC-34: +5V Sensor Voltage Supply Circuit Test” on page D-115.

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 5: Install Short Circuit Between Pin-C and Pin-B of the Sensor Harness Connector and Check for an Active Short Circuit Diagnostic Code.		
• Turn the ignition switch ON, engine OFF. • Make a jumper wire (4 to 6 inches, 100 to 150 mm long) with Deutsch Pins (for Temperature Sensors) or Deutsch Sockets (for Pressure Sensors) on **both** ends. **Deutsch Pin Contact** **Deutsch Pin Contact**  **Deutsch Socket Contact** **Deutsch Socket Contact**  • Monitor the Active Diagnostic Code screen before **and** after installing the jumper wire (short circuit). • Install the jumper between pin-C (sensor signal pin) and pin-B (Sensor Common) on the Engine Harness Connector. Wait at least 15 seconds for the Short Circuit Diagnostic Code to become Active. • **Does a sensor Short Circuit Diagnostic Code become Active with the jumper in place, and with it removed is an Open Circuit Diagnostic Code Active?** **Deutsch DT Connector Receptacle** **Deutsch Socket Contact**  **Deutsch DT Connector Plug** **Deutsch Pin Contact** 	**YES ⇒** **NO ⇒**	**The engine harness and ECM have checked OK.** Temporarily connect the suspect sensor. If the diagnostic code continues Active, replace the sensor and verify the diagnostic code is no longer Active. Clear all logged diagnostic codes. STOP. **The Open Circuit Diagnostic Code remains Active with the jumper in place.** Most likely there is an open circuit in either the Sensor Common or sensor signal wire in the Engine harness from the ECM to the sensor. Remove the jumper and proceed to the next step.

<table>
<tr><th>TEST STEP</th><th>RESULT</th><th>DIAGNOSIS/ACTION</th></tr>
<tr><td>

Step 6: Disconnect ECM Connector J2/P2 and Check for Active Diagnostic Codes

• Ensure the ignition switch is OFF, engine is OFF.

• Disconnect ECM Connector J2/P2. Thoroughly inspect both halves of the Connector J2/P2 for corrosion or moisture.

• With the ignition switch ON and engine OFF, monitor the Active Diagnostic Code screen.

NOTE: With the Engine Harness disconnected, all of the Sensor Open Circuit Diagnostic Codes and the Inlet Air Heater Open Circuit will be Active. Monitor and concentrate on the Diagnostic Codes for the suspect sensor only.

• Turn the ignition switch ON, engine OFF.

• **An Open Circuit Diagnostic Code should be Active.**

• Turn the ignition switch OFF, engine OFF.

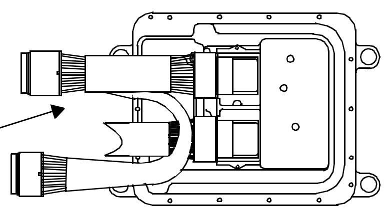
• Connect a 40-Pin Breakout T to the ECM Connector J2 **only**.

• Make a jumper wire with a Deutsch Pin on both ends.

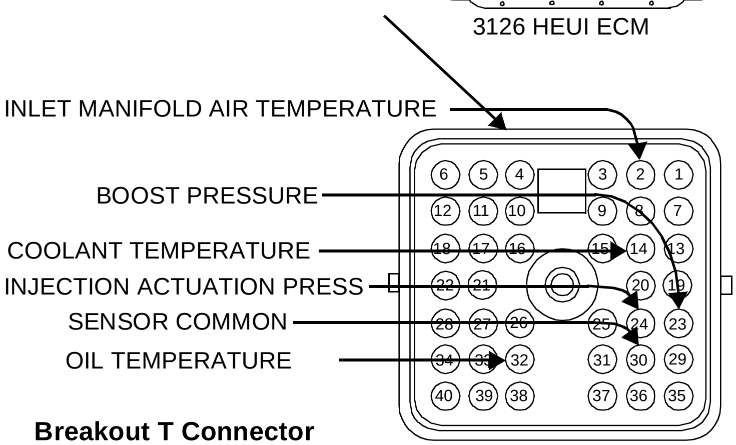
Deutsch Pin Contact **Deutsch Pin Contact**

• Insert the jumper between the sensor signal pin (refer to the diagram below for signal pins) and pin-30 (Sensor Common) of the Breakout T.

• **A Short Circuit diagnostic code should be Active with the short circuit in place.**



3126 HEUI ECM



Breakout T Connector

• **Is an Open Circuit and Short Circuit Diagnostic Code Active as indicated?**

</td><td>

YES ⇒

NO ⇒

</td><td>

The ECM is working properly. Proceed to the next step.

Either the Open Circuit Diagnostic Code is not active without the harness connected, **or the Short Circuit diagnostic code does not appear** with the short circuit in place, **or the short circuit diagnostic code is Active** without the short circuit in place.

Temporarily install another ECM. **Repeat this test step.** If the problem is resolved with the new ECM, install the old ECM to verify the problem returns with the ECM. If the new ECM works and the one on the engine did not, replace the ECM. STOP.

</td></tr>
</table>

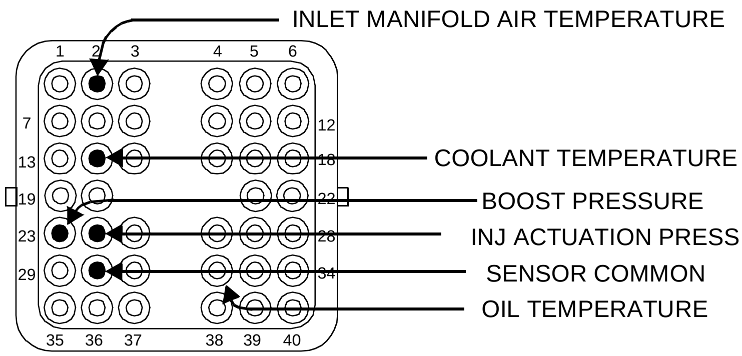
<table>
<tr><th>TEST STEP</th><th>RESULT</th><th>DIAGNOSIS/ACTION</th></tr>
<tr><td>

Step 7: Install Sensor Bypass Wiring.

• Ensure the ignition switch is OFF, engine is OFF.

• Disconnect ECM Engine Harness Connector J2/P2, and the Sensor Connector.

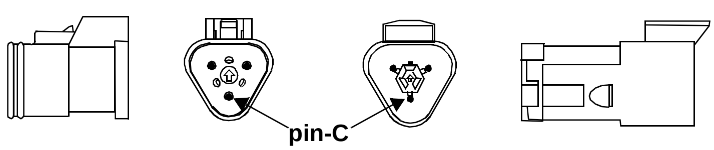
• Using a Deutsch removal tool, remove the Sensor Signal wire from the Engine Harness ECM Connector P2.



Harness Side **ECM Connector P2**

• Remove the Signal wire (Socket C) from the Engine Harness Sensor Connector.

Deutsch DT Connector Plug **Deutsch DT Connector Receptacle**



• Insert a 125-3662 3-Pin Engine Sensor Harness Bypass or make a bypass wire long enough to reach from the ECM to the Sensor.

NOTE: If making a bypass, crimp a Deutsch Socket on one end to connect to the ECM, and a socket (for Temperature Sensors) or pin (for Pressure Sensors) on the other end.

• Insert the bypass into the Engine Harness ECM Connector P2 for the sensor, and the Engine Harness Sensor Connector.

• Connect the ECM Connector J2/P2 and Sensor Connector.

• Turn the ignition switch ON, engine OFF.

• Monitor the Active Diagnostic Code screen for either the Sensor Open Circuit or Short Circuit Diagnostic Code.

• **Does the Sensor Diagnostic Code disappear with the bypass installed?**

</td><td>

YES ⇒

NO ⇒

</td><td>

There is a problem in the wiring harness. Either repair or replace the harness. Clear all diagnostic codes. STOP.

Repeat this procedure and carefully perform each step again.

</td></tr>
</table>

PC-36: Injection Actuation Pressure Sensor Test

System Operation

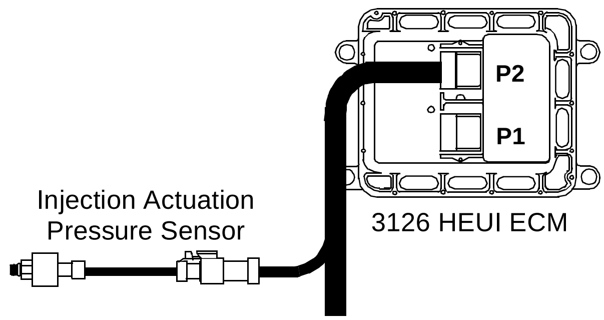
When to Use This Procedure

Use this procedure to troubleshoot the system when there is an Active, logged, or easily repeated 164-02 Injection Actuation Pressure Erratic Code. Use procedure “PC-35: Engine Sensor Open or Short Circuit Test” on page D-121 to troubleshoot 164 - 03 Injection Actuation Pressure Sensor Open Circuit or 164 - 04 Injection Actuation Pressure Sensor Short Circuit codes.

This procedure also describes a method of checking the Injection Actuation Pressure Sensor accuracy against a pressure gauge. Proceed to Step 4 on page D-132 to check the sensor accuracy.

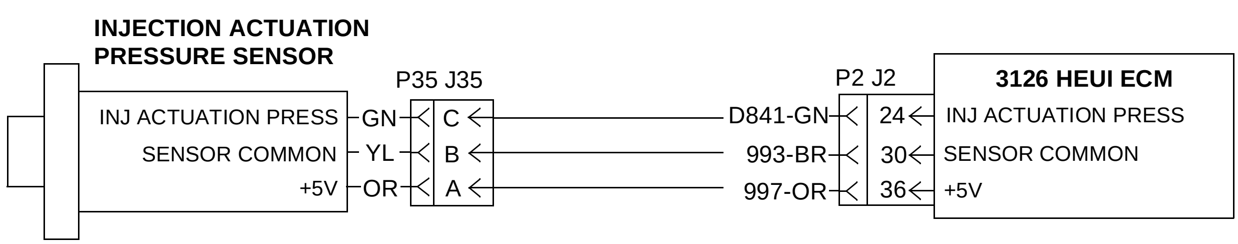
Background

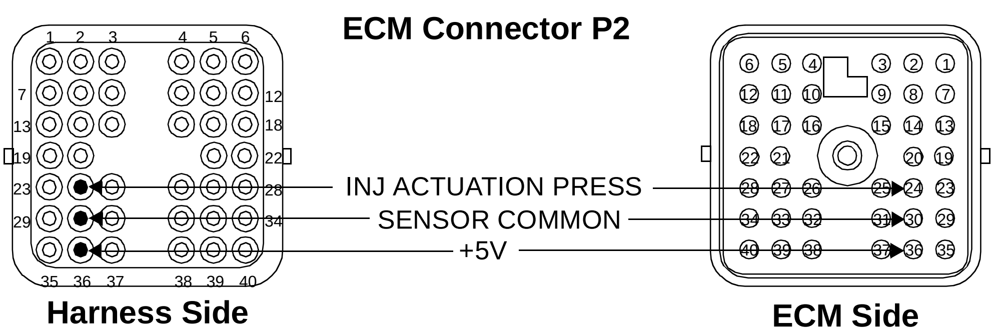
The Injection Actuation Pressure Sensor measures the pressure of the oil in the high pressure oil manifold.



This pressure determines the fuel injection pressure for the engine. The ECM uses this pressure in addition to engine speed (and oil temperature when in cold mode) to determine operation of the Injection Actuation Pressure Control Valve.

Schematic





Diagnostic Codes

PID-FMI and Description of Code:	Systems Response:	Troubleshooting:
164-02 Injection Actuation Pressure Sensor Erratic (17) An Injection Actuation Pressure is indicated when the engine is not running.	**Electronic System Response -** The ECM will indicate the code is Active and it will be logged. **Engine Response -** The engine does not have to be running for this code to occur.	Proceed with procedure PC-36.

Functional Test

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 1: Connect ET and Note All Active Diagnostic Codes.		
• Connect ET to the Cab Data Link Connector. • Turn the ignition switch ON, engine OFF. **• Is 164-02 Injection Actuation Pressure Sensor Erratic (17) Active or Logged?**	**YES** ⇒ **NO** ⇒	Proceed to the next step. If the code is not Active or Logged and the **engine will not start,** proceed to the next step. If the code is not Active or Logged and **the engine will start,** the system is operating correctly at this time. STOP.

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 2: Disconnect Sensor from Harness and Start Engine.		
• Ensure the ignition switch is OFF, engine is OFF. • Disconnect Sensor Connector from Engine Harness at Connector J35/P35. • Try to start the engine. • **Does the engine start?**	**YES** ⇒ **NO** ⇒	Proceed to the next step. **Reconnect the sensor.** Refer to “PA-17: Engine Cranks But Will Not Start” on page D-31.
Step 3: Check Electrical Connectors and Wiring		
• Check the Sensor Connector J35/P35 for loose pins/sockets using 10 pound (44.5 N) pull test, and make sure the connector is completely locked, (if not completely locked, check for moisture entry). • Check ECM Connector J2/P2 pin-24 and verify it is seated into Connector P2 using 10 pound (44.5 N) pull test. • Check ECM Connector (Allen screw) for proper torque. • Check the harness and wiring for abrasion and pinch points from the sensor back to the ECM. • Refer to “PB-10: Inspecting Electrical Connectors” on page D-43 for details on inspecting connectors. • **All connectors and pins/sockets should be completely mated and inserted, and the harness/wiring should be free of abrasion, corrosion, or pinch points.**	**OK** ⇒ **NOT OK** ⇒	Reconnect all connectors and verify the diagnostic code is still active. Proceed to next step. **Repair or replace wiring or connectors as necessary.** Ensure all seals are properly in place and connectors completely mated. Verify the repair eliminates the problem. STOP.
Step 4: Check the Sensor Status with the Engine OFF.		
• Connect ET to the Cab Data Link Connector. • Turn the ignition switch ON, engine OFF. • Access the ET status screen that displays the Injection Actuation Pressure. • **Does the Injection Actuation Pressure Sensor indicate 0 psi (0 kPa)?**	**YES** ⇒ **NO** ⇒	Proceed to Step 6 on page D-134. Proceed to the next step.

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 5: Measure the Sensor Supply Voltage with a Voltmeter.		
• Turn the ignition switch OFF, engine OFF. • Disconnect the Sensor from the Engine Harness at Connector J35/P35. • Connect a 3-Pin Breakout T to Connector J35 **only**. • Turn the ignition switch ON, engine OFF. • Use a voltmeter on the DC setting and measure the voltage from pin-A (+ 5V) to pin-B (Sensor Common) at the Breakout T. • **Does the DC voltage from pin-A to pin-B measure from 4.5 to 5.5 volts DC (VDC)?**	**YES** ⇒ **NO** ⇒	**The sensor supply voltage is correct.** Remove the Breakout T. Proceed to the next step. **The +5 V Sensor Supply voltage is out of range.** Refer to procedure “PC-34: +5V Sensor Voltage Supply Circuit Test” on page D-115.

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 6: Compare Status Against a Pressure Gauge. • Ensure the ignition switch is OFF, engine is OFF. • Disconnect Sensor Connector P35 from the Engine Harness at Connector J35. • Install a 125-2589 Diagnostic Fitting into the port where the Injection Actuation Pressure Sensor was located. • Install the removed Injection Actuation Pressure Sensor in one of the ports of the 125-2589 Diagnostic Fitting. Install an 8T-0852 Pressure Gauge to one of the other ports of the 125-2589 Diagnostic Fitting. Plug the remaining port. • Reconnect the Injection Actuation Pressure Sensor to the Engine Harness at Connector J35/P35. • Connect ET to the Cab Data Link Connector. **WARNING** **Always use a board or cardboard protector when performing this test. Escaping fluid under pressure, even a pin hole size leak, can penetrate body tissue, causing serious injury or possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.** • Start the engine. • Locate the Injection Actuation Pressure Test under from the Interactive Diagnostics screen of the ET. • Begin the test, and monitor the ET Indicated Pressure for comparison with the 8T-0852 Pressure Gauge. Step through the available pressures of the test while noting the Service Tool indicated pressure and gauge pressure at each point. • The chart below indicates the approximate sensor range and the gauge comparison range **• Are the Service Tool and Pressure Gauge within range?**	**YES ⇒** **NO ⇒**	**The sensor and ECM are operating properly.** If the engine is still not running properly, refer to “Troubleshooting Without a Diagnostic Code” on page D-23 to check the specific symptoms of the engine. **Temporarily replace the sensor and repeat this test.** If the new sensor indicates the correct pressure, replace the sensor. If it also is out of range, the pressure gauge is faulty. STOP.

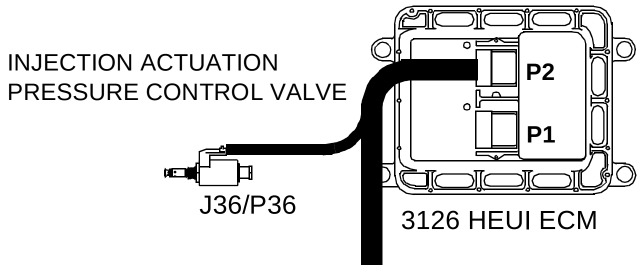
Service Tool Pressure Reading	8T-0852 Pressure Gauge Reading Range
725 psi (5000 kPa)	525-1000 psi (3600-6900 kPa)
1500 psi (10300 kPa)	1300-1700 psi (9000-11700 kPa)
2180 psi (15000 kPa)	1980-2380 psi (13600-16400 kPa)
3350 psi (23100 kPa)	3150-3500 psi (21700-24100 kPa)

PC-37: Injection Actuation Pressure Control Valve Circuit Test

System Operation

When to Use This Procedure

Use this procedure to troubleshoot the system only when there is an Active, or easily repeated 42-11 Injection Actuation Pressure Valve Driver Fault code. Do not use this procedure if the 164 - 11 Injection Actuation Pressure System Fault is active unless PC-38: Injection Actuation Pressure System Test has directed you to this test.

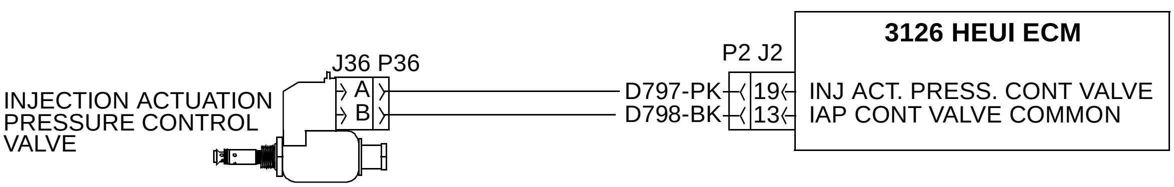


Background

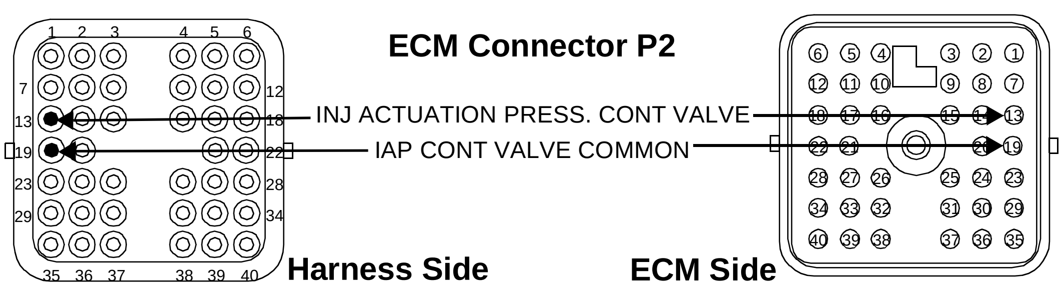
The Injection Actuation Pressure Control Valve regulates the high pressure oil to the injectors through the high pressure rail. The high pressure manifold oil pressure provides the actuation force to determine the injection pressure for the engine. The Injection Actuation Pressure Control Valve is an electronically controlled dump valve maintaining the high pressure for the high pressure oil manifold by dumping excessive oil flow back to the sump.

The ECM determines operation of the Injection Actuation Pressure Control Valve based on engine rpm and the actual pressure as measured by the Injection Actuation Pressure Sensor.

Schematic



ECM Pin Locations



Diagnostic Codes

PID-FMI and Description of Code:	Systems Response:	Troubleshooting:
42-11 Injection Actuation Pressure Control Valve Driver Fault (18) The ECM has detected an open circuit, short circuit to ground, short circuit to +Battery, or short circuit across the solenoid with the engine running.	**Electronic System Response -** ECM cycles the Injection Actuation Pressure Control Valve on and off several times per second while the engine is running and the fault is Active. **Engine Response -** If an open circuit condition or the Injection Actuation Pressure Control Valve signal line is shorted to ground the engine will stop. If the Injection Actuation Pressure Control Valve Common is shorted to ground, the engine may continue running but may be unstable.	Proceed with procedure PC-37.

Functional Test

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 1:Connect ET and Note All Active Diagnostic Codes.		
• Connect ET to the Cab Data Link Connector. • Start the engine. **• Is a 42-11 Injection Actuation Pressure Valve Driver Fault code Active or the reason for an engine shutdown?**	**YES ⇒** **NO ⇒**	Proceed to the next step. A 42-11 Injection Actuation Pressure Valve Driver Fault is not logged or active, refer to “Troubleshooting Without a Diagnostic Code” on page D-23.
Step 2: Check Electrical Connectors and Wiring		
• Thoroughly inspect the Injection Actuation Pressure Control Valve Connector J36/P36 and ECM Connector J2/P2. (Refer to “PB-10: Inspecting Electrical Connectors” on page D-43 for details on inspecting connectors.) • Check ECM Connector (Allen screw) for proper torque. **• All connectors and pins/sockets should be completely mated and inserted, and the harness/wiring should be free of corrosion, abrasion or pinch points.** **NOTE:** Ensure the seal is installed in the harness connector before connecting the harness to the Injection Actuation Pressure Control Valve. If the seal is missing, use a 123-1199 replacement seal.	**OK ⇒** **NOT OK ⇒**	**Reconnect all connectors and make sure the diagnostic code is still active.** Proceed to the next step. **Repair or replace wiring or connectors as necessary.** Make sure all seals are properly in place and connectors completely mated. Verify the repair eliminates the problem. STOP.

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 3: Measure the Injection Actuation Pressure Control Valve Solenoid Resistance.		
• Make sure the ignition switch is OFF, engine is OFF. • Disconnect Injection Actuation Pressure Control Valve Connector J36/P36. • Connect a 122-8842 Injector Actuation Pressure Control Valve Harness Section to the Injection Actuation Pressure Control Valve. • Use a multimeter to measure and note the resistance between the two pins of the Injection Actuation Pressure Control Valve Harness Section. • Reverse the meter leads and measure again to double check measurement and meter. • **Is the resistance from Connector J36 pin-A (Injection Actuation Pressure Control Valve) to Connector J36 pin-B (Injection Actuation Pressure Control Valve Common) from 4.0 to 16.0 Ohms (Ω)?**	**YES** ⇒ **NO** ⇒	**Reconnect the control valve to the harness.** Proceed to the next step. **The Injection Actuation Pressure Control Valve is faulty.** Replace the Injection Actuation Pressure Control Valve and start the engine to make sure the code does not reappear. STOP.
Step 4: Measure the Solenoid Resistance Through the Engine Harness.		
• Turn the ignition switch OFF, engine OFF. • Disconnect the ECM Engine Harness Connector J2/P2. • Use a multimeter to measure the resistance from ECM Engine Harness Connector P2 pin-19 (Injection Actuation Pressure Control Valve) to P2 pin-13 (Injection Actuation Pressure Control Valve Common). • The resistance should be within 2.0 Ohms of the value found in **Step 3**. • Use a multimeter to measure the resistance from ECM Connector P2 pin-13 (Injection Actuation Pressure Control Valve Common) to the surrounding pins, pin-7, pin-8, pin-14, pin-20, pin-23 and pin-24 to check for a short circuit. • Use a multimeter to measure the resistance from ECM Connector P2 pin-19 (INJ ACTUATION PRESS. CONT VALVE) to the surrounding pins, pin-7, pin-8, pin-14, pin-20, pin-23 and pin-24. • The resistance should be greater than 10,000 Ohms. • Use a multimeter to measure the resistance from ECM Connector P2 pin-19 (Injection Actuation Pressure Control Valve) to the engine ground stud, and from P2 pin-13 (Injection Actuation Pressure Control Valve Common) to the engine ground stud. • The resistance should be greater than 10,000 Ohms. • **Are all resistances as specified?**	**YES** ⇒ **NO** ⇒	Proceed to the next step. **Replace the Injection Actuation Pressure Control Valve harness using a 122-8842 harness.** STOP.

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 5: Check Harness Using ET Injection Actuation Pressure Driver Test.		
• Connect ET to the Cab Data Link Connector. • Turn the ignition switch ON, engine OFF. • Access the Injection Actuation Pressure Driver Test under the Special Tests area of the Interactive Diagnostics screen on ET. • Disconnect the Injection Actuation Pressure Control Valve from the Engine Harness. **NOTE:** Do not insert any wire larger than 18 AWG, or the voltage test lamp probe directly into the Injection Actuation Pressure Driver Harness Connector P36. This will spread the connector sockets causing damage to connector and resulting in intermittent connections. • Insert a 9X-7200 Packard Connector Pin into each of the sockets of the Injection Actuation Pressure Driver Harness Connector P36. If a 9X-7200 Packard Connector Pin is not available, remove the insulation from two pieces of 18 AWG wire (4 inches, 100 mm long) and insert the wires into the Injection Actuation Pressure Driver Harness Connector P36. Connect a voltage test lamp to the Engine Harness Injection Actuation Pressure Control Valve Connector P36. • With the voltage test lamp connected to Connector P36, start and stop the Injection Actuation Pressure Driver Test. **• Does the voltage test lamp come ON when the test is Active, and turn OFF when the test is not Active?** **NOTE:** Using the Injection Actuation Pressure Driver Test with a voltage test lamp connected may cause a 42-11 Injection Actuation Pressure Control Valve Driver Fault (18). This is because the voltage test lamp is a different load than the Injection Actuation Pressure Control Valve and is normal.	**YES** ⇒ **NO** ⇒	Proceed to Step 7 on page D-139. Proceed to the next step.

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 6: Check ECM Using ET Injection Actuation Pressure Driver Test.		
• Disconnect the ECM Engine Harness Connector J2/P2. • Turn the ignition switch ON, engine OFF. • Access the Injection Actuation Pressure Driver Test under the Special Tests area of the Interactive Diagnostics screen on ET. • Connect a 40-Pin Breakout T to the ECM Engine Harness Connector J2 (only). • Connect a voltage test lamp to the Engine Harness Injection Actuation Pressure Control Valve Connector pin-13 and pin-19 of the Breakout T. • With the voltage test lamp connected to Breakout T, start and stop the Injection Actuation Pressure Driver Test. **• Does the voltage test lamp come ON when the test is Active, and turn OFF when the test is not Active?** **NOTE:** Using the Injection Actuation Pressure Driver Test with a voltage test lamp connected may cause a 42-11 Injection Actuation Pressure Control Valve Driver Fault (18). This is because the voltage test lamp is a different load than the Injection Actuation Pressure Control Valve and is normal.	**YES ⇒** **NO ⇒**	**Replace the Injection Actuation Pressure Control Valve harness using a 122-8842 harness.** STOP. Temporarily install another ECM. **Repeat this test step.** If the problem is resolved with the new ECM, install the old ECM to verify the problem returns with the ECM. If the new ECM works and the old one did not, replace the ECM. STOP.
Step 7: Run Injection Actuation Pressure Test.		
• Disconnect the Injection Actuation Pressure Control Valve from the engine harness at Connector J36/P36. • Crank the engine three times for 30 seconds each time. • Connect the Injection Actuation Pressure Control Valve to the engine harness at Connector J36/P36. • Start engine and run the Injection Actuation Pressure Test. • After running the Injection Actuation Pressure Test, check for active or logged 42-11 Diagnostic Codes. **• Does the engine start and run without any 42-11 Diagnostic Codes?**	**YES ⇒** **NO ⇒**	**The problem is corrected.** STOP. **Replace the Injection Actuation Pressure Control Valve.** STOP.

PC-38: Injection Actuation Pressure System Test

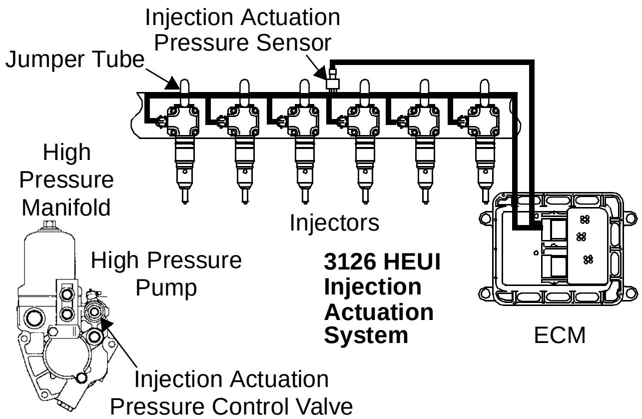
System Operation

When to Use This Procedure

Use this procedure to troubleshoot the system only when there is an Active, or easily repeated 164-11 Injection Actuation Pressure System (39), or 164-00 Excessive Injection Actuation Pressure (17) Diagnostic **Event** Code. If a 42-11 Injection Actuation Pressure Control Valve Driver (18), or the 164-02, 164-03, or 164-04 Injection Pressure Sensor Diagnostic Codes are Active, repair the cause of these codes before using this procedure.

Background

The 164-11 Injection Actuation Pressure System (39) Diagnostic Event Code indicates a problem with the high pressure oil system. It indicates a mechanical problem detected by the electronic system. It is not an electrical/electronic problem.



Diagnostic Codes

PID-FMI and Description of Code:	Systems Response:	Troubleshooting:
164-00 Injection Actuation Pressure Out of Range (17) The ECM has detected an Injection Actuation Pressure above 3480 psi (24000 kPa) while the engine is running. **NOTE**: This is a diagnostic Event code, not a fault code.	**Electronic System Response -** The ECM limits power. **Engine Response -** The engine may have low power and limit machine speed. **NOTE**: This problem may only exist when the engine is at operating temperature.	Proceed with procedure PC-38.
164-11 Injection Actuation Pressure System (39) The ECM has detected a significant difference between the actual and desired Injection Actuation Pressure, or the Injection Actuation Pressure Control Valve Driver is at maximum or minimum output longer than desired indicates it should be. **NOTE**: This is a diagnostic Event code, not a fault code. (No diagnostic lamp indication).	**Engine Response -** The engine may have low power and or run unstable. The engine may start when cold, but difficult to start or not start at all when at operating temperature. **NOTE**: Problem may only exist when engine is warm. If the high pressure oil system has been recently disassembled, start and run the engine for a few minutes at 1500 rpm to remove trapped air. Air may be trapped in the system temporarily causing this diagnostic code.	Proceed with procedure PC-38.

Functional Test

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 1: Check Engine Oil Level.		
• Check Engine Oil Level. **• Is the engine low on oil?**	**YES ⇒** **NO ⇒**	**Add the necessary oil.** Proceed to the next step. Proceed to the next step.
Step 2: Connect ET and Note All Active Diagnostic Codes		
• Turn ignition switch ON, engine OFF. • Connect ET to the Cab Data Link Connector. • Note all logged codes and the number of occurrences. • Check for these codes: • 164-02 Injection Act. Press. Sensor Erratic (15) • 164-03 Injection Act. Press. Sensor Open Circuit (15) • 164-04 Injection Act. Press. Sensor Short Circuit (15) • 42-11 Injection Act. Press. Control Valve Driver (18) **• Are any of the listed Injection Actuation Pressure System Diagnostic Code(s) Active or Logged in addition to Diagnostic Event Code 164-00 or 164-11?**	**YES ⇒ 164-02** **YES ⇒ 42-11** **YES ⇒ 164-03 164-04** **NO ⇒**	Refer to “PC-36: Injection Actuation Pressure Sensor Test” on page D-130. Refer to “PC-37: Injection Actuation Pressure Control Valve Circuit Test” on page D-135. Refer to “PC-35: Engine Sensor Open of Short Circuit Test” on page D-121. If the 164-00 or 164-11 Diagnostic Event Code is the ONLY code active or logged proceed to the next step. Otherwise there is not a problem with the IAP System at this time. STOP.
Step 3: Check the Injection Actuation Pressure Sensor Status with the Engine OFF.		
• Connect ET to the Cab Data Link Connector. • Turn the ignition switch ON, engine OFF. • Access the ET screen with the Injection Actuation Pressure. **NOTE**: If ET does not communicate with the ECM, refer to PA-13: ET Will Not Communicate With ECM. **• Does the Injection Actuation Pressure Sensor indicate 0 psi (0 kPa)?**	**YES ⇒** **NO ⇒**	Proceed to the next step. Refer to “PC-36: Injection Actuation Pressure Sensor Test” on page D-130.
Step 4: Attempt to Start the Engine.		
• Try to start the engine. **• Does the engine start?**	**YES ⇒** **NO ⇒**	Proceed to Step 7 on page D-143. Proceed to the next step.
Step 5: Disconnect Sensor & Attempt to Start the Engine. • Disconnect Injection Actuation Pressure Sensor Connector J35 from Connector P35. **• Does the engine start?**	**YES ⇒** **NO ⇒**	Refer to “PC-36: Injection Actuation Pressure Sensor Test” on page D-130. Reconnect J35/P35. Proceed to the next step.

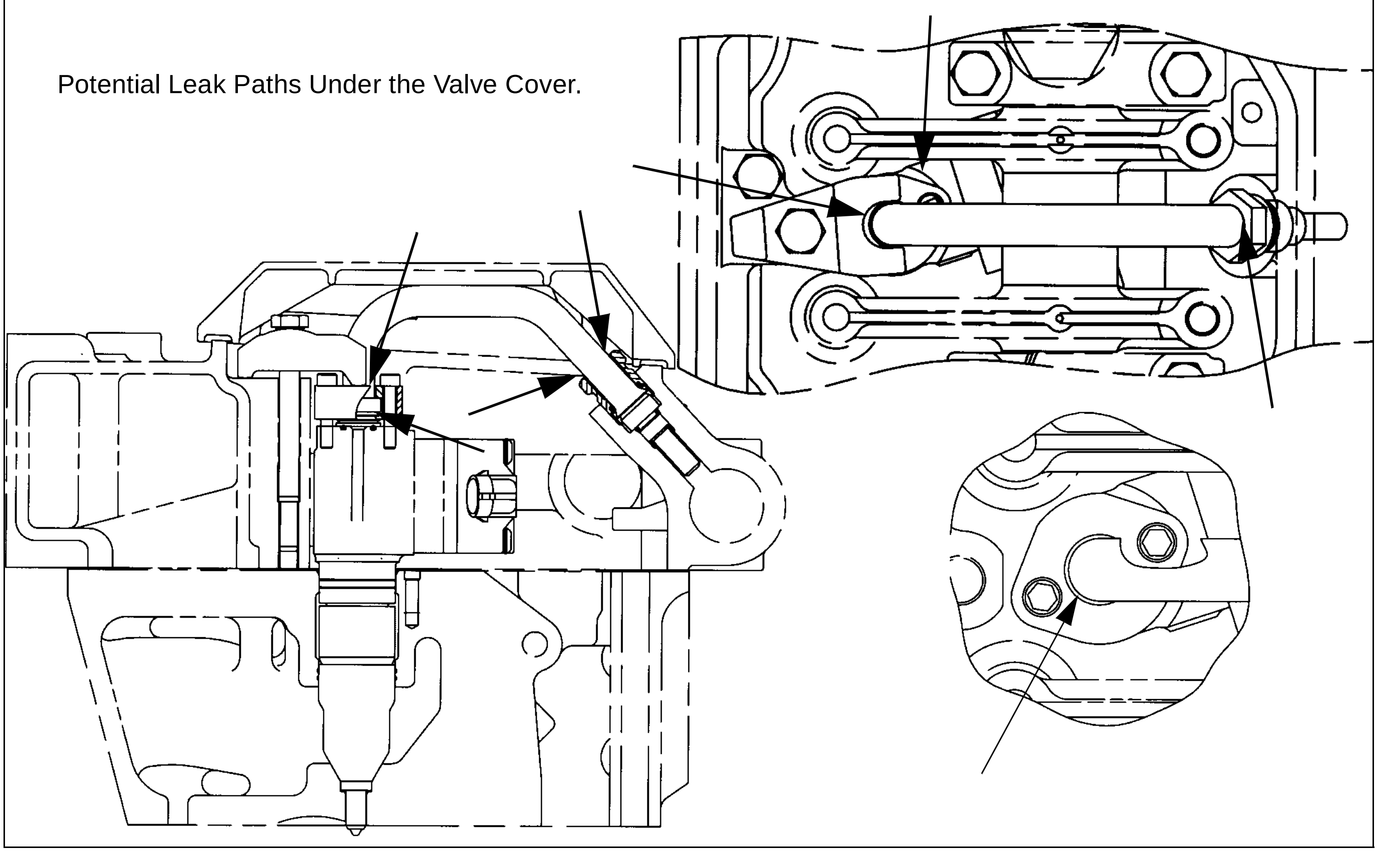
TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 6: Crank Engine While Monitoring Injection Actuation Pressure.		
• Turn ignition switch ON and crank engine while monitoring Actual Injection Actuation Pressure (IAP) and compare it to the Desired Injection Actuation Pressure (IAP).	**YES** ⇒	Refer to “PA-17: Engine Cranks But Will Not Start” on page D-31.
• Does the Actual IAP equal the Desired IAP (within 100 psi) and is the Injection Actuation Output less than 100%?	**NO** ⇒	Proceed to Step 8 on page D-144.

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 7: Connect ET and Test System Using Injection Actuation Pressure Test.		
• Start the engine. • Wait until engine operating temperature is 160°F (70°C) or above. • Connect ET to the Cab Data Link Connector, if not already connected. • Access the Injection Actuation Pressure Test under the Interactive Diagnostics screen of ET. • Begin the test. • Leave the test at the first pressure, 725 psi (5000 kPa). Monitor the Actual Injection Actuation Pressure (IAP) and compare it to the Desired Injection Actuation Pressure (IAP). **• Actual IAP and Desired IAP should be within 100 psi (689 kPa) at this pressure and Injector Actuation Output should be less than 65%.** • Step the pressure up to the next pressure, 1500 psi (10300 kPa) of the Injection Actuation Pressure Test. • Monitor the Actual Injection Actuation Pressure (IAP) and compare it to the Desired Injection Actuation Pressure (IAP). **• Actual IAP and Desired IAP should be within 100 psi (689 kPa) at this pressure and Injector Actuation Output should be less than 65%.** • Step the pressure up to the next pressure, 2180 psi (15000 kPa) of the Injection Actuation Pressure Test. • Monitor the Actual Injection Actuation Pressure (IAP) and compare it to the Desired Injection Actuation Pressure (IAP). **• Actual IAP and Desired IAP should be within 100 psi (689 kPa) at this pressure and Injector Actuation Output should be less than 65%.** • Step the pressure up to the next pressure, 3350 psi (23100 kPa) of the Injection Actuation Pressure Test. • Monitor the Actual Injection Actuation Pressure (IAP) and compare it to the Desired Injection Actuation Pressure (IAP). **• Actual IAP and Desired IAP should be within 100 psi (689 kPa) at this pressure and Injector Actuation Output should be less than 65%.** **• Does Actual IAP follow Desired IAP as indicated, and is the Injector Actuation Output less than 65%?** **NOTE:** The Injection Actuation Pressure Test allows stepping up or down between pressure selections.	**YES ⇒** **NO ⇒**	Clear logged faults and logged events. Perform field test. If logged faults and/or events refer to Step 2 on page D-141. Otherwise, hydraulic system is currently operating correctly. STOP. Proceed to the next step.

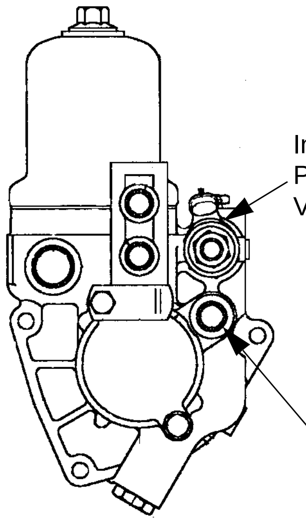
TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 8: Disconnect IAPCV, Crank Engine and Test System Using Injection Actuation Pressure Test.		
• Turn ignition switch OFF, engine OFF. • Disconnect Injection Actuation Pressure Control Valve Connector J36 from Connector P36. • Turn ignition switch ON and crank engine for 10 seconds. • Turn ignition switch OFF, engine OFF. • Reconnect Connector J36 to Connector P36. • Start the engine. • Wait until engine operating temperature is 160°F (70°C) or above.	**YES** ⇒	Clear logged faults and logged events. Perform field test. If logged faults and/or events refer to Step 2 on page D-141. Otherwise, hydraulic system is currently operating correctly. STOP.
• Access the Injection Actuation Pressure Test under the Interactive Diagnostics screen of ET. • Begin the test. • Leave the test at the first pressure, 725 psi (5000 kPa). Monitor the Actual Injection Actuation Pressure (IAP) and compare it to the Desired Injection Actuation Pressure (IAP). • **Actual IAP and Desired IAP should be within 100 psi (689 kPa) at this pressure and Injector Actuation Output should be less than 65%.** • Step the pressure up to the next pressure, 1500 psi (10300 kPa) of the Injection Actuation Pressure Test. • Monitor the Actual Injection Actuation Pressure (IAP) and compare it to the Desired Injection Actuation Pressure (IAP). • **Actual IAP and Desired IAP should be within 100 psi (689 kPa) at this pressure and Injector Actuation Output should be less than 65%.** • Step the pressure up to the next pressure, 2180 psi (15000 kPa) of the Injection Actuation Pressure Test. • Monitor the Actual Injection Actuation Pressure (IAP) and compare it to the Desired Injection Actuation Pressure (IAP). • **Actual IAP and Desired IAP should be within 100 psi (689 kPa) at this pressure and Injector Actuation Output should be less than 65%.** • Step the pressure up to the next pressure, 3350 psi (23100 kPa) of the Injection Actuation Pressure Test. • Monitor the Actual Injection Actuation Pressure (IAP) and compare it to the Desired Injection Actuation Pressure (IAP). • **Actual IAP and Desired IAP should be within 100 psi (689 kPa) at this pressure and Injector Actuation Output should be less than 65%.** • **Does Actual IAP follow Desired IAP as indicated, and is the Injector Actuation Output less than 65%?** **NOTE:** The Injection Actuation Pressure Test allows stepping up or down between pressure selections.	**NO** ⇒	Proceed to the next step.

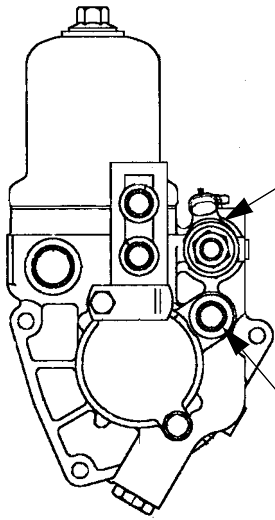
TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 9: Check High Pressure Oil System for Leaks.		
• Start the engine and wait until engine operating temperature is 160°F (70°C) or above. • Turn the ignition switch OFF, engine OFF. • Remove Valve Covers. **⚠ WARNING** **Always use a board or cardboard protector when performing this test. Escaping fluid under pressure, even a pin hole size leak, can penetrate body tissue, causing serious injury or possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.** • Turn the ignition switch ON and crank/run engine and monitor the High Pressure Oil System for leaks under the valve cover as indicated in the following diagram. **• Are any leaks apparent?** NOTE: Most likely the oil leak will not squirt out, look for oil seeping out instead.	**YES ⇒** **NO ⇒**	**Repair or replace the components as required.** Proceed to Step 7 on page D-143. Proceed to the next step.

Potential Leak Paths Under the Valve Cover.



TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 10: Check High Pressure Oil System for Leaks While Using Injection Actuation Pressure Test.		
• Start the engine and wait until engine operating temperature is 160°F (70°C) or above. • Turn the ignition switch OFF, engine OFF. • Remove Valve Covers, if not already removed. • Connect ET to the Cab Data Link Connector, if not already connected. • Access the Injection Actuation Pressure Test under the Interactive Diagnostics screen of ET. **WARNING** **Always use a board or cardboard protector when performing this test. Escaping fluid under pressure, even a pin hole size leak, can penetrate body tissue, causing serious injury or possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.** • Begin the test. • Monitor the High Pressure Oil System for leaks under the valve cover as indicated in the diagram appearing in step 9 on page D-145. **• Are any leaks apparent?** NOTE: Most likely the oil leak will not squirt out, look for oil seeping out instead.	**YES ⇒** **NO ⇒**	**Repair or replace the components as required.** Proceed to Step 7 on page D-143. Proceed to the next step.
Step 11: Run Injector Solenoid Test.		
• Turn the ignition switch ON, engine OFF. • Connect ET to the Cab Data Link Connector. • Access the Injector Solenoid Test from the ET Interactive Diagnostics screen. • Run the test through all six cylinders and listen to ensure each injector is operating. **• Is each Injector operating?**	**YES ⇒** **NO ⇒**	Proceed to the next step. **Repair or replace the faulty Injector as required.** Refer to “PC-33: Injector Solenoids Circuit Test” on page D-108. STOP.

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 12: Block Off High Oil Pressure Pump and Check Pressure.		
• Disconnect the Injection Actuation pump to high pressure oil manifold tube. • Connect an 8T-0852 Pressure Gauge to the output of the Injection Actuation Pump.  • While attempting to start the engine, monitor the Injection Actuation Pressure using 8T-0852 Pressure Gauge at output of pump. **• Does the gauge Injection Actuation Pressure indicate greater than 0 psi (kPa) and less than 4000 psi (28000 kPa)?**	**YES ⇒** **Pressure = 0 ⇒** **Greater Than 28000 kPa (4000 psi) ⇒**	Proceed to the next step. **If the pressure = 0 psi (0 kPa), the pump is not turning.** Remove the pump and inspect the gear train. **If the pressure is greater than 4000psi (28000 kPa), the pump and Injection Actuation Pressure Control Valve are OK.** The oil is leaking elsewhere. Proceed to Step 9 on page D-145.
Step 13: Remove Injection Actuation Pressure Control Valve and Inspect O-rings.		
• Remove the Injection Actuation Pressure Control Valve from the engine (Refer to the Systems Operation, Testing and Adjusting Manual for details). • Inspect the O-rings. **• Are the O-rings undamaged?**	**YES ⇒** **NO ⇒**	**Replace the Injection Actuation Pressure Control Valve** and proceed to the next step. **Replace the O-rings and reinstall the Injection Actuation Pressure Control Valve.** Proceed to Step 12 on page D-147.

<table>
<tr><th>TEST STEP</th><th>RESULT</th><th>DIAGNOSIS/ACTION</th></tr>
<tr><td>Step 14: Block Off High Oil Pressure Pump and Check Pressure.</td><td></td><td></td></tr>
<tr><td>• Disconnect the Injection Actuation pump to high pressure oil manifold tube.
• Connect an 8T-0852 Pressure Gauge to the output of the Injection Actuation Pump.


• While attempting to start the engine, monitor the Injection Actuation Pressure using 8T-0852 Pressure Gauge at output of pump.
• Does the gauge Injection Actuation Pressure indicate approximately 4000 psi (28000 kPa)?</td><td>YES ⇒

NO ⇒</td><td>The hydraulic system is currently operating correctly. STOP.

Replace pump and repeat this test step.

If the pump has been replaced and the pressure is still below 4000 psi (28000 kPa) troubleshoot for electrical problems.</td></tr>
</table>

PC-39: Inlet Air Heater Circuit Test

System Operation

When to Use This Procedure

Use this procedure if there is an Active or easily repeatable 70-05 Inlet Air Heater Open Circuit or 70-06 Inlet Air Heater Short Circuit Diagnostic Code. Also use this procedure to check the Inlet Air Heater and Inlet Air Heater Relay Operation.

Background

The Inlet Air Heater is used to improve the cold start capability of the engine and to reduce white smoke. The ECM controls the Inlet Air Heater through the Inlet Air Heater Relay. The Inlet Air Heat function is disabled when the Crank Without Inject Mode is activated.

The Inlet Air Heater operation is determined at three different times, Power Up/Preheat, Cranking and Engine Started Cycle, based on engine parameters. The Inlet Air Heater is disabled in Arctic Mode.

ECM Power Up and Preheat Cycle

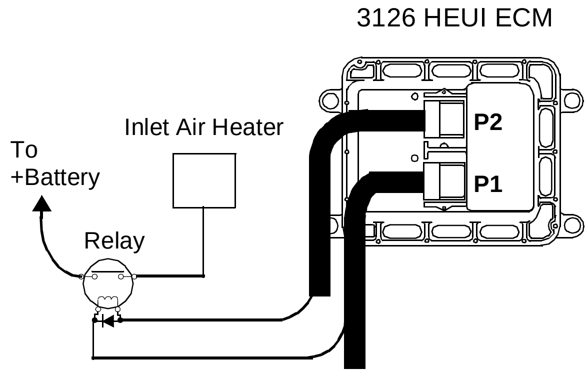
When the ECM is first powered up, the Inlet Air Heater Lamp should come ON for a minimum of two seconds regardless of the coolant temperature. If the sum of Coolant Temperature and Inlet Manifold Air Temperature is less than 109 °F (or the sum is less than 25°C), the ECM will signal the Heater to activate ON for 30 seconds as a preheat cycle.

The Heater and Starting Aid Lamp should turn ON, and then OFF when the cycle is complete. If the operator attempts to start the engine before the 30 second preheat cycle ends, the ECM controls the Heater for the Cranking Cycle.

Cranking Cycle

When the engine is cranking, the Heater will turn ON if the combination of the Coolant Temperature and Inlet Manifold Air Temperature is less than 109°F (25°C), and stay ON while cranking. If the engine fails to start the Heater will activate for 30 seconds (preheat cycle is restarted).

If Oil Temperature is below -13 °F (-25 °C) and the block heater is activated (coolant temperature greater than 15 °F (-9 °C), the Inlet Air Heater is deactivated during cranking and engine acceleration to cold mode idle speed.



Engine Start Cycle

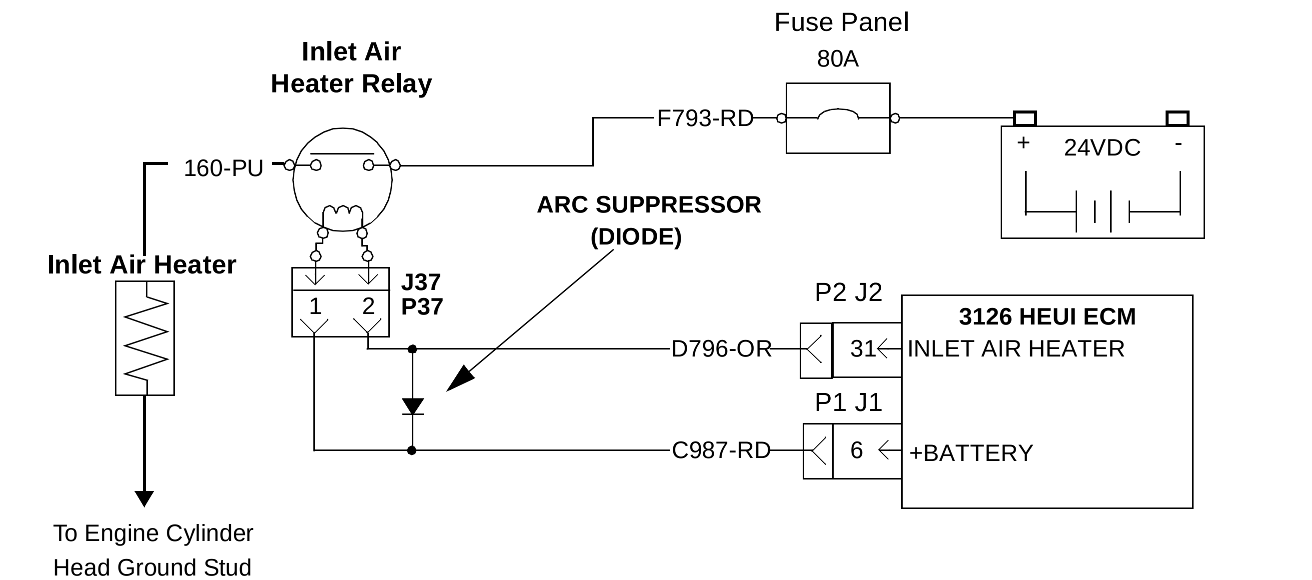
After the engine has started, the Heater operation is determined by the same combination of both the Inlet Manifold Air Temperature and Coolant Temperature.

If the combined temperature is less than 109°F (25°C), the Engine Start Cycle begins.The Engine Start Cycle has two segments, a continuous mode followed by an On/Off cycling mode. The Continuous On mode lasts for a maximum of seven minutes. The On/Off cycle mode can last for a maximum of 13 minutes. During the On/Off cycle mode, the Heater is cycled ON and OFF for ten seconds. The Inlet Air Heater will turn OFF anytime the combination of the Inlet Manifold Air Temperature and Coolant Temperature exceeds 127°F (35°C).

Active Coolant Temperature or Inlet Manifold Air Temperature Open/Short Circuit Diagnostic Code and Heater Operation

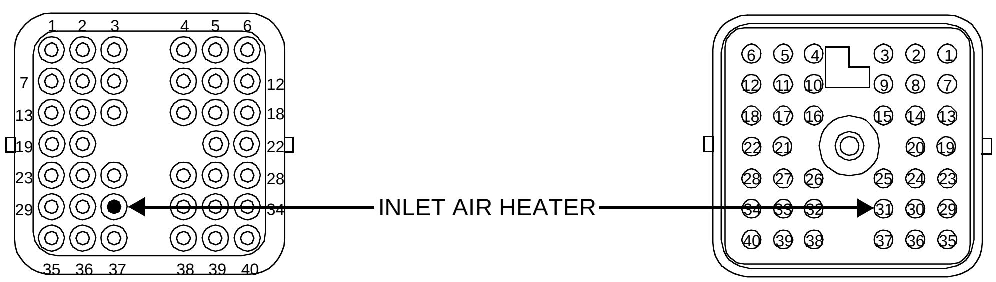
Whenever there is an Active Open or Short Circuit Diagnostic Code for the Coolant Temperature Sensor, the Heater will activate if the Inlet Manifold Air Temperature is less than 50°F (10°C). For an Active Inlet Manifold Air Temperature Sensor Diagnostic, the Heater will activate if Coolant Temperature is less than 104°F (40°C).

Schematic



Note: Refer to the Electrical System Schematic

ECM Pin Locations



Harness Side ECM Connector P2 ECM Side

Diagnostic Codes

PID-FMI and Description of Code:	Systems Response:	Troubleshooting:
70-05 Inlet Air Heater Open Circuit (49) After attempting to turn the Inlet Air Heater Relay ON the ECM has detected an open circuit.	**Electronic System Response -** The ECM is unable to turn the Heater ON. The Inlet Air Heater will not come ON even though the ECM determines the conditions indicate it should. **Engine Response -** The engine may have white smoke in exhaust and/or an increase in cranking time before starting with cold temperatures.	Proceed with procedure PC-39: to test the Inlet Air Heater Circuit.
70-06 Inlet Air Heater Short Circuit (49) After attempting to turn the Inlet Air Heater ON the ECM has detected an open or short circuit.		

Functional Test

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 1: Check Electrical Connectors and Wiring		
• Thoroughly inspect ECM Engine Harness Connector J2/P2, Inlet Air Heater Relay Connector J37/P37, Inlet Air Heater, and the terminal connections to the Inlet Air Heater Relay. (Refer to procedure “PB-10: Inspecting Electrical Connectors” on page D-43 for details on inspecting connectors.) F • Perform 10 pound (44.5 N) pull test on each of the wires in the Engine Harness associated with the Inlet Air Heater. • Check ECM Connector (Allen screw) for proper torque. • Check the harness and wiring for abrasion and pinch points from the sensor back to the ECM. • **All connectors/pins/sockets should be completely mated/inserted, and the harness/wiring should be free of corrosion, abrasion or pinch points.**	**OK ⇒** **NOT OK ⇒**	Proceed to the next step. **Repair or replace wiring or connectors as necessary.** Ensure all seals are properly in place and connectors completely mated. Verify the repair eliminates the problem. STOP.
Step 2: Test Inlet Air Heater Power Up.		
• Turn the ignition switch ON, engine OFF. • Connect ET to the Service Tool Connector. • Access the Inlet Air Heater Enable Special Test on ET. • Begin the Inlet Air Heater Enable Special Test while listening for the Relay to click. (You may need to be near the engine to hear the Relay click). • **Does the Relay come on as outlined above?** **NOTE:** Do not leave the Inlet Air Heater Enable Special Test ON longer than is required, and avoid unnecessary cycling to prevent battery drain. The Inlet Air Heater Enable Special Test has a built in 1 minute timer to disable the test after the time expires.	**YES ⇒** **NO ⇒**	**If the Relay activates, the Relay is functioning normally at this time.** If you still suspect a problem with the Inlet Air Heater, proceed to Step 7 on page D-154. **The Relay does not activate,** there is a problem in the Relay circuit. Proceed to the next step.
Step 3: Check +Battery Voltage at Inlet Air Heater Relay Connector P37.		
• Disconnect Inlet Air Heater Relay Connector J37/P37 (2-Pin DT Connector). • Connect a voltage test lamp to socket-1 (C987-RD) of the Engine Harness side (P37) of the Inlet Air Heater Connector. Connect the other end of the test lamp to ground. • Turn the ignition switch ON, engine OFF and watch the voltage test lamp. • **Does the test lamp come ON?**	**YES ⇒** **NO ⇒**	Proceed to the next step. **The Inlet Air Heater Relay Connector J37/P37 is not receiving the correct voltage.** Repair wiring between P1 socket-6 (+Battery) and P37 socket-1. STOP.

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 4: Check ECM Control Voltage at Inlet Air Heater Relay Connector P37.		
• Keep Inlet Air Heater Relay Connector J37/P37 (2-Pin DT Connector) disconnected. • Connect a voltage test lamp to the two sockets of the Engine Harness side (P37) of the Inlet Air Heater Connector. • Turn the ignition switch ON, engine OFF. • Access the Inlet Air Heater Enable Special Test on ET. • Begin the Inlet Air Heater Enable Special Test while watching the voltage test lamp. • **Does the test lamp come ON and then shut OFF with the Inlet Air Heater Enable Special Test?** **NOTE:** Do not leave the Inlet Air Heater Enable Special Test ON longer than is required, and avoid unnecessary cycling to prevent battery drain. The Inlet Air Heater Enable Special Test has a built in 1 minute timer to disable the test after the time expires.	**YES** ⇒ **NO** ⇒	**The ECM and harness wiring to the Inlet Air Heater Relay are OK.** Reconnect all wires and repeat Step 2 on page D-152. If problem is not resolved, replace the Inlet Air Heater Relay. STOP. **The Inlet Air Heater Relay Connector J37/P37 is not receiving the correct voltage.** Temporarily remove Arc Suppressor Diode and repeat this step. If OK, replace Arc Suppressor. Otherwise, reconnect Arc Suppressor and proceed to the next step.
Step 5: Check the ECM.		
• Turn the ignition switch OFF, engine OFF. • Disconnect ECM Engine Harness Connector J2/P2 and install a 40-Pin Breakout T to the ECM Connector J2 **only**. • Connect a voltage test lamp from +Battery to the Breakout T pin-31. • Turn the ignition switch ON, engine OFF. • Access the Inlet Air Heater Enable Special Test on ET. • Begin the Inlet Air Heater Enable Special Test while watching the voltage test lamp. • **Does the test lamp come ON and then shut OFF with the Inlet Air Heater Enable Special Test?** **NOTE:** Do not leave the Inlet Air Heater Enable Special Test ON longer than is required, and avoid unnecessary cycling to prevent battery drain. The Inlet Air Heater Enable Special Test has a built in 1 minute timer to disable the test after the time expires. **NOTE:** When ECM Engine Harness Connector J2/P2 is disconnected with the ignition switch ON, Open Circuit diagnostic codes will be Active/Logged for all of the engine +5V Sensors and the Inlet Air Heater Open Circuit. This is normal.	**YES** ⇒ **NO** ⇒	**The ECM is properly controlling the Inlet Air Heater at P2.** Remove Breakout T and connect ECM Engine Harness Connector J2/P2. Repair wiring between P2 and P37 as required. STOP. Proceed to the next step.

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 6:Test Battery Voltage to the ECM.		
• Turn the ignition switch OFF, engine OFF. • Disconnect the ECM Machine Harness Connector J1/P1 and install a 40-Pin Breakout T. • Connect a voltmeter between Breakout T pin-6 (+Battery) and pin-5 (-Battery). • Turn the ignition switch ON, engine OFF. **• Is the voltage between 22.0 VDC and 27 VDC while the ignition switch is switched to the ON position?** • Turn the ignition switch OFF, engine OFF. • Connect a voltmeter between Breakout T pin-28 (+Battery) and pin-4 (-Battery). • Turn the ignition switch ON, engine OFF. **• Is the voltage between 22 VDC and 27 VDC while the ignition switch is switched to the ON position?**	**YES ⇒** **NO ⇒**	**The ECM is receiving the correct voltage but not turning ON the Relay.** Replace the ECM. Ensure this corrects the problem. **The problem is in the Machine Wiring. Inspect and repair as required.** STOP.
Step 7: Check Voltage at Inlet Air Heater Relay Contacts.		
• Connect one end of a a voltage test lamp to ground. • Turn the ignition switch ON, engine OFF. • Access the Inlet Air Heater Enable Special Test on ET. • Begin the Inlet Air Heater Enable Special Test. • Connect the other end of the test lamp to the Inlet Air Heater Relay +Battery Power Terminal (wire F793-RD from breaker) and observe the voltage test lamp. • Disconnect Test Lamp from the Inlet Air Heater Relay +Battery terminal and connect to the Output Terminal (wire 160-PU to heater) and observe the voltage test lamp. **• Is the test lamp ON at BOTH relay power terminals when the Inlet Air Heater Enable Special Test is activated?** **NOTE:** Do not leave the Inlet Air Heater Enable Special Test ON longer than is required, and avoid unnecessary cycling to prevent battery drain. The Inlet Air Heater Enable Special Test has a built in 1 minute timer to disable the test after the time expires.	**YES ⇒** **NO ⇒**	**The relay and +Battery Connection to the Inlet Air Heater Relay are OK.** Proceed the next step. **There is a problem in the relay or wiring.** If the test lamp does not illuminate when connected to the +Battery Power Terminal, there is a problem in the wire F793-RD or the breaker. If the +Battery Power Terminal checks OK, but the lamp does not illuminate at the Output Terminal (wire 160-PU to heater), the relay is faulty. Repair as necessary. STOP.

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 8: Check Voltage at Inlet Air Heater.		
• Connect a voltage test lamp both terminals of the Inlet Air Heater. • Access the Inlet Air Heater Enable Special Test on ET. • Begin the Inlet Air Heater Enable Special Test and observe the voltage test lamp. **• Is the test lamp ON when the Inlet Air Heater Enable Special Test is activated?** **NOTE:** Do not leave the Inlet Air Heater Enable Special Test ON longer than is required, and avoid unnecessary cycling to prevent battery drain. The Inlet Air Heater Enable Special Test has a built in 1 minute timer to disable the test after the time expires.	**YES ⇒** **NO ⇒**	**The Inlet Air Heater is receiving the correct voltage.** Check for an open circuit in the Air Inlet Heater if a problem is still suspected. Replace if necessary. STOP. **Repair or replace the wiring from the Air Inlet Heater Relay to the Air Inlet Heater.** STOP.

PB-41: Ether Injection System

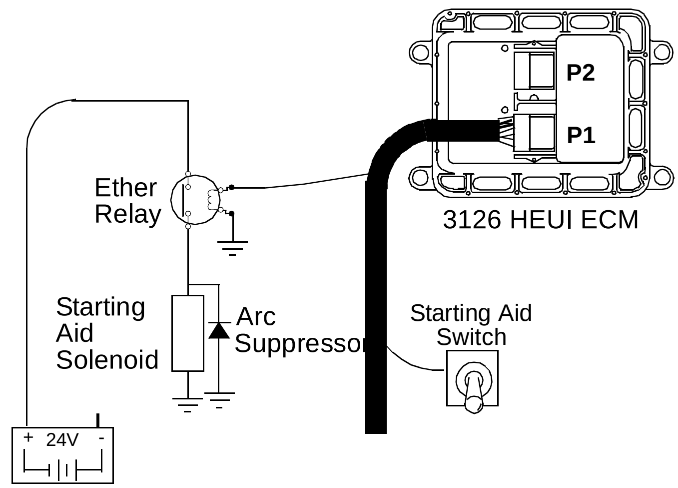
System Operation

When to Use This Procedure

Use the following information if troubleshooting a 131-05 or 131-06 diagnostic code or to test Ether Injection System components for electrical problems.

Background:

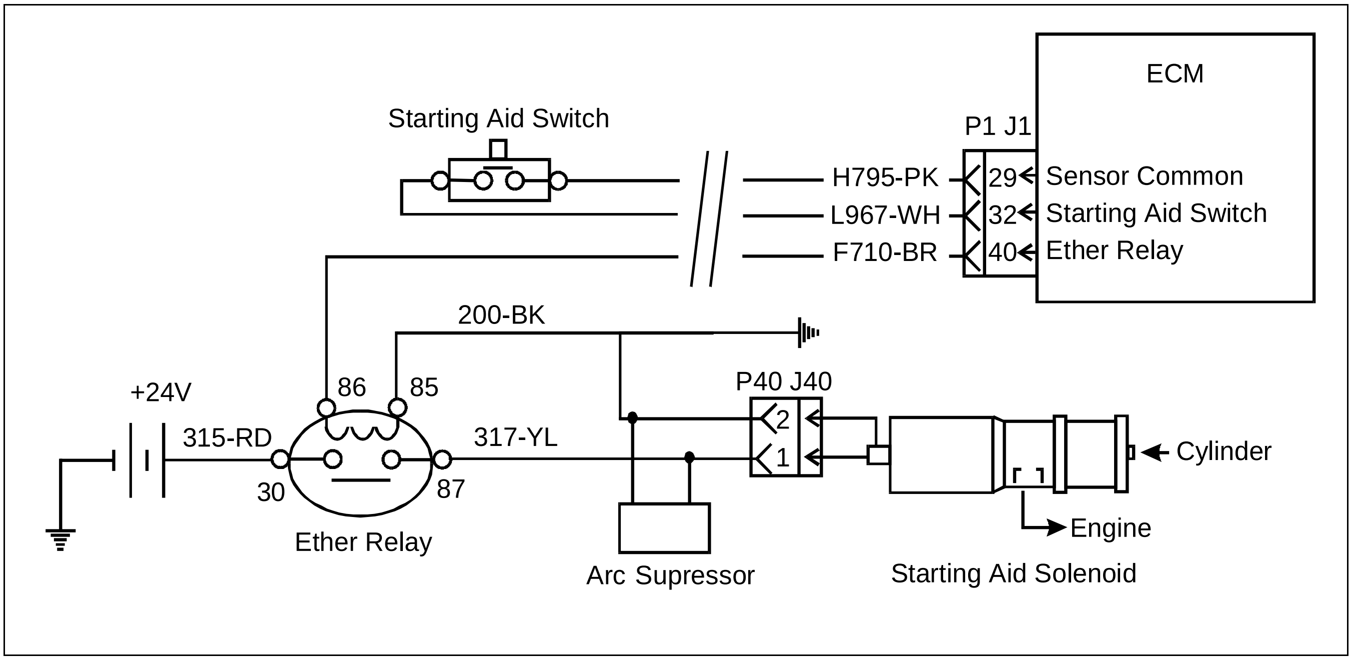
The Ether Injection System allows the operator to activate the ether start aid by momentarily depressing the Starting Aid Switch. One 2.25 cm^3 shot of ether is injected each time J1/P1 pin-32 (Starting Aid Switch) is grounded provided engine speed is below 1000 rpm, coolant temperature is below 40 °C (104 °F), and Inlet Manifold Air Temperature is below 0 °C (32 °F). The Starting Aid Lamp is illuminated to indicate if the Air Inlet Heater is ON or if ether is being injected.



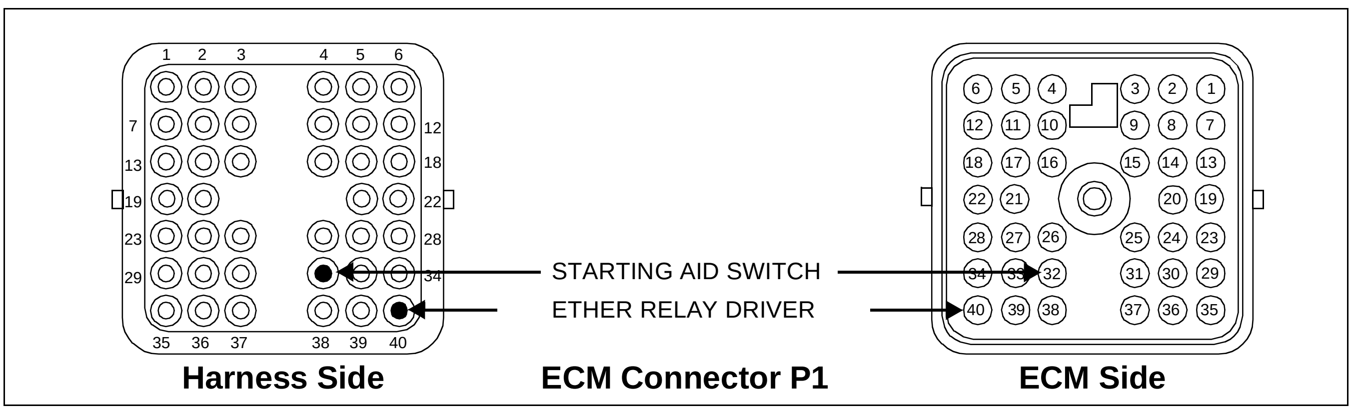
Diagnostic Codes

PID-FMI and Description of Code:	Systems Response:	Troubleshooting:
131-05 Ether Relay Open Circuit Indicates the circuit from the Ether Relay to the ECM is open.	**Electronic System Response -** A diagnostic code is generated. The Check Engine Lamp is illuminated if the Blackout Switch is not Activated. **Engine Response -** The engine may be difficult to start.	Proceed with procedure PB-41.
131-06 Ether Relay Short Circuit Indicates the circuit from the Ether Relay to the ECM is shorted to ground.		

Schematic:

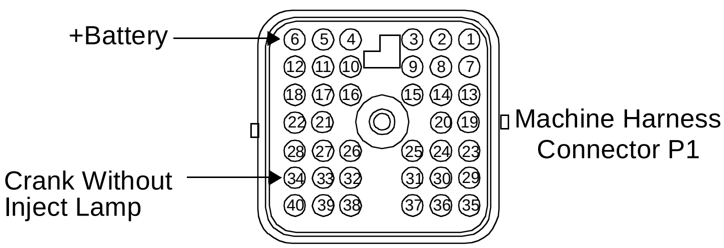


ECM Pin Locations



Functional Test

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 1: Check Electrical Connectors and Wiring.		
• Thoroughly inspect ECM Machine Harness Connector J1/P1, the bulkhead connector, and the Ether Relay, Starting Aid Solenoid, and Starting Aid Switch pins in the Connectors. (Refer to procedure “PB-10: Inspecting Electrical Connectors” on page D-43 for details on inspecting connectors.) • Perform 10 pound (44.5 N) pull test on each of the wires in the ECM Connector associated with the Check Engine, Crank Without Inject, or Starting Aid Lamp. • Check ECM Connector (Allen screw) for proper torque. • Check the harness and wiring for abrasion and pinch points from the sensor back to the ECM. • Refer to PB-15: Blackout, Diagnostic Enable, Engine Speed Control, and Starting Aid Switch Circuit Test to verify proper operation of the Starting Aid Switch. **• All connectors/pins/sockets should be completely mated/inserted, and the harness/wiring should be free of corrosion, abrasion or pinch points.**	**OK ⇒** **NOT OK ⇒**	Proceed to the next step. **Repair or replace wiring or connectors as necessary.** Ensure all seals are properly in place and connectors completely mated. Verify the repair eliminates the problem. STOP.
Step 2: Check Ether Relay Resistance At P1.		
For the Check Engine/Service Engine Soon Lamp, • Turn the ignition switch to the OFF position. • Disconnect J1/P1 and measure the resistance between P1 socket-40 and engine ground. **• Is the resistance between 180 and 540 Ohms?**	**YES ⇒** **NO ⇒**	**The Ether Relay and ECM wiring check OK.** Proceed to the next step. There is a problem in the wiring or relay. Repair as necessary. STOP.

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 3: Test the Ether Circuit.		
⚠ WARNING **Ether is extremely flammable. Do not perform this procedure within 15 M (50 ft) of an open flame. Failure to follow these precautions can result in personal injury, death or property damage.**	**YES ⇒**	**The ether circuit is functioning properly**. Reconnect all connectors and reinstall ether canister. STOP.
• Remove Ether Canister from the Starting Aid Solenoid. • Disconnect Starting Aid Solenoid Connector J40/P40. • Fabricate a jumper wire 4 inches (100 mm) long with a Deutsch Pin crimped to both ends. **Deutsch Pin Contact** **Deutsch Pin Contact**  • Insert the jumper into connector P1 socket-40 (Ether Relay). Connect the other side of the jumper wire to the +Battery socket-6.  • Turn the ignition switch ON, engine OFF. • Momentarily connect/disconnect the Starting Aid Solenoid Connector J40/P40 while listening for the Starting Aid Solenoid. **NOTE:** Do not leave the Starting Aid Solenoid connected for more than a few seconds at a time or damage could result. **• Does the Starting Aid Solenoid click when Connector J40/P40 is connected and disconnected?**	**NO ⇒**	Proceed to the next step.

TEST STEP	RESULT	DIAGNOSIS/ACTION
Step 4: Check Starting Aid Solenoid For Open Circuit		
• Turn the ignition switch to the OFF position. • Disconnect the Starting Aid Solenoid Connector J40/P40. • Measure the resistance between J40 pin-1 and J40 pin-2. **• Is the resistance less than 50 Ohms?**	**YES** ⇒	**There is a problem in the wiring between the Ether Relay and Starting Aid Solenoid or the Ether Relay is bad.** Use a test lamp to trace for voltage across the circuit. Refer to the Electrical System Schematic. Repair as necessary. STOP.
	NO ⇒	Replace the Starting Aid Solenoid. STOP.

Glossary Of Terms

ATA (American Trucking Association) Data Link

A two-wire electrical connection for communication with other microprocessor based devices that are compatible with the American Trucking Association and SAE Standards (J1587 and J1708) such as trip recorders, electronic dashboards, powertrain controls, and maintenance systems. The Data Link is also the serial communication medium used for programming and troubleshooting with Caterpillar devices.

Active Diagnostic Code

Describes a condition that is currently present to alert the driver or service technician of an abnormal engine operation parameter. Refer to Diagnostic Fault Code.

Air-To-Air Aftercooler (ATAAC)

A means of cooling intake air after the turbocharger, using ambient air for cooling. The intake air is passed through an aftercooler (heat exchanger) mounted in front of the radiator before going to the intake manifold.

Alternating Current (AC)

The direction of current flow changes (alternates) regularly and constantly in a circuit.

American Wire Gauge (AWG)

A measure of the diameter (and therefore the current carrying ability) of electrical wire. The smaller the AWG number, the larger the wire.

Before Top Center (BTC)

The 180 degrees of crankshaft rotation before the piston reaches the very top of its travel (normal direction of rotation).

Boost Pressure Sensor

This sensor measures inlet manifold air pressure and sends a signal to the ECM.

Bypass Circuit

A circuit, usually temporary, to substitute for an existing circuit, typically for test purposes.

Calibration

As used here, is an electronic adjustment of a sensor signal.

Caterpillar Engine Monitoring

The part of the Caterpillar Electronic Engine Control that monitors Coolant Temperature to alert the operator of detected problems. The Coolant Temperature Sensor is supplied by Caterpillar and monitored by the ECM. After market engine monitoring systems do not interface with the Caterpillar Electronic Engine Control.

Check Engine Lamp

Sometimes referred to as the “Diagnostic Lamp”, it is used to alert the operator of the presence of an active event and is used to flash a diagnostic code.

Code

Refer to Diagnostic Fault Code and Diagnostic Event Code.

Cold Mode

A mode of engine operation where the timing is retarded and the low idle may be raised for engine protection, reduced smoke emissions and faster warm up time.

Data Link

Refer to ATA Data Link.

Desired RPM

An input to the electronic governor within the ECM. The electronic governor uses inputs from the Throttle Position Sensor, Engine Speed/Timing Sensor and Customer Parameters to determine “Desired RPM”.

Diagnostic Event Code

These codes indicate an event that describe an abnormal engine condition, such as an Idle Shutdown Occurrence. They are not necessarily (or usually) an indication of problems within the Electronic System.

Diagnostic Fault Code

Sometimes referred to as a “fault code”. These codes indicate an electronic system malfunction or problem with the machine engine Electronic System.

Diagnostic Flash Code

These codes are flashed out using the Check Engine/Service Engine Soon Lamp to indicate an electronic system malfunction or an event detected by the Electronic System ECM.

Diagnostic Lamp

Sometimes referred to as the “check engine lamp”, it is used to alert the operator of the presence of an active diagnostic code.

Direct Current (DC)

The type of current where the direction of current flow is consistently in one direction only.

Duty Cycle

Refer to Pulse Width Modulation.

Electronic Control Module (ECM)

The engine control computer that provides power to the machine engine electronics. It accepts inputs that monitor and outputs that control or change to act as a governor to control engine rpm.

Electronic Engine Control

The complete electronic system that monitors and controls engine operation under all conditions.

Electronically Controlled Unit Injector

The injection pump which is mechanically actuated, electronically controlled unit injector combining the pumping, electronic fuel metering and injecting elements in a single unit.

Electronic Technician (CAT ET)

A software program to run on a service tool like a personal computer (PC). This program will supplement and eventually replace ECAP.

Engine Speed/Timing Sensor

Provides a variable amplitude and Pulse Width Modulated Signal to the ECM, which the ECM interprets as crankshaft position and engine speed.

Failure Mode Identifier (FMI)

Type of failure the component experienced (adopted from SAE standard practice J1587 diagnostics).

(FMI) Description

0	Data valid but above normal operational range
1	Data valid but below normal operational range
2	Data erratic, intermittent, or incorrect
3	Voltage above normal or shorted high
4	Voltage below normal or shorted low
5	Current below normal or open circuit
6	Current above normal or grounded circuit
7	Mechanical system not responding properly
8	Abnormal frequency, pulse width, or period
9	Abnormal update
10	Abnormal rate of change
11	Failure mode not identifiable
12	Defective device or component
13	Uncalibrated device or component
14/15	Reserved for future assignment

Flash Code (FC)

The Caterpillar proprietary code numbers which are flashed out on the diagnostic lamp.

Flash Programming

A way of programming or updating an ECM with an Electronic Service Tool over the data link instead of replacing components.

Fuel Ratio Control (FRC)

FRC Fuel Pos. - is a limit based on control of the fuel-air ratio and is used for emissions control purposes. When the ECM senses a higher boost pressure (more air into cylinder), it increases the “FRC Fuel Pos” limit (allows more fuel into cylinder).

Fuel Position

An internal signal within the ECM, from the Electronic Governor to Fuel Injection Control. It is based on Desired RPM, FRC Fuel Position, rated fuel position and engine rpm. Reference “3100 System Overview” in Section 1 of this manual.

Full Load Setting (FLS)

Number representing fuel system adjustment made at the factory to “fine tune” the fuel system maximum fuel delivery. Correct value for this parameter is stamped on the engine information ratings plate. This parameter must be programmed or a Diagnostic Code 253-02 Check Customer Or System Parameters (56) will be generated.

Full Torque Setting (FTS)

Similar to Full Load Setting. This parameter must be programmed or a Diagnostic Code 253-02 Check Customer Or System Parameters (56) will be generated.

Harness

The wiring bundle (loom) connecting all components of the Electronic System.

Hertz (Hz)

Measure of frequency in cycles per second.

Hydraulic Electronic Unit Injector (HEUI)

The injection pumping is hydraulically actuated, electronically controlled injector combining the pumping, fuel metering and injecting elements in a single unit.

Injection Actuation Pressure Control Valve

This is an electronically controlled dump valve maintaining the high pressure for the high pressure oil manifold. The valve outputs controlled pressure depending on inputs from the ECM. The control valve regulates the high pressure oil to the injectors through the high pressure rail to provide the actuation force to determine the injection pressure for the engine.

Injection Actuation Pressure Sensor

A device used to detect and convert mechanical oil pressure in the high pressure manifold to an electrical signal to the ECM.

Inlet Air Heater

The Inlet Air Heater is used to improve the cold start capability of the engine and to reduce white smoke. The operation is determined at three different times, Power Up/Preheat, Cranking and Engine Started Cycle, based on engine parameters.

Intake Manifold Air Temperature Sensor

This sensor detects the intake manifold air temperature. The ECM monitors the inlet air temperature and coolant temperature to adjust injection timing.

Integrated Electronic Controls

The engine is designed with the electronic controls as a necessary part of the system. The engine will not operate without the electronic controls.

Logged Diagnostic Codes

Describes codes which are stored in memory. They are meant to be an indicator of possible causes for intermittent problems. Refer to Diagnostic Fault Code.

Open Circuit

Condition where an electrical wire or connection is broken or a switch is open, so that the signal or the supply voltage can no longer reach its intended destination.

Parameter

A programmable value or limit which determines the characteristics or behavior of the engine and/or vehicle.

Passive Magnetic Vehicle Speed Sensor

A vehicle speed sensor not requiring a power and ground connection. It produces a signal based on the change in magnetic flux of a ferrous metal gear near the sensing tip.

Password

A group of numeric or alpha-numeric characters, designed to restrict access to parameters. The electronic system requires correct passwords in order to change Customer Specified Parameters (Customer Passwords) or certain engine specifications (Factory Passwords). Passwords are also required to clear certain diagnostic codes.

Pedal Mounted Throttle Position Sensor

This sensor measures pedal position and sends a signal to the ECM. The sensor is mounted on a throttle pedal assembly.

Personality Module or Ratings Personality Module

The module attached inside of the ECM which contains all the instructions (software) for the ECM and performance maps for a specific power family.

Parameter Identifier (PID)

Two or three digit code which is assigned to each component to identify data via data link to ECM.

Progressive Shifting

Shifting up through the lower gears quickly by not using excessive engine rpm in each gear. Shifts are made above peak torque but below rated rpm. Using excessive engine (higher) rpm ranges before shifting to the next gear wastes fuel and fails to take advantage of the torque rise of the engine. The two steps (LoGr1, LoGr2) approximate ideal progressive shifting. Low gear #1 is typically set no lower than peak torque plus 200 rpm. Low gear #2 is typically set midway between Low gear #1 rpm limit and Top Engine Limit.

Power Take Off (PTO)

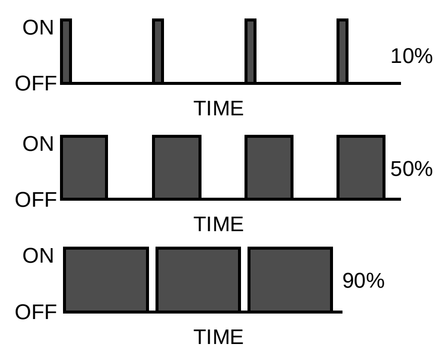
Operates with the cruise control switches or Dedicated PTO, this mode permits setting a constant engine rpm when the vehicle is not moving (like a manual throttle control cable).

PTO Configuration

Programmable parameter which determines the use of the ECM Multi-Function inputs, if any, for PTO applications.

Pulse Width Modulation (PWM)

A signal consisting of variable width pulses at fixed intervals, whose ratio of “TIME ON” versus total “TIME OFF” can be varied (also referred to as “duty cycle”)



Example of Pulse Width Modulation (PWM) Signals

Rated Fuel Position

(”Rated Fuel Pos” on ECAP) - this indicates the maximum allowable fuel position (longest injection pulse). It will produce rated power for this engine configuration.

Reference Voltage

A regulated, unchanging voltage supplied by the ECM to a sensor. The reference voltage is used by the sensor to generate a signal voltage.

Sensor

A device used to detect and convert a change in pressure, temperature, or mechanical movement into an electrical signal.

Short Circuit

A condition where an electrical circuit is unintentionally connected to an undesirable point. Example: a wire which rubs against a vehicle frame until it wears off its insulation and makes electrical contact with the frame.

Signal

A voltage or waveform used to transmit information typically from a sensor to the ECM.

Speed "burp"

A sudden, brief, unwanted change in engine rpm.

Speed/Timing Sensor

A sensor that measures crankshaft position, direction of rotation and engine rpm and sends signal to ECM.

Standard SAE Diagnostic Communications Data Link

Refer to ATA Data Link.

Subsystem

As used here, it is a part of the Electronic System that relates to a particular function, for instance throttle subsystem, etc.

Supply Voltage

A constant voltage supplied to a component to provide electrical power for its operation. It may be generated by the ECM, or it may be vehicle battery voltage supplied by the vehicle wiring.

System Configuration Parameters

Parameters which affect power rating family or emissions.

"T" Harness

A test harness designed to connect into vehicle or engine harness which allows normal circuit operation while providing a breakout or "T" to measure signals.

Throttle Position

The ECM interpretation of the signal from the Throttle Position Sensor.

Throttle Position Sensor

An electronic sensor which is connected to the accelerator pedal and sends a Pulse Width Modulated Signal to the ECM.

Timing Calibration

The adjustment of an electrical signal as a means of correcting timing error between the crankshaft and camshaft. Refer to Speed/Timing Sensor.

Total Tattletale

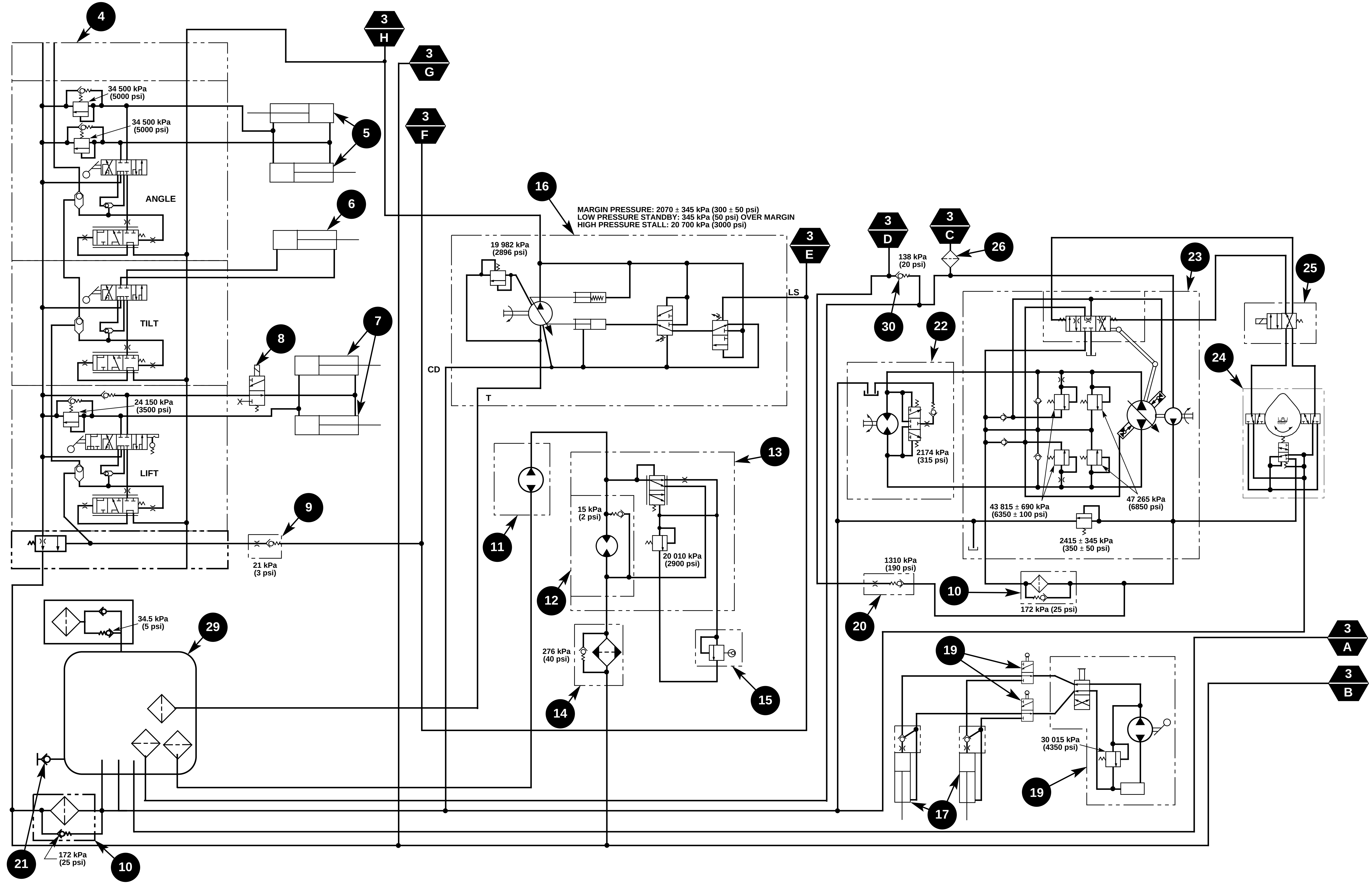
Total number of changes to all Customer Specified Parameters stored in the ECM.

Programmable parameter used by the ECM to scale the vehicle speed signal into miles per hour (or kilometers per hour).

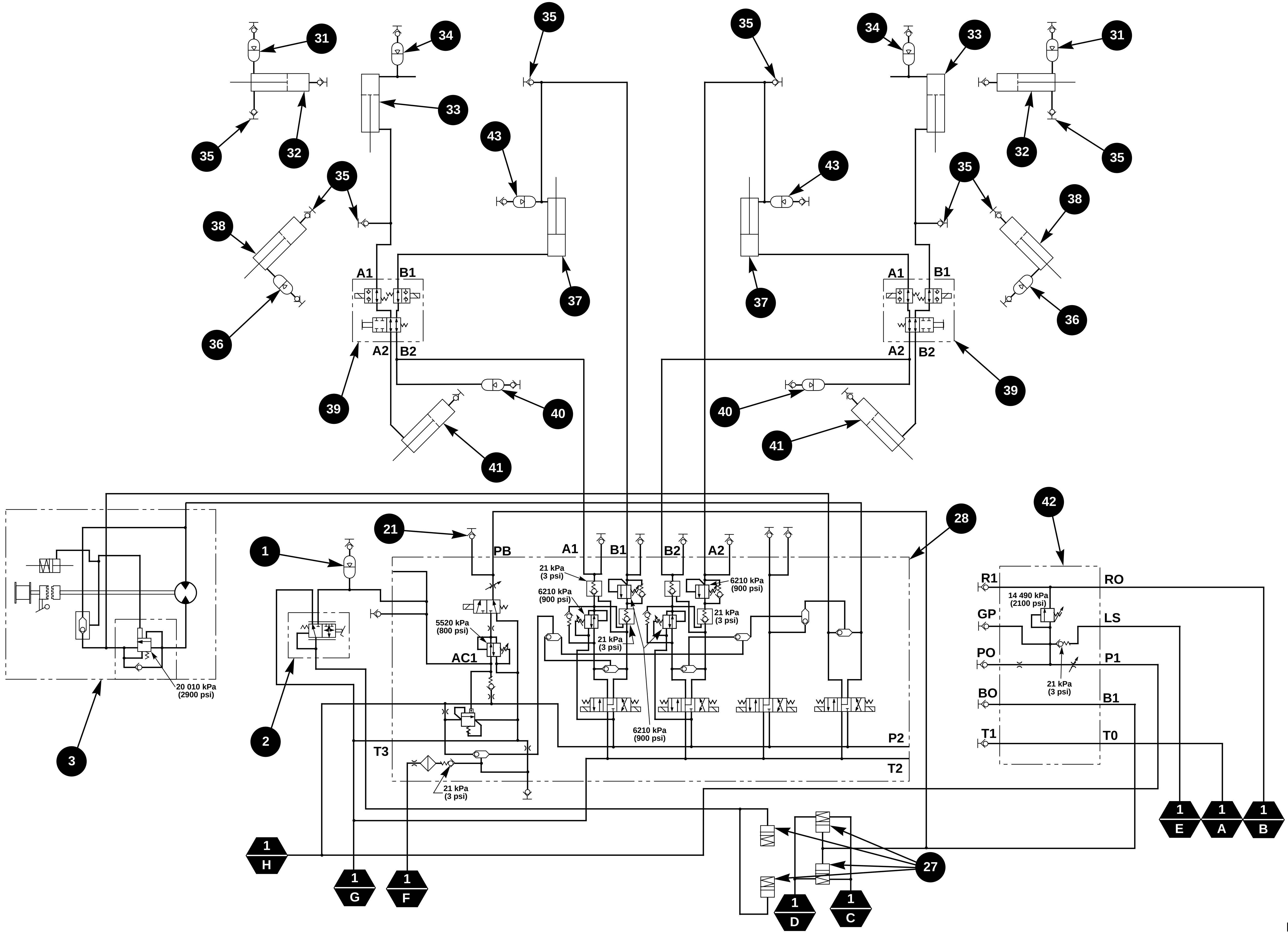
Vehicle Speed Sensor

An electromagnetic pickup that measures vehicle speed from the rotation of gear teeth in the drive train of the vehicle.

Printed in U.S.A.



34 500 kPa (5000 psi)
34 500 kPa (5000 psi)
ANGLE
TILT
24 150 kPa (3500 psi)
LIFT
21 kPa (3 psi)
MARGIN PRESSURE: 2070 ± 345 kPa (300 ± 50 psi)
LOW PRESSURE STANDBY: 345 kPa (50 psi) OVER MARGIN
HIGH PRESSURE STALL: 20 700 kPa (3000 psi)
19 982 kPa (2896 psi)
LS
CD
T
15 kPa (2 psi)
20 010 kPa (2900 psi)
276 kPa (40 psi)
34.5 kPa (5 psi)
172 kPa (25 psi)
138 kPa (20 psi)
2174 kPa (315 psi)
43 815 ± 690 kPa (6350 ± 100 psi)
47 265 kPa (6850 psi)
2415 ± 345 kPa (350 ± 50 psi)
1310 kPa (190 psi)
172 kPa (25 psi)
30 015 kPa (4350 psi)
3 H
3 G
3 F
3 E
3 D
3 C
3 A
3 B

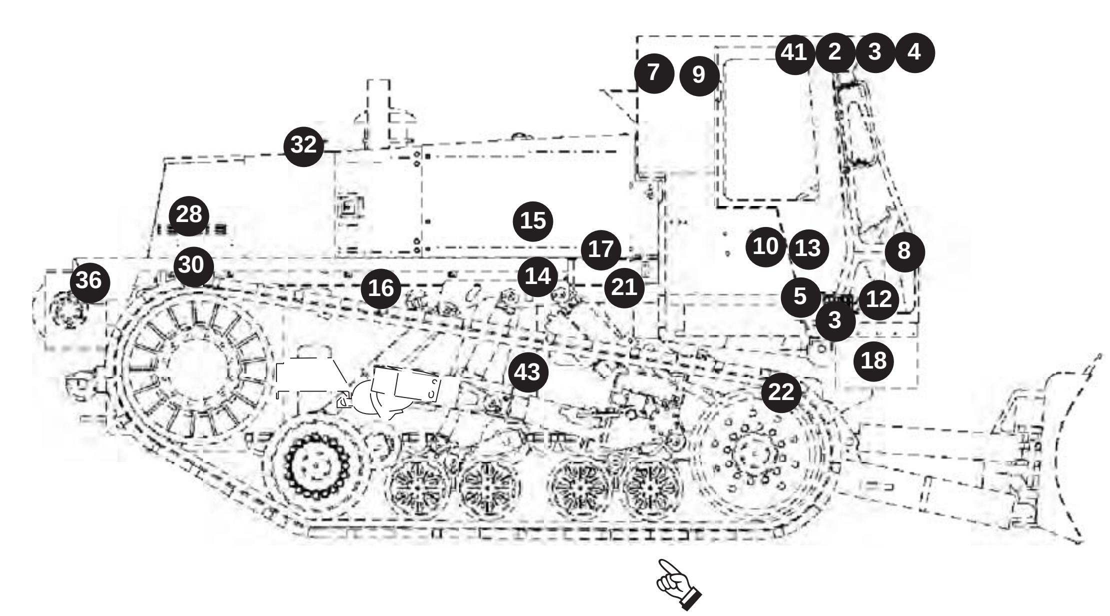

31
34
35
33
32
43
38
36
37
39
40
41
A1
B1
A2
B2
21
1
2
3
28
42
PB
AC1
T3
P2
T2
21 kPa
(3 psi)
6210 kPa
(900 psi)
5520 kPa
(800 psi)
20 010 kPa
(2900 psi)
14 490 kPa
(2100 psi)
R1
RO
GP
LS
PO
P1
BO
T1
T0
27
1 E
1 A
1 B
1 H
1 G
1 F
1 D
1 C

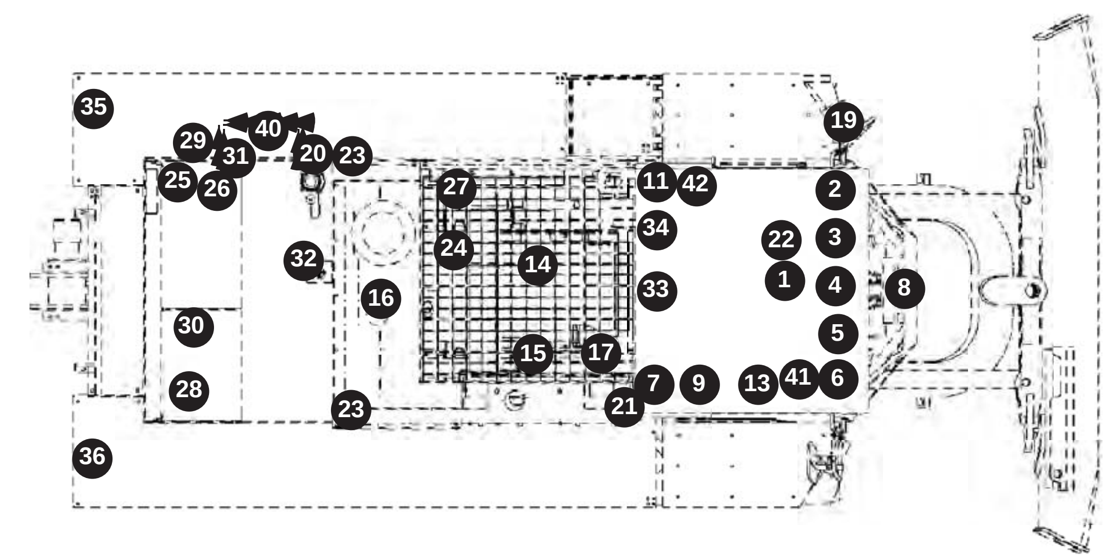
COMPONENT LOCATION

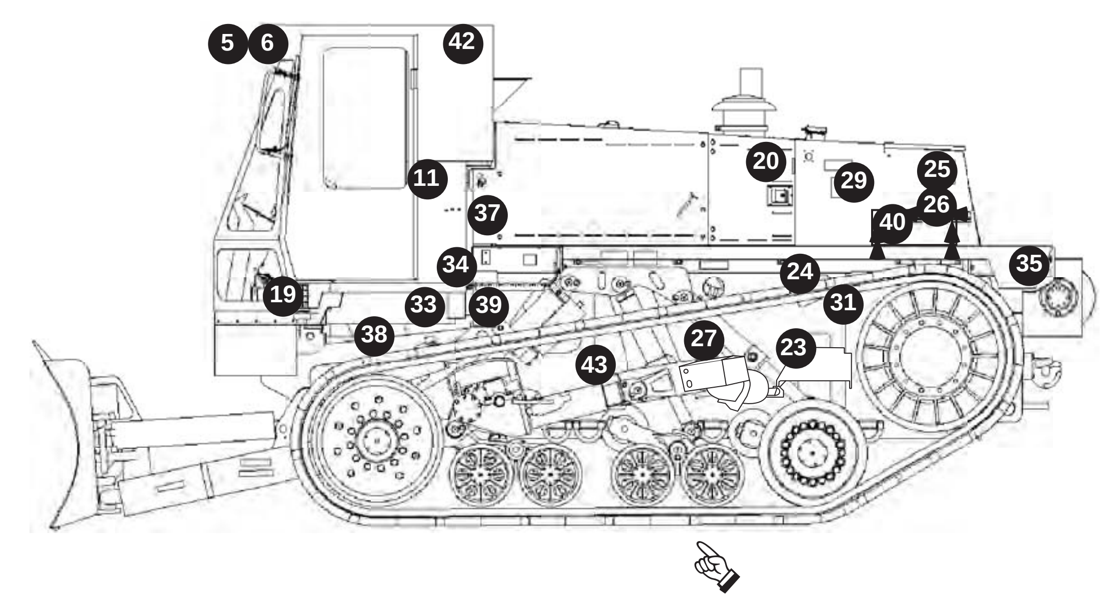
COMPONENT	PAGE NO.	SCHEMATIC LOCATION	Machine Location (white callouts)
Shift Lever Switch	FO-9	A - 5	1
Shifter Indicator Lamp	FO-9	A–5	1
Left Turn Lamp	FO-9	A–4	1
Tension Fail Lamp	FO-9	A–4	1
Fan Group	FO-9	B-3	41
Fan Group	FO-9	B-3	42
Low Brake Pressure Lamp	FO-9	B–4	1
Blade Down Alarm	FO-9	B–4	1
Blade Down Lamp	FO-9	B–4	1
Engine Oil Pressure Lamp	FO-9	C–4	1
Check Engine Lamp	FO-9	C–4	1
Crank W/O Inject Lamp	FO-9	C–4	1
Right Turn Lamp	FO-9	C–4	1
Kneeling Lamp	FO-9	D–4	1
Winch Enable Lamp	FO-9	D–4	1
Self-Deploy Lamp	FO-9	D–4	1
Coolant Temperature Gauge	FO-9	A–6	1
Engine Oil Pressure Gauge	FO-9	A–6	1
Transmission Oil Temp Gauge	FO-9	B–6	1
Voltmeter	FO-9	B–6	1
Fuel Level Gauge	FO-9	C–6	1
Tachometer/Hourmeter	FO-9	C–6	1
Speedometer/Odometer	FO-9	C–6	1
Blackout Headlamp	FO-9	A–1	19
L/H Front Work Lamp	FO-9	A–1	2
L/H Turn/Tail Blackout Lamp	FO-9	B–1	2
L/H Low Beam Head Lamp	FO-9	B–1	2
L/H Center Work Lamp	FO-9	C–1	3
Front Horn	FO-9	C–1	4
R/H Center Work Lamp	FO-9	C–1	5
R/H Low Beam Head Lamp	FO-9	D–1	6
R/H Turn/Marker Blackout Lamp	FO-9	D–1	6
R/H Front Work Lamp	FO-9	F-2	5
Dome Lamp	FO-9	B–3	7
Wiper Motor	FO-9	D–3	8
Washer Motor	FO-9	D–3	9
Diode Blocks	FO-11	F,G–5	10
Kneeling Limit Switch	FO-11	I–5	39
Blade Position Switch	FO-11	J–5	38
Wiper Relay 1	FO-11	F–7	10
Wiper Relay 2	FO-11	G–7	10
Diagnostic Relay	FO-11	G–7	10
Roading Relay	FO-11	G–7	10
Parking Brake Relay	FO-11	H–7	10
Lamp Test Relay	FO-11	H–7	10

COMPONENT LOCATION

COMPONENT	PAGE NO.	SCHEMATIC LOCATION	Machine Location (white callouts)
Horn Relay	FO-11	I–7	10
Backup Relay	FO-11	I–7	10
Steering Flip Flop Relay	FO-11	I–7	10
Blackout Switch Relay	FO-11	J–7	10
Suspension Relay	FO-11	J–7	10
Throttle Position Sensor	FO-13	A–11	13
Kneeling Switch	FO-13	B–11	1
Winch Enable Switch	FO-13	C–11	1
Self-Deploy/Earthmoving Switch	FO-13	C–11	1
Panel Lamp	FO-13	A–12	1
Start-Aid Switch	FO-13	A–12	1
Start-Aid Lamp	FO-13	B-12	1
Horn Off Switch	FO-13	B–12	1
Winch Control Switch	FO-13	C–12	1
Work Lamp Switch	FO-13	C–12	1
Panel Lamp	FO-13	C–12	1
SINCGAR Radio	FO-13	A–13	11
Front Wiper Switch	FO-13	A–13	1
Turn/Hazard Horn Switch	FO-13	B–14	1
Blackout Lamp Switch	FO-13	C–14	1
Starter Switch	FO-13	A–12	1
Flasher	FO-15	G–10	10
Dimmer Resistor	FO-15	G–10	10
Service Brake Switch	FO-15	G–12	12
Solenoid Drivers	FO-15	J–14	10
Engine Control Module	FO-17	A–20	14
Engine Oil Press Switch	FO-17	C–20	14
Hydraulic Temp Switch	FO-17	C–19	15
Transmission Oil Temp Sensor	FO-17	C–19	16
Coolant Temperature Sensor	FO-17	D–19	17
Engine Oil Pressure Sensor	FO-17	D–19	14
Top Dead Center Service Probe	FO-17	B-20	14
Crank-without-inject Plugs	FO-17	C-20	20
Charge Switch	FO-17	C–20	20
A/C Pressure Switch	FO-17	C–20	21
A/C Clutch Solenoid	FO-17	D–20	21
ARC Suppressor	FO-17	D–20	14
Blade Lock Solenoid	FO-17	D–20	22
Steering Solenoid	FO-17	D–20	18
Top Speed Timing Sensor	FO-17	B–21	14
Bottom Speed Timing Sensor	FO-17	B–21	14
Inlet Air Temperature Sensor	FO-17	C–21	14
Injectors #1-6	FO-17	D–22	14
Suspension R/D Solenoids	FO-17	A–23	23
L/H Belt Tension Pressure Switch	FO-17	A–23	23







COMPONENT LOCATION			
COMPONENT	SHEET NO.	SCHEMATIC LOCATION	Machine Location (white callouts)
Oil Temperature Sensor	FO-17	B-23	14
Injection Pressure Actuation Sol.	FO-17	B–23	14
Coolant Temperature Sensor	FO-17	B–23	14
Injection Actuation Pressure Sens.	FO-17	B–23	14
Boost Pressure Sensor	FO-17	C–23	14
Park Brake Switch	FO-19	H–19	13
Park Brake Lamp	FO-19	H–19	13
Charge Solenoid	FO-19	F-21	24
Winch In/Out Solenoid	FO-19	F–21	24
Kneeling Solenoid	FO-19	F–21	24
Park Brake Release Solenoid	FO-19	G–21	24
Low Brake Pressure Switch	FO-19	G–21	24
Blackout Relay	FO-19	H–21	10
Recoil Alert Switch	FO-19	I-17	43
Circuit Breakers CB7-9, CB11-16	FO-19	I–21	10
Transmission Switch	FO-19	F–23	30
P2 Pressure Switch	FO-19	F–23	30
Transmission Upshift Solenoid	FO-19	F–23	30
Transmission Downshift Solenoid	FO-19	F–23	30
Torque Converter Lockup Solenoid	FO-19	F–23	31
Transmission Speed Sensor	FO-19	G–23	30
Fuel Level Sender	FO-19	G–23	32
Eng. Coolant Heater Switch/Lamp	FO-19	H–23	13
Remote Throttle Lamp	FO-19	H–23	13
Panel Lamp	FO-19	H–22	13
Remote Throttle Switch	FO-19	H–22	13
Engine Diagnostic Switch	FO-19	I–23	13
Hydraulic Temperature Lamp	FO-19	I–22	13
R/H Belt Tension Pressure Switch	FO-19	I–23	23
Suspension Lock Solenoids	FO-19	J–23	23
Blower A/C Switch	FO-19	H–18	13
Start Relay	FO-21	A–27	13
ARC Suppressor	FO-21	B–27	13
Engine Coolant Heater	FO-21	C–27	26
Power Buss Bars (Fuel Tank)	FO-21	A–28, 29	25
Power Buss Bars	FO-21	B,C-30	25
Main Power Relay	FO-21	A-29	25
Air Intake Heater Relay	FO-21	B–29	14
Start-Aid Relay	FO-21	B–29	14
Alternator	FO-21	D–28	21
Starter Motor	FO-21	D-29	27
Air Intake Heater	FO-21	C–29	14
Circuit Breakers CB1-CB6	FO-21	A,B,C–30	25
Disconnect Switch	FO-21	A–30	25

COMPONENT LOCATION			
COMPONENT	SHEET NO.	SCHEMATIC LOCATION	Machine Location (white callouts)
Batteries	FO-21	B–30	28
Auxiliary Start Receptacle (NATO)	FO-21	C–31	29
Wiring Gp and Battery (Optional)	FO-21	B-31	40
Blower Motor	FO-21	D-28	33
A/C Thermostat Switch	FO-21	E-28	33
A/C Resistor	FO-21	E–28	33
L/H Stop/Tail/Turn/Lamp	FO-21	D–30	35
L/H Blackout Tail Lamp	FO-21	D–30	35
Backup Alarm	FO-21	E–30	35
L/H Rear Flood Lamp	FO-21	E–30	35
R/H Blackout Tail Lamp	FO-23	F–30	36
R/H/Stop/Tail/Turn/Lamp	FO-23	G–30	36
Start Aid Solenoid	FO-23	H–30	37
ARC Suppressor	FO-23	H–30	37
Transmission Control	FO-23	H–29	34
R/H Rear Flood Lamp	FO-23	F–30	36
Engine Diagnostic Plug	FO-23	G–29	13
Transmission Diagnostic Plug	FO-23	G–28	13
Transmission Check Switch	FO-23	H–27	13
Transmission Scroll Switch	FO-23	H–27	13
Panel Lamp	FO-23	H–27	13
Thermal Cut Out Switch	FO-25	A-34	26
Partial Load Resistor	FO-25	A-36	26
Temperature Sensor	FO-25	A-37	26
Glow Plug	FO-25	A-37	26
Series Resistor	FO-25	A-38	26
Flame Sensor	FO-25	A-38	26
Coolant Pump	FO-25	B-35	26
Blower	FO-25	B-38	26
Main Circuit Breaker	FO-25	C-38	26
Heater Control Unit	FO-25	D-36	26
Fuel Pump	FO-25	D-37	26
ARC Suppressor	FO-19	G–17	9
Horn Recoil	FO-19	G-17	9
Panel Lamp Recoil	FO-19	G-17	9

1 / AA — FO SHEET NUMBER / WIRE GROUP

1 — LOCATION ON MACHINE

SYMBOLS

ABBREV	COLOR
RD	RED
WH	WHITE
OR	ORANGE
YL	YELLOW
PK	PINK
BK	BLACK
GY	GRAY
PU	PURPLE
BR	BROWN
GN	GREEN
BU	BLUE

SYMBOL	DESCRIPTION
°	BLADE, SPADE, RING, OR SCREW TERMINAL
•	CIRCUIT CONNECTED
+	CIRCUIT NOT CONNECTED
⏚	ELECTRICAL CONNECTION TO VEHICLE STRUCTURE
	INTERNAL ELECTRICAL CONNECTION TO SURFACE OF COMPONENT CONNECTOR
→)—	CONNECTOR
—	WIRE, CABLE, COMPONENT
L#	CIRCUIT GROUPING DESIGNATION NUMBER

IDENT	PART NO. HARNESS AS.	CHG	DESCRIPTION	NOTE
A	139-3847	03	TRANSMISSION CTRL	
C	139-3839	04	FRONT LIGHTS	
E	139-3846	00	RH CONSOLE	
F	139-3845	00	FRONT CONSOLE	
G	139-3848	00	CIRCUIT BREAKERS	
H	139-3840	00	MAIN	
J	139-3842	00	POWER BOX	
K	139-3843	00	REAR LIGHTS - RH	
L	158-2236	00	ENGINE	
M	118-5044	00	A/C	
N	139-3841	00	ENGINE POWER	
P	139-3844	00	REAR LIGHTS - LH	
R	143-9953	00	POWER	
T	120-9288	01	TRANSMISSION SWITCH	
	WIRE AS. CABLE AS.			
AA	130-2784	00	ALTERNATOR	
CC	139-5516	00	BATTERY - RD	
EE	139-5517	00	BATTERY - BK	
HH	4P-1826	02	AIH POWER	

UNLESS OTHERWISE SPECIFIED: ALL WIRE IS 16 GAGE

UNLESS OTHERWISE SPECIFIED: ALL WIRES IN A SPLICE ARE THE SAME IDENT. NUMBER, COLOR, AND 16 GAGE.
COMPONENTS ARE SHOWN INSTALLED ON A FULLY OPERABLE MACHINE WITH THE KEY AND ENGINE OFF AND TRANSMISSION SHIFTER IN NEUTRAL.

NOTE A: NORMALLY OPEN BEFORE REFRIGERANT CHARGE

NOTE B: ATA LINK WIRES G792-BU AND G793-YL ARE TWISTED ONCE PER INCH

NOTE C: CAT DATA LINK WIRES 944-OR AND 945-BR ARE TO BE TWISTED PAIR, TWIST 1 TURN PER25

NOTE D: TO OPERATE IN THE CRANK W/OINJECT MODE. INSERT CONNECTOR C281 INTO C251A.

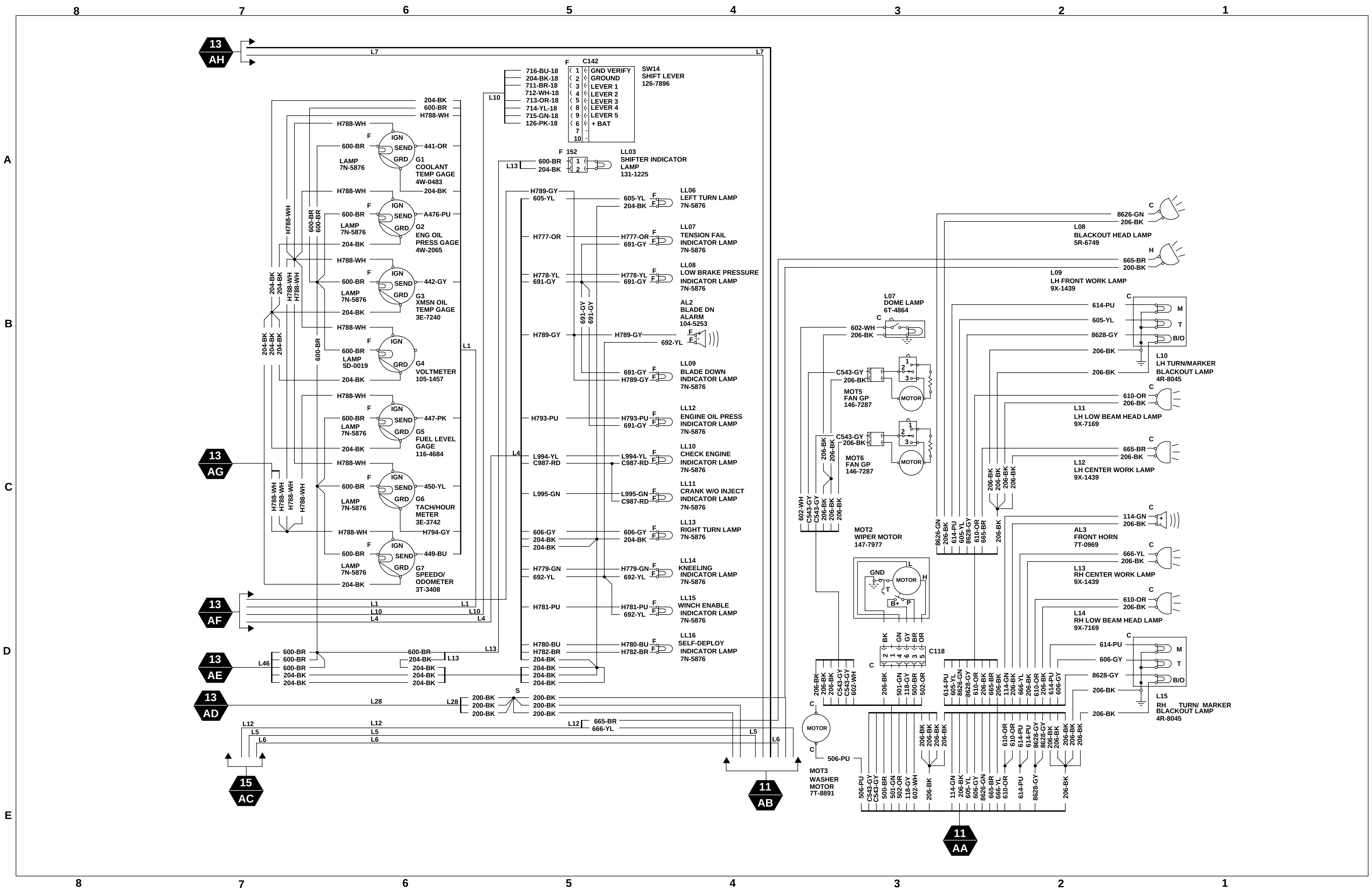
NOTE E: CAB GND TERMINALS A, B & C. ALL CONNECTTO CAB GROUND STUD.

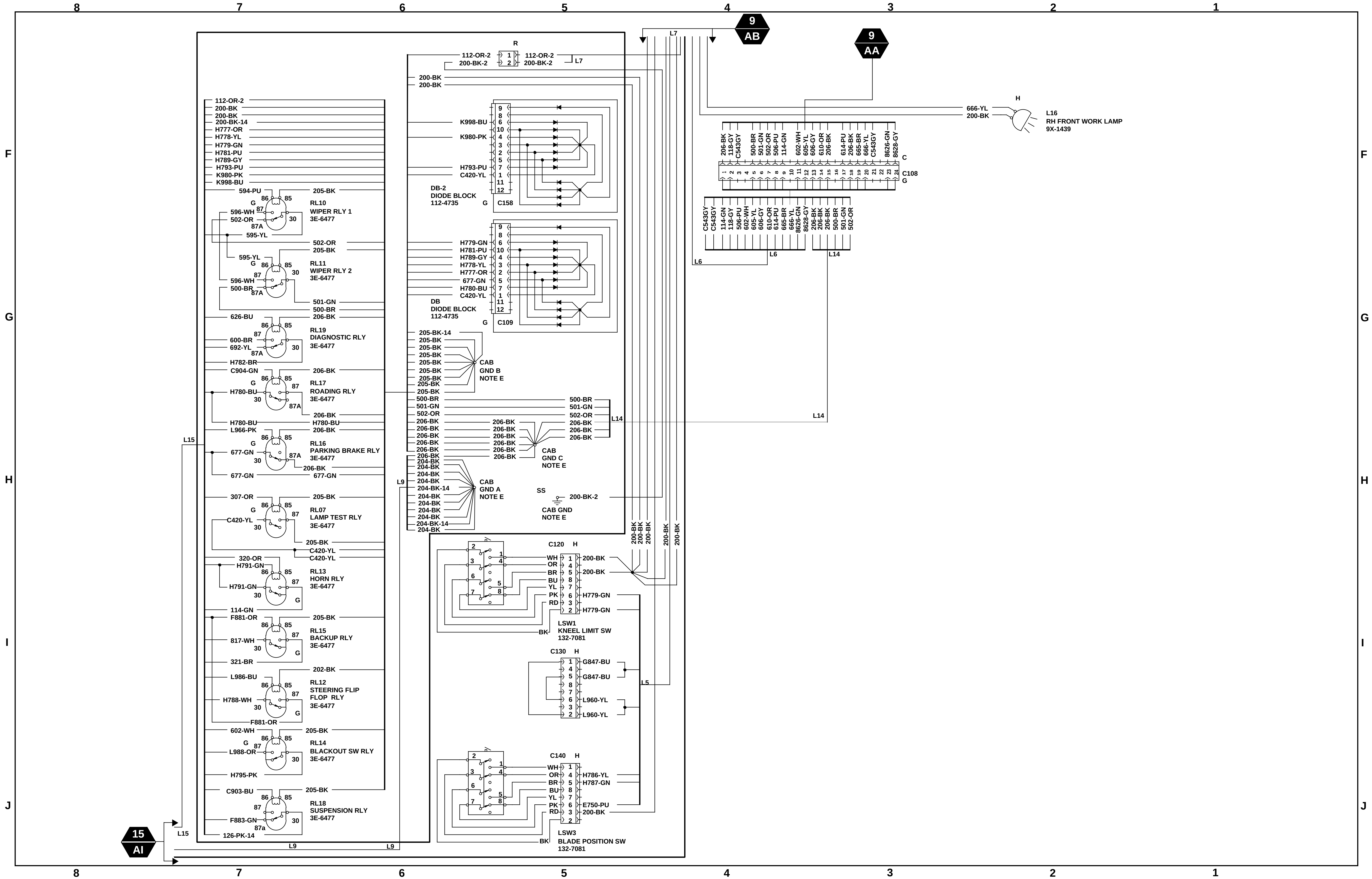
NOTE F: SPARE WIRES FOR CAB FAN

NOTE G: SPARE WIRES FOR SECOND HORN

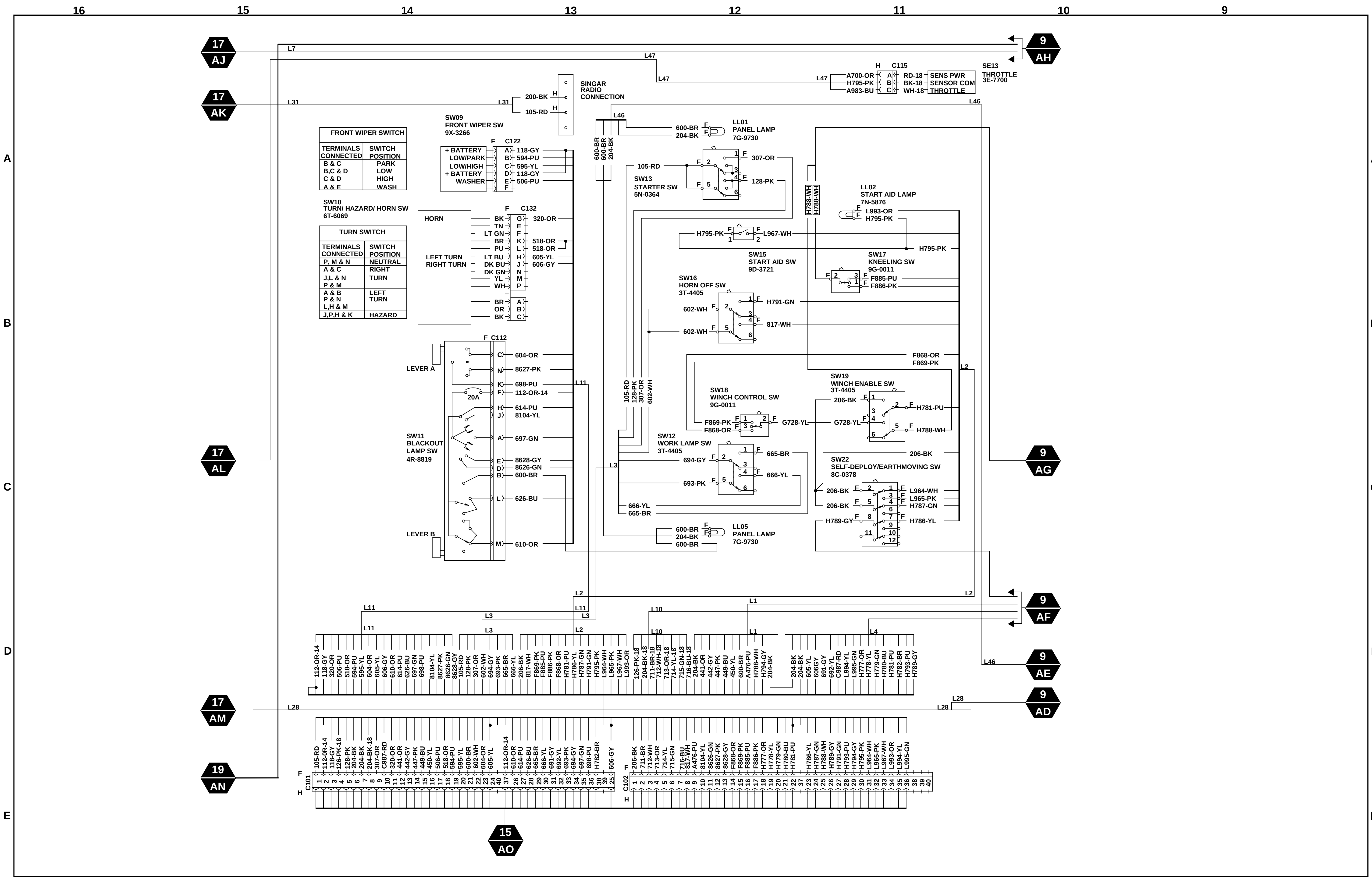
NOTE H: SPARE WIRES

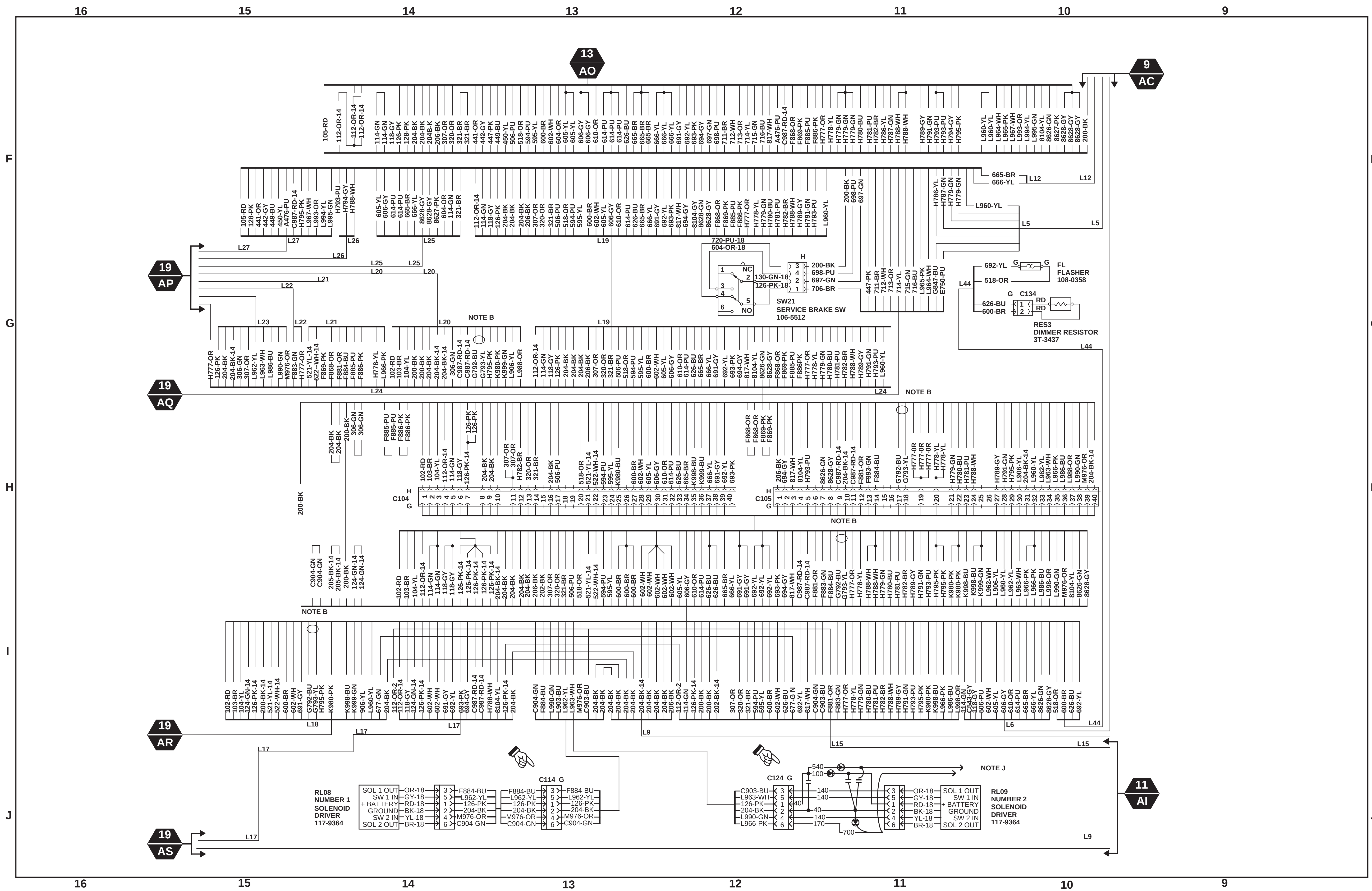
NOTE J: CONNECTION OF HARNESS. LOCATION (J-12) WIRES 966 AND 126 WILL CONNECT AS SHOWN AT LOCATION (H-19)

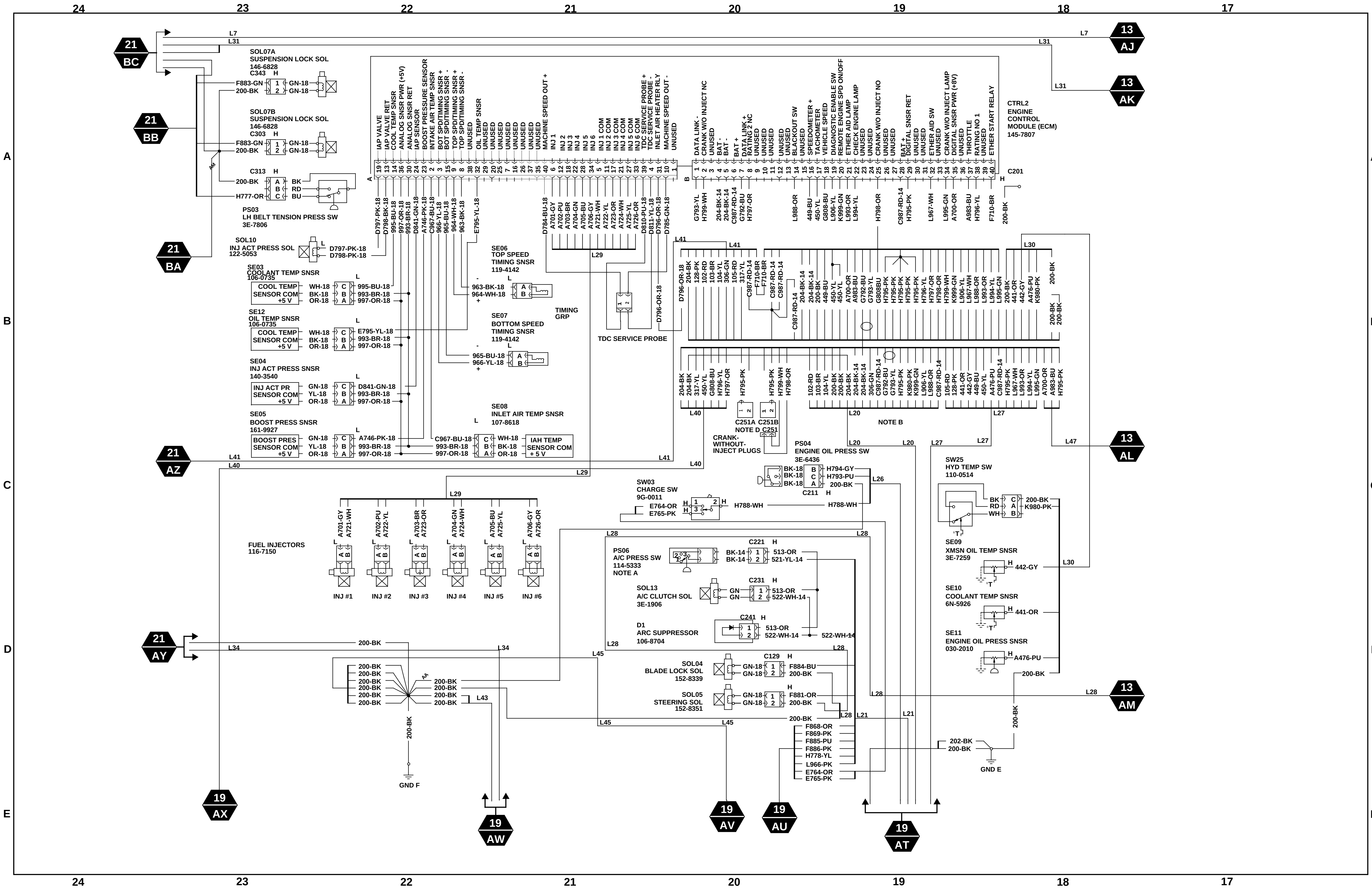

SW14
SHIFT LEVER
126-7896
C142
GND VERIFY
GROUND
LEVER 1
LEVER 2
LEVER 3
LEVER 4
LEVER 5
+ BAT
G1
COOLANT
TEMP GAGE
4W-0483
G2
ENG OIL
PRESS GAGE
4W-2065
G3
XMSN OIL
TEMP GAGE
3E-7240
G4
VOLTMETER
105-1457
G5
FUEL LEVEL
GAGE
116-4684
G6
TACH/HOUR
METER
3E-3742
G7
SPEEDO/
ODOMETER
3T-3408
LL03
SHIFTER INDICATOR
LAMP
131-1225
LL06
LEFT TURN LAMP
7N-5876
LL07
TENSION FAIL
INDICATOR LAMP
7N-5876
LL08
LOW BRAKE PRESSURE
INDICATOR LAMP
7N-5876
AL2
BLADE DN
ALARM
104-5253
LL09
BLADE DOWN
INDICATOR LAMP
7N-5876
LL12
ENGINE OIL PRESS
INDICATOR LAMP
7N-5876
LL10
CHECK ENGINE
INDICATOR LAMP
7N-5876
LL11
CRANK W/O INJECT
INDICATOR LAMP
7N-5876
LL13
RIGHT TURN LAMP
7N-5876
LL14
KNEELING
INDICATOR LAMP
7N-5876
LL15
WINCH ENABLE
INDICATOR LAMP
7N-5876
LL16
SELF-DEPLOY
INDICATOR LAMP
7N-5876
L07
DOME LAMP
6T-4864
MOT5
FAN GP
146-7287
MOT6
FAN GP
146-7287
MOT2
WIPER MOTOR
147-7977
MOT3
WASHER
MOTOR
7T-8891
C118
L08
BLACKOUT HEAD LAMP
5R-6749
L09
LH FRONT WORK LAMP
9X-1439
L10
LH TURN/MARKER
BLACKOUT LAMP
4R-8045
L11
LH LOW BEAM HEAD LAMP
9X-7169
L12
LH CENTER WORK LAMP
9X-1439
AL3
FRONT HORN
7T-0969
L13
RH CENTER WORK LAMP
9X-1439
L14
RH LOW BEAM HEAD LAMP
9X-7169
L15
RH TURN/ MARKER
BLACKOUT LAMP
4R-8045
13 AH
13 AG
13 AF
13 AE
13 AD
15 AC
11 AB
11 AA

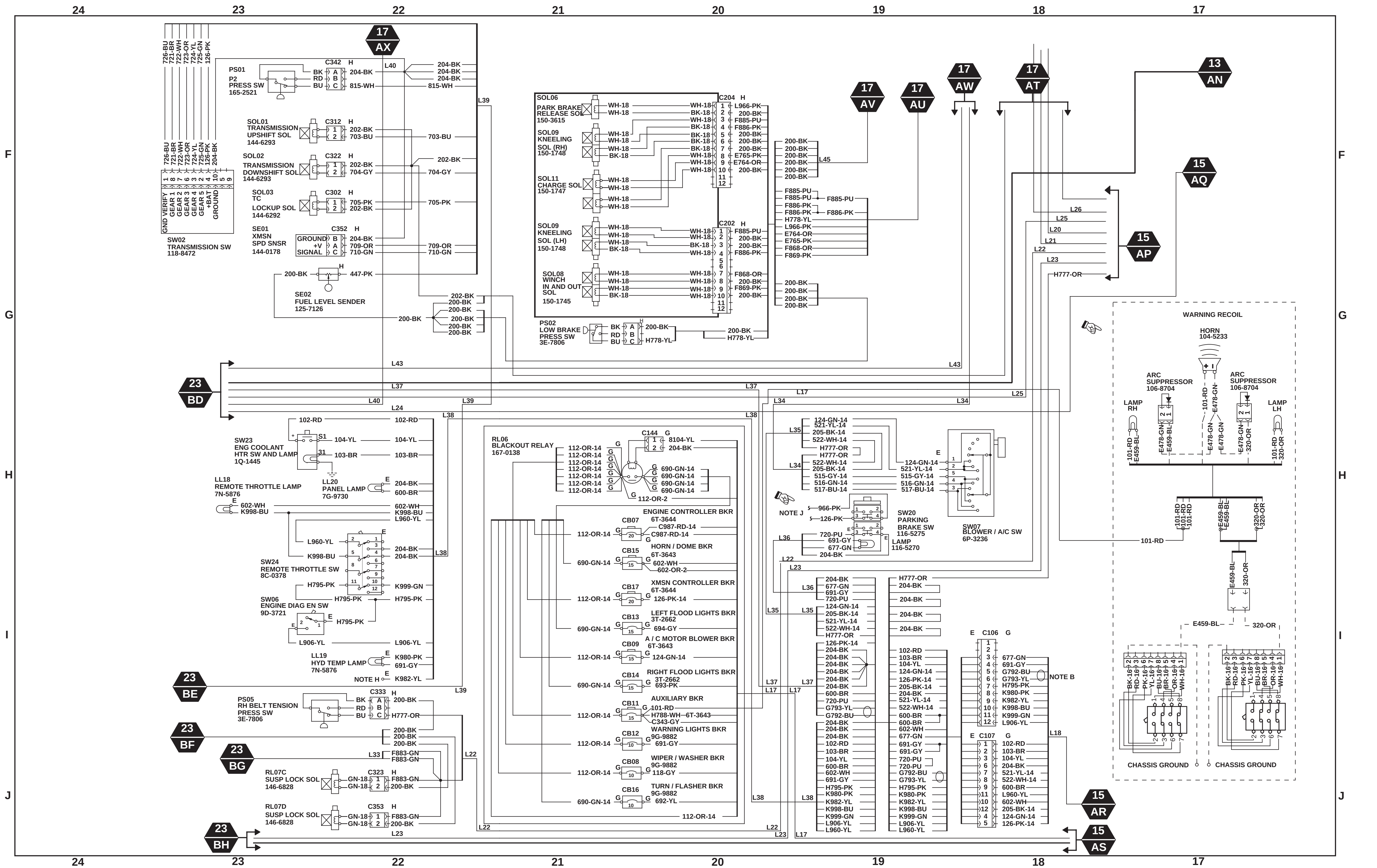


L16
RH FRONT WORK LAMP
9X-1439
DB-2
DIODE BLOCK
112-4735
DB
DIODE BLOCK
112-4735
RL10
WIPER RLY 1
3E-6477
RL11
WIPER RLY 2
3E-6477
RL19
DIAGNOSTIC RLY
3E-6477
RL17
ROADING RLY
3E-6477
RL16
PARKING BRAKE RLY
3E-6477
RL07
LAMP TEST RLY
3E-6477
RL13
HORN RLY
3E-6477
RL15
BACKUP RLY
3E-6477
RL12
STEERING FLIP
FLOP RLY
3E-6477
RL14
BLACKOUT SW RLY
3E-6477
RL18
SUSPENSION RLY
3E-6477
CAB
GND B
NOTE E
CAB
GND C
NOTE E
CAB
GND A
NOTE E
CAB GND
NOTE E
LSW1
KNEEL LIMIT SW
132-7081
LSW3
BLADE POSITION SW
132-7081
C158
C109
C108
C120
C130
C140

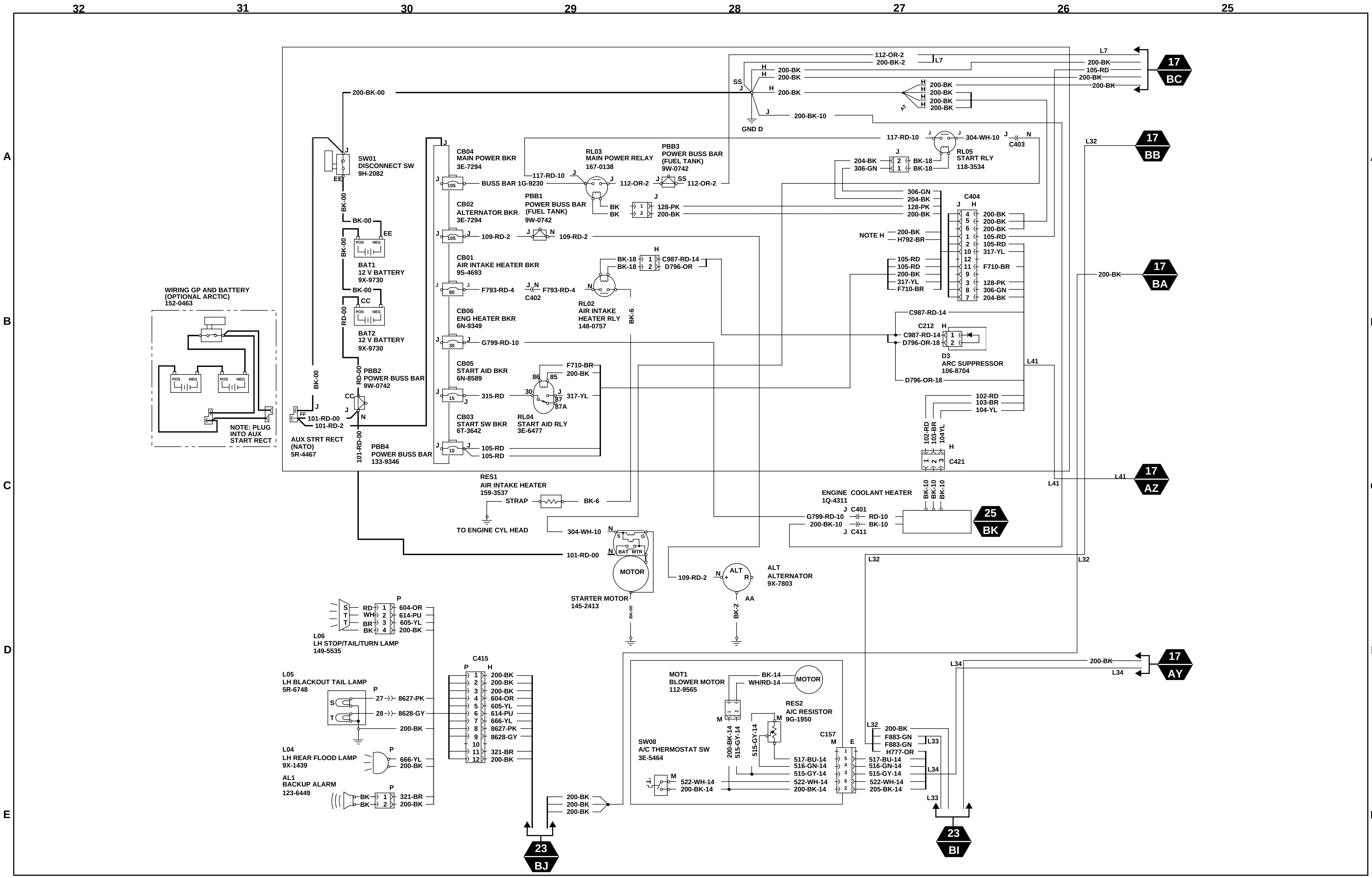

FRONT WIPER SWITCH
SW09
FRONT WIPER SW
9X-3266
SW10
TURN/ HAZARD/ HORN SW
6T-6069
TURN SWITCH
SW11
BLACKOUT
LAMP SW
4R-8819
SW13
STARTER SW
5N-0364
SW15
START AID SW
9D-3721
SW16
HORN OFF SW
3T-4405
SW18
WINCH CONTROL SW
9G-0011
SW12
WORK LAMP SW
3T-4405
SW17
KNEELING SW
9G-0011
SW19
WINCH ENABLE SW
3T-4405
SW22
SELF-DEPLOY/EARTHMOVING SW
8C-0378
LL01
PANEL LAMP
7G-9730
LL02
START AID LAMP
7N-5876
LL05
PANEL LAMP
7G-9730
SE13
THROTTLE
3E-7700
SINGAR
RADIO
CONNECTION
C101
C102
C112
C115
C122
C132


AO
AC
AP
AQ
AR
AS
AI
SW21
SERVICE BRAKE SW
106-5512
FL
FLASHER
108-0358
RES3
DIMMER RESISTOR
3T-3437
C104
C105
C114
C124
C134
NOTE B
NOTE J
RL08
NUMBER 1
SOLENOID
DRIVER
117-9364
RL09
NUMBER 2
SOLENOID
DRIVER
117-9364
SOL 1 OUT
SW 1 IN
+ BATTERY
GROUND
SW 2 IN
SOL 2 OUT

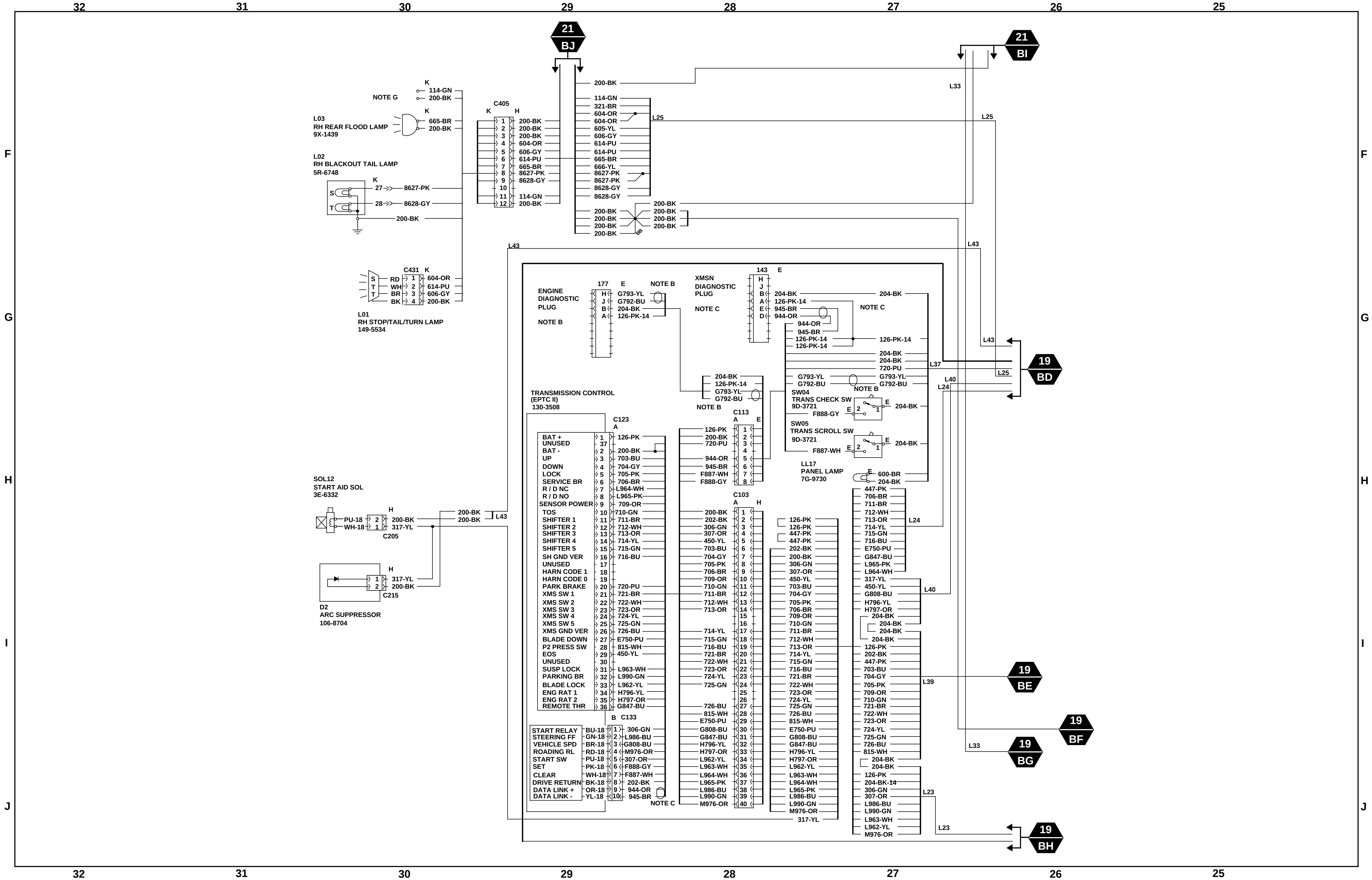

CTRL2
ENGINE
CONTROL
MODULE (ECM)
145-7807
C201
SOL07A
SUSPENSION LOCK SOL
146-6828
C343
SOL07B
SUSPENSION LOCK SOL
146-6828
C303
C313
PS03
LH BELT TENSION PRESS SW
3E-7806
SOL10
INJ ACT PRESS SOL
122-5053
SE03
COOLANT TEMP SNSR
106-0735
SE12
OIL TEMP SNSR
106-0735
SE04
INJ ACT PRESS SNSR
140-3540
SE05
BOOST PRESS SNSR
161-9927
SE06
TOP SPEED
TIMING SNSR
119-4142
SE07
BOTTOM SPEED
TIMING SNSR
119-4142
TIMING
GRP
TDC SERVICE PROBE
SE08
INLET AIR TEMP SNSR
107-8618
FUEL INJECTORS
116-7150
INJ #1
INJ #2
INJ #3
INJ #4
INJ #5
INJ #6
C251A
C251B
NOTE D
C251
CRANK-
WITHOUT-
INJECT PLUGS
NOTE B
PS04
ENGINE OIL PRESS SW
3E-6436
C211
SW03
CHARGE SW
9G-0011
SW25
HYD TEMP SW
110-0514
PS06
A/C PRESS SW
114-5333
NOTE A
C221
SOL13
A/C CLUTCH SOL
3E-1906
C231
D1
ARC SUPPRESSOR
106-8704
C241
SOL04
BLADE LOCK SOL
152-8339
C129
SOL05
STEERING SOL
152-8351
SE09
XMSN OIL TEMP SNSR
3E-7259
SE10
COOLANT TEMP SNSR
6N-5926
SE11
ENGINE OIL PRESS SNSR
030-2010
GND F
GND E



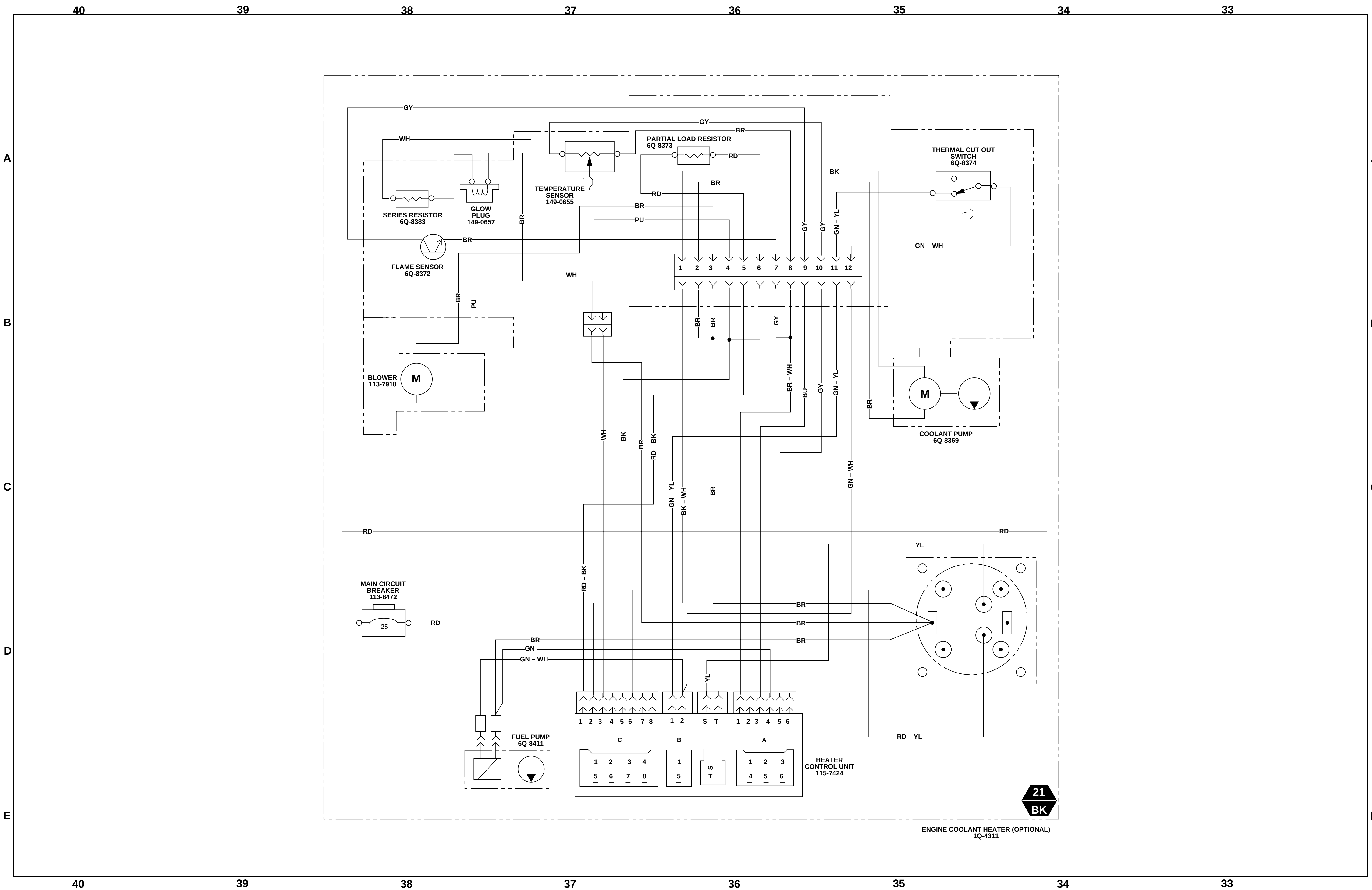
PS01 P2 PRESS SW 165-2521
SOL01 TRANSMISSION UPSHIFT SOL 144-6293
SOL02 TRANSMISSION DOWNSHIFT SOL 144-6293
SOL03 TC LOCKUP SOL 144-6292
SE01 XMSN SPD SNSR 144-0178
SE02 FUEL LEVEL SENDER 125-7126
SW02 TRANSMISSION SW 118-8472
SOL06 PARK BRAKE RELEASE SOL 150-3615
SOL09 KNEELING SOL (RH) 150-1748
SOL11 CHARGE SOL 150-1747
SOL09 KNEELING SOL (LH) 150-1748
SOL08 WINCH IN AND OUT SOL 150-1745
PS02 LOW BRAKE PRESS SW 3E-7806
SW23 ENG COOLANT HTR SW AND LAMP 1Q-1445
LL18 REMOTE THROTTLE LAMP 7N-5876
LL20 PANEL LAMP 7G-9730
SW24 REMOTE THROTTLE SW 8C-0378
SW06 ENGINE DIAG EN SW 9D-3721
LL19 HYD TEMP LAMP 7N-5876
NOTE H
PS05 RH BELT TENSION PRESS SW 3E-7806
RL07C SUSP LOCK SOL 146-6828
RL07D SUSP LOCK SOL 146-6828
RL06 BLACKOUT RELAY 167-0138
ENGINE CONTROLLER BKR
HORN / DOME BKR
XMSN CONTROLLER BKR
LEFT FLOOD LIGHTS BKR
A / C MOTOR BLOWER BKR
RIGHT FLOOD LIGHTS BKR
AUXILIARY BKR
WARNING LIGHTS BKR
WIPER / WASHER BKR
TURN / FLASHER BKR
NOTE J
SW20 PARKING BRAKE SW 116-5275
LAMP 116-5270
SW07 BLOWER / A/C SW 6P-3236
NOTE B
WARNING RECOIL
HORN 104-5233
ARC SUPPRESSOR 106-8704
LAMP RH
LAMP LH
CHASSIS GROUND



SW01
DISCONNECT SW
9H-2082
BAT1
12 V BATTERY
9X-9730
BAT2
12 V BATTERY
9X-9730
PBB2
POWER BUSS BAR
9W-0742
PBB4
POWER BUSS BAR
133-9346
AUX STRT RECT
(NATO)
5R-4467
WIRING GP AND BATTERY
(OPTIONAL ARCTIC)
152-0463
NOTE: PLUG
INTO AUX
START RECT
CB04
MAIN POWER BKR
3E-7294
BUSS BAR 1G-9230
CB02
ALTERNATOR BKR
3E-7294
CB01
AIR INTAKE HEATER BKR
9S-4693
CB06
ENG HEATER BKR
6N-9349
CB05
START AID BKR
6N-8589
CB03
START SW BKR
6T-3642
RL03
MAIN POWER RELAY
167-0138
PBB3
POWER BUSS BAR
(FUEL TANK)
9W-0742
PBB1
POWER BUSS BAR
(FUEL TANK)
9W-0742
RL02
AIR INTAKE
HEATER RLY
148-0757
RL04
START AID RLY
3E-6477
RL05
START RLY
118-3534
GND D
C404
NOTE H
C212
D3
ARC SUPPRESSOR
106-8704
C421
RES1
AIR INTAKE HEATER
159-3537
STRAP
TO ENGINE CYL HEAD
STARTER MOTOR
145-2413
ALT
ALTERNATOR
9X-7803
ENGINE COOLANT HEATER
1Q-4311
C401
C411
L06
LH STOP/TAIL/TURN LAMP
149-5535
L05
LH BLACKOUT TAIL LAMP
5R-6748
L04
LH REAR FLOOD LAMP
9X-1439
AL1
BACKUP ALARM
123-6449
C415
MOT1
BLOWER MOTOR
112-9565
RES2
A/C RESISTOR
9G-1950
SW08
A/C THERMOSTAT SW
3E-5464
C157
17 BC
17 BB
17 BA
17 AZ
17 AY
25 BK
23 BJ
23 BI



21 BJ
21 BI
19 BD
19 BE
19 BF
19 BG
19 BH
NOTE G
L03
RH REAR FLOOD LAMP
9X-1439
L02
RH BLACKOUT TAIL LAMP
5R-6748
C405
C431
L01
RH STOP/TAIL/TURN LAMP
149-5534
ENGINE
DIAGNOSTIC
PLUG
NOTE B
XMSN
DIAGNOSTIC
PLUG
NOTE C
TRANSMISSION CONTROL
(EPTC II)
130-3508
C123
C113
C103
C133
SW04
TRANS CHECK SW
9D-3721
SW05
TRANS SCROLL SW
9D-3721
LL17
PANEL LAMP
7G-9730
SOL12
START AID SOL
3E-6332
C205
C215
D2
ARC SUPPRESSOR
106-8704
BAT +
UNUSED
BAT -
UP
DOWN
LOCK
SERVICE BR
R / D NC
R / D NO
SENSOR POWER
TOS
SHIFTER 1
SHIFTER 2
SHIFTER 3
SHIFTER 4
SHIFTER 5
SH GND VER
UNUSED
HARN CODE 1
HARN CODE 0
PARK BRAKE
XMS SW 1
XMS SW 2
XMS SW 3
XMS SW 4
XMS SW 5
XMS GND VER
BLADE DOWN
P2 PRESS SW
EOS
UNUSED
SUSP LOCK
PARKING BR
BLADE LOCK
ENG RAT 1
ENG RAT 2
REMOTE THR
START RELAY
STEERING FF
VEHICLE SPD
ROADING RL
START SW
SET
CLEAR
DRIVE RETURN
DATA LINK +
DATA LINK -



40
39
38
37
36
35
34
33
A
B
C
D
E
SERIES RESISTOR
6Q-8383
GLOW
PLUG
149-0657
TEMPERATURE
SENSOR
149-0655
PARTIAL LOAD RESISTOR
6Q-8373
THERMAL CUT OUT
SWITCH
6Q-8374
FLAME SENSOR
6Q-8372
BLOWER
113-7918
COOLANT PUMP
6Q-8369
MAIN CIRCUIT
BREAKER
113-8472
FUEL PUMP
6Q-8411
HEATER
CONTROL UNIT
115-7424
21
BK
ENGINE COOLANT HEATER (OPTIONAL)
1Q-4311

By Order of the Secretary of the Army:

ERIC K. SHINSEKI
General, United States Army
Chief of Staff

Official:

JOEL B. HUDSON
Administrative Assistant to the
Secretary of the Army

9920210

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PART I – ALL PUBLICATIONS (EXCEPT RPSTL AND SC/SM) AND BLANK FORMS

PUBLICATION/FORM NUMBER	DATE	Title
TM 5-2430-200-24	01 Mar 0	Maintenance Manual for Deployable Universal Combat Eathmover (DEUCE)

ITEM NO.	PAGE NO.	PARA-GRAPH	LINE NO. *	FIGURE NO.	TABLE NO.	RECOMMENDED CHANGES AND REASON (Provide exact wording of recommended changes, if possible).
						SAMPLE

*Reference to line numbers within the paragraph or subparagraph.

TYPED NAME, GRADE OR TITLE	TELEPHONE EXCHANGE/AUTOVON, PLUS EXTENSION	Signature
Your Name		*Your Signature*

TO: (Forward direct to addressee listed in publication)	FROM: (Activity and location) (Include ZIP Code)	DATE
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PUBLICATION NUMBER	DATE	TITLE
TM 5-2430-200-24	01 Mar 01	Maintenance Manual for Deployable Universal Combat Earthmover (DEUCE)

PAGE NO.	COLM NO.	LINE NO.	NATIONAL STOCK NUMBER	REFERENCE NO.	FIGURE NO.	ITEM NO.	TOTAL NO. OF MAJOR ITEMS SUPPORTED	RECOMMENDED ACTION

SAMPLE

PART III – REMARKS **(Any general remarks or recommendations, or suggestions for improvement of publications and blank forms. Additional blank sheets may be used if more space is needed.)**

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THE METRIC SYSTEM AND EQUIVALENTS

LINEAR MEASURE

1 Centimeter = 10 Millimeters = 0.01 Meters = 0.3937 Inches
1 Meter = 100 Centimeters = 1000 Millimeters = 39.37 Inches
1 Kilometer = 1000 Meters = 0.621 Miles

SQUARE MEASURE

1 Sq Centimeter = 100 Sq Millimeters = 0.155 Sq Inches
1 Sq Meter = 10,000 Sq Centimeters = 10.76 Sq Feet
1 Sq Kilometer = 1,000,000 Sq Meters = 0.386 Sq Miles

WEIGHTS

1 Gram = 0.001 Kilograms = 1000 Milligrams = 0.035 Ounces
1 Kilogram = 1000 Grams = 2.2 Lb
1 Metric Ton = 1000 Kilograms = 1 Megagram = 1.1 Short Tons

CUBIC MEASURE

1 Cu Centimeter = 1000 Cu Millimeters = 0.06 Cu Inches
1 Cu Meter = 1,000,000 Cu Centimeters = 35.31 Cu Feet

LIQUID MEASURE

1 Milliliter = 0.001 Liters = 0.0338 Fluid Ounces
1 Liter = 1000 Milliliters = 33.82 Fluid Ounces

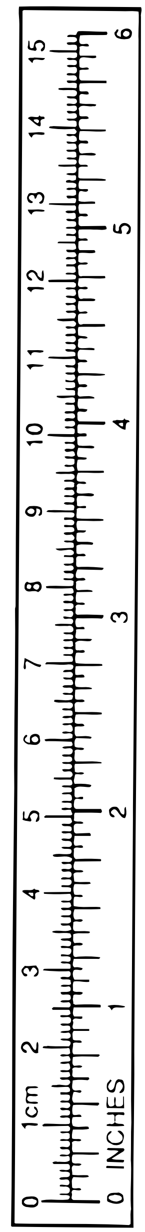
TEMPERATURE

5/9 (^{o}F – 32) = ^{o}C
212^{o} Fahrenheit is equivalent to 100^{o} Celsius
90^{o} Fahrenheit is equivalent to 32.2^{o} Celsius
32^{o} Fahrenheit is equivalent to 0^{o} Celsius
9/5 C^{o} + 32) = F^{o}

APPROXIMATE CONVERSION FACTORS

TO CHANGE	TO	MULTIPLY BY
Inches	Centimeters	2.540
Feet	Meters	0.305
Yards	Meters	0.914
Miles	Kilometers	1.609
Square Inches	Square Centimeters	6.451
Square Feet	Square Meters	0.093
Square Yards	Square Meters	0.836
Square Miles	Square Kilometers	2.590
Acres	Square Hectometers	0.405
Cubic Feet	Cubic Meters	0.028
Cubic Yards	Cubic Meters	0.765
Fluid Ounces	Milliliters	29.573
Pints	Liters	0.473
Quarts	Liters	0.946
Gallons	Liters	3.785
Ounces	Grams	28.349
Pounds	Kilograms	0.454
Short Tons	Metric Tons	0.907
Pound-Feet	Newton-Meters	1.356
Pounds per Square Inch	Kilopascals	6.895
Miles per Gallon	Kilometers per Liter	0.425
Miles per Hour	Kilometers per Hour	1.609

TO CHANGE	TO	MULTIPLY BY
Centimeters	Inches	0.394
Meters	Feet	3.280
Meters	Yards	1.094
Kilometers	Miles	0.621
Square Centimeters	Square Inches	0.155
Square Meters	Square Feet	10.764
Square Meters	Square Yards	1.196
Square Kilometers	Square Miles	0.386
Square Hectometers	Acres	2.471
Cubic Meters	Cubic Feet	35.315
Cubic Meters	Cubic Yards	1.308
Milliliters	Fluid Ounces	0.034
Liters	Pints	2.113
Liters	Quarts	1.057
Liters	Gallons	0.264
Grams	Ounces	0.035
Kilograms	Pounds	2.205
Metric Tons	Short Tons	1.102
Newton-Meters	Pound-Feet	0.738
Kilopascals	Pounds per Square Inch	0.145
Kilometers per Liter	Miles per Gallon	2.354
Kilometers per Hour	Miles per Hour	0.621



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