ARMY TM 9-2320-280-20-1
AIR FORCE TO 36A12-1A-2092-1-1
MARINE CORPS TM 2320-20/7B
Volume No. 1
(SUPERSEDES TM 9-2320-280-20-1, 19 JANUARY 1990)

TECHNICAL MANUAL
UNIT MAINTENANCE

TRUCK, UTILITY: CARGO/TROOP CARRIER, 1-1/4 TON, 4X4, M998 (2320-01-107-7155) (EIC: BBD); M998A1 (2320-01-371-9577) (EIC: BBN);

TRUCK, UTILITY: CARGO/TROOP CARRIER, 1-1/4 TON, 4X4, W/WINCH, M1038 (2320-01-107-7156) (EIC: BBE); M1038A1 (2320-01-371-9578) (EIC: BBP);

TRUCK, UTILITY: HEAVY VARIANT, 4X4, M1097 (2320-01-346-9317) (EIC:BBM); M1097A1 (2320-01-371-9583) (EIC: BBU); M1097A2 (2320-01-380-8604) (EIC: BB6); M1123 (2320-01-455-9593) (EIC: B6G);

TRUCK, UTILITY: TOW CARRIER, ARMORED, 1-1/4 TON, 4X4, M966 (2320-01-107-7153) (EIC: BBC); M966A1 (2320-01-372-3932) (EIC: BBX); M1121 (2320-01-456-1282) (EIC: B6H);

TRUCK, UTILITY: TOW CARRIER, ARMORED, 1-1/4 TON, 4X4, W/WINCH, M1036 (2320-01-107-7154) (EIC: BBH);

TRUCK, UTILITY: TOW CARRIER, W/SUPPLEMENTAL ARMOR, 1-1/4 TON, 4X4, M1045 (2320-01-146-7191); M1045A1 (2320-01-371-9580) (EIC: BBR); M1045A2 (2320-01-380-8229) (EIC: BB5);

TRUCK, UTILITY: TOW CARRIER, W/SUPPLEMENTAL ARMOR, 1-1/4 TON, 4X4, W/WINCH, M1046 (2320-01-146-7188); M1046A1 (2320-01-371-9582) (EIC: BBT);

TRUCK, UTILITY: ARMAMENT CARRIER, ARMORED, 1-1/4 TON, 4X4, M1025 (2320-01-128-9551) (EIC: BBF); M1025A1 (2320-01-371-9584) (EIC: BBV); M1025A2 (2320-01-380-8233) (EIC: BB3);

TRUCK, UTILITY: ARMAMENT CARRIER, ARMORED, 1-1/4 TON, 4X4, W/WINCH, M1026 (2320-01-128-9552) (EIC: BBG); M1026A1 (2320-01-371-9579) (EIC: BBQ);

TRUCK, UTILITY: ARMAMENT CARRIER, W/SUPPLEMENTAL ARMOR, 1-1/4 TON, 4X4, M1043 (2320-01-146-7190); M1043A1 (2320-01-372-3933) (EIC: BBY); M1043A2 (2320-01-380-8213) (EIC: BB4);

TRUCK, UTILITY: ARMAMENT CARRIER, W/SUPPLEMENTAL ARMOR, 1-1/4 TON, 4X4, W/WINCH, M1044 (2320-01-146-7189); M1044A1 (2320-01-371-9581) (EIC: BBS);

TRUCK, UTILITY: S250 SHELTER CARRIER, 4X4, M1037 (2320-01-146-7193) (EIC: BBK);

TRUCK, UTILITY: S250 SHELTER CARRIER, 4X4, W/WINCH, M1042 (2320-01-146-7187);

TRUCK, AMBULANCE, 2-LITTER, ARMORED, 4X4, M996 (2310-01-111-2275) (EIC: BBB); M996A1 (2310-01-372-3935) (EIC: BB2);

TRUCK, AMBULANCE, 4-LITTER, ARMORED, 4X4, M997 (2310-01-111-2274) (EIC: BBA); M997A1 (2310-01-372-3934) (EIC: BBZ); M997A2 (2310-01-380-8225) (EIC: BB8);

TRUCK, AMBULANCE, 2-LITTER, SOFT TOP, 4X4, M1035 (2310-01-146-7194); M1035A1 (2310-01-371-9585) (EIC: BBW); M1035A2 (2310-01-380-8290) (EIC: BB9).

HEADQUARTERS, DEPARTMENTS OF THE ARMY, THE AIR FORCE, AND MARINE CORPS

JANUARY 1996

PIN: 068172-001

WARNING

EXHAUST GASES CAN KILL

Brain damage or death can result from heavy exposure. Precautions must be followed to ensure crew safety when the personnel heater, main, or auxiliary engine of any vehicle is operated for any purpose.

1. Do not operate your vehicle engine in enclosed areas.
2. Do not idle vehicle engine with vehicle windows closed.
3. Be alert at all times for exhaust odors.
4. Be alert for exhaust poisoning symptoms. they are:
   - Headache
   - Dizziness
   - Sleepiness
   - Loss of muscular control
5. If you see another person with exhaust poisoning symptoms:
   - Remove person from area
   - Expose to open air
   - Keep person warm
   - Do not permit physical exercise
   - Administer artificial respiration, if necessary*
   - Notify a medic

   *For artificial respiration, refer to FM 21-11.
6. BE AWARE, the field protective mask for nuclear, biological or chemical (NBC) protection will not protect you from carbon monoxide poisoning.

THE BEST DEFENSE AGAINST EXHAUST POISONING IS ADEQUATE VENTILATION.

WARNING SUMMARY (Cont'd)

Ž Drycleaning solvent is flammable and will not be used near an open flame. A fire extinguisher will be kept nearby when the solvent is used. Use only in well-ventilated places. Failure to do this may result in injury to personnel and/or damage to equipment.

Ž Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

Ž Diesel fuel is highly flammable. Do not perform any procedure near fire, flames, or sparks. Severe injury or death will result.

Ž Do not touch hot exhaust system components with bare hands. Severe injury will result.

Ž Do not remove surge tank filler cap before releasing internal pressure when engine temperature is above 190°F (88°C). Steam or hot coolant under pressure will cause injury.

Ž Do not drain oil when engine is hot. Severe injury to personnel will result.

Ž Always wear eye protection when bleeding brakes. Failure to do this may cause injury if brake fluid comes in contact with eyes.

Ž Do not perform battery system checks or inspections while smoking or near fire, flames, or sparks. Batteries may explode causing damage to vehicle, injury, or death to personnel.

Ž Remove all jewelry such as rings, dog tags, bracelets, etc. If jewelry or disconnected battery ground cable contacts battery terminal, a direct short will result, causing injury to personnel, or damage to equipment.

Ž Use caution when testing thermostat. Hot water will cause burns.

Ž Negative battery cable must be disconnected before disconnecting any harness from protective control box, or serious injury to personnel or damage to equipment will result.

Ž Keep hands and arms away from fan blade and drivebelts while engine is running, or serious injury may result.

Ž Battery acid (electrolyte) is extremely harmful. Always wear safety goggles and rubber gloves, and do not smoke when performing maintenance on batteries. Injury will result if acid contacts eyes or skin.

Ž When removing battery cable clamps, disconnect ground cable first. Ensure all switches are in OFF position before disconnecting ground cable. Do not allow tools to come in contact with vehicle when disconnecting cable clamps. A direct short can result, causing instant heating of tools, tool damage, battery damage, or battery explosion.

Ž Allow transmission/transfer case to cool before performing maintenance. Failure to do this may cause injury.

Ž Always apply parking brake and chock opposite wheel before removing wheel. Avoid removing wheel when vehicle is on sloping terrain. Injury to personnel or damage to equipment may result.

Ž Gloves must be worn whenever handling winch cable. Severe injury may result.

Ž Opening one end of cargo door without ensuring opposite end is securely closed will cause both ends to open simultaneously, resulting in injury to personnel or damage to equipment.

Ž Direct all personnel to stand clear during engine hoisting operations. Failure to do this may cause injury to personnel.

Ž Hydraulic jacks are used for raising and lowering, and are not used to support vehicle. Never work under vehicle unless wheels are blocked and it is properly supported. Injury or damage to equipment may result if vehicle suddenly shifts or moves.

• Remove only the inner group of nuts when removing a wheel from the vehicle. Removing the outer nuts which hold the rim together while the assembly is inflated could result in serious injury or death.

WARNING SUMMARY (Cont'd)

- In all disassembly of the wheel assembly operations, ensure the tire is totally deflated before removing wheel nuts. Failure to follow proper safety precautions could cause serious injury or death.
- Never inflate a wheel assembly with the wheel locknuts removed in an attempt to separate inner and outer rim halves. The assembly will separate under pressure resulting in serious injury or death.
- Never use wheel assemblies with studs which are damaged, loose, or have damaged threads. Damaged studs can cause improper assembly, which could cause individual fasteners to fail. Any of these situations could cause serious injury or death.
- Never use tubes in wheel assemblies. Use of a tube defeats built-in safety features, and could allow the wheel to come apart under pressure, resulting in serious injury or death.
- Use only replacement parts specified in TM 9-2320-280-24P. Wheels assembled with components which do not meet specifications could cause the assembly to separate under pressure, resulting in serious injury or death.
- Never inflate a wheel assembly without having checked wheel locknut torques to ensure to wheel locknuts are tightened to specifications. An assembly with improperly tightened locknuts could separate under pressure resulting in serious injury or death.
- Always use a tire inflation cage for inflation purposes. Stand on one side of cage, during inflation, never directly in front. Keep hands out of the cage during inflation. Inflate assembly to recommended pressure, using a clip-on air chuck. Do not exceed 30 psi (207 kPa) cold bias tire inflation pressure or 50 psi (344 kPa) cold radial tire inflation pressure. Failure to follow these instructions may result in serious injury or death.
- Never mix radial tires and bias ply tires on the same vehicle. Injury to personnel or damage to equipment may result.
- Rear steps must be raised before disconnecting retractor lever from rear steps. Failure to do this may cause injury to personnel and damage to equipment.
- NBC contaminated filters must be handled and disposed of only by authorized and trained personnel. The unit commander or senior officer in charge of maintenance personnel must ensure that prescribed protective clothing (FM 3-4) is used, and prescribed safety measures and decontamination procedures (FM 3-5) are followed. The local unit SOP is responsible for final disposal of contaminated air filters. Failure to do this may cause severe injury to personnel.
- Seatbelta are to be replaced as a set. Failure to do this may cause injury to personnel or damage to equipment.
- The Department of Transportation requires 105 mm cannon ammunition to be in wooden boxes when transporting ammunition on public highways, by fixed wing aircraft, rail, or ship. Movement of cannon ammunition in fiber containers (inner pack) in the HMMWV ammunition rack is restricted to other than public highways.

LIST OF EFFECTIVE PAGES

NOTE: The portion of the text affected by the changes is indicated by a vertical line in the outer margins of the page.

Dates of issue for original and changed pages of volume 1 are:

Original...... 0 .. 31 January 1996
Change ...... 1 .... 30 June 1999
Volume 1 contains 914 pages

Dates of issue for original and changed pages of volume 2 are:

Original........ 0 ......31 January 1996
Change .... 1 ..14 September 1998
Change .... 2 .... 30 June 1999
Volume 2 contains 940 pages

Dates of issue for original and changed pages of volume 3 are:

Original...... 0 .. 31 January 1996
Change ...... 1 .... 30 June 1999
Volume 3 contains 1,157 pages

TOTAL NUMBER OF PAGES IN THIS PUBLICATION IS 3,011. CONSISTING OF THE FOLLOWING:

Page No.	*Change No.
VOLUME 1	
a - c	0
d Blank	0
A - E	1
F Blank	1
i - ii	1
iii	0
iv	1
v - xi	0
xii Blank	0
1-1 - 1-2	1
1-3	0
1-4 - 1-7	1
1-8 - 1-12	0
1-13 - 1-14	1
1-15 - 1-23	0
1-24	1
1-25 - 1-29	0
1-30 - 1-35	1
1-36 - 1-37	0
1-38	1
1-39 - 1-42	0
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2-2 - 2-3	1
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*Zero in this column indicates original page.

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FP-32 Blank	0

VOLUME 2

Page No.	*Change No.
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iii	0
iv Blank	0
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3-6 - 3-12	0
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4-16 - 4-19	2

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4-242 - 4-247	0
4-248 - 4-256	0
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8-87 - 8-88 Added	2
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9-2 - 9-11	0
9-12	2
9-13 - 9-14	0
9-14.1 Added	2
9-14.2 Blank	2
9-15 - 9-23	0
9-24 Blank	0
Index-1 - Index-23	2
Index-24 - Index-26 Added	2
VOLUME 3	
a - b	0
A - B	1
i - ii	1
10-1 - 10-2	1
10-3 - 10-7	0
10-8 - 10-9	1
10-10 - 10-14	0
10-14.1 Added	1
10-14.2 Blank	1
10-15	0

*Zero in this column indicates original page.

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10-35 - 10-36	0
10-37 - 10-38	1
10-39 - 10-45	0
10-46	1
10-47 - 10-56	0
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10-57	1
10-58 - 10-80	0
10-80.1 - 10-80.2 Added	1
10-81	1
10-82	0
10-82.1 - 10-82.2 Added	1
10-83	1
10-84 - 10-92	0
10-93	1
10-94 - 10-110	0
10-111 - 10-112	1
10-113 - 10-114	0
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10-175 - 10-176	1
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11-4	1
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11-51 - 11-68	0
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Page No.	*Change No.
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12-110 - 12-111	1
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B-1 - B-3	0
B-4 - B-27	1
B-28 Blank	0
C-1	0
C-2 - C-7	1

*Zero in this column indicates original page.

LIST OF EFFECTIVE PAGES (Contd)

*Zero in this column indicates original page.

CHANGE

NO. 1

HEADQUARTERS
DEPARTMENTS OF THE ARMY,
THE AIR FORCE, AND MARINE CORPS
Washington, D.C., ***30 JUNE 1999***

TECHNICAL MANUAL
VOLUME 1 OF 3
UNIT MAINTENANCE

TRUCK, UTILITY: CARGO/TROOP CARRIER, 1-1/4 TON, 4X4,
M998 (2320-01-107-7155) (EIC: BBD); M998A1 (2320-01-371-9577) (EIC: BBN);

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M1046 (2320-01-146-7188); M1046A1 (2320-01-371-9582) (EIC: BBT);

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M1025 (2320-01-128-9551) (EIC: BBF); M1025A1 (2320-01-371-9584) (EIC: BBV); M1025A2 (2320-01-380-8233) (EIC: BB3);

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TRUCK, UTILITY: ARMAMENT CARRIER, W/SUPPLEMENTAL ARMOR, 1-1/4 TON, 4X4, W/WINCH,
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TRUCK, UTILITY: S250 SHELTER CARRIER, 4X4, M1037 (2320-01-146-7193) (EIC: BBK);

TRUCK, UTILITY: S250 SHELTER CARRIER, 4X4, W/WINCH, M1042 (2320-01-146-7187);

TRUCK, AMBULANCE, 2-LITTER, ARMORED, 4X4, M996 (2310-01-111-2275) (EIC: BBB); M996A1 (2310-01-372-3935) (EIC: BB2);

TRUCK, AMBULANCE, 4-LITTER, ARMORED, 4X4, M997 (2310-01-111-2274) (EIC: BBA);
M997A1 (2310-01-372-3934) (EIC: BBZ); M997A2 (2310-01-380-8225) (EIC: BB8);

TRUCK, AMBULANCE, 2-LITTER, SOFT TOP, 4X4,
M1035 (2310-01-146-7194); M1035A1 (2310-01-371-9585) (EIC: BBW); M1035A2 (2310-01-380-8290) (EIC: BB9).

TM 9-2320-280-20-1, 31 January 1996, is changed as follows:

1. Two new models have been added to the front cover. The new cover, located at the end of the change package, replaces the existing cover.
2. Remove old pages and insert new pages as indicated below.
3. New or changed material is indicated by a vertical bar in the margin of the page.

Remove pages	Insert page
None	A through E/(F blank)
i through iv	i through iv
1-1 through 1-8	1-1 through 1-8
1-13 and 1-14	1-13 and 1-14
1-23 and 1-24	1-23 and 1-24
1-29 through 1-38	1-29 through 1-38
None	1-42.1 through 1-42.3/(1-42.4 blank)
1-51 and 1-52	1-51 and 1-52
1-55 through 1-58	1-55 through 1-58

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Remove pages	Insert pages
2-1 through 2-34	2-1 through 2-34
2-67 and 2-68	2-67 and 2-68
2-77 through 2-82	2-77 through 2-82
2-105 through 2-108	2-105 through 2-108
2-145 through 2-148	2-145 through 2-148
2-155 and 2-156	2-155 and 2-156
2-159 and 2-160	2-159 and 2-160
2-169 and 2-170	2-169 and 2-170
2-173 through 2-178	2-173 through 2-178
2-193 through 2-210	2-193 through 2-210
2-213 and 2-214	2-213 and 2-214
2-217 through 2-249/(2-250 blank)	2-217 through 2-249/(2-250 blank)
2-261 through 2-268	2-261 through 2-268
2-271 and 2-272	2-271 and 2-272
2-275 through 2-284	2-275 through 2-284
2-289 through 2-304	2-289 through 2-304
2-311 and 2-312	2-311 and 2-312
None	2-318.1 through 2-318.15/(2-318.16 blank)
2-331 through 2-344	2-331 through 2-344
2-401 through 2-404	2-401 through 2-404
2-427 through 2-430	2-427 through 2-430
2-437 and 2-438	2-437 and 2-438
2-445 and 2-446	2-445 and 2-446
2-449 and 2-450	2-449 and 2-450
2-469 and 2-470	2-469 and 2-470
2-473 and 2-474	2-473 and 2-474
2-477/(2-478 blank) through 2-480	2-477/(2-478 blank) through 2-480
2-761 and 2-762	2-761 and 2-762
Index 1 through Index 3	Index 1 through Index 3/(Index 4 blank)
cover	cover

4. File this change sheet in front of the publication for reference purposes.

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General, United States Army
Chief of Staff

Official:

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Secretary of the Army
05690

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ARMY TM 9-2320-280-20-1
AIR FORCE TO 36A12-1A-2092-1-1
MARINE CORPS TM 2320-20/7B

TECHNICAL MANUAL
NO. 9-2320-280-20-1
NO. 2320-20/7B

HEADQUARTERS
DEPARTMENTS OF THE ARMY,
THE AIR FORCE, AND MARINE CORPS
Washington, D.C., *31 JANUARY 1996*

TECHNICAL ORDER
NO. 36A12-1A-2092-1-1

TECHNICAL MANUAL

VOLUME 1 OF 3

UNIT MAINTENANCE

TRUCK, UTILITY: CARGO/TROOP CARRIER, 1-1/4 TON, 4X4, M998 (2320-01-107-7155) (EIC: BBD);
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REPORTING OF 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 2028-2 (Recommended Changes to Equipment Technical Publications), through the Internet, on the Army Electronic Product Support (AEPS) website. The Internet address is http://aeps.ria.army.mil. If you need a password, scroll down and click on "ACCESS REQUEST FORM." The DA Form 2028 is located in the ONLINE FORMS PROCESSING section of the AEPS. 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 email your letter, DA Form 2028, or DA Form 2028-2 direct to: Commander, U.S. Army Tank-automotive and Armaments Command, ATTN: AMSTA-LC-CIP-WT, Rock Island, IL 61299-7630. The email address is amsta-ac-nml@ria.army.mil. The fax number is DSN 793-0726 or Commercial (309) 782-0726. (Marine Corps) Submit NAVMC 10772 to the Commanding General (826), MCLB, 814 Radford Blvd., Albany, GA 31704-1128.

This manual is published in three parts. TM 9-2320-280-20-1 contains chapters 1 and 2, TM 9-2320-280-20-2 contains chapters 3 through 9, and TM 9-2320-280-20-3 contains chapters 10 through 13 and appendices A through G.

This manual contains a table of contents for all three volumes 1, 2, and 3 and alphabetical index for chapters 1 and 2.

*This publication supersedes TM 9-2320-280-20-1 dated 19 January 1990 and all changes.

VOLUME 1 OF 3

VOLUME 2 OF 3

HOW TO USE THIS MANUAL

ABOUT YOUR MANUAL

a. Spend some time looking through this manual. You'll find that it has a new look, different than most of the TMs you've been using. New features added to improve the convenience of this manual and increase your efficiency are:

1. Accessing Information - These include physical entry features such as the bleed-to-edge indicators on the cover and edge of the manual. Extensive troubleshooting guides for specific systems lead directly to step by step directions for problem solving and maintenance tasks.

2. Illustrations - A variety of methods are used to make locating and fixing components much easier. Locator illustrations with keyed text, exploded views, and cut-away diagrams make the information in this manual easier to understand.

3. Keying Text With Illustrations - Instructions are located together with figures that illustrate the specific task you are working on. In most cases, the task steps and figures are located side by side making part identification and procedure sequence easier to follow.

The TM is the fundamental means by which the Army communicates to soldiers the requirements and procedures necessary to perform equipment operations and maintenance. This manual describes in detail the Unit Maintenance authorized by the Maintenance Allocation Chart (appendix B) and Source, Maintenance, and Recovery (SMR) codes (TM 9-2320-280-24P).

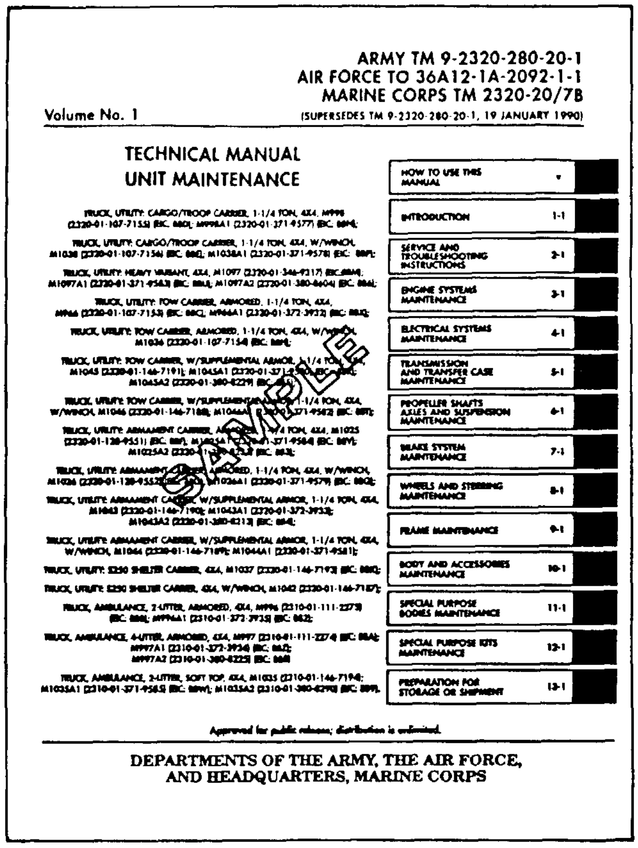
b. General Features. Your TM is the best source available for providing information and data critical to vehicle operation and maintenance:

- Safety summary (warning page a, b, and c)
- General information, equipment descriptions, and data (chapter 1)
- Principles of operation (chapter 1, section III)
- Preventive Maintenance Checks and Services – PMCS (chapter 2, section III)
- Electrical/Mechanical Systems Troubleshooting (chapter 2, section IV)
- Detailed maintenance procedures (chapters 3-12)
- General maintenance instructions (chapter 2, section II and III)
- Maintenance Allocation Chart - MAC (appendix B)
- Expendable/durable supplies and materials list (appendix C)
- Manufactured items (appendix D)
- Torque limits (appendix E)
- Wiring Diagrams and Schematic (appendix F)
- Mandatory replacement parts (appendix G)

A typical example of how to use this manual is provided on the following pages.

USING YOUR MANUAL AN EXAMPLE

a. TASK: The operator of an M998 series vehicle has complained that his TOW carrier uses too much engine oil. The vehicle has been assigned to you for repair.


ARMY TM 9-2320-280-20-1
AIR FORCE TO 36A12-1A-2092-1-1
MARINE CORPS TM 2320-20/7B
Volume No. 1
(SUPERSEDES TM 9-2320-280-20-1, 19 JANUARY 1990)

TECHNICAL MANUAL
UNIT MAINTENANCE

HOW TO USE THIS MANUAL	v
INTRODUCTION	1-1
SERVICE AND TROUBLESHOOTING INSTRUCTIONS	2-1
ENGINE SYSTEMS MAINTENANCE	3-1
ELECTRICAL SYSTEMS MAINTENANCE	4-1
TRANSMISSION AND TRANSFER CASE MAINTENANCE	5-1
PROPELLER SHAFTS AXLES AND SUSPENSION MAINTENANCE	6-1
BRAKE SYSTEM MAINTENANCE	7-1
WHEELS AND STEERING MAINTENANCE	8-1
FRAME MAINTENANCE	9-1
BODY AND ACCESSORIES MAINTENANCE	10-1
SPECIAL PURPOSE BODIES MAINTENANCE	11-1
SPECIAL PURPOSE KITS MAINTENANCE	12-1
PREPARATION FOR STORAGE OR SHIPMENT	13-1

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DEPARTMENTS OF THE ARMY, THE AIR FORCE, AND HEADQUARTERS, MARINE CORPS

b. TROUBLESHOOTING STEPS:

1. Look at the cover of this manual. You'll see chapter titles listed from top to bottom on the right-hand side.

2. Look at the right edge of the manual. On some of the pages you'll see black bars (bleed-to-edge indicators) that are alined with the chapter bars on the cover. These are the locations of the chapters in the text.

3. Look for "SERVICE AND TROUBLESHOOTING INSTRUCTIONS" in the chapter list on the cover. This is where the troubleshooting information is located.

4. Turn to those pages with the edge indicator matching the black bar for service and troubleshooting instructions. Page numbers are also listed next to chapter titles.

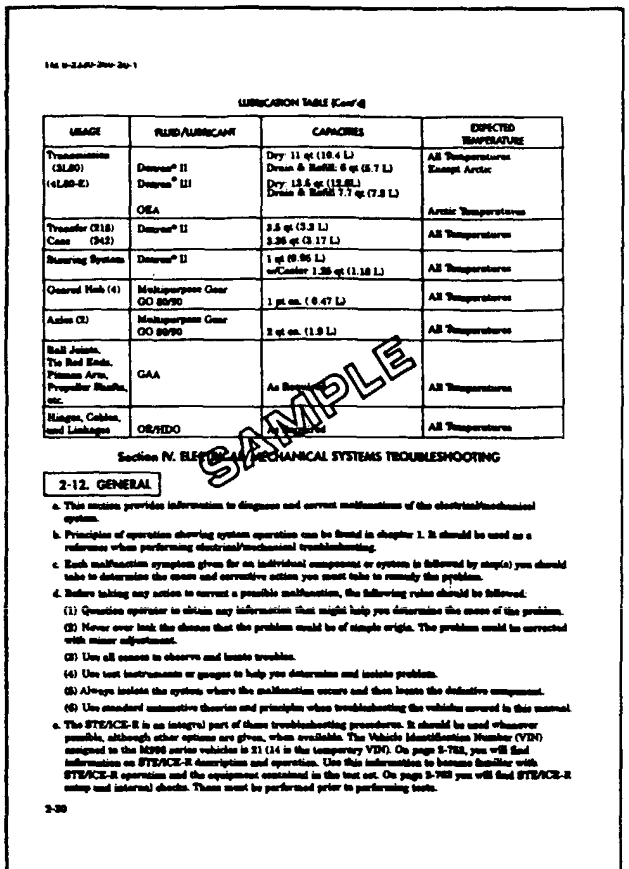
5. Chapter 2 is divided into four sections:

Section I - Repair Parts, Special Tools, TMDE, and Support Equipment

Ž Section II - Service Upon Receipt

Ž Section III – PMCS

Ž Section IV – Electrical/Mechanical Systems Troubleshooting


LUBRICATION TABLE (Cont'd)

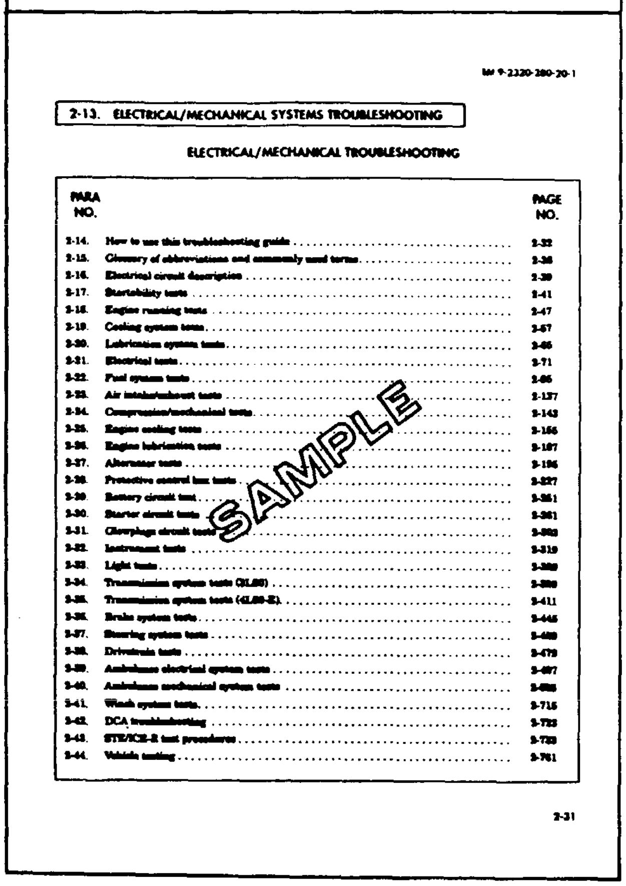
Section IV. ELECTRICAL/MECHANICAL SYSTEMS TROUBLESHOOTING

2-12. GENERAL

SAMPLE

2-30

6. Turn to section IV, "ELECTRICAL/ MECHANICAL SYSTEMS TROUBLE-SHOOTING (page 2-30).
This troubleshooting section is system-oriented and is broken down into five top level tests and twenty-one system level tests.


2-13. ELECTRICAL/MECHANICAL SYSTEMS TROUBLESHOOTING

ELECTRICAL/MECHANICAL TROUBLESHOOTING

SAMPLE

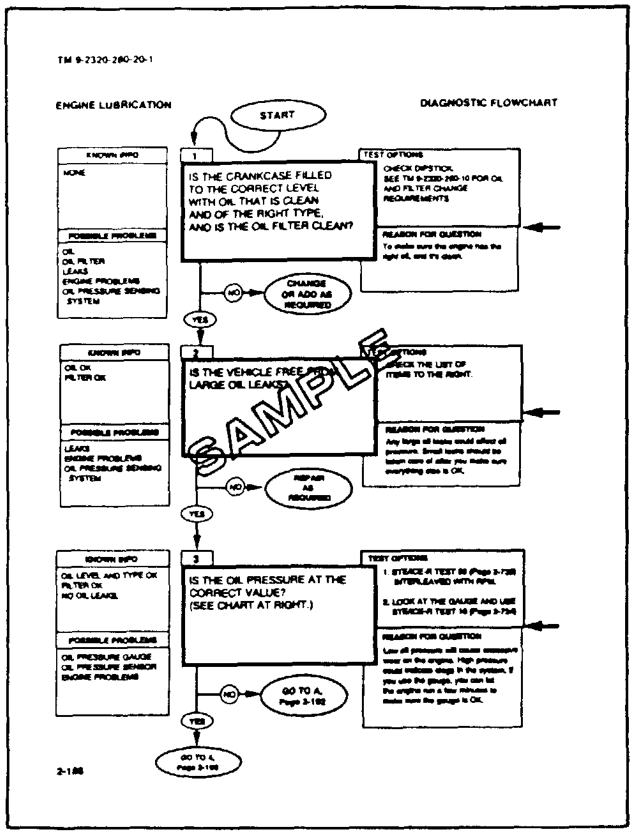
2-31

7. One of the first pages of this section is the "ELECTRICAL/MECHANICAL SYSTEM TROUBLESHOOTING" (turn to page 2-31)

8. Look down the list of symptoms until you find "ENGINE LUBRICATION TESTS". In that paragraph you will find the diagnostic flow chart that the vehicle operator can pick the test as "OIL LEAKS OR ENGINE PROBLEMS".

9. Turn to the test indicated.

10. On page 2-188, steps relating to resolving the problem of excessive oil loss are listed. Read the diagnostic flow chart until you find "OIL LEAKS OR ENGINE PROBLEMS". The tests listed are shown in the example page to the right of this text.



11. In accordance with Test 1, you checked the oil level and filter for leaks. The oil level and filter appears normal and you move on to Test 2.

12. In Test 2, you begin a methodical check of the engine lubricating system. You discover a leak in the oil cooler assembly adjacent to one of the mounting brackets. One of the welds has cracked, allowing a class III leak from a small area of the cooling fins. The oil cooler assembly must be repaired or replaced.

13. At this point, the engine lubrication diagnostic flow chart would direct you to a specific detailed procedure to solve the problem. However, the engine lubricating system is complex and you must now refer to the table of contents to locate the proper task paragraph.

NOTE: Before attempting to repair or replace the oil cooler assembly, as a Unit mechanic, you must:

a. Determine the maintenance responsibility of repair or replacement of the component.

b. If the task is at your echelon of maintenance responsibility, you must identify the tools needed and the replacement parts required.

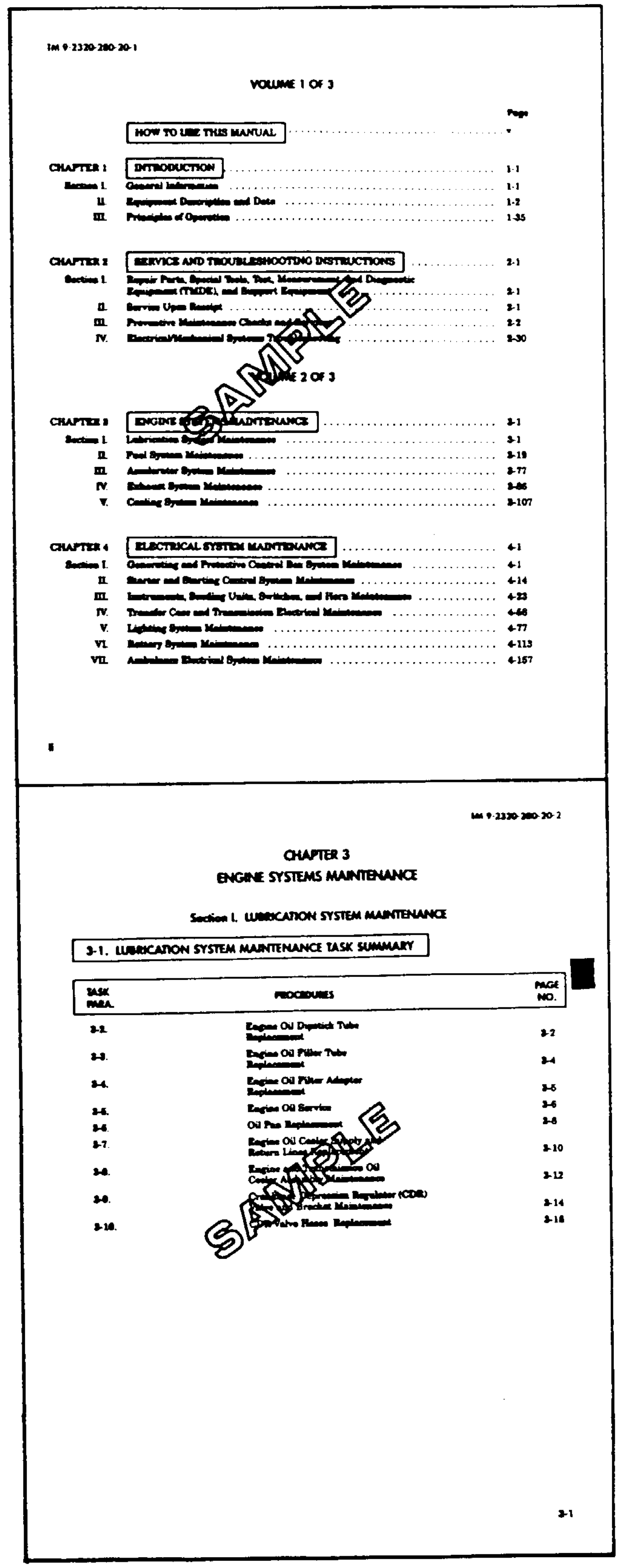
Refer to the Maintenance Allocation Chart – MAC (appendix B) to determine not only the maintenance responsibility of the item, but also to obtain an estimate of the time required to perform the task, tools needed, and any special notes/requirements necessary.

Refer to TM 9-2320-280-24P, Unit Maintenance Repair Parts and Special Tools List for M998 Series Vehicles, for requisition data concerning replacement parts for this task.

c. OIL COOLER ASSEMBLY REPLACEMENT. After reporting the results of your troubleshooting efforts to your supervisor, he decides that the most expedient means of returning the vehicle to service would be to replace the oil cooler assembly.

1. Turn to the “TABLE OF CONTENTS” and find the chapter dealing with the engine. You find it as "CHAPTER 3, ENGINE SYSTEMS MAINTENANCE”. Furthermore, you note that the chapter is divided into five sections; you are interested in "Section I. Lubrication System Maintenance”.

2. Turn to chapter 3, section I on page 3-1. Here you find the "Lubrication System Maintenance Task Summary". Read down the list of tasks until you find the one that will correct your maintenance problem. For our example, you find it as task 3-8 "Engine and Transmission Oil Cooler Assembly Maintenance". Turn to page 3-12.


TM 9-2320-280-20-1

VOLUME 1 OF 3

ii

TM 9-2320-280-20-2

CHAPTER 3

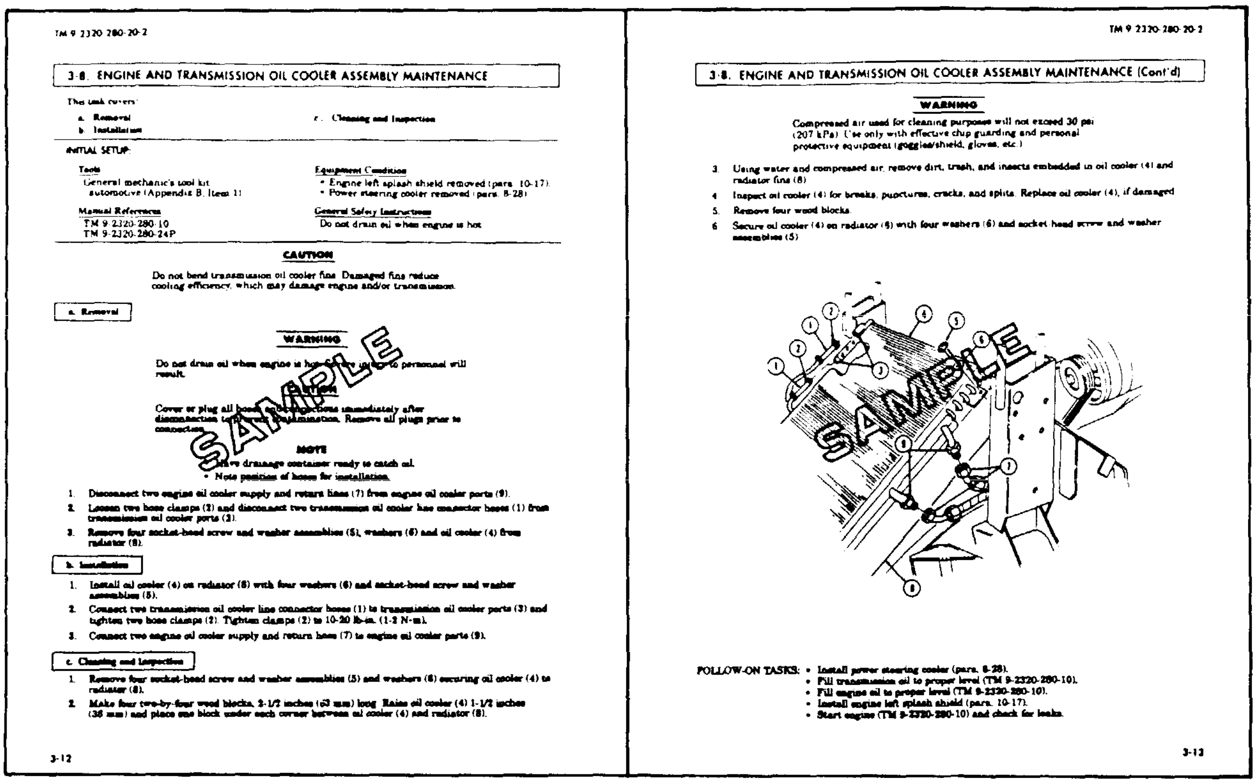
ENGINE SYSTEMS MAINTENANCE

Section I. LUBRICATION SYSTEM MAINTENANCE

3-1. LUBRICATION SYSTEM MAINTENANCE TASK SUMMARY

TASK PARA.	PROCEDURES	PAGE NO.
3-2.	Engine Oil Dipstick Tube Replacement	3-2
3-3.	Engine Oil Filler Tube Replacement	3-4
3-4.	Engine Oil Filter Adapter Replacement	3-5
3-5.	Engine Oil Service	3-6
3-6.	Oil Pan Replacement	3-8
3-7.	Engine Oil Cooler Supply and Return Lines Replacement	3-10
3-8.	Engine and Transmission Oil Cooler Assembly Maintenance	3-12
3-9.	Crankcase Depression Regulator (CDR) Valve and Bracket Maintenance	3-14
3-10.	CDR Valve Hoses Replacement	3-18

3-1


TM 9 2320-280-20-2

3-8. ENGINE AND TRANSMISSION OIL COOLER ASSEMBLY MAINTENANCE

This task covers:
a. Removal
b. Installation
c. Cleaning and Inspection

INITIAL SETUP:

Tools
General mechanic's tool kit: automotive (Appendix B, Item 1)

Equipment Condition
• Engine left splash shield removed (para. 10-17).
• Power steering cooler removed (para. 8-28).

Manual References
TM 9-2320-280-10
TM 9-2320-280-24P

General Safety Instructions
Do not drain oil when engine is hot.

CAUTION
Do not bend transmission oil cooler fins. Damaged fins reduce cooling efficiency, which may damage engine and/or transmission.

a. Removal

WARNING
Do not drain oil when engine is hot. Severe injury to personnel will result.

CAUTION
Cover or plug all hoses and connections immediately after disconnection to prevent contamination. Remove all plugs prior to connection.

NOTE
• Have drainage container ready to catch oil.
• Note position of hoses for installation.

1. Disconnect two engine oil cooler supply and return lines (7) from engine oil cooler ports (9).
2. Loosen two hose clamps (2) and disconnect two transmission oil cooler line connector hoses (1) from transmission oil cooler ports (3).
3. Remove four socket-head screw and washer assemblies (5), washers (6) and oil cooler (4) from radiator (8).

b. Installation

1. Install oil cooler (4) on radiator (8) with four washers (6) and socket-head screw and washer assemblies (5).
2. Connect two transmission oil cooler line connector hoses (1) to transmission oil cooler ports (3) and tighten two hose clamps (2). Tighten clamps (2) to 10-20 lb-in. (1-2 N·m).
3. Connect two engine oil cooler supply and return lines (7) to engine oil cooler ports (9).

c. Cleaning and Inspection

1. Remove four socket-head screw and washer assemblies (5) and washers (6) securing oil cooler (4) to radiator (8).
2. Make four two-by-four wood blocks, 2-1/2 inches (63 mm) long. Raise oil cooler (4) 1-1/2 inches (38 mm) and place one block under each corner between oil cooler (4) and radiator (8).

3-12

TM 9 2320-280-20-2

3-8. ENGINE AND TRANSMISSION OIL COOLER ASSEMBLY MAINTENANCE (Cont'd)

WARNING
Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

3. Using water and compressed air, remove dirt, trash, and insects embedded in oil cooler (4) and radiator fins (8).
4. Inspect oil cooler (4) for breaks, punctures, cracks, and splits. Replace oil cooler (4), if damaged.
5. Remove four wood blocks.
6. Secure oil cooler (4) on radiator (8) with four washers (6) and socket head screw and washer assemblies (5).

FOLLOW-ON TASKS:
• Install power steering cooler (para. 8-28).
• Fill transmission oil to proper level (TM 9-2320-280-10).
• Fill engine oil to proper level (TM 9-2320-280-10).
• Install engine left splash shield (para. 10-17).
• Start engine (TM 9-2320-280-10) and check for leaks.

3-13

3. On page 3-12 you find paragraph 3-8, the detailed procedure for replacing the oil cooler assembly.

d. DETAILED MAINTENANCE PROCEDURES. Detailed maintenance procedures include everything you must do to accomplish a basic maintenance task. Unless otherwise stated, general mechanic's automotive tool kit will be used for maintenance of this vehicle.

1. Before beginning the maintenance task, look through the procedure. You must familiarize yourself with the entire maintenance procedure of para. 3-8: "Engine and Transmission Oil Cooler Assembly Maintenance". The task includes "a. Removal" "b. Installation" and "c. Cleaning and Inspection".

2. The ten basic headings listed under "INITIAL SETUP" outline task conditions, materials, special tools, manpower requirements, and special conditions. The headings are:

- **Applicable Models:** Any models that require a particular maintenance task. If a maintenance task covers all models, then this heading will not be used.
- **Test Equipment:** Test equipment needed to complete a task. If test equipment is not required, this heading will not be used.
- **Tools** These are common tools and general mechanic tool sets required to perform maintenance tasks. These common tools should be on hand to properly perform the task. Torque wrenches are required for many tasks; the proper torque wrench should be available to tighten mounting hardware.
- **Special Tools:** Those special tools needed to complete a maintenance task. If no special tools are needed, this heading will not be used.

  If you don't have one of these special tools, requisition it (before starting the task) using the data supplied in TM 9-2320-280-24P, the repair parts and special tools list for this level of maintenance. Special tools are located in section III.
- **Materials/Parts:** This heading lists only mandatory replacement materials or parts (gaskets, O-rings, sealant, etc.). To replace other unserviceable parts, refer to TM 9-2320-280-24P for requisition data. If no mandatory replacement materials/parts are required, this heading will not be used.

- **Personnel Required:** The number of personnel needed to perform a task. If only one mechanic is needed, this heading will not be used.

NOTE

If you think that you need more help to adequately or safely complete a task, perhaps as the result of unusual conditions, etc., alert your supervisor and ask for help.

- **Manual References:** Those TMs needed to complete the task.
- **Equipment Condition:** Notes the conditions that must exist before starting the task. If none are required, this heading will not be used. For oil cooler assembly replacement, the left-hand engine splash shield should be removed before we can start the task. If not already done, follow the procedure for splash shield removal in para. 10-17, before proceeding with this task.
- **General Safety Instructions:** Summarizes all safety warnings for the maintenance task. If none are required, this heading will not be used.

3. A step by step maintenance procedure follows the "INITIAL SETUP" and gives detailed instructions for the procedure. These instructions give the part's general location and name and action performed. In the example, oil cooler assembly replacement -a. Removal, step 1 is "Disconnect engine oil cooler supply and return lines (7) from engine oil cooler ports (9)". Note that the numbers in parenthesis correspond to the part's callout number in the accompanying illustration.

NOTE

Warnings, cautions, and notes provide supplemental information:

- **Warnings**: Indicate conditions, practices, or procedures which must be observed to avoid personnel injury, loss of life, loss of life, or long-term health hazard.
- **Cautions:** Indicate condition, practices, or procedures which must be observed to avoid damage to equipment or destruction of equipment.
- **Notes:** Include essential information of special importance, interest, or aid in job performance which should be remembered and would be otherwise difficult to find or incorporate into the text.

4. At the end of a procedure, "FOLLOW-ON TASKS" will list those additional tasks that must be performed to complete the procedure. The Follow-On Tasks for oil cooler assembly replacement are:

Ž Fill oil to proper level (TM 9-2320-280-10).

Ž Install left-hand splash shield (para. 10-17).

Ž Start engine (TM 9-2320-280-10) and check for leaks.

e. Refer to the example pages for para. 3-8, Engine and Transmission Oil Cooler Assembly Maintenance, as we review the following points:

1. **Modular Text:** Both pages of text and illustrations are to be used together. This manual was designed so that the two pages would be visible at once, making part identification and procedure sequence easy to follow.
2. **Initial Setup:** Outlines task conditions.
3. **Illustrations:** An exploded diagram of the component shows part locations, attachments, and spatial relationships. Cutaway views (part of the vehicle is "erased") show the location and orientation of screws and attachments.

f. Your manual is easy to use once you understand its design. We hope it will encourage you to use your TM more often as an aid to maintenance support for M998 series vehicles.

CHAPTER 1
INTRODUCTION

Section I. GENERAL INFORMATION

1-1. SCOPE

a. This technical manual contains instructions for organizational maintenance of the 1-1/4 ton, 4X4, M998 series vehicles.

b. Models included are:

(1) M998 and M998A1, Cargo/Troop Carrier
(2) M1038 and M1038A1, Cargo/Troop Carrier, W/Winch
(3) M1097, M1097A1, M1097A2, and M1123 Heavy Variant
(4) M966, M966A1, and M1121 TOW Carrier, Armored
(5) M1036, TOW Carrier, Armored, W/Winch
(6) M1045, M1045A1, and M1045A2 TOW Carrier, W/Supplemental Armor
(7) M1046 and M1046A1, TOW Carrier, W/Supplemental Armor, W/Winch
(8) M1025, M1025A1, and M1025A2 Armament Carrier, Armored
(9) M1026 and M1026A1, Armament Carrier, Armored, W/Winch
(10) M1043, M1043A1, and M1043A2 Armament Carrier, W/Supplemental Armor
(11) M1044 and M1044A1, Armament Carrier, W/Supplemental Armor, W/Winch
(12) M1037, S250 Shelter Carrier
(13) M1042, S250 Shelter Carrier, W/Winch
(14) M996 and M996A1 2-Litter Ambulance, Armored
(15) M997, M997A1, and M997A2 4-Litter Ambulance, Armored
(16) M1035, M1035A1, and M1035A2 2-Litter Ambulance, Soft Top

1-2. MAINTENANCE FORMS, RECORDS, AND REPORTS

(Army) Department of the Army forms and procedures used for equipment maintenance will be those prescribed by DA Pam 738-750, The Army Maintenance Management System (TAMMS). (Marine Corps) Refer to TM 4700-15/1–.

1-3. DESTRUCTION OF ARMY EQUIPMENT TO PREVENT ENEMY USE

Refer to TM 750-244-6, Procedures for Destruction of Army Tank-Automotive Equipment to Prevent Enemy Use.

1-4. PREPARATION FOR STORAGE AND SHIPMENT

(Army) Refer to TM 740-90-1, Administrative Storage of Equipment and TM 746-10, Marking, Packaging and Shipment of Supplies and Equipment: General Packaging Instructions for Field Use. (Marine Corps) Refer to MCO 4450-7.

1-5. REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATIONS (EIR)

(Army) If your M998 series vehicles need improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us what you don't like about your vehicle. Let us know why you don't like the design or performance. Put it on an SF 368 (Product Quality Deficiency Report). Mail it to us at: Commander, U.S. Army Tank-automotive and Armaments Command, ATTN: AMSTA-TR-Q, Warren, Michigan 48397-5000. We'll send you a reply. (Marine Corps) Submit QDR's in accordance with MCO 4855-10.

1-6. EQUIPMENT IMPROVEMENT REPORT AND MAINTENANCE DIGEST (EIR MD)

The quarterly Equipment Improvement Report and Maintenance Digest, TB 43-0001-39 series, contains valuable field information on the equipment covered in this manual. The information in the TB 43-0001-39 series is compiled from some of the Equipment Improvement Reports that you prepared on the vehicles covered in this manual. Many of these articles resulted from comments, suggestions, and improvement recommendations that you submitted to the EIR program. The TB 43-0001-39 series contains information on equipment improvements, minor alterations, proposed Modification Work Orders (MWOs), warranties (if applicable), actions taken on some of your DA, Form 2028's (Recommended Changes to Publications), and advance information on proposed changes that may affect this manual. The information will help you in doing your job better and will help in keeping you advised of the latest changes to this manual. Also refer to DA Pam 25-30, Consolidated Index of Army Publications and Blank Forms and Appendix A, References, of this manual. For those with access to the World Wide Web (WWW), the EIR MD can be viewed through the Army Electronic Product Support. The site is http://aeps.ria.army.mil.

1-7. METRIC SYSTEM

The equipment described herein contains metric components and requires metric common and special tools; therefore, metric units in addition to standard units will be used throughout this publication. In addition, a metric conversion table is located on the inside back cover of this publication.

1-8. MANDATORY REPLACEMENT PARTS

The maintenance instructions contained herein make reference to removing and discarding piece parts such as: gaskets, lockwashers, cotter pins, O-rings, seals; etc.; these items should be considered mandatory replacement items and replaced with new parts during assembly/installation.

1-9. BREAK-IN PROCEDURE

Upon receipt of vehicles, or after engine replacement, break-in procedures must be observed during the first 500 miles (804 kilometers) of operation. For break-in procedure, refer to TM 9-2320-280-10.

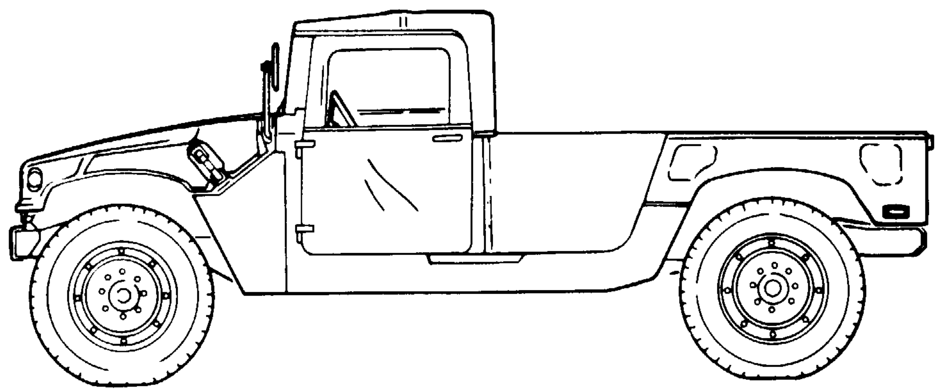
Section II. EQUIPMENT DESCRIPTION AND DATA

1-10. EQUIPMENT CHARACTERISTICS, CAPABILITIES, AND FEATURES

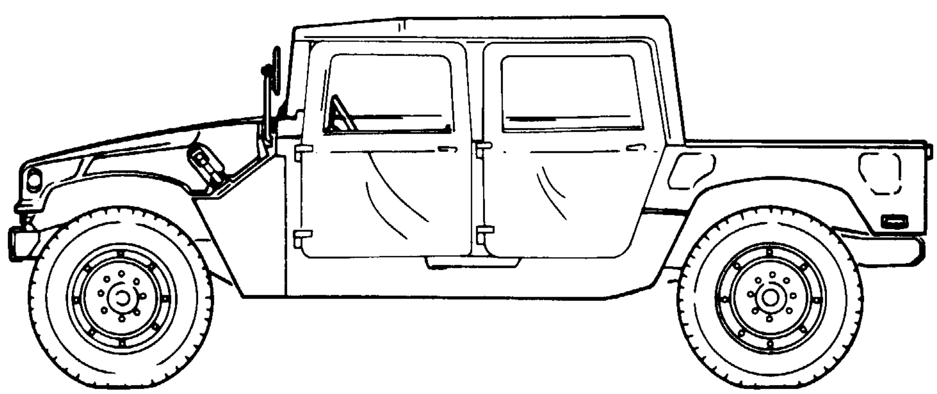
The 1-1/4 ton, 4x4, M998 series of vehicles are tactical vehicles designed for use over all types of roads, as well as cross-country terrain in all weather conditions. The vehicles have four driving wheels powered by a V-8, liquid-cooled, diesel engine. Four-wheel hydraulic service brakes and a mechanical parking brake are common to all models in the M998 series. All vehicles are equipped with a pintle hook for towing. Tiedown and lifting eyes are provided for air, rail, or sea shipment.

CARGO/TROOP CARRIERS: M998, M998A1, M1038, AND M1038A1

PURPOSE: These models are used to transport cargo and troops. The M1038 and M1038A1 models, which have a winch, can be used for recovery operations. Both models utilize a troop seat kit for troop transport operations.



M998/M998A1
(WITH 2-MAN SOFT TOP INSTALLED)



M1038/M1038A1 W/WINCH
(WITH 4-MAN SOFT TOP INSTALLED)

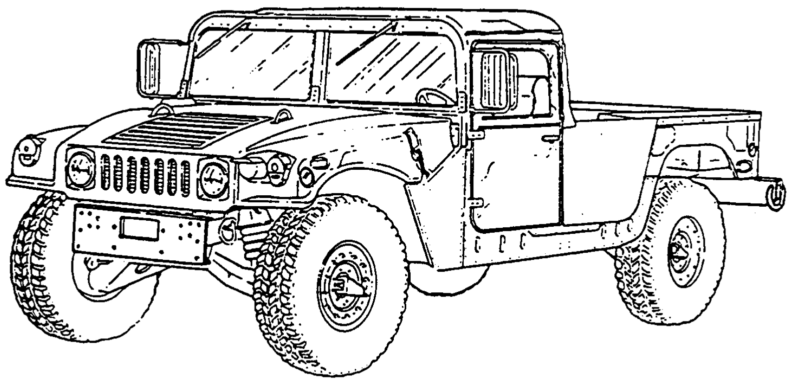
HEAVY VARIANT CARGO/TROOP CARRIERS: M1097, M1097A1, M1097A2, AND M1123

PURPOSE: This model is used for transporting equipment, materials, and/or personnel (including crew) of 4,400 pounds (1,998 kilograms). The only difference between the M998 and M998A1 cargo/troop carriers and the M1097, M1097A1, M1097A2, and M1123 heavy variant cargo/troop carriers is that the M1097, M1097A1, M1097A2, and M1123 are specifically designed to accommodate a higher payload capacity. This difference affects vehicle length, width, and shipping dimensions, but does not affect the basic purpose and performance of the vehicle. The increased payload capabilities accomodate the following kit configurations:

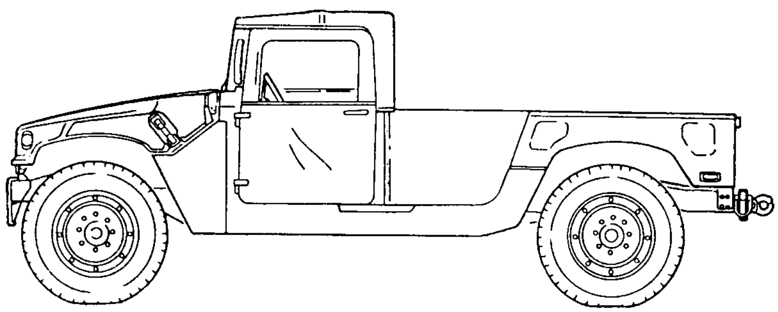
A. 105MM TOWED HOWITZER PRIME MOVER (L119 KIT) consists of:
- Larger rear bumper and reinforced mounting
- Body wiring harness trailer receptacle extension
- Ammunition stowage rack and tiedown straps
- Camouflage net stowage rack
- Winch
- Two-man crew area soft top
- Troop area soft top
- Cargo bulkhead

B. TOWED VULCAN SYSTEMS (TVS) MOVER consists of:
- Two-man crew area soft top
- Troop area soft top
- Camouflage net stowage rack
- Troop seat kit
- Cargo bulkhead

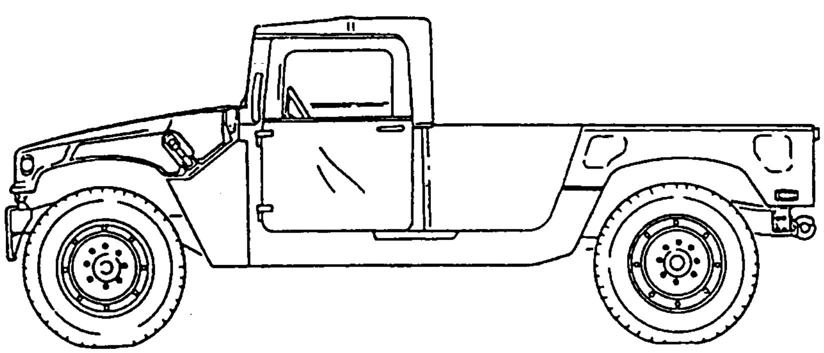
C. S250 ELECTRICAL EQUIPMENT SHELTER consists of:
- Shelter support
- Shelter tailgate
- 200 amp umbilical power cable



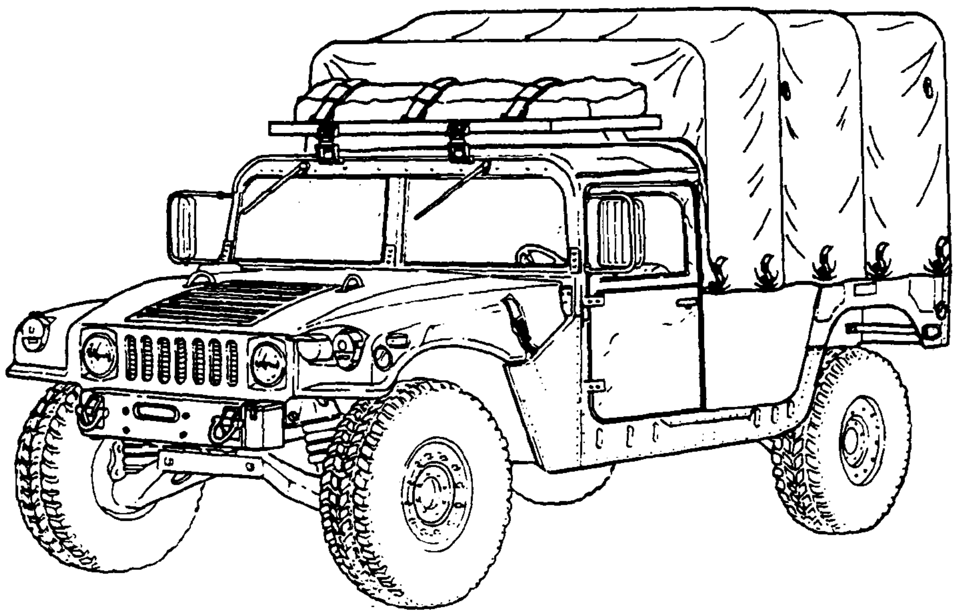
M1097/M1097A1/M1097A2/M1123
(WITH 2-MAN SOFT TOP INSTALLED)



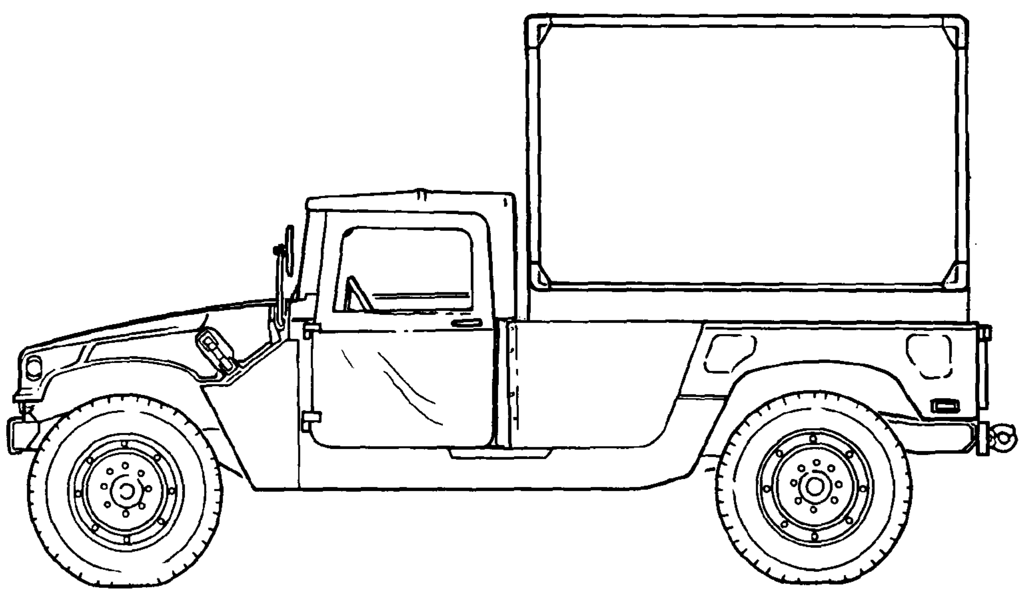
M1097A2



M1123



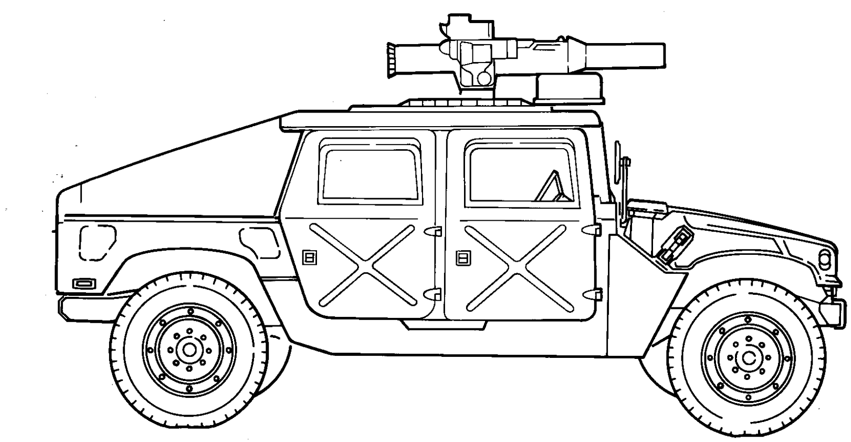
M1097/M1097A1/M1097A2/M1123
(WITH L119 KIT INSTALLED)
(WITHOUT WINCH, TOWED VULCAN SYSTEMS (TVS) MOVER)



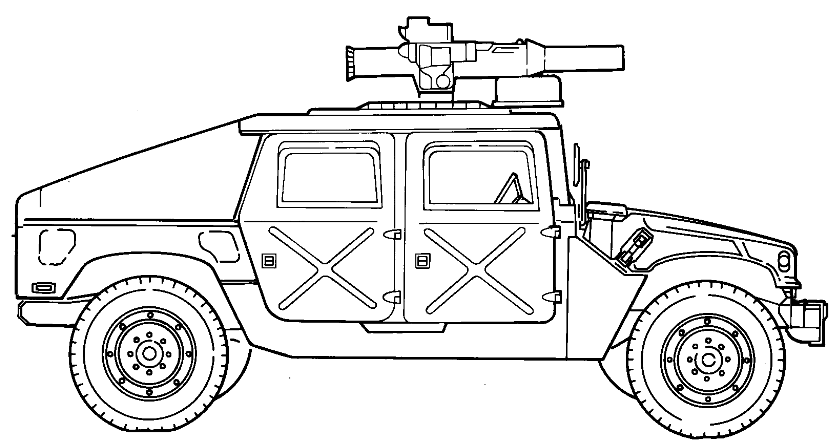
M1097/M1097A1/M1097A2/M1123
(WITH S250 SHELTER INSTALLED)

TOW CARRIERS: M966, M966A1, M1036, AND M1121

PURPOSE: These models are used to transport, mount, and operate the TOW missile launcher system with armor protection for crew, TOW system components, and ammunition. The M1036 model, which has a winch, can be used for recovery operations.



M966/M966A1/M1121

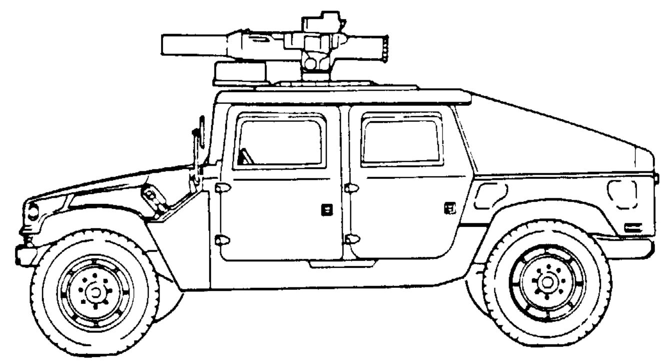


M1036 W/WINCH

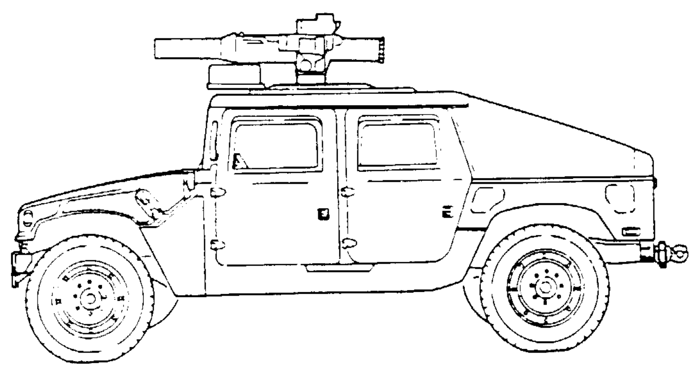
TOW CARRIERS, W/SUPPLEMENTAL ARMOR M1045, M1045A1, M1045A2, M1046, AND M1046A1

a. PURPOSE: These models are used to transport, mount, and operate the TOW missile launcher system with added ballistic protection for crew, TOW system components, and ammunition. The M1046 and M1046A1 models, which have a winch, can be used for recovery operations.

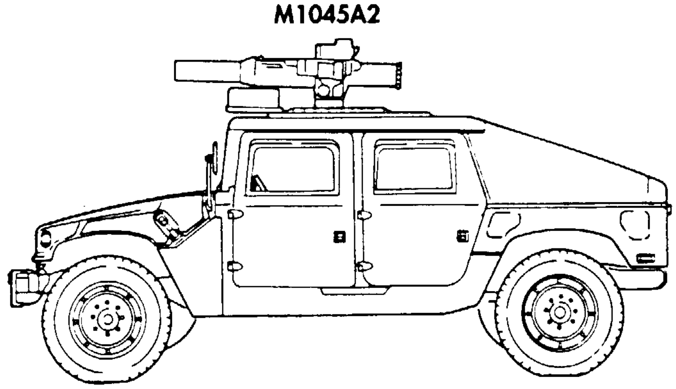
b. SPECIAL LIMITATIONS: Weapon station azimuth is limited to 300° left and right of vehicle centerline when Vehicle Power Conditioner (VPC) cables are connected. With launcher installed, elevation is limited to 20° and depression is limited to 10°.



M1045/M1045A1



M1045A2

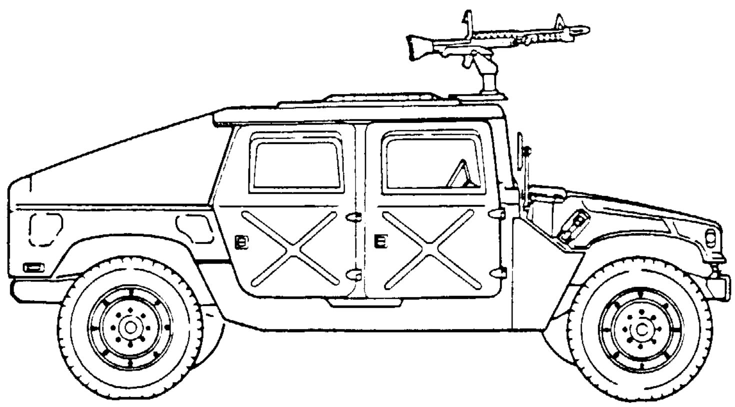


M1046/M1046A1 W/ WINCH

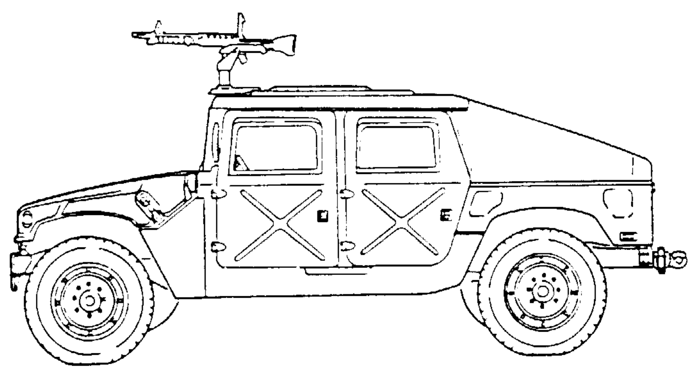
ARMAMENT CARRIERS, W/SUPPLEMENTAL ARMOR: M1025, M1025A1, M1025A2, M1026, AND M1026A1

a. PURPOSE: These models are used to transport, mount, and operate the M2 and M60 machine guns and MK19 automatic grenade launcher with armor protection for crew, weapons components, and ammunition. The M1026 and M1026A1 models, which have a winch, can be used for recovery operations.

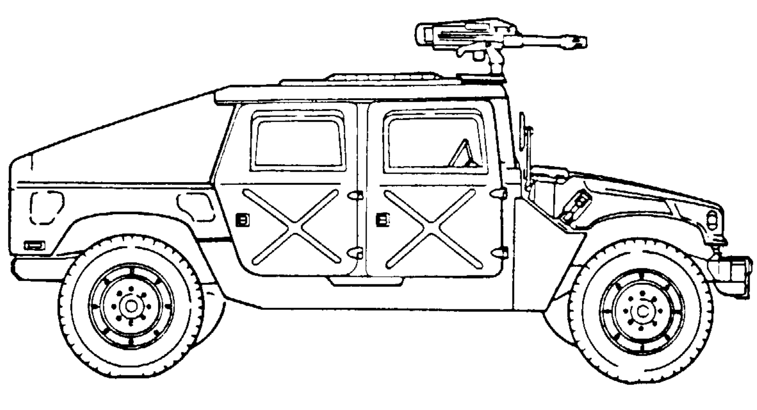
b. SPECIAL LIMITATIONS: Weapon station azimuth is limited to 300° left and right of vehicle centerline when Vehicle Power Condition (VPC) cables are connected. With launcher installed, elevation is limited to 20° and depression is limited to 10°.



M1025/M1025A1
(WITH M60, 7.62 MM MACHINE GUN MOUNTED)



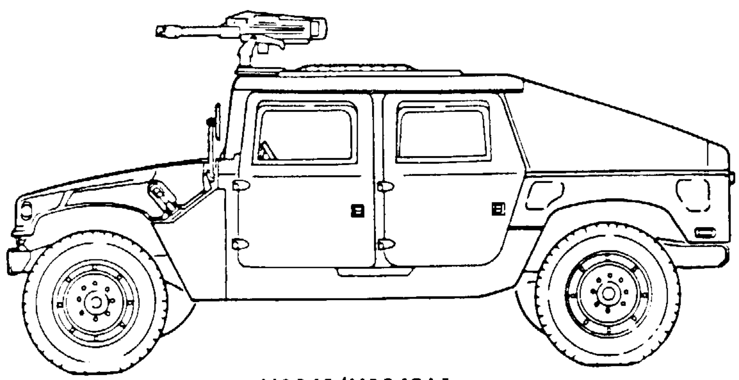
M1025A2
(WITH M60, 7.62 MM MACHINE GUN MOUNTED)



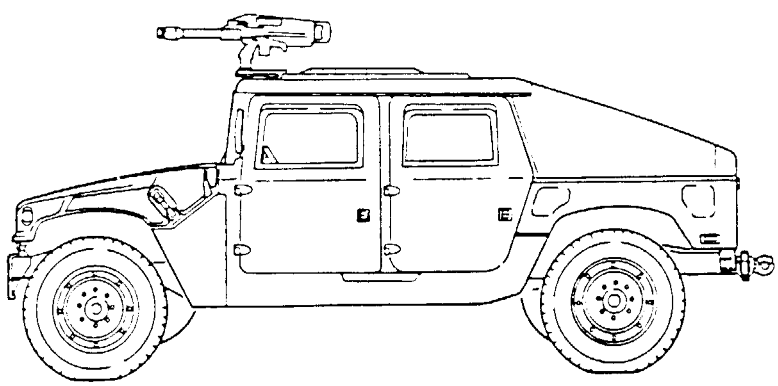
M1026/M1026A1 W/WINCH
(WITH MK19 GRENADE LAUNCHER MOUNTED)

ARMAMENT CARRIERS, W/SUPPLEMENTAL ARMOR M1043, M1043A1, M1043A2, M1044, AND M1044A1

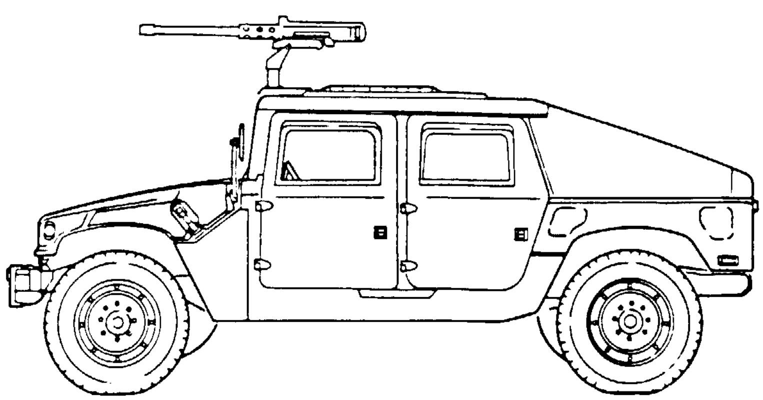
PURPOSE: These models are used to transport, mount, and operate the M2 and M60 machine guns and MK19 automatic grenade launcher with added ballistic protection for crew, weapons components, and ammunition. The M1044 and M1044A1 models, which have a winch, can be used for recovery operations.



M1043/M1043A1
(WITH MK19 GRENADE LAUNCHER MOUNTED)



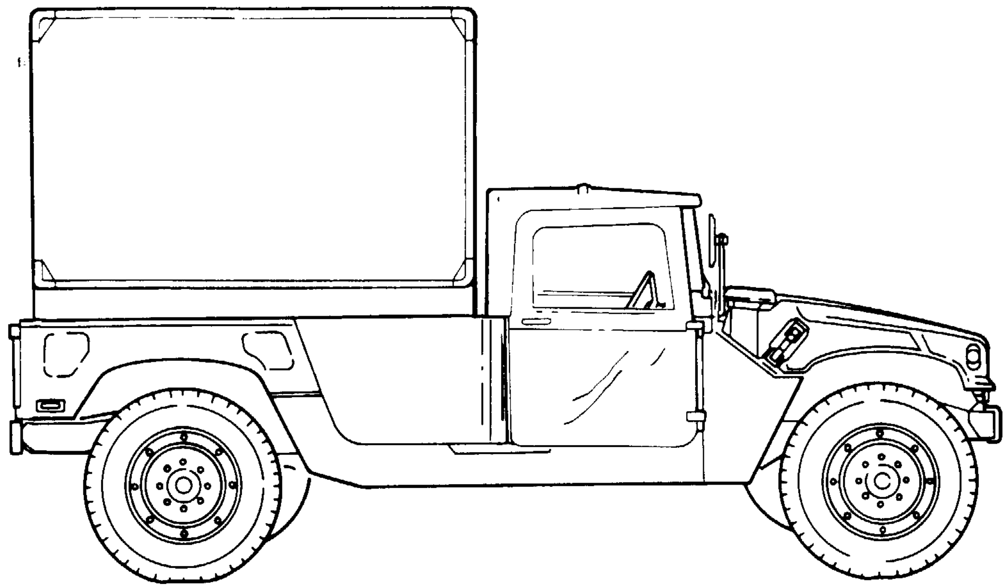
M1043A2
(WITH MK19 GRENADE LAUNCHER MOUNTED)



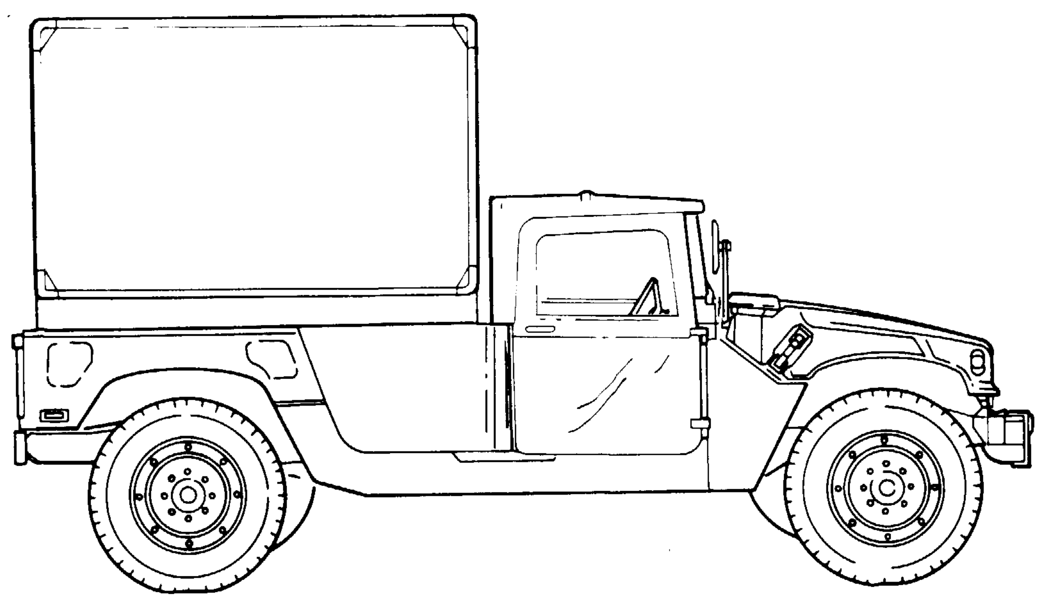
M1044/M1044A1 W/ WINCH
(WITH M2, CALIBER .50 MACHINE GUN MOUNTED)

S250 SHELTER CARRIERS M1037 AND M1042

PURPOSE: These models are used for securing and transporting the S250 electrical equipment shelter. The M1042 model, which has a winch, can be used for recovery operations.



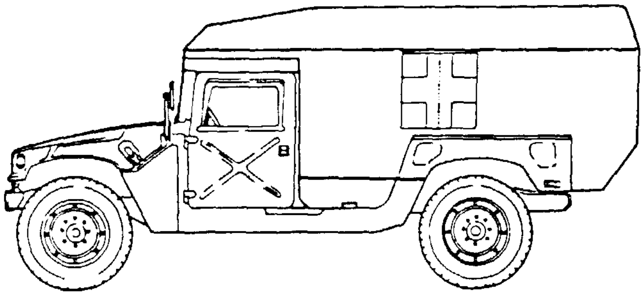
M1037



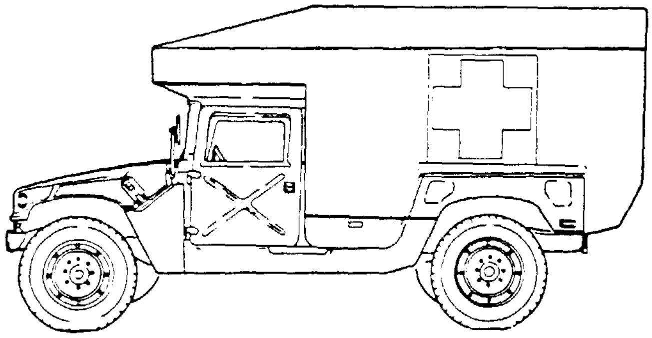
M1042
W/WINCH

ARMORED AMBULANCES: M996, M996A1, M997, M997A1, AND M997A2

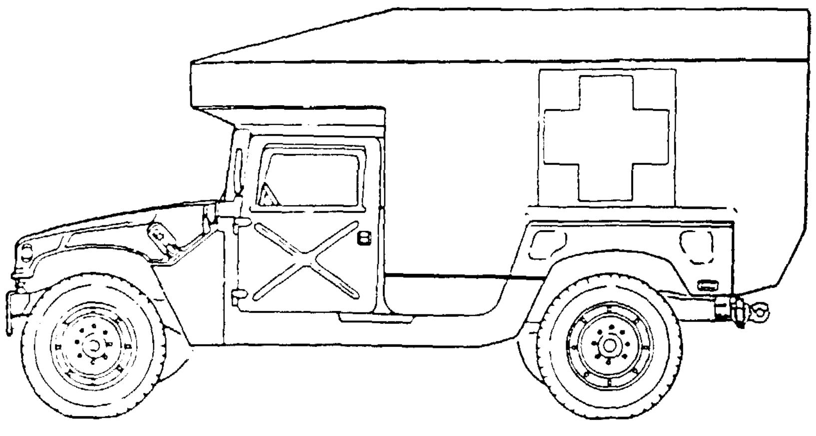
PURPOSE: These models are used to transport patients with armor protection for crew and patients. The M996 and M996A1 are reducible in height for CH47 helicopter transport. The M997, M997A1, and M997A2 have air conditioning for patient comfort. For operation in an NBC environment, the M997, M997A1, and M997A2 is equipped with a Gas-Particulate Filter Unit (GPFU) with heaters capable of supporting up to seven personnel equipped with either M25 series protective masks or M13 series patient protective masks.



M996/M996A1



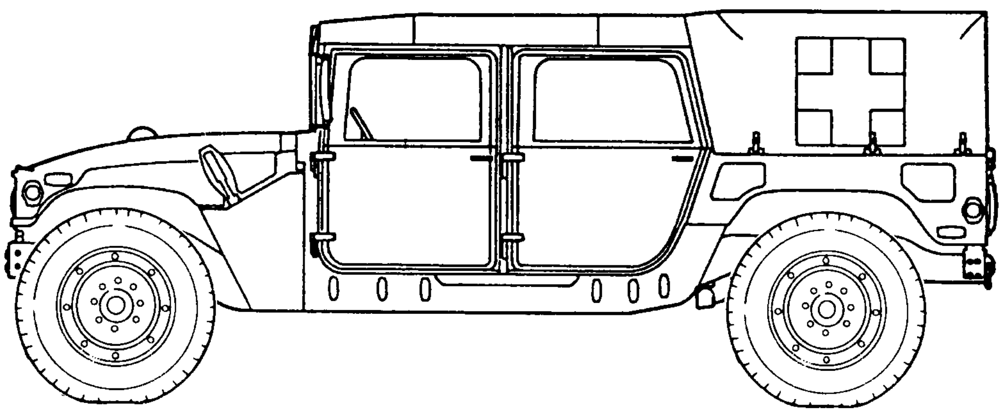
M997/M997A1



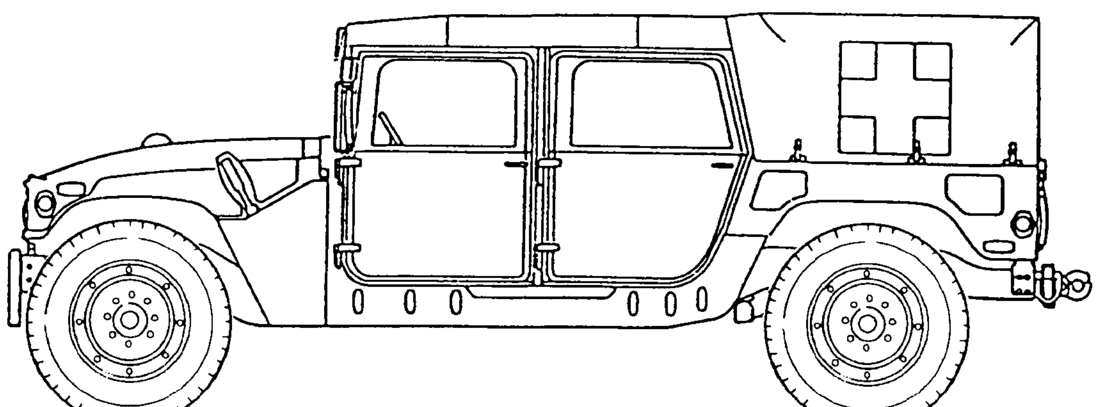
M997A2

SOFT TOP AMBULANCES: M1035, M1035A1, AND M1035A2

PURPOSE: These models are used to transport a maximum of 2 litter and 2 ambulatory patients and are transportable by a CH47 helicopter.



M1035/M1035A1



M1035A2

1-11. LOCATION AND DESCRIPTION OF MAJOR EXTERIOR COMPONENTS

The exterior components described below are common to all vehicles covered in this manual. Special differences are found in TM 9-2320-280-10 or table 1-1, differences between models, of this manual.

A **AIR CLEANER** – Filters air before it enters intake manifold.

B **ENGINE** – Provides power for the vehicle.

C **TRANSMISSION** – Transmits engine power to transfer case at varying speeds.

D **FUEL TANK** – Stores fuel.

E **GEARED HUB** – Transfers turning action of half shafts to wheels for vehicle motion.

F **PINTLE HOOK** – Permits towing of vehicles or equipment.

G **REAR PROPELLER SHAFT** – Transmits power from the transfer case to the rear differential.

H **TRANSFER CASE** – Provides full-time four-wheel drive with three drive ranges.

I **FRONT PROPELLER SHAFT** – Transmits power from the transfer case to the front differential.

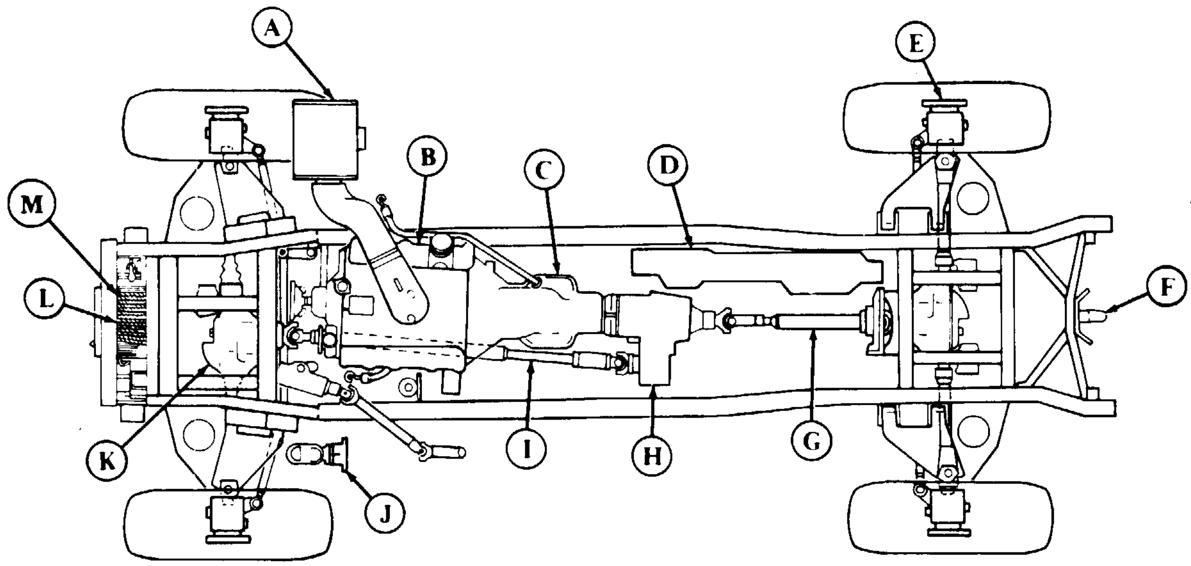
J **MASTER CYLINDER AND HYDRO-BOOST** – Provides hydraulic pressure and power assist for vehicle stopping power.

K **DIFFERENTIAL** – Transfers turning action of the propeller shaft to the geared hubs through the half shafts.

L **WINCH** – 6000 lb (M1026, M1026A1, M1036, M1038, M1038A1, M1042, M1044, M1044A1, M1046, and M1046A1 only), electrically powered to provide recovery capability.

M **WINCH** – 9000 lb, can be used on “A2” models M1025A2, M1043A2, M1045A2, and M1097A2 and M1123.

1-11. LOCATION AND DESCRIPTION OF MAJOR EXTERIOR COMPONENTS (Cont'd)



(A) AIR CLEANER	(G) REAR PROPELLER SHAFT
(B) ENGINE	(H) TRANSFER CASE
(C) TRANSMISSION	(I) FRONT PROPELLER SHAFT
(D) FUEL TANK	(J) MASTER CYLINDER AND HYDRO-BOOST
(E) GEARED HUB	(K) DIFFERENTIAL
(F) PINTLE HOOK	(L) WINCH (6000 lb)
	(M) WINCH (9000 lb)

1-12. LOCATION AND DESCRIPTION OF MAJOR INTERIOR COMPONENTS

The major interior components shown below are common to all vehicles covered in this manual. Components not covered here can be found in TM 9-2320-280-10 or the applicable maintenance chapters of this manual.

(A) **AIR RESTRICTION GAUGE** – Indicates restrictions in the air cleaner.

(B) **DIRECTIONAL SIGNAL CONTROL** - Activates turn signal lights.

(C) **STEERING WHEEL** – Manual control for turning vehicle.

(D) **INSTRUMENT CLUSTER** – Houses controls and indicators.

(E) **DIAGNOSTIC CONNECTOR** – Connection point for STE/ICE-R test set.

(F) **TRANSMISSION SHIFT LEVER** – Manual control for shifting transmission.

(G) **TRANSFER CASE SHIFT LEVER** – Manual control for shifting transfer case.

(H) **PARKING BRAKE LEVER** - Manual control for applying parking brake.

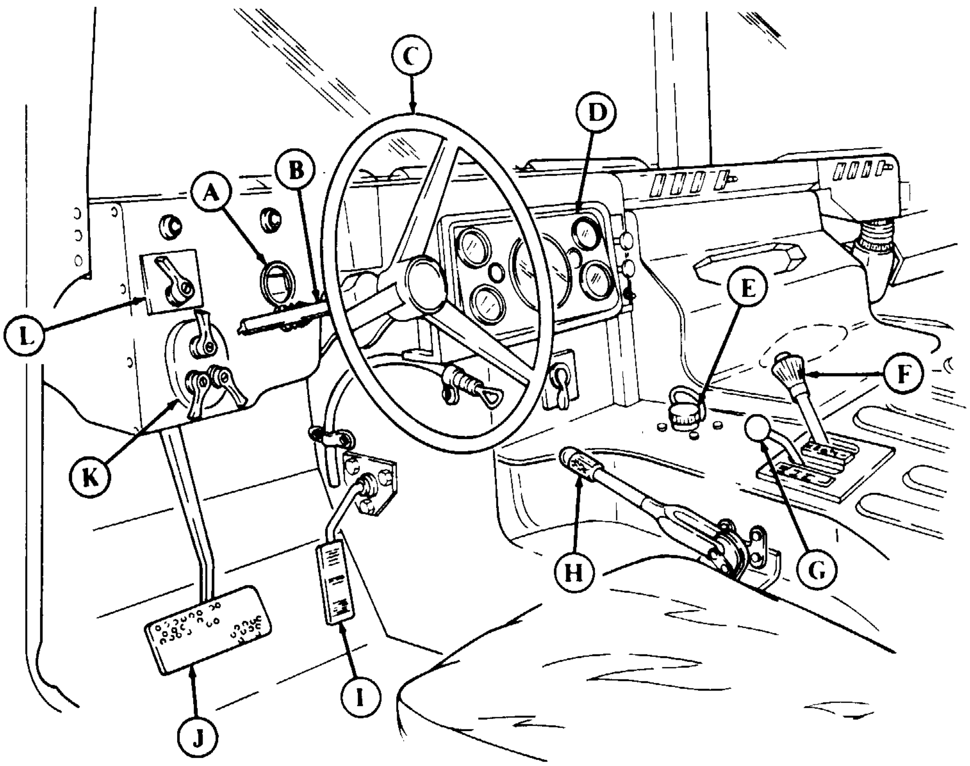
(I) **ACCELERATOR PEDAL** – Foot control for determining engine speed.

(J) **BRAKE PEDAL** – Foot control for stopping vehicle.

(K) **MAIN LIGHT SWITCH** - Controls operation of vehicle lights.

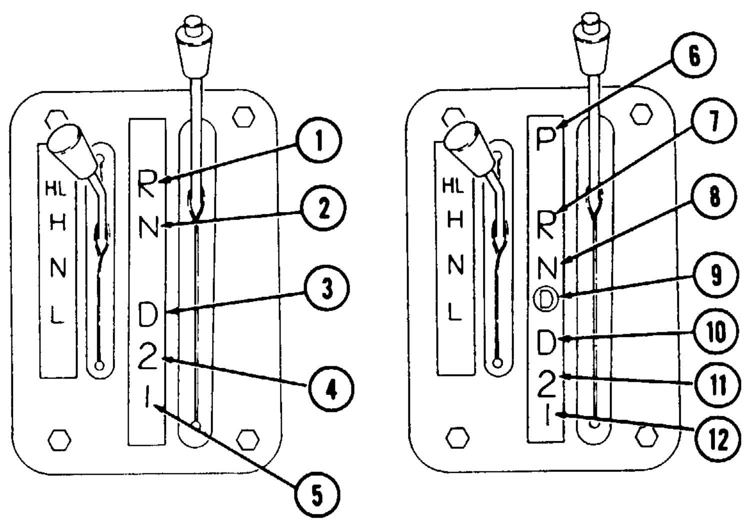
(L) **ROTARY SWITCH** – When positioned to START, the starter is engaged to crank the engine.

1-12. LOCATION AND DESCRIPTION OF MAJOR INTERIOR COMPONENTS (Cont'd)



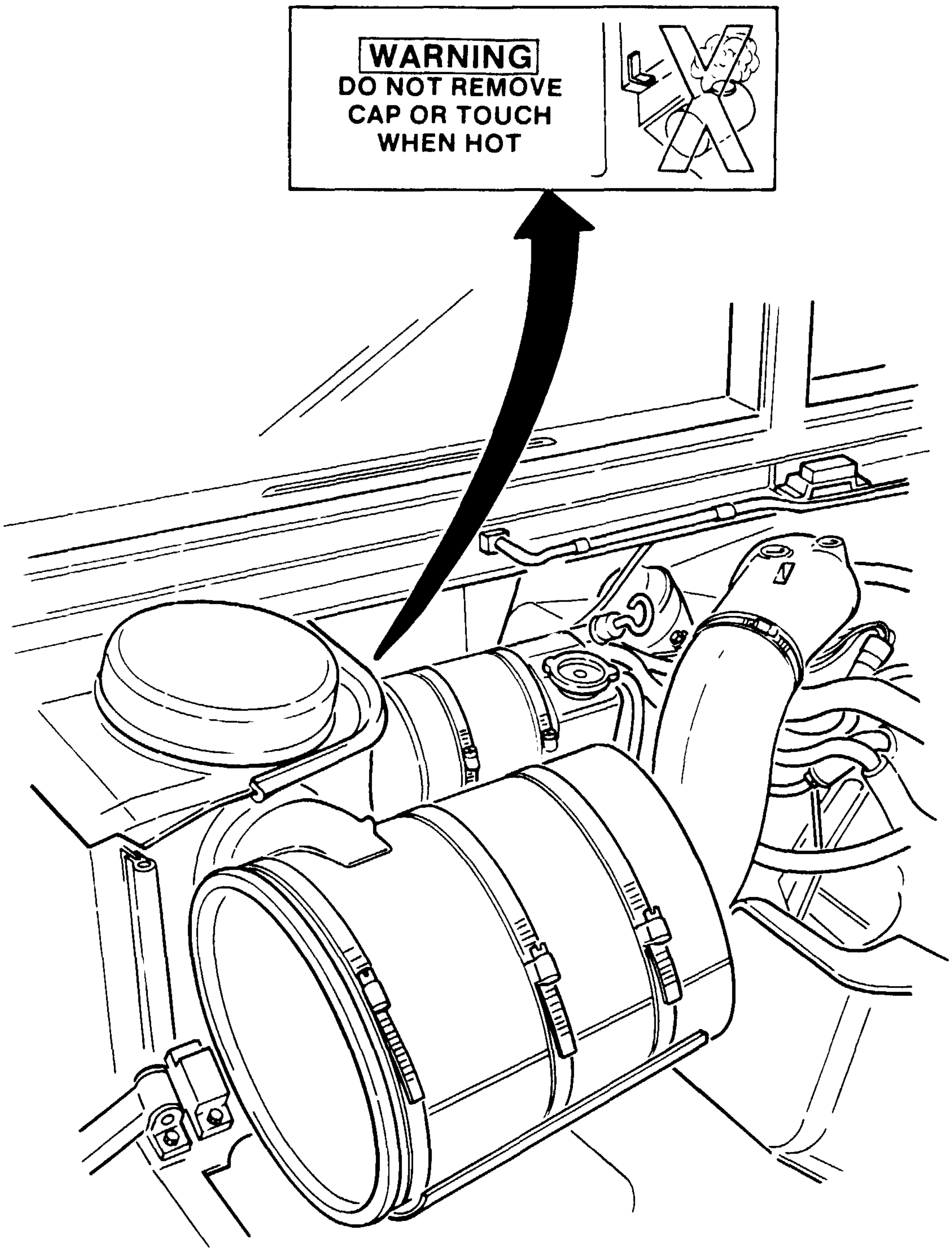
1. "R" (Reverse)
2. "N" (Neutral)
3. "D" (Manual Third)
4. "2" (Manual Second)
5. "1" (Manual First)
6. "P" (Park)
7. "R" (Reverse)
8. "N" (Neutral)
9. "Ⓓ" (Overdrive)
10. "D" (Manual Third)
11. "2" (Manual Second)
12. "1" (Manual First)

3L80 TRANSMISSION 4L80-E TRANSMISSION

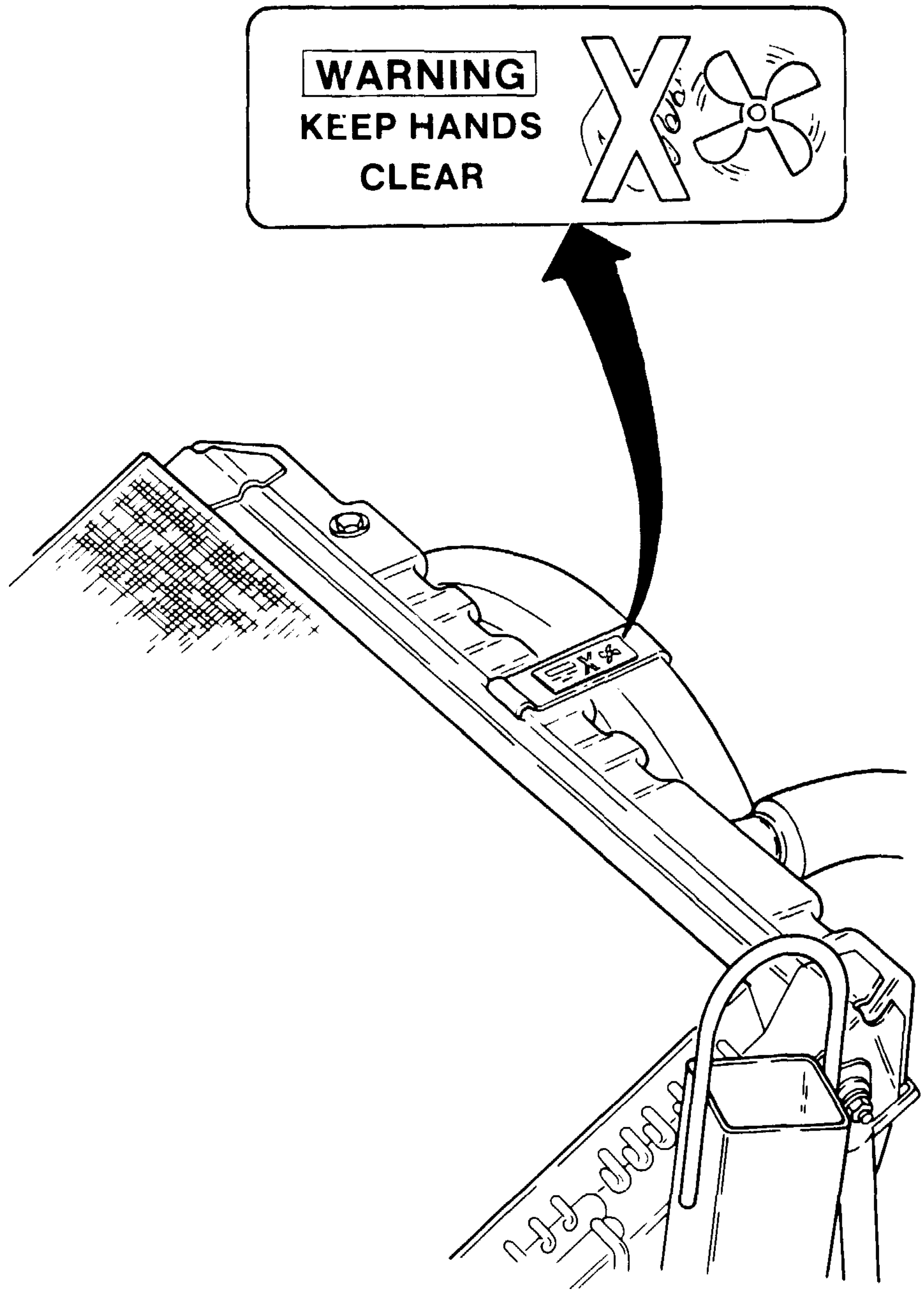


1-13. LOCATION AND CONTENTS OF WARNING, CAUTION, AND DATA PLATES

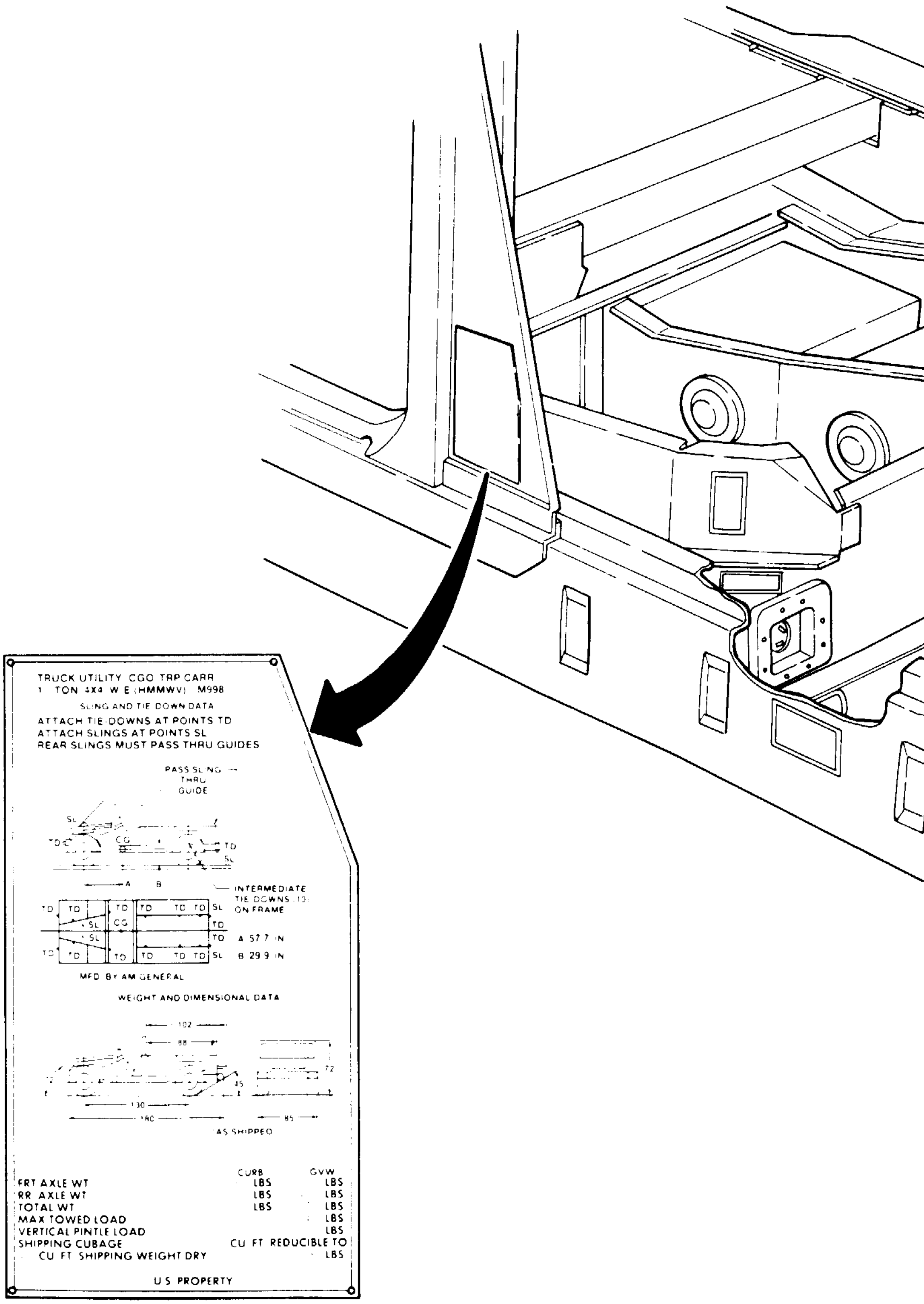
The location and contents of caution, data, and warning plates are provided in this paragraph. If any of these plates are worn, broken, painted over, missing, or unreadable, they must be replaced. Information on data plate may vary per model.



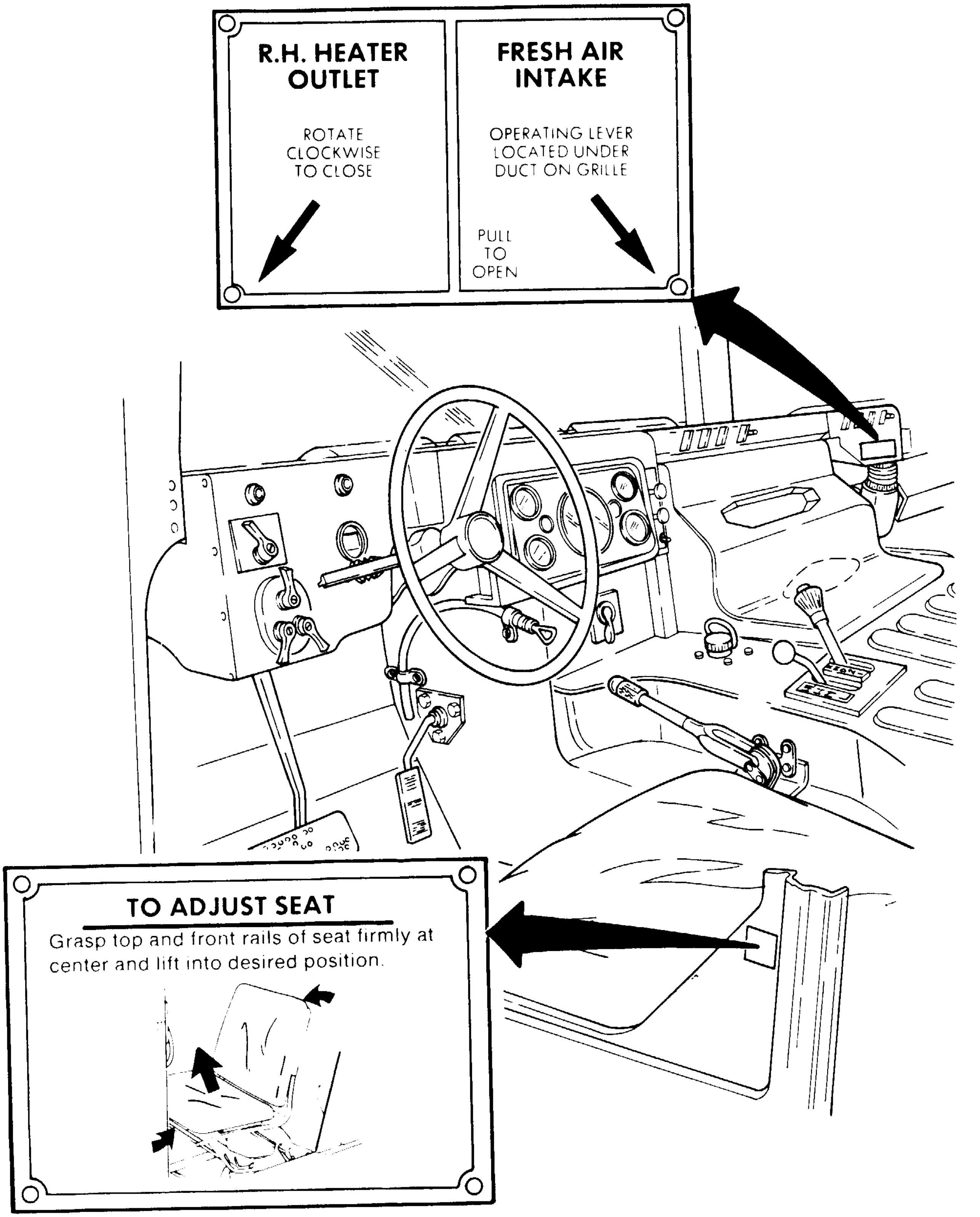
1-13. LOCATION AND CONTENTS OF WARNING, CAUTION, AND DATA PlATES (Cont'd)



1-13. LOCATION AND CONTENTS OF WARNING, CAUTION, AND DATA PLATES (Cont'd)



1-13. LOCATION AND CONTENTS OF WARNING, CAUTION, AND DATA PLATES (Cont'd)



1-13. LOCATION AND CONTENTS OF WARNING, CAUTION, AND DATA PLATES (Cont'd)

MAX. VEHICLE OPERATING SPEEDS

TRANSMISSION RANGE SELECTION	TRANSFER CASE RANGE SELECTION "L" Low Lock	"H" High	"H/L" High Lock
"R" Reverse	11 MPH	29 MPH	11 MPH
"D" Drive	27 MPH	55 MPH	55 MPH
"2" Second	19 MPH	48 MPH	48 MPH
"1" First	11 MPH	29 MPH	29 MPH

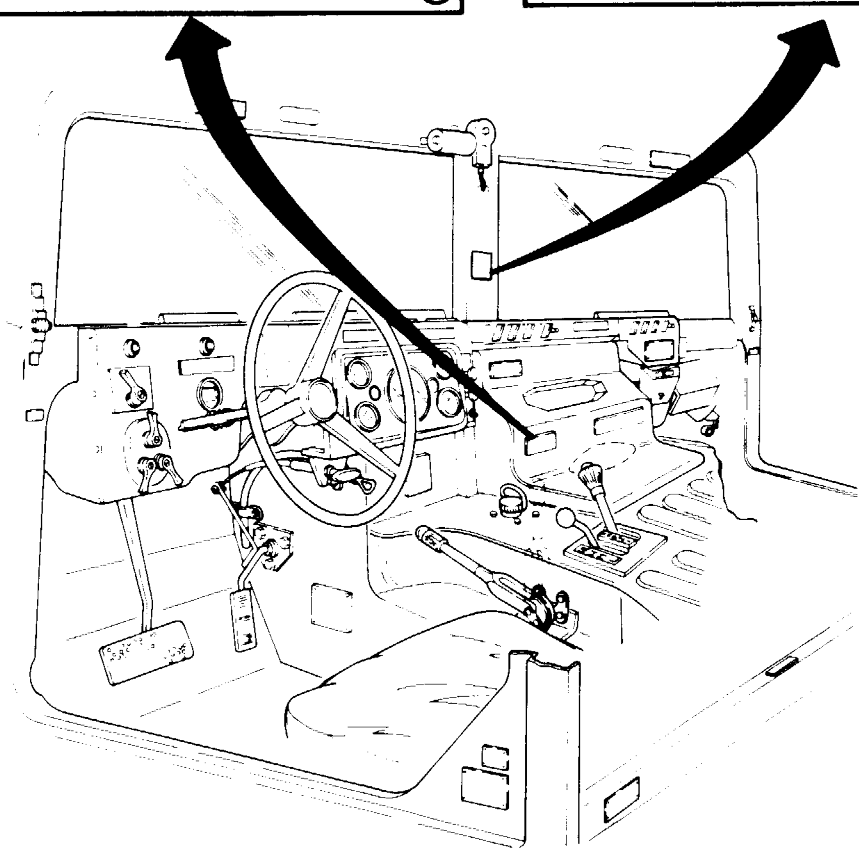
TRANSFER CASE IN HIGH "H" WHEN OPERATING ON HARD SURFACE

FORDING
SHALLOW FORDING DEPTH 30 INCHES

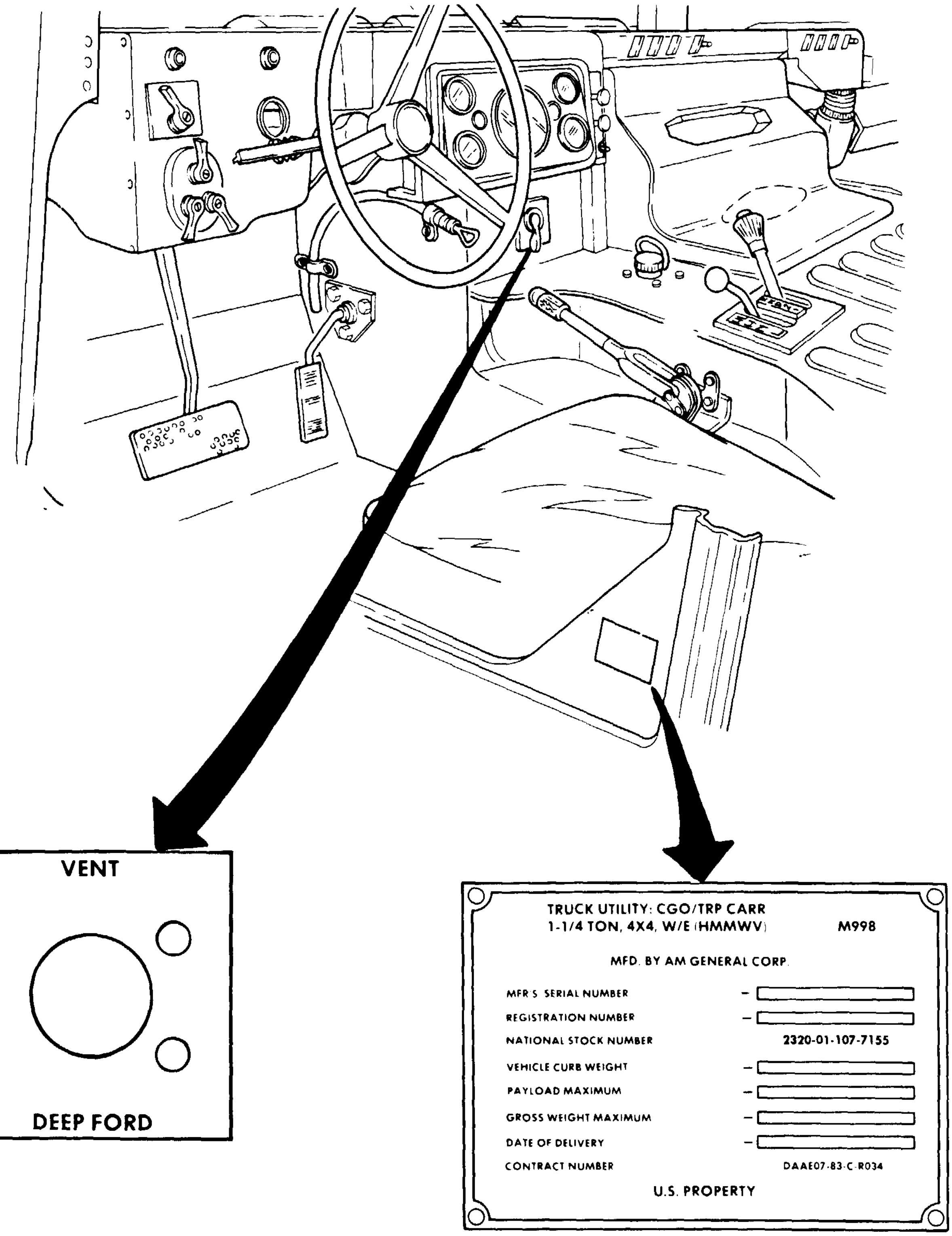
VEHICLE BREAK-IN SERVICE

DURING THE FIRST 500 MI. (804 KM) OF OPERATION:

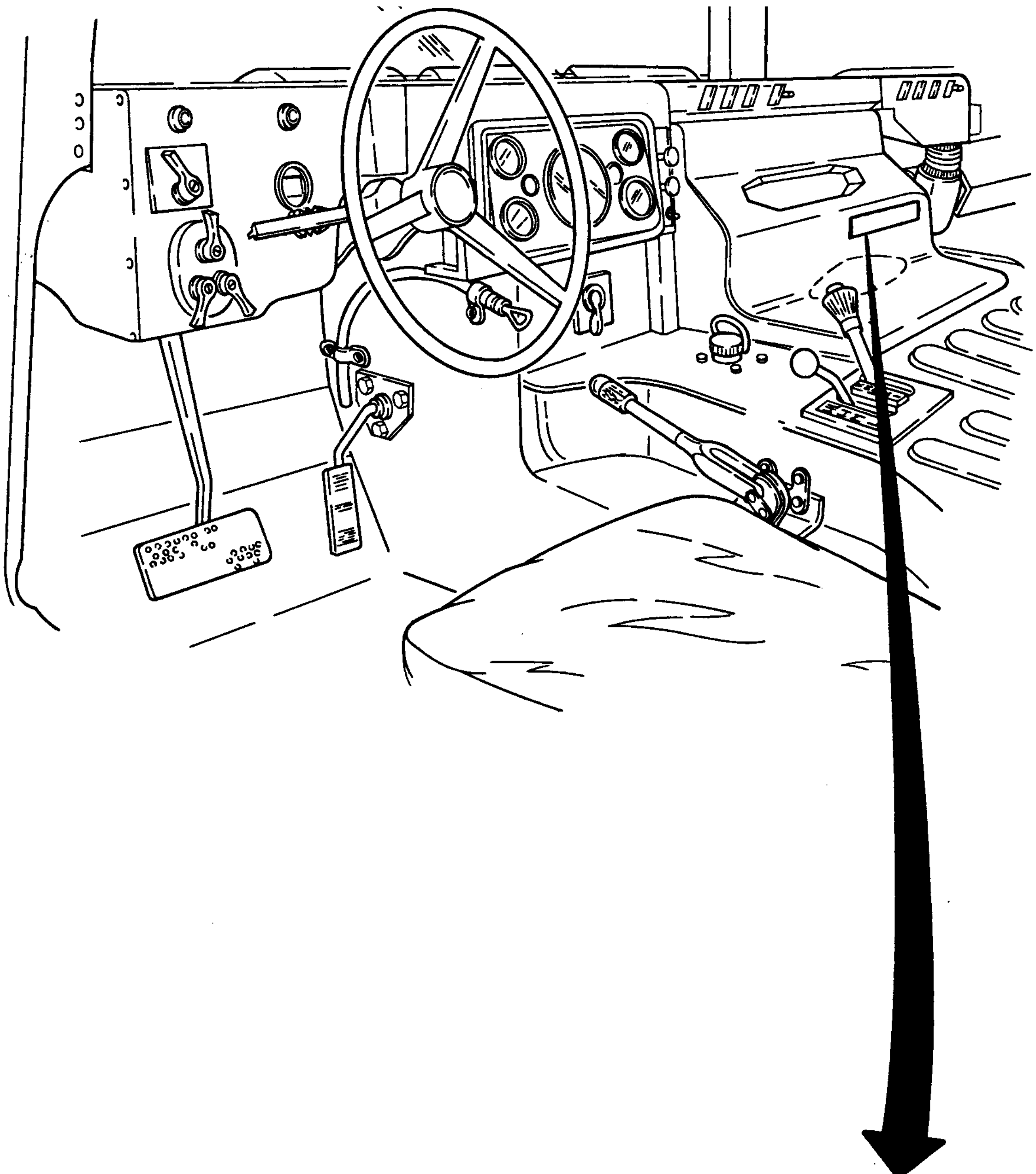
- DO NOT EXCEED A SPEED OF 55 MPH (88 KPH)
- DO NOT DRIVE FOR LONG PERIODS OF TIME AT CONSTANT SPEED
- AVOID RAPID ACCELERATION OR DECELERATION
- DRIVE AT MODERATE SPEED UNTIL THE ENGINE IS FULLY WARMED UP
- NO TRAILER TOWING



1-13. LOCATION AND CONTENTS OF WARNING, CAUTION, AND DATA PLATES (Cont'd)



1-13. LOCATION AND CONTENTS OF WARNING, CAUTION, AND DATA PLATES (Cont'd)



SERVICING DATA	
FUEL	DIESEL NO. 1, NO. 2, DFA
FUEL TANK CAPACITY	25 GALS
COOLING SYSTEM CAPACITY	25 QTS
CRANKCASE CAPACITY	7 QTS + 1 QT FOR FILTER

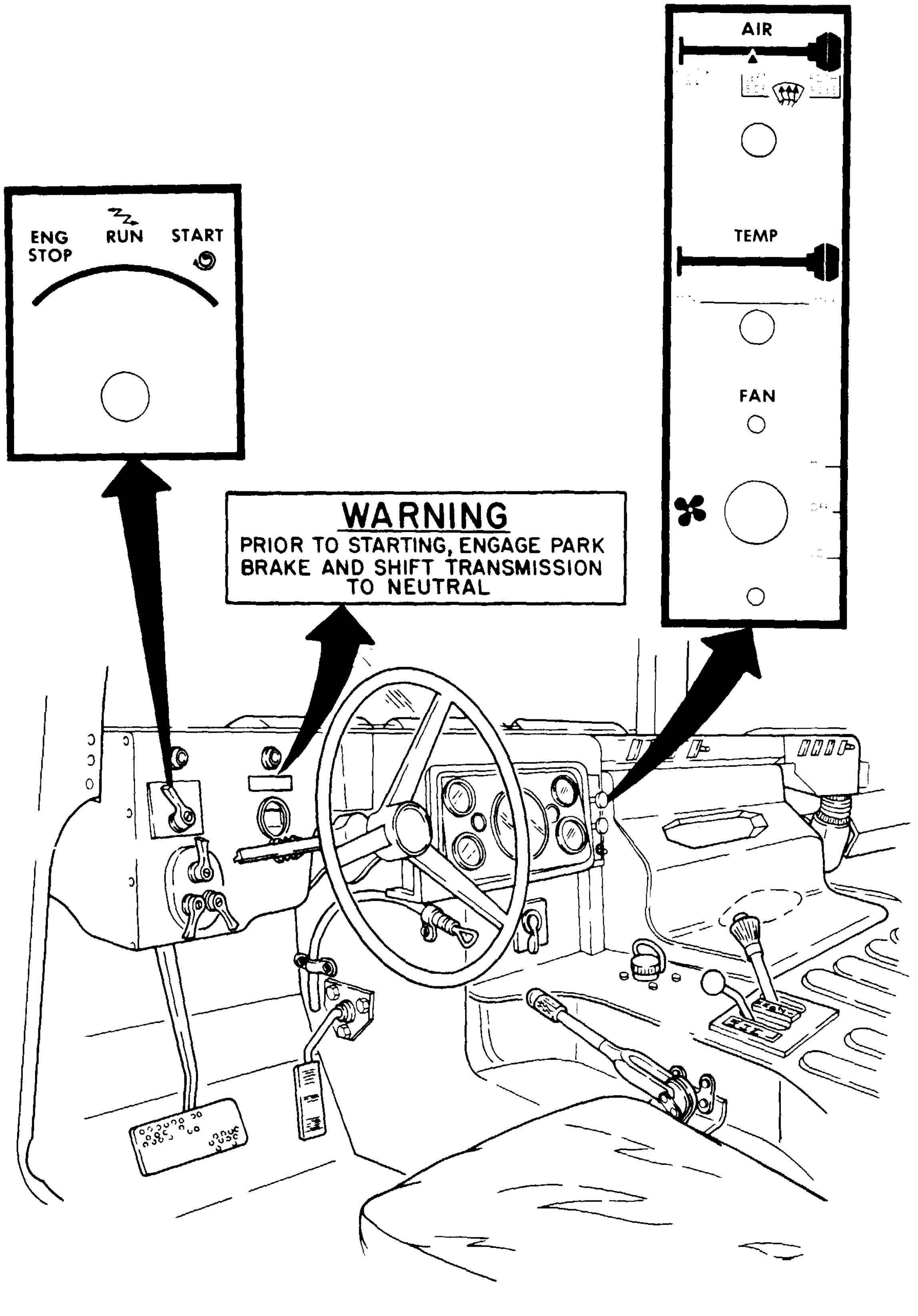
TIRE INFLATION PRESSURE	FRONT P.S.I.	REAR P.S.I.
ALL MODELS EXCEPT M996, M997, M1037, AND M1042	20	22
M996, M997, M1037, M1042	22	30

TEMPERATURE	ABOVE +15°F	+40° TO -15°F	+40° TO -65°F
ENGINE OIL	OE-30	OE-10	OEA
GEAR OIL	GO 80/90	GO 80/90	GO 75
GREASE	GAA	GAA	GAA

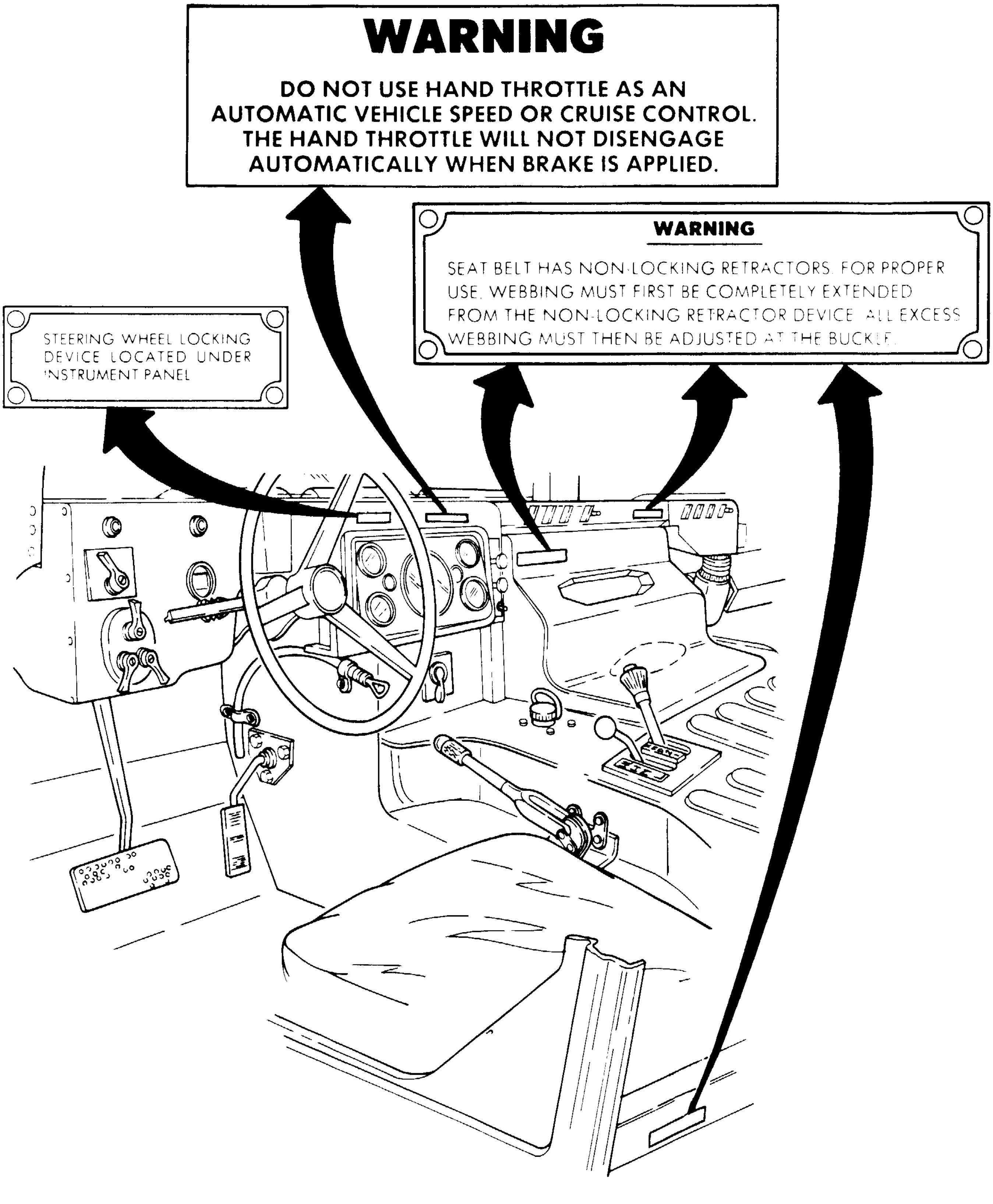
TO DRAIN COOLING SYSTEM OPEN DRAINCOCK LOCATED AT LOWER RADIATOR TUBE

MANUALS	
MAINTENANCE MANUAL	TM 9-2320-280-20 TM 9-2320-280-34
OPERATOR'S MANUAL	TM 9-2320-280-10
PARTS LIST	TM 9-2320-280-20P TM 9-2320-280-34P

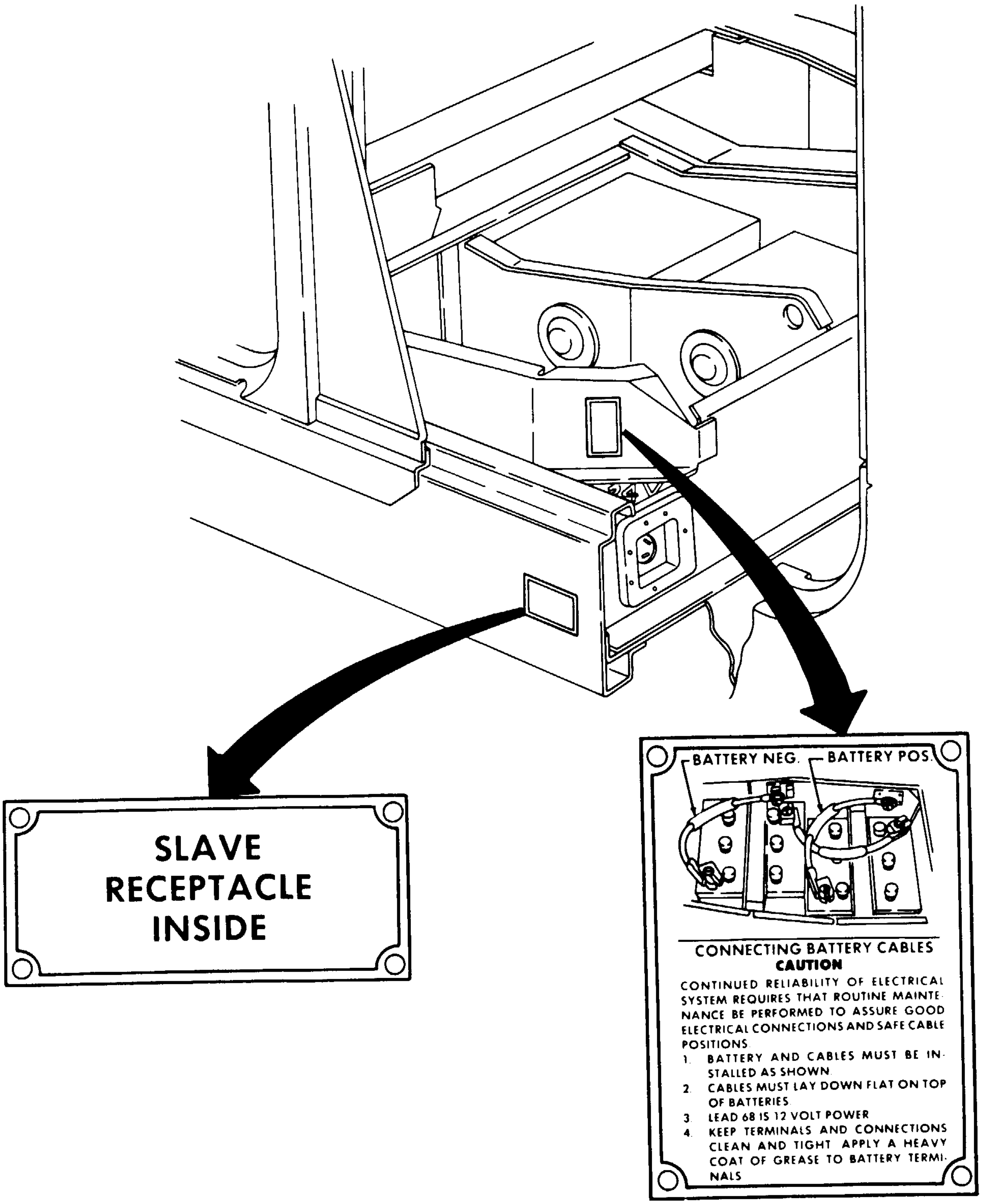
1-13. LOCATION AND CONTENTS OF WARNING, CAUTION, AND DATA PLATES (Cont'd)



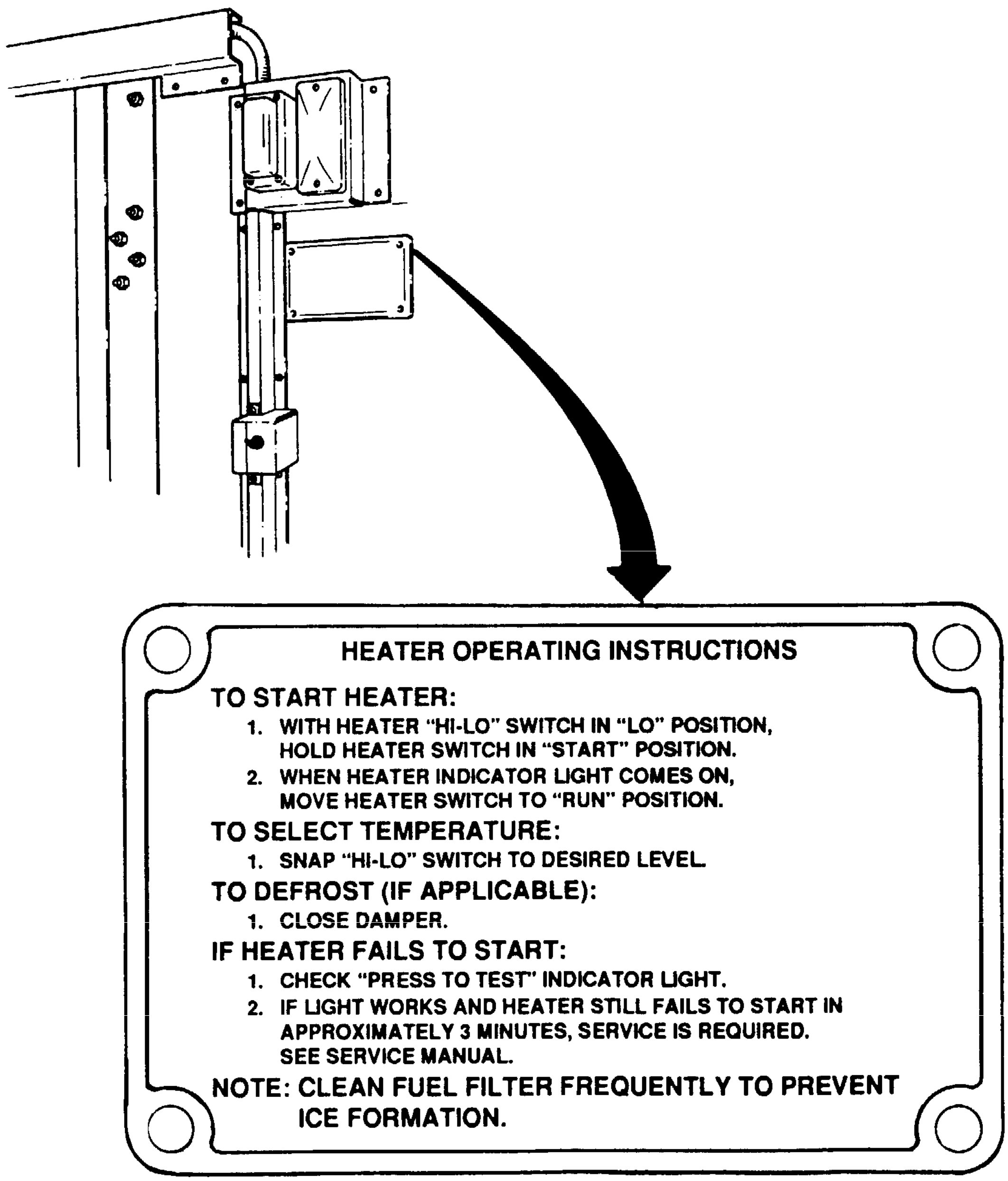
1-13. LOCATION AND CONTENTS OF WARNING, CAUTION, AND DATA PLATES (Cont'd)



1-13. LOCATION AND CONTENTS OF WARNING, CAUTION, AND DATA PLATES (Cont'd)



1-13. LOCATION AND CONTENTS OF WARNING, CAUTION, AND DATA PLATES (Cont'd)



1-13. LOCATION AND CONTENTS OF WARNING, CAUTION, AND DATA PLATES (Cont'd)

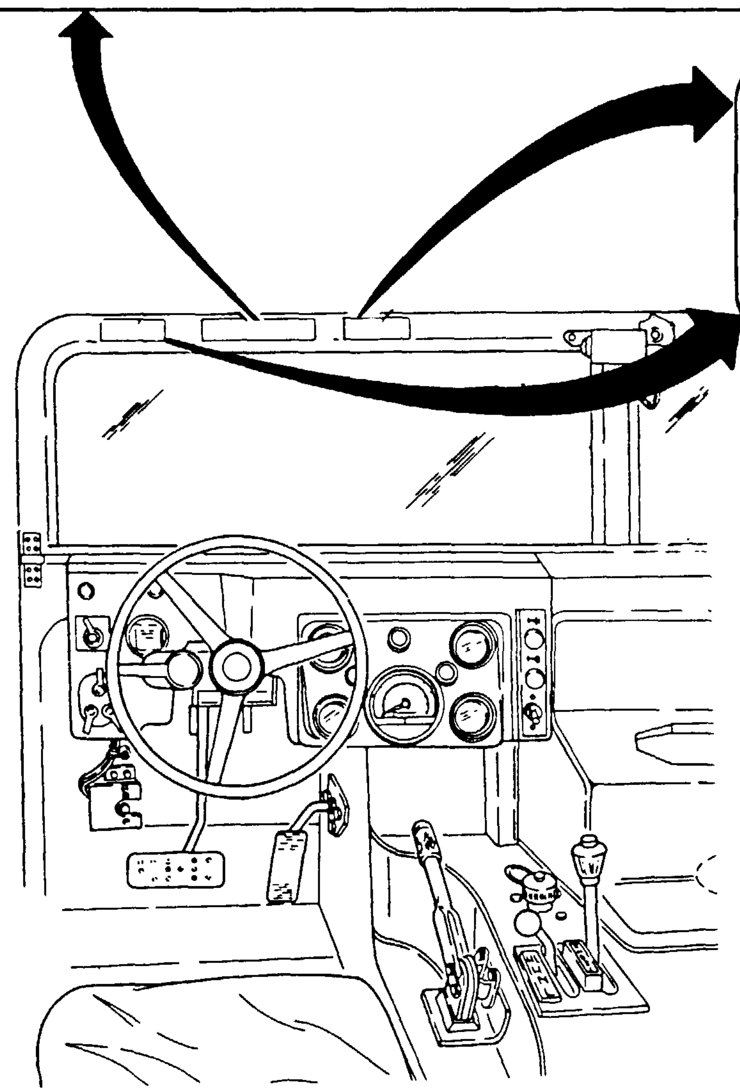
WARNING

THE DEPARTMENT OF TRANSPORTATION REQUIRES 105 MM CANNON AMMUNITION TO BE IN WOODEN BOXES WHEN TRANSPORTING AMMUNITION ON PUBLIC HIGHWAYS, BY FIXED WING AIRCRAFT, RAIL, OR SHIP.

RESTRICT MOVEMENT OF CANNON AMMUNITION IN FIBER CONTAINERS (INNER PACK) IN THE AMMUNITION RACK OF THE HMMWV TO OTHER THAN PUBLIC HIGHWAYS.

CAUTION

HIGH INTENSITY NOISE HEARING PROTECTION REQUIRED



1-14. DIFFERENCES BETWEEN MODELS

Table 1-1. Differences Between Models

Equipment/ Function	M966, M966A1, M1121	M996, M996A1	M997, M997A1, M997A2	M998, M998A1	M1025, M1025A1, M1025A2	M1026, M1026A1	M1035, M1035A1, M1035A2	M1036	M1037	M1038, M1038A1	M1042	M1043, M1043A1, M1043A2	M1044, M1044A1	M1045, M1045A1, M1045A2	M1046, M1046A1	M1097, M1097A1, M1097A2, M1123
Personnel/Cargo Operations				x						x						x
TOW Launcher Mounting	x							x						x	x	
Armament Mounting					x	x						x	x			
S250 Shelter Configuration									x		x					x
Ambulance:																
Two Litter Patients		x					x									
Four Litter Patients			x													
Eight Ambulatory Patients			x													
Six Ambulatory Patients		x														
Two Litter and Four Ambulatory Patients			x													
One Litter and Three Ambulatory Patients		x														
Vehicle Winch						x		x		x	x		x		x	
Communications:																
AN/GRC-160	x	x	x	x	x	x		x		x		x	x	x	x	
AN/VRC-12 Series				x					x							
Collective NBC Protection		x	x													
Basic Armor	x	x	x		x	x		x								
Supplemental Armor												x	x	x	x	
Howitzer Prime Mover																x

1-15. TABULATED DATA

Vehicle performance data for the M998 series vehicles is listed in table 1-2. This information includes only that data applicable to unit maintenance. Information not covered can be found in TM-9-2320-280-10.

Table 1-2. Tabulated Data

NOTE

Standard and metric measurements will be used in this table.
A list of their abbreviations is provided below.

TABULATED DATA ABBREVIATIONS

MEASUREMENT	ABBREVIATION	MEASUREMENT	ABBREVIATION
Pint	pt	Fahrenheit	F
Quart	qt	Celsius	C
Gallon	gal.	Liters	L
Inch	in.	Centimeter	cm
Miles Per Hour	mph	Kilometers Per Hour	kph
Miles Per Gallon	mpg	KiloPascal	kPa
Pounds Per Square Inch	psi	Maximum	max
Revolutions Per Minute	rpm	Minimum	min
Kilometers Per Liter	km/L	Kilogram	kg
Pound-Feet	lb-ft	Newton-Meter	N•m
Gallon Per Minute	gpm	Millimeter	mm
Volt	V	Ampere	A
Horsepower	hp	KiloWatt	kW
Liters Per Minute	l/m		

	STANDARD	METRIC
1. PAYLOAD		
M998, M998A1, M1038, and M1038A1	2,500 lb	1,135 kg
M1097, M1123, “A1” and “A2” Series	4,400 lb	1,998 kg
2. CAPACITIES*		
Cooling System	26 qt	24.6 L
Engine		
Crankcase Only	7 qt	6.6 L
Crankcase and Filter	8 qt	7.6 L
Fuel Tank	25 gal.	94.6 L
Differential (each)	2 qt	1.9 L
Transmission (3L80):		
Drain and Refill	6 qt	5.7 L
W/Dry Converter	11 qt	13.2 L
Transmission (4L80-E):		
Drain and Refill	7.7 qt	7.3 L
W/Dry Converter	13.5 qt	12.8 L
Transfer Case (model 218)	3.5 qt	3.3 L
Transfer Case (model 242)	3.35 qt	3.17 L
Geared Hub	1 pt	0.47 L
Steering Hydraulic System	1 qt	0.95 L
Steering Hydraulic System with Steering Cooler	1.25 qt	1.18 L
Brake Hydraulic System (All except M1097, M1123, “A1” and “A2” series)	1.2 pt	0.57 L
Brake Hydraulic System (M1097, M1123, “A1” and “A2” series)	1.63 pt	0.77 L
Brake Master Cylinder (All except M1097, M1123, “A1” and “A2 series)	0.69 pt	0.33 L
Brake Master Cylinder (M1097, M1123, “A1” and “A2” series)	1.12 pt	0.53 L
Windshield Washer Reservoir	1 qt	0.95 L

*ALL HYDRAULIC SYSTEMS AND ALL FUEL CAPACITIES
ARE CALCULATED APPROXIMATIONS

Table 1-2. Tabulated Data (Cont'd)

	STANDARD	METRIC
3. ENGINE		
Model	DDA 6.2 L	
Type	Diesel, Naturally Aspirated Liquid-Cooled, V8	
Brake Horsepower	150 hp @ 3,600 rpm	111.9 kW @ 3,600 rpm
Idle Speed	650 ± 25 rpm	
Operating Speed	1,500-2,300 rpm	
Oil Pressure:		
@ Idle	15 psi	103 kPa
@ Operating Speed	40-50 psi	276-345 kPa
4. ENGINE		
Model	DDA 6.5 L	
Type	Diesel, Naturally Aspirated, Liquid-Cooled, V8	
Brake Horsepower	160 hp @ 3,400 rpm	119.4 kW @ 3,400 rpm
Idle Speed	650 ± 25 rpm	
Operating Speed	1,500-2,300 rpm	
Oil Pressure		
@ Idle	10 psi	69 kPa
@ Operating Speed	40-50 psi	276-345 kPa
5. FUEL SYSTEM		
Fuel Pump (Mechanical):		
Type	Cam-Driven Diaphragm	
Fuel Filter		
Type	Fuel/Water Separator	
Air Cleaner:		
Type	Dry Element	
Glowplug:		
Type	Fast Start	
6. COOLING SYSTEM		
Surge Tank Cap Pressure	15 psi	103 kPa
Thermostat:		
Starts to Open	190°F	88°C
Fully Open	212°F	100°C
Radiator:		
Type	Downflow	
Fan:		
Type	Ten Blade	
Diameter	19 in.	48.26 cm
7. ELECTRICAL SYSTEM		
Alternator:		
60 Ampere	60 A @ 28 V	
100 Ampere	100 A @ 28 V	
200 Ampere	200 A @ 28 V	
400 Ampere	400 A @ 28 V	
Starter:		
Voltage	14 V	
Batteries (2):		
Voltage	12 V	

Table 1-2. Tabulated Data (Cont'd)

		STANDARD	METRIC
8.	TRANSMISSION		
	Model	3L80	
	Type	3-Speed, Automatic	
	Oil Type	Dexron® II	
	Oil Pressure	55-160 psi	379-1,103 kPa
9.	TRANSMISSION		
	Model	4L80-E	
	Type	4-speed, Automatic Torque Converter Stall Ratio and Direct Drive w/Lock Up Clutch	
	Gear Ratios		
	First	2.48:1	
	Second	1.45:1	
	Third	1.00:1	
	Fourth	0.75:1	
	Reverse	2.08:1	
	Oil Type	Dexron® III	
	Oil Pressure	35-324 psi	241-2,234 kPa
10.	TRANSFER CASE		
	Model	NPG 218 w/Cooler NPG 242 w/Cooler	
	Type	2-speed	
	Oil Type	Dexron® II	
11.	SERVICE BRAKE CALIPER (FRONT)		
	Manufacturer	Kelsey-Hayes	
	Piston Diameter	2.6 in.	66 mm
12.	SERVICE/PARKING BRAKE CALIPER (REAR)		
	Manufacturer	Kelsey-Hayes	
	Piston diameter	2.6 in.	66 mm
13.	SERVICE BRAKE ROTOR (FRONT)		
	Manufacturer	Kelsey-Hayes	
	A2 Manufacturer	Kelsey-Hayes	
	Diameter	10.5 in.	267 mm
	A2 Diameter	12 in.	305 mm
	Thickness	0.87 in.	22.1 mm
	A2 Thickness	1.02 in.	26 mm
14.	SERVICE/PARKING BRAKE ROTOR (REAR)		
	Manufacturer	Kelsey-Hayes	
	A2 Manufacturer	Kelsey-Hayes	
	Diameter	10.5 in.	267 mm
	A2 Diameter	12 in.	305 mm
	Thickness	0.87 in.	22.1 mm
	A2 Thickness	1.02 in.	26 mm

Table 1-2. Tabulated Data (Cont'd)

15. PARKING BRAKE (VEHICLES SERIAL NUMBERS 1 THROUGH 44824)		
Type	Rod and Cable Actuated, Caliper	
Rotor Diameter	8 in.	203 mm
Brake Pad:		
Type	Bonded	
Minimum thickness	0.125 in.	3.2 mm
Lever Type	Over-Center	
16. WHEELS AND TIRES		
Tire size (Bias ply)	36 in. x 12.5 in. x 16.5 in.	91.4 cm x 31.75 cm x 41.9 cm
Tire size (Radial)	37 in. x 12.5 in. x 16.5 in.	93.98 cm x 31.75 cm x 41.9 cm
Wheels:		
Type	Offset Disc	
Runflat Insert:		
Type	2-Piece Magnesium	
17. STEERING SYSTEM		
Steering Gear:		
Manufacturer	Saginaw	
Type	Variable Ratio	
Ratio	13/16:1	
Power Steering Pump:		
Model	Saginaw 125	
Output Pressure (max)	1,450 psi	9,998 kPa
Flow Rate (max)	3.5 gpm	13.2 l/m
Tow-In (Front/Rear @ curb weight):		
M998, M998A1, M1025, M1025A1, M1025A2, M1026, M1026A1, M1035, M1035A1, M1035A2, M1038, M1038A1, M1043, M1043A1, M1043A2, M1044, M1044A1, M1097, M1097A1, M1097A2, and M1123	0.438 in. ± 0.125 in.	11 mm ± 3.2 mm
M966, M966A1, M996, M996A1, M997, M997A1, M997A2, M1036, M1037, M1042, M1045, M1045A1, M1045A2, M1046, M1121, and M1046A1	0.312 in. ± 0.125 in.	8 mm ± 3.2 mm
18. WINCH		
Model	W6000D25	
Type	Electric Drive, Thermal Cutoff Switch	
Capacity	6,000 lb	2,724 kg
19. WINCH		
Model	MIL-9000	
Type	Electric Drive, Thermal Cutoff Switch	
Capacity	9,000 lb	4,086 kg
19.1. WINCH		
Model	983-75-50050	
Type	Hydraulic	
Capacity	10,500 lb	4,767 kg
20. AIR-CONDITIONING COMPRESSOR		
Manufacturer	Sanden	
Model	510	
Field Coil	24V	

Section III. PRINCIPLES OF OPERATION

1-16. GENERAL

This section explains how components of the M998 series vehicles work together. The systems (functional groups) covered are listed in the Principles of Operation Reference Index, paragraph 1-17.

1-17. PRINCIPLES OF OPERATION REFERENCE INDEX

1-18. DRIVETRAIN OPERATION

The drivetrain is identical for all models covered in this manual. It converts horsepower into mechanical force to move the vehicle. Major components of the drivetrain are:

(A) **ENGINE** - The water-cooled 6.2 liter, V-8, Diesel engine provides up to 150 horsepower at 3600 rpm to power the vehicle. The 6.5 liter V-8 engine develops approximately 160 horsepower at 3400 rpm to power the vehicle. The engines are essentially the same on all models except those equipped with deep water fording kit installed, which adds a specially sealed dipstick, dipstick tube, and vented CDR valve. These differences do not affect engine performance.

(B) **TRANSMISSION (3L80)** - Adapts engine power to meet different driving conditions. The automatic transmission has three forward speeds, a reverse and a neutral. A neutral safety switch prevents the vehicle from being started with the transmission in any selector lever position except neutral.
TRANSMISSION (4L80E) - Adapts engine power to meet different driving conditions. The automotic transmission has four forward speeds, a reverse, a neutral and a park. A neutral safety switch prevents the vehicle from being started with the transmission in any selector lever position except park and neutral.

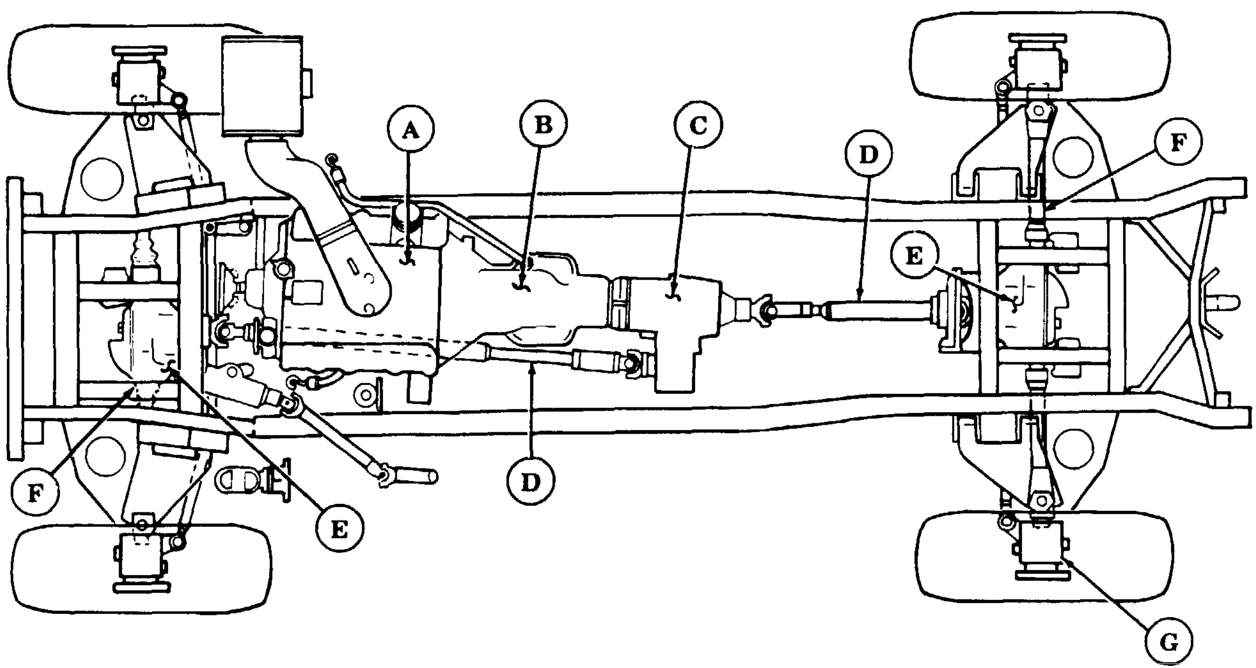
(C) **TRANSFER CASE** - Directs engine-to-transmission power to front and rear differentials simultaneously. This condition means the vehicle is always in four-wheel drive. The transfer case allows for selection of three drive ranges and a neutral position. A complete description of these driving ranges and the recommended driving conditions during which they are used can be found in TM 9-2320-280-10.

(D) **PROPELLER SHAFTS** - Link transfer case to differentials. Universal joints, located at either end of the front and rear propeller shafts, permit inline driving power between the transfer case and differentials even though they are mounted at different angles.

(E) **DIFFERENTIALS** - Transmit driving power, via halfshafts and geared hubs, to left and right wheels. The differential ensures power is applied to the wheel having traction, regardless of which wheel is slipping. This feature is called torque biasing.

(F) **HALFSHAFTS** - Transmits power from differentials to geared hubs.

(G) **GEARED HUBS** - Serve as the front wheel steering spindle and act as the final drive components to front and rear wheels.



1-19. FUEL SYSTEM OPERATION

The HMMWV diesel fuel system operation is identical for all models covered in this manual. It stores, cleans, and supplies fuel for the engine. Major components of the fuel system are:

(A) **FUEL PUMP** - Draws fuel from fuel tank through the supply line and pumps it to the fuel filter.

(B) **FUEL RETURN LINE** - Directs unused fuel from the injection pump back to the fuel tank.

(C) **FUEL SUPPLY LINE** - Directs fuel from fuel tank to the system.

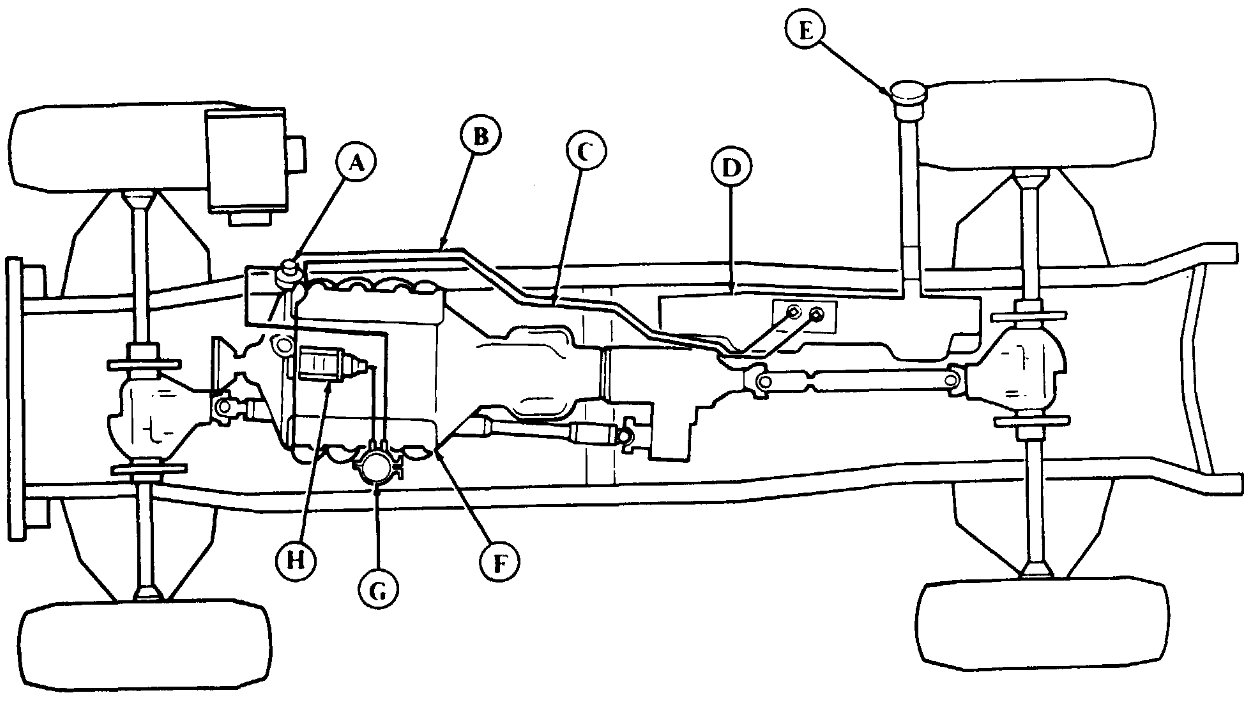
(D) **FUEL TANK** – Stores 25 gallons of diesel fuel.

(E) **FUEL FILLER CAP** - Located at right rear side of vehicle, the cap is removed to permit fuel tank servicing.

(F) **FUEL INJECTORS** - Receive metered fuel from the injection pump and sprays fuel into the combustion chamber.

(G) **FUEL FILTER/WATER SEPARATOR-** Filters water and sediment from fuel before fuel enters the injection pump.

(H) **INJECTION PUMP** - Directs metered and pressurized fuel to the eight injector nozzles. It is mounted on top of the engine under the intake manifold.



1-20. COOLING SYSTEM OPERATION

The cooling system removes excess heat from the engine, engine oil, transfer oil, and transmission oil. This system is identical on all models covered in this manual. Major components of the cooling system are:

A **ENGINE TEMPERATURE SENDING UNIT** – Sends signal indicating coolant temperature to gauge on instrument cluster.

B **ENGINE TEMPERATURE SWITCH** – Sends signal to activate control valve system to operate fan when engine temperature exceeds 215°F (102°C) and deactivate when engine temperature drops below 190°F (88°C).

C **WATER CROSSOVER** – Collects coolant from cylinder heads and channels it to the thermostat housing where it is redirected through the cooling system.

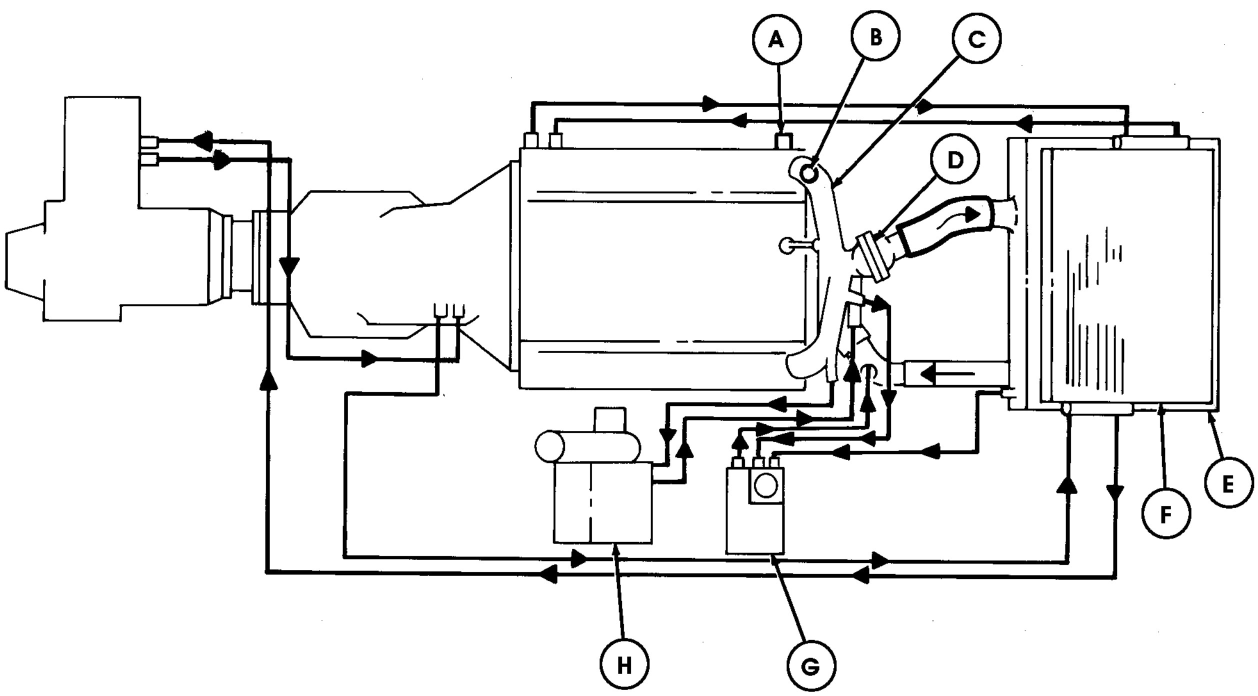
D **THERMOSTAT** – Shuts off coolant return flow to radiator until temperature reaches 190°F (88°C). Coolant is then directed to the radiator through the radiator inlet hose.

E **RADIATOR** – Directs coolant through a series of fins and baffles so outside air can dissipate excess engine heat before the coolant is recirculated through the engine.

F **OIL COOLER** – Directs engine oil (lower half of cooler) and transmission oil (upper half of cooler) through a series of fins or baffles so outside air can remove heat from oil.

G **SURGE TANK** – Filling and expansion point for cooling system.

H **PERSONNEL HEATER** – Provides heat for personnel and interior of vehicle.



1-20. COOLING SYSTEM OPERATION (Cont'd)

(I) **FAN** - Pulls outside air through radiator to remove heat from coolant.

(J) **HYDRAULIC CONTROL VALVE** - Directs hydraulic fluid to provide required pressure to actuate fan clutch as required by engine temperature. Hydraulic pressure supplied by power steering pump.

(K) **TIME DELAY MODULE** - Sends delayed signal to fan clutch solenoid for delay of fan actuation to provide needed horsepower for engine acceleration.

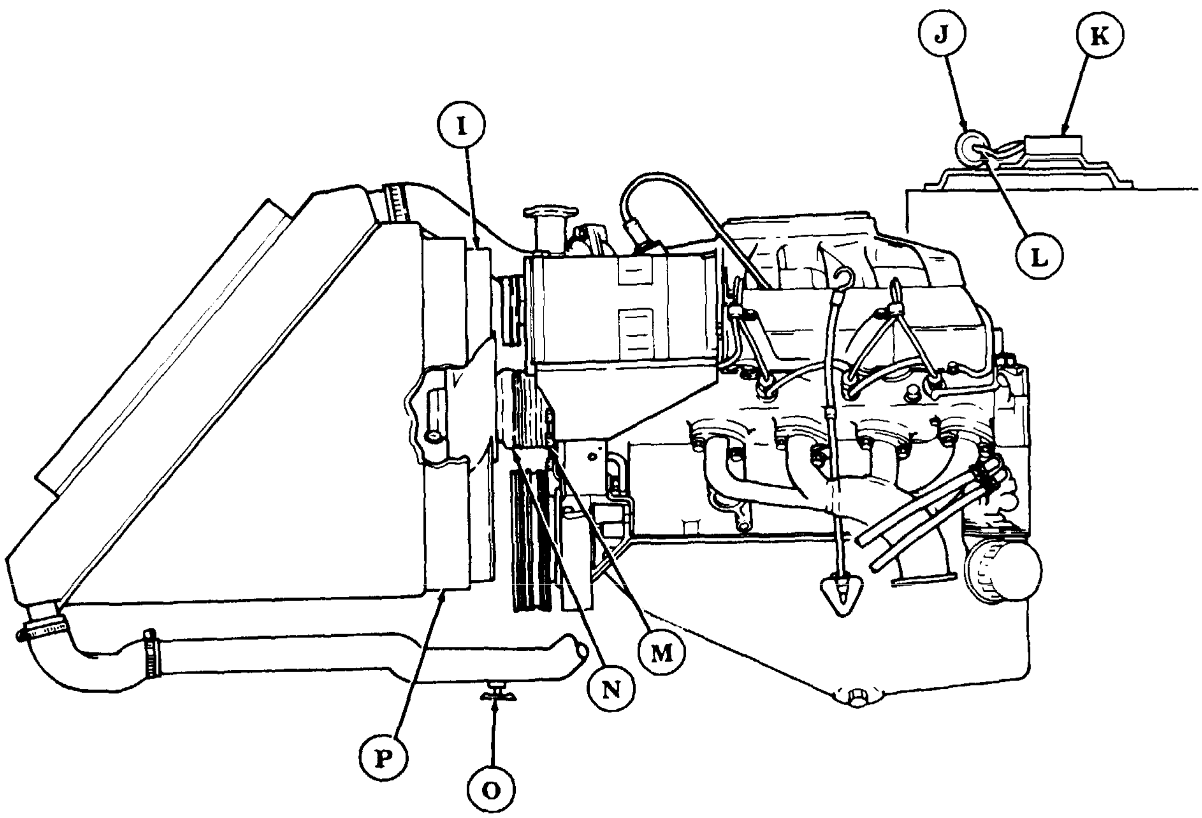
(L) **FAN CLUTCH SOLENOID** - Actuates hydraulic control valve as required by coolant temperature.

(M) **WATER PUMP** - Driven by V-belts provides circulation of coolant through cooling system.

(N) **FAN CLUTCH** - Hydraulically actuated by pressure from hydraulic control valve to control operation of fan. Hydraulic pressure supplied by power steering pump.

(O) **DRAINCOCK** - Draining point for radiator and cooling system.

(P) **RADIATOR SHROUD** - Permits a greater concentration of air to be pulled through the radiator.



1-21. STARTING SYSTEM OPERATION

The starting system is identical for all vehicles covered in this manual, and consists of the following components and circuits.

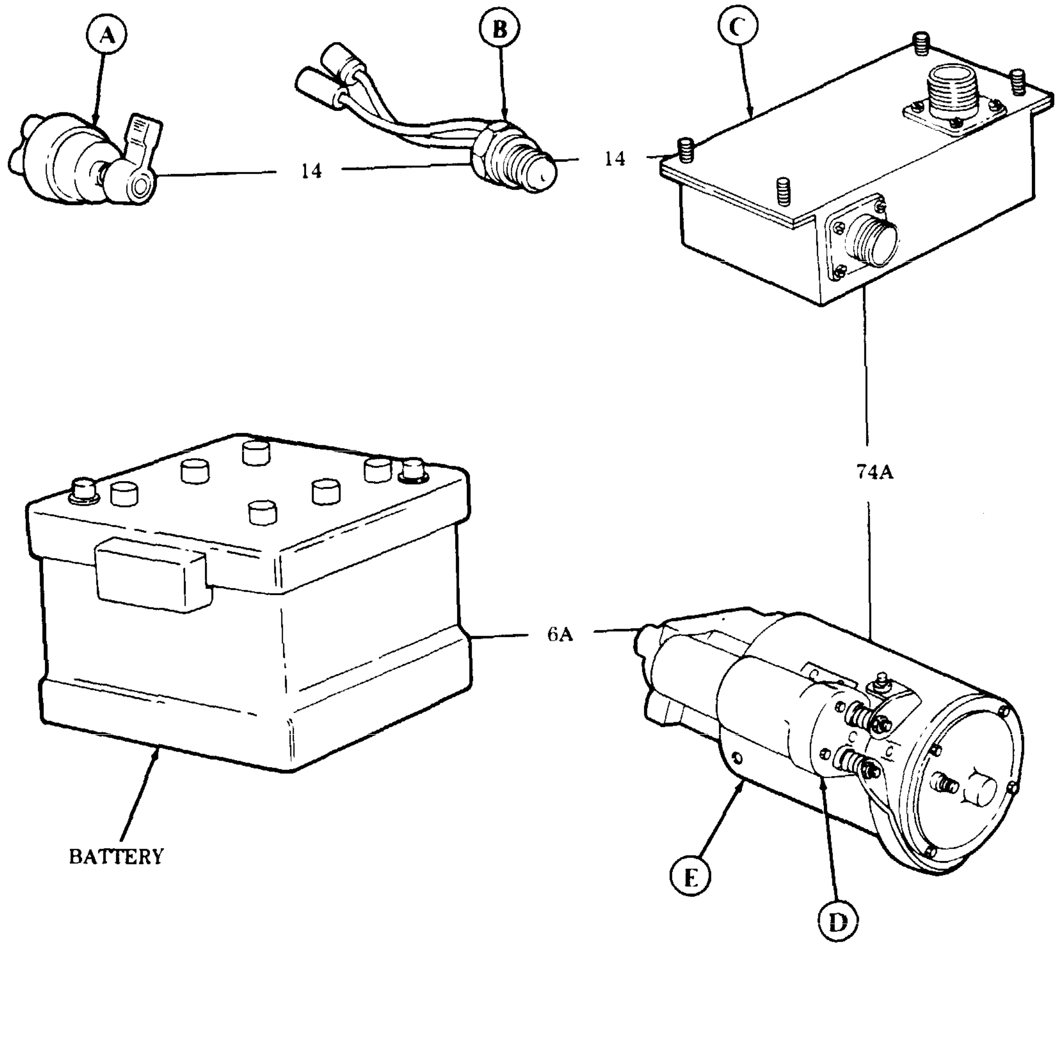
(A) **ROTARY SWITCH** - When in "START" position, provides battery power to the starter solenoid and to the neutral start switch through circuit 14.

(B) **NEUTRAL STARTER SWITCH** - When transmission shift lever is in "N" (neutral) position, this switch closes a relay in the protective control box through circuit 14 allowing battery power to reach the starter solenoid.

(C) **PROTECTIVE CONTROL BOX** - Locks out the starter circuit, which prevents starter from reengaging while engine is running.

(D) **STARTER SOLENOID** - A magnetic relay that transmits 24-volt battery power to the starter motor.

(E) **STARTER MOTOR** - Cranks the engine for starting, and is supplied 24-volt battery power through circuit 6A.



1-22. GENERATING SYSTEM OPERATION (60/100 AMPERE ALTERNATOR)

The 60 ampere generating system is identical for all vehicles except the M997, M997A1, M997A2 4-litter and M996, M996A1 2-litter ambulances.

(A) **BATTERY GAUGE – Indicates electrical system voltage. It is connected to the electrical system through circuit 567.**

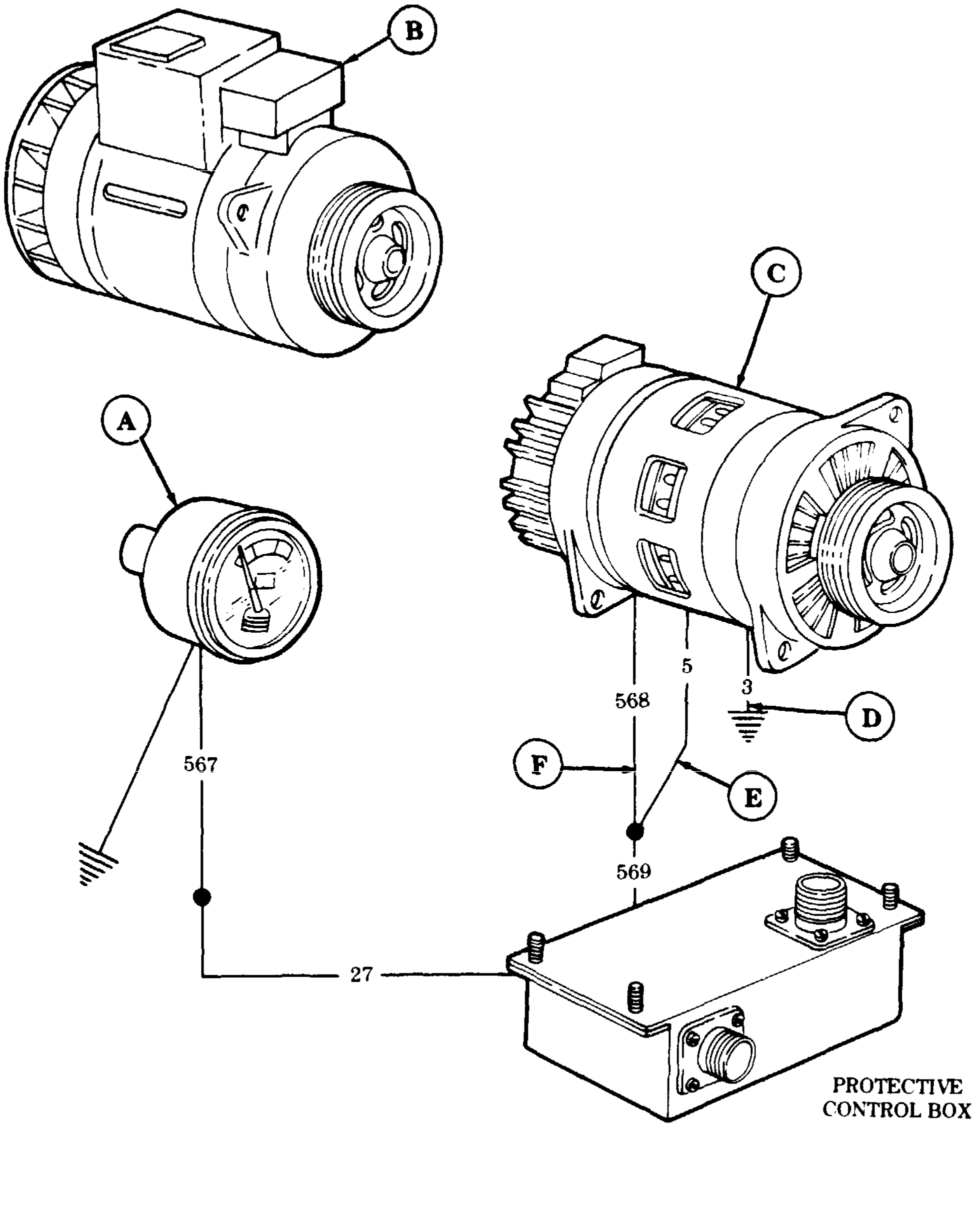
(B) **ALTERNATOR (100 ampere) – Rated at 28 volts, 100 amperes, with external regulator. The alternator assists and recharges the batteries during operation.**

(C) **ALTERNATOR (60 ampere) – Rated at 28 volts, 60 amperes, with internal regulator. The alternator assists and recharges the batteries during operation.**

(D) **CIRCUIT 3 – Provides a ground circuit to alternator.**

(E) **CIRCUIT 5 – Conducts alternator output to charge the batteries and maintain vehicle voltage.**

(F) **CIRCUIT 568 – Senses vehicle voltage activating the field current in the alternator to generate current.**



1-23. GENERATING SYSTEM OPERATION (200 AMPERE ALTERNATOR)

The 200 ampere generating system maintains battery charge and provides electrical power to operate vehicle circuits. Major components of the generating system are:

(A) **BATTERY GAUGE** - Indicates electrical system voltage. It is connected to the electrical system through circuit 567.

(B) **ALTERNATOR (200 AMPERE)** - Is rated at 28 volts, 200 amperes, with external regulator. The alternator assists and recharges the vehicle batteries during operation.

(C) **CIRCUIT 568/CIRCUIT 5 (ALTERNATOR A0013036AA ONLY)** - Senses vehicle voltage, and activates the field current in the alternator to generate current.

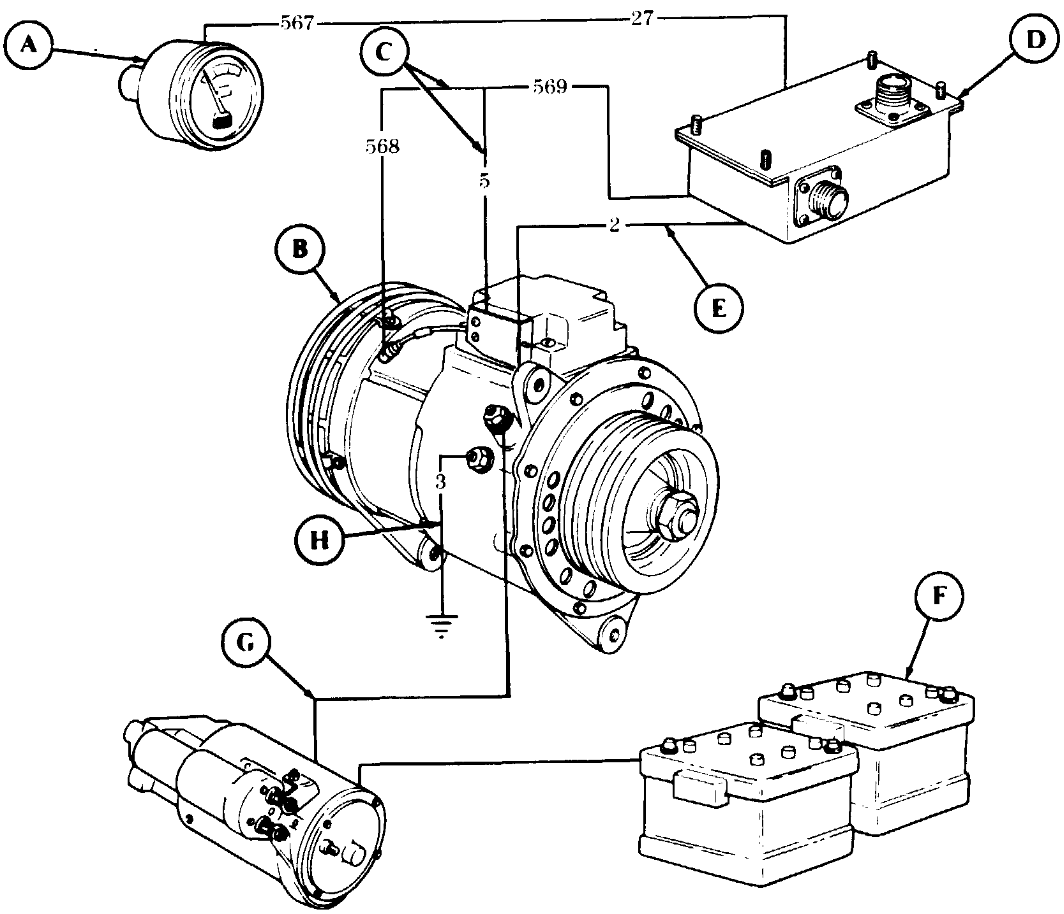
(D) **PROTECTIVE CONTROL BOX** - Protects the vehicle electrical system in the event battery polarity is reversed.

(E) **CIRCUIT 2** - Sends AC signal, indicating alternator shaft rpm, to frequency switch in protective control box to prevent operation of starter solenoid when engine is running.

(F) **BATTERIES** - Two 12-volt batteries are connected in a series to provide 24 volts to start vehicle and assist alternator during operation.

(G) **POSITIVE CABLE** - Transmits alternator output to maintain battery charge. A fuse at the alternator power stud will prevent damage to alternator if battery polarity is reversed.

(H) **CIRCUIT 3** - Connects to negative stud on alternator with engine ground strap to provide a ground circuit to alternator.



1-23.1. GENERATING SYSTEM OPERATION (100 AMPERE DUAL VOLTAGE ALTERNATOR)

The 100-ampere dual voltage generating system maintains battery charge and provides electrical power to operate vehicle circuits. Major components of the generating system are:

A **BATTERY GAUGE** – Indicates electrical system voltage. It is connected to the electrical system through circuit 567.

B **ALTERNATOR (100 AMPERE)**– Is rated at 28 volts at 100 amperes and 14 volts at 50 amperes with external regulator. The alternator assists and recharges the vehicle batteries during operation.

C **CIRCUIT 568** – Senses vehicle voltage, and activates the field current in the alternator circuit to alternator.

D **PROTECTIVE CONTROL BOX / DISTRIBUTION BOX*** – Protects the vehicle electric system in the event battery polarity is reversed. Provides load dump, glow plug operation, and interfacing of engine and body harnesses.

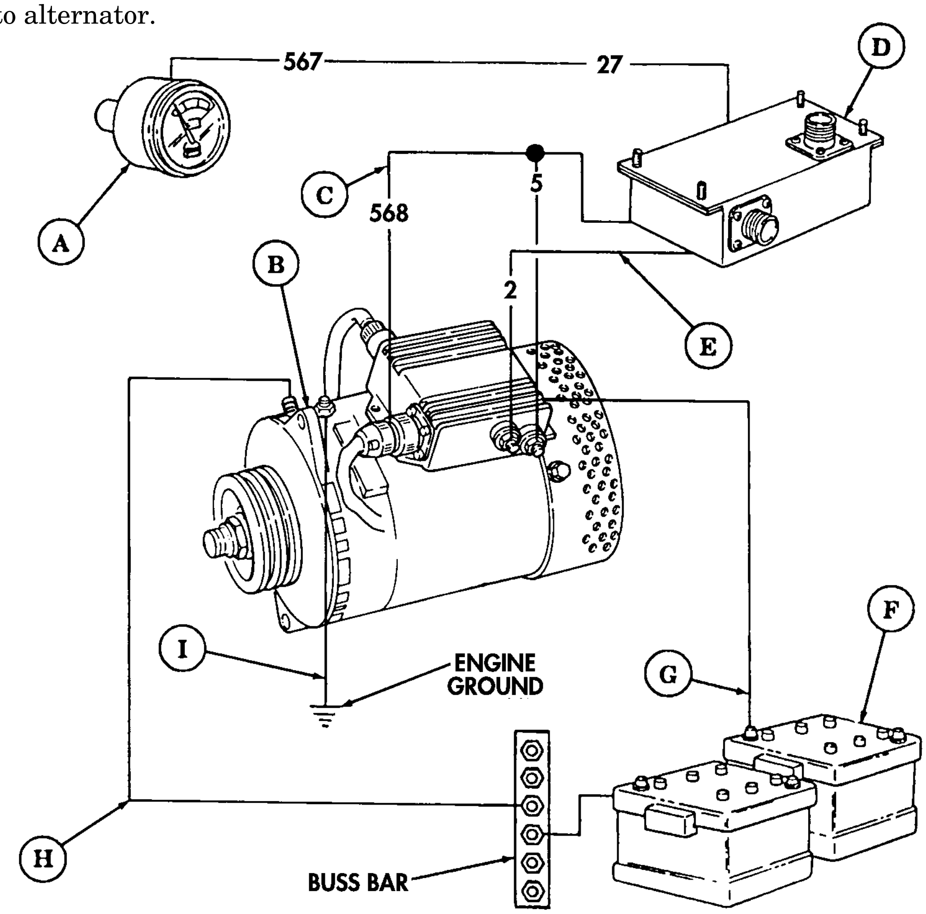
E **CIRCUIT 2** – Sends AC signal, indicating alternator shaft rpm, to frequency switch in protective control box to prevent operation of starter solenoid when engine is running.

F **BATTERIES** – Two 12-volt batteries are connected in a series to provide 24 volts to start vehicle and assist alternator during operation.

G **POSITIVE CABLE 6** – Provides 28-volt alternator output to maintain charge across two batteries.

H **POSITIVE CABLE 68A** – Provides 16-volt alternator output to maintain charge across the lower battery.

I **CIRCUIT 3** – Connects to negative stud on alternator with engine ground strap to provide a ground circuit to alternator.



* Distribution box provides same function as protective control box except distribution box does not protect against reversal of battery polarity.

1-23.2. GENERATING SYSTEM OPERATION (200 AMPERE DUAL VOLTAGE ALTERNATOR)

The 200-ampere dual voltage generating system maintains battery charge and provides electrical power to operate vehicle circuits. Major components of the generating system are:

A **BATTERY GAUGE** – Indicates electrical system voltage. It is connected to the electrical system through circuit 567.

B **ALTERNATOR (200 AMPERE)** – Is rated at 28 volts at 200 amperes and 14 volts at 50 amperes with external regulator. The alternator assists and recharges the vehicle batteries during operation.

C **CIRCUIT 568** – Senses vehicle voltage, and activates the field current in the alternator circuit to alternator.

D **PROTECTIVE CONTROL BOX / DISTRIBUTION BOX*** – Protects the vehicle electric system in the event battery polarity is reversed. Provides load dump, glow plug operation, and interfacing of engine and body harnesses.

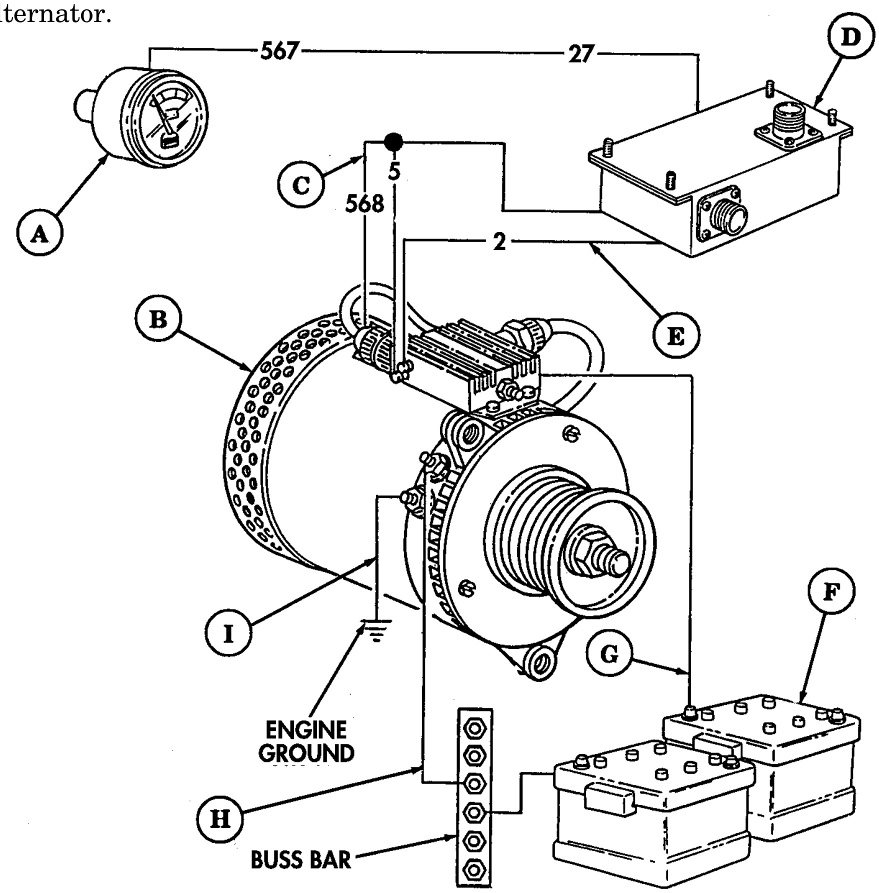
E **CIRCUIT 2** – Sends AC signal, indicating alternator shaft rpm, to frequency switch in protective control box to prevent operation of starter solenoid when engine is running.

F **BATTERIES** – Two 12-volt batteries are connected in a series to provide 24 volts to start vehicle and assist alternator during operation.

G **POSITIVE CABLE 6** – Provides 28-volt alternator output to maintain charge across two batteries.

H **POSITIVE CABLE 68A** – Provides 16-volt alternator output to maintain charge across the lower battery.

I **CIRCUIT 3** – Connects to negative stud on alternator with engine ground strap to provide a ground circuit to alternator.



* Distribution box provides same function as protective control box except distribution box does not protect against reversal of battery polarity.

1-23.3. GENERATING SYSTEM OPERATION (400 AMPERE DUAL VOLTAGE ALTERNATOR)

The 400-ampere dual voltage generating system maintains battery charge and provides electrical power to operate vehicle circuits. Major components of the generating system are:

A **BATTERY GAUGE** – Indicates electrical system voltage. It is connected to the electrical system through circuit 567.

B **ALTERNATOR (400 AMPERE)** – Is rated at 28 volts at 400 amperes and 14 volts at 50 amperes with external regulator. The alternator assists and recharges the vehicle batteries during operation.

C **CIRCUIT 568** – Senses vehicle voltage, and activates the field current in the alternator circuit to alternator.

D **PROTECTIVE CONTROL BOX / DISTRIBUTION BOX*** – Protects the vehicle electric system in the event battery polarity is reversed. Provides load dump, glow plug operation, and interfacing of engine body harnesses.

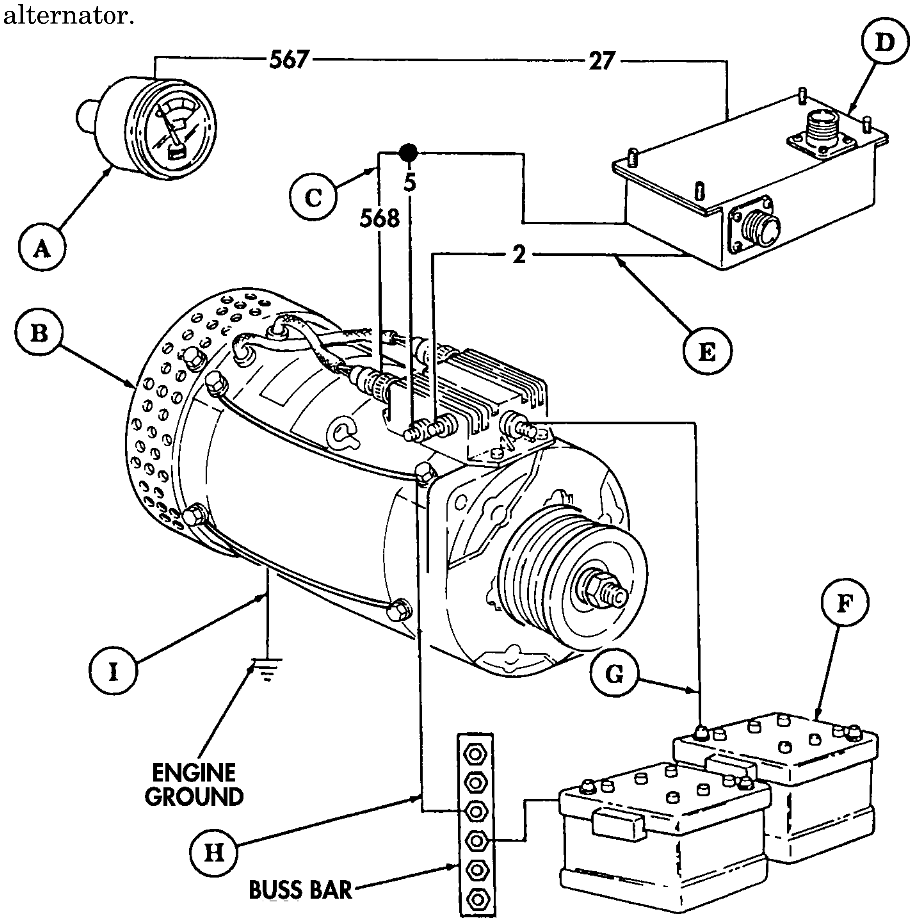
E **CIRCUIT 2** – Sends AC signal, indicating alternator shaft rpm, to frequency switch in protective control box to prevent operation of starter solenoid when engine is running.

F **BATTERIES** – Two 12-volt batteries are connected in a series to provide 24 volts to start vehicle and assist alternator during operation.

G **POSITIVE CABLE 6** – Provides 28-volt alternator output to maintain charge across two batteries.

H **POSITIVE CABLE 68A** – Provides 16-volt alternator output to maintain charge across the lower battery.

I **CIRCUIT 3** – Connects to negative stud on alternator with engine ground strap to provide a ground circuit to alternator.



* Distribution box provides same function as protective control box except distribution box does not protect against reversal of battery polarity.

1-24. BATTERY SYSTEM OPERATION

The battery system is identical for all vehicles covered in this manual and consists of the following circuits and components.

A **CIRCUIT 6A-** Connects the batteries to the starter and to the protective control box through circuit 74A.

B **BATTERIES** - Two 6TN batteries are connected to provide 24 volts D.C. for the electrical starting system.

C **SLAVE RECEPTACLE** - Links an external power source directly to the slaved vehicle's batteries to assist in cranking the engine when the vehicle's batteries are not sufficiently charged.

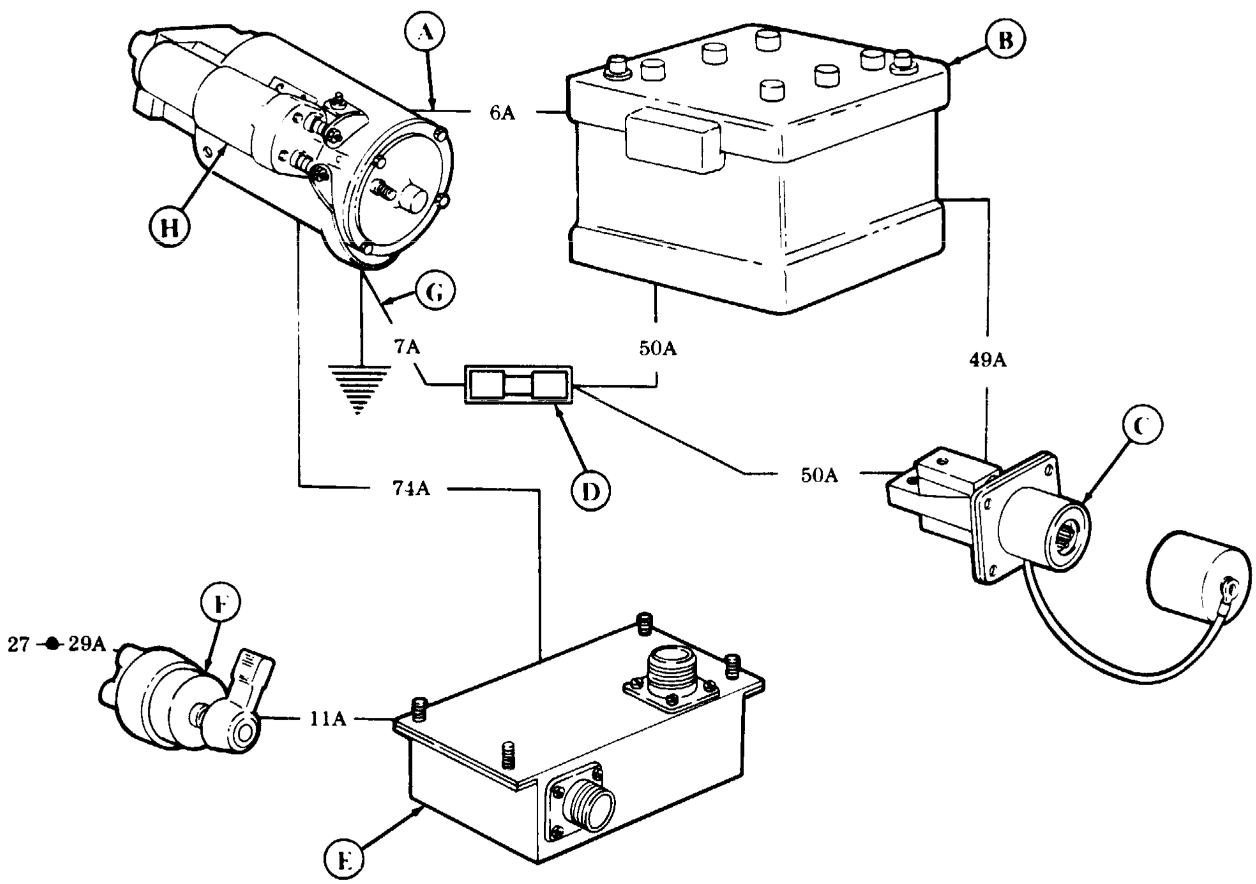
D **SHUNT** - Used when measuring current draw from batteries utilizing STE/ICE-R.

E **PROTECTIVE CONTROL BOX** - Protects the vehicle electrical system in the event the battery system polarity is reversed.

F **ROTARY SWITCH** - When in "START" position actuates starter solenoid through circuit 11A and 74A. When in "RUN" position closes circuit 29A to activate instrument cluster gages through circuit 27.

G **CIRCUIT 7A-** Connects the battery system to the starter negative terminal and chassis ground.

H **STARTER SOLENOID** - Actuates starter motor gear to crank vehicle engine.



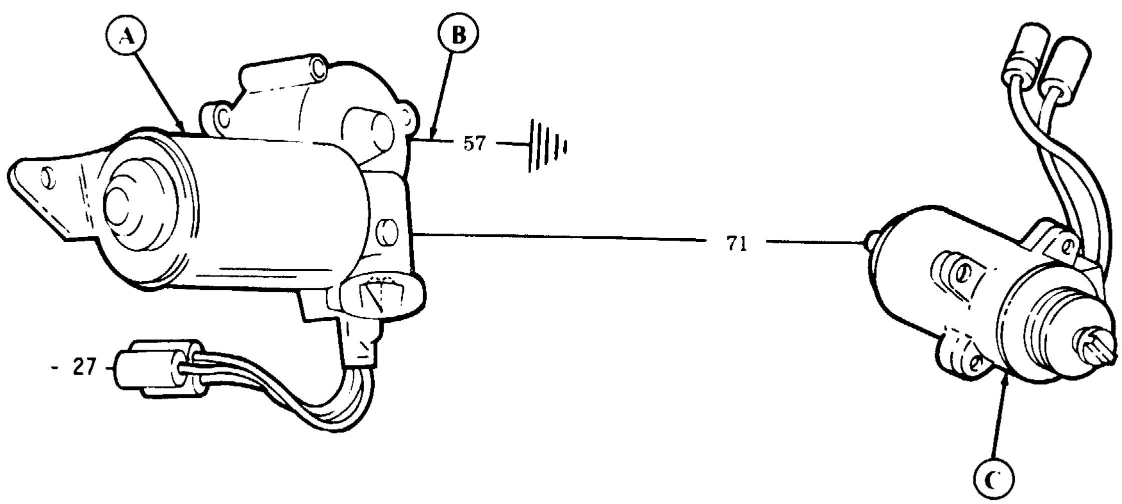
1-25. WINDSHIELD WIPER/WASHER SYSTEM OPERATION

The following miscellaneous components and circuits are not covered in any of the other electrical systems:

(A) **WINDSHIELD WIPER MOTOR** - When knob is turned to "LOW" or "HIGH" position, circuit 27 carries battery power to wiper motor to activate windshield wipers.

(B) **CIRCUIT 57-** Provides a ground circuit for wiper motor.

(C) **WINDSHIELD WASHER MOTOR** - When knob on wiper motor is pushed, the washer motor is activated through circuit 71 to spray water onto windshield.



1-26. PARKING BRAKE SYSTEM OPERATION

The parking brake system for vehicles with serial numbers 1 through 44824 is a mechanically-actuated system that provides a means of keeping the vehicle still once it stops. It also assists in emergency stopping if there is a service brake system failure. Major components of the parking brake system are:

(A) **PARKING BRAKE ROTOR** - Attached to pinion flange on rear differential, rotor prevents pinion flange from turning when parking brake is applied.

(B) **BRAKE PADS** - Apply friction to rotor when hand lever is applied.

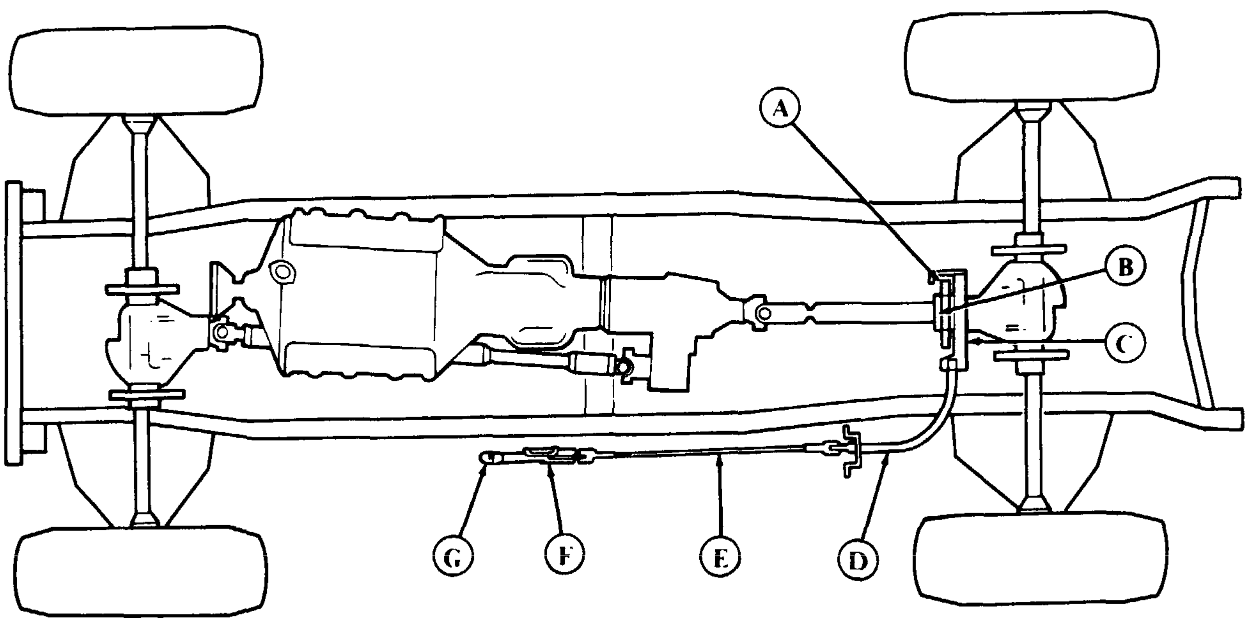
(C) **PARKING BRAKE CALIPER** - Forces brake pads against rotor when hand lever is applied.

(D) **PARKING BRAKE CABLE** - Connects brake caliper to parking brake rod at bracket on left frame rail.

(E) **PARKING BRAKE ROD** - Connects parking brake hand lever to parking brake cable by means of a adjustable clevis.

(F) **PARKING BRAKE HAND LEVER** - Permits operator to engage the parking brake.

(G) **PARKING BRAKE HAND LEVER ADJUSTING CAP** – Permits operator to make minor tension adjustment of parking brake.



1-27. SERVICE/PARKING BRAKE SYSTEM OPERATION

The parking brake system is a mechanically-actuated system that provides a means of keeping the vehicle still once it stops. It also assists in emergency stopping if there is a complete service brake system failure. Major components of the parking brake system are:

(A) **PARKING BRAKE ROTORS** - Attached to output flanges on rear differential, rotors prevents output flanges from turning when parking brake is applied.

(B) **BRAKE PADS** – Apply friction to rotors when hand lever is applied.

(C) **PARKING BRAKE CALIPERS** - Forces brake pads against rotors when hand lever is applied.

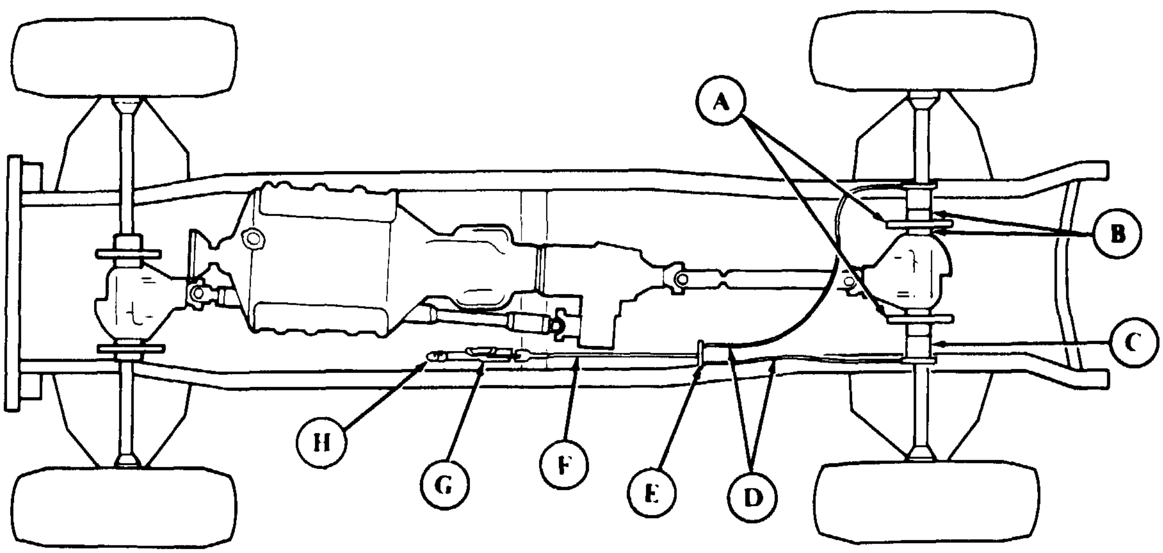
(D) **PARKING BRAKE CABLES** - Connects parking brake hand lever to equalizer bar.

(E) **EQUALIZER BAR** - Evenly distributes braking pressure to the rear brake rotors.

(F) **PARKING BRAKE ROD** - Connects parking brake hand lever to equalizer bar.

(G) **PARKING BRAKE HAND LEVER** - Permits operator to engage the parking brake.

(H) **PARKING BRAKE HAND LEVER ADJUSTING CAP** - Permits operator to make minor tension adjustment of parking brake.



1-28. SERVICE BRAKE SYSTEM OPERATION

The service brake system is identical for all models covered in this manual. It is an inboard-mounted, four-wheel, disc brake, hydraulically-assisted system. Major components of the braking system are:

A **HYDRO-BOOST** - Converts hydraulic power from the steering pump to mechanical power to the master cylinder, providing power assist during braking.

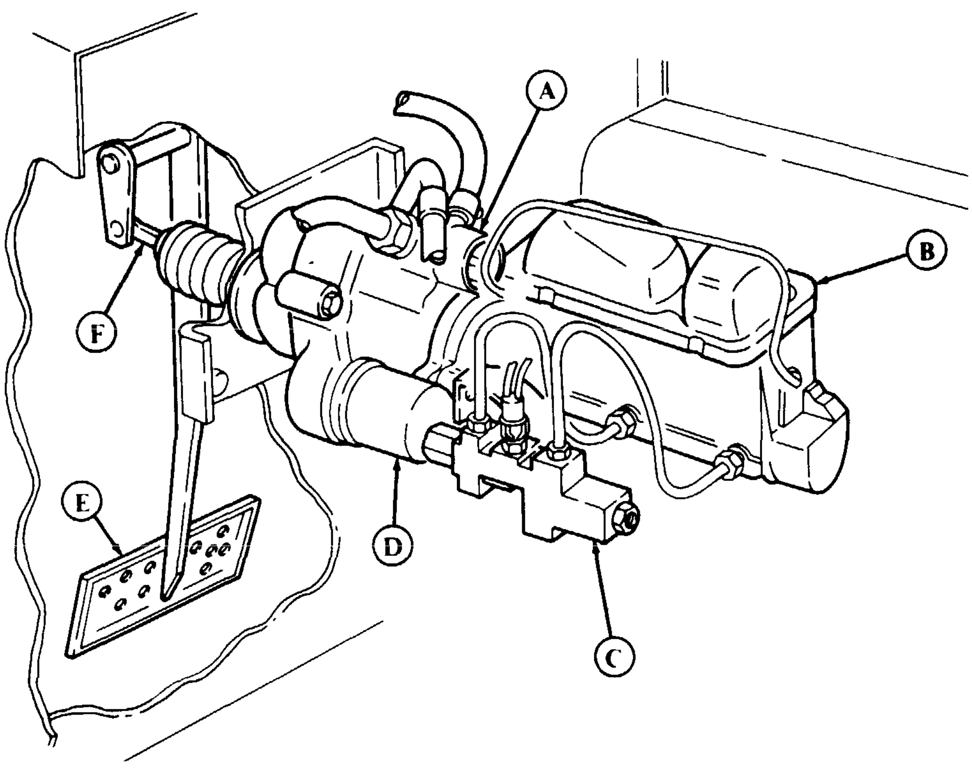
B **MASTER CYLINDER/RESERVOIR** - Stores brake fluid, and converts mechanical pedal pressure to hydraulic pressure.

C **PROPORTIONING VALVE** - Provides balanced front-to-rear braking and activates brake warning lamp in case of brake system malfunction.

D **ACCUMULATOR** - Stores hydraulic pressure for additional power-assisted braking in case of loss of pressure in steering system.

E **BRAKE PEDAL** - Provides operator control for stopping vehicle.

F **BRAKE LINKAGE** - Directs brake pedal pressure to hydro-boost.



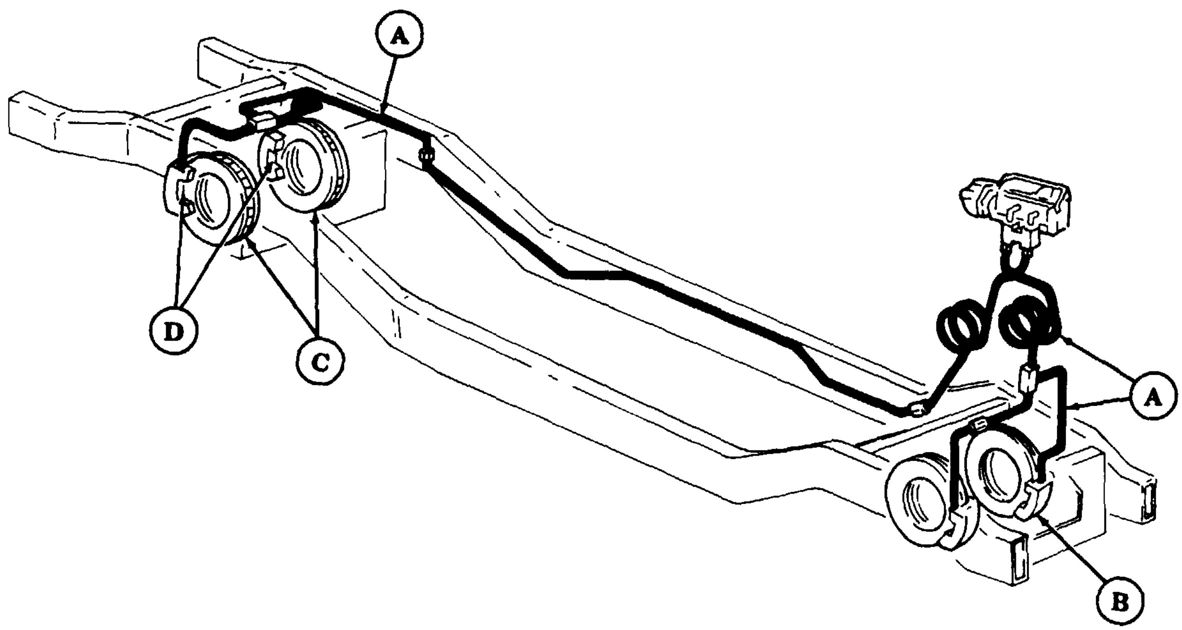
1-28. SERVICE BRAKE SYSTEM OPERATION (Cont'd)

(A) **HYDRAULIC BRAKE LINES** - Directs brakes fluid under pressure to all four brake calipers from master cylinder.

(B) **BRAKE CALIPER** - Converts hydraulic pressure to mechanical force to compress brake pads against brake rotors.

(C) **BRAKE ROTOR** - Attached to output flange on front and rear differentials, rotor prevents output flange from turning when brakes are applied.

(D) **BRAKE PADS** - Apply friction to brake rotor when brake pedal is depressed.



1-29. STEERING CONTROL SYSTEM OPERATION

The steering system is identical for all models covered in this manual. Major components of the steering system are:

A **HYDRAULIC CONTROL VALVE** - Directs hydraulic fluid to provide required pressure to actuate and deactuate fan clutch as required by engine temperature. Hydraulic pressure supplied by power steering pump.

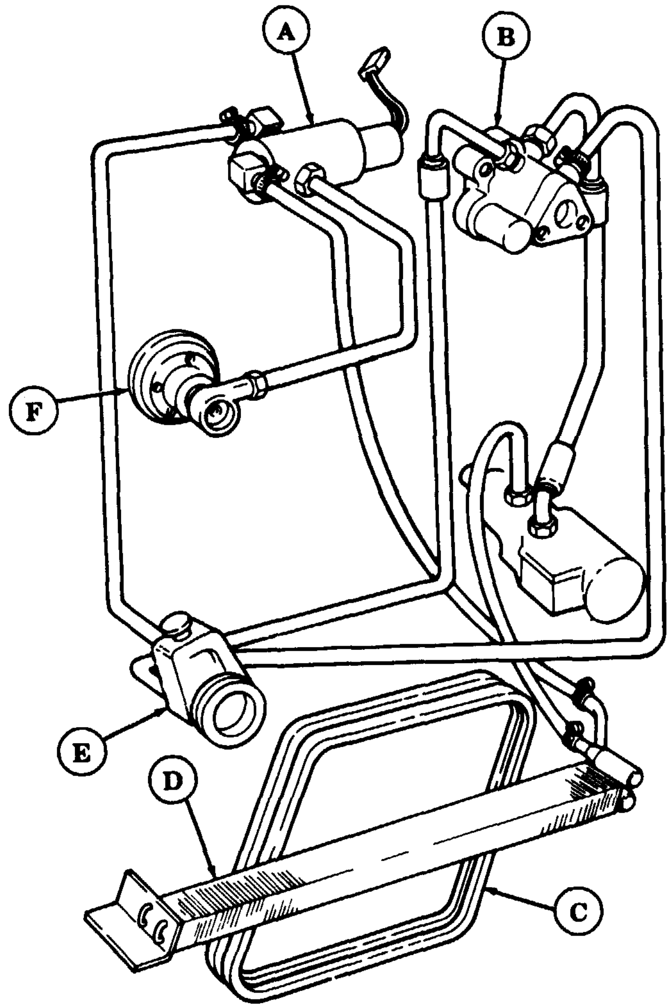
B **HYDRO-BOOST** - Converts hydraulic power from the steering pump to mechanical power to the master cylinder, providing power assist during braking.

C **ACCESSORY DRIVE PULLEY BELTS** - Transmits mechanical driving power from crankshaft drive pulley to steering pump pulley which drives the steering pump.

D **POWER STEERING COOLER** - Directs power steering fluid through a series of fins or baffles so outside air can dissipate excess heat before the fluid is recirculated through the steering system.

E **OIL RESERVOIR AND STEERING PUMP** - Combined in one unit, the reservoir serves as an oil filling point and the pump supplies the oil under pressure throughout the steering system.

F **FAN CLUTCH** - Hydraulically-actuated by pressure from hydraulic control valve to control operation of fan. Hydraulic pressure supplied by power steering pump.



1-29. STEERING CONTROL SYSTEM OPERATION (Cont'd)

(A) **STEERING WHEEL** - Serves as manual steering control for the operator.

(B) **STEERING COLUMN** - Transmits turning effort from steering wheel to intermediate steering shaft.

(C) **INTERMEDIATE STEERING SHAFT** - Permits angle of torque from steering column to input shaft of power steering gear.

(D) **STEERING GEAR** - Converts hydraulic power from steering pump to mechanical power at pitman arm.

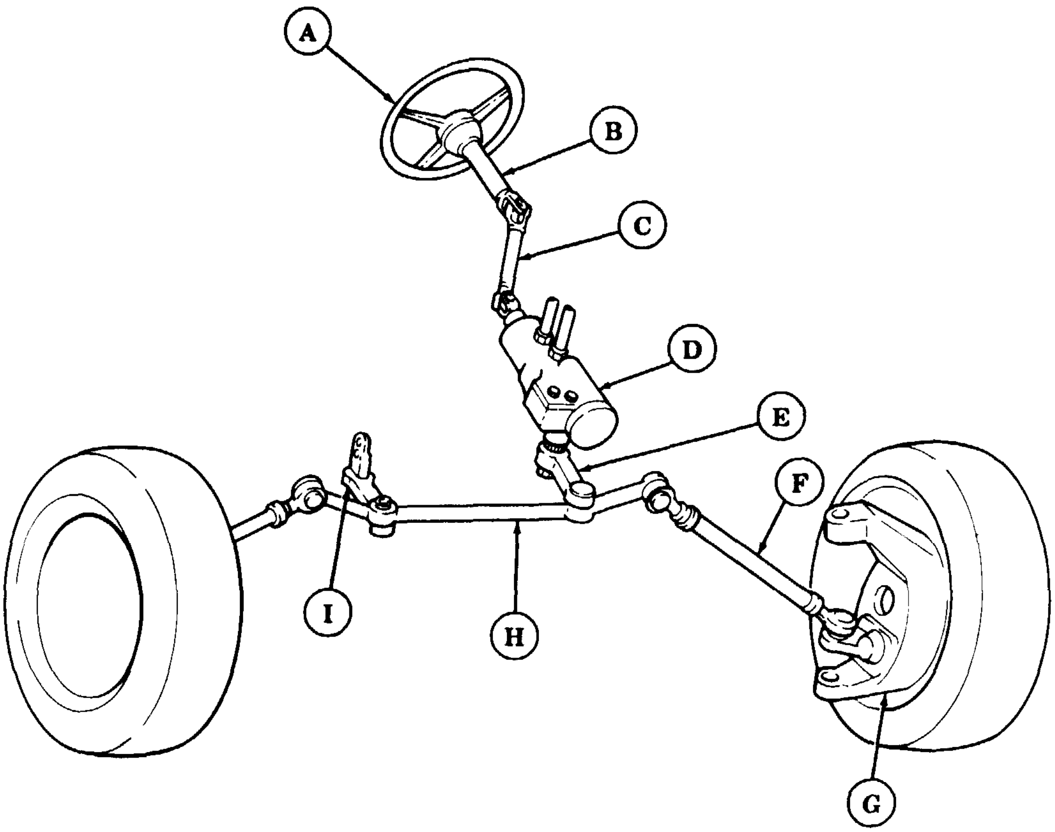
(E) **PITMAN ARM** - Transfers steering torque from power steering gear to center link.

(F) **TIE ROD ASSEMBLY** - Transmits movement from center link to geared hub.

(G) **GEARED HUB** - Serves as the pivot point and link for the front wheels via the tie rod assembly.

(H) **CENTER LINK** - Transmits movement from pitman arm to tie rods.

(I) **IDLER ARM** – Supports right side of center link.



1-30. SUSPENSION SYSTEM OPERATION

The suspension system is identical for all models covered in this manual. It is an independent coil spring type system. Major components of the suspension system are:

A **BALL JOINTS** – Connects geared hub to control arms, and allows change of angle between geared hub and control arms during suspension movement.

B **UPPER CONTROL ARM** – Connects geared hub to frame rail.

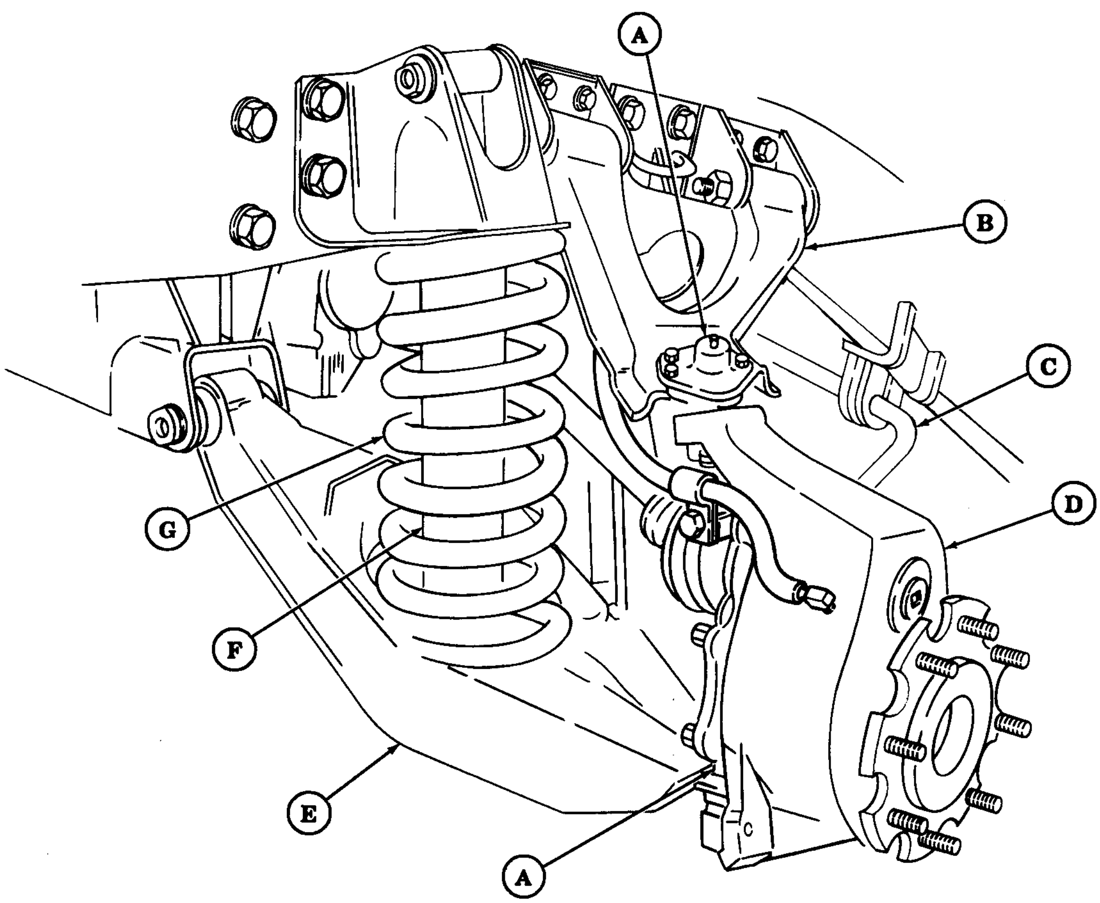
C **STABILIZER BAR (FRONT ONLY)** – Prevents vehicle sway when cornering.

D **GEARED HUB** – Serves as a mounting point for wheel and tire assembly and provides 1.92:1 gear reduction to increase torque to wheel and tire assembly.

E **LOWER CONTROL ARM** – Connects geared hub to frame rail.

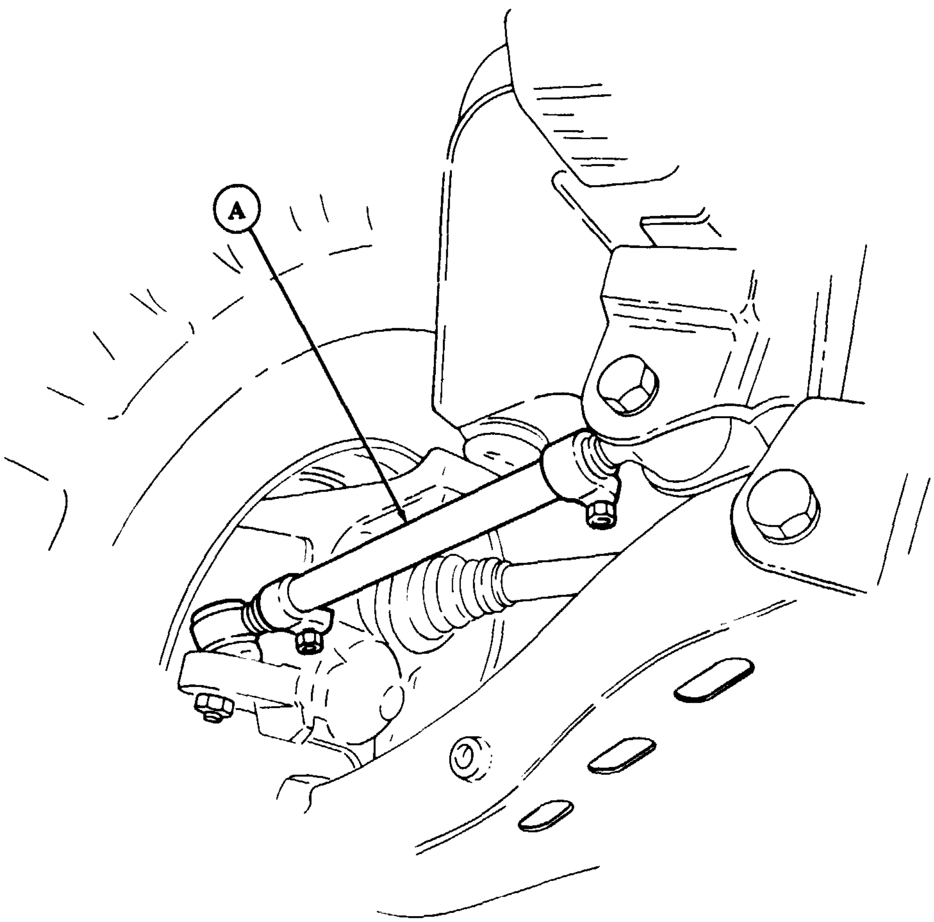
F **SHOCK ABSORBER** – Dampens suspension movement and limits amount of suspension travel.

G **COIL SPRING** – Supports weight of vehicle and allows suspension travel to vary depending on terrain and vehicle loading.



1-30. SUSPENSION SYSTEM OPERATION (Cont'd)

(A) **RADIUS ROD (REAR ONLY) –** Connects geared hub to frame, to maintain rear end alinement.



1-31. AMBULANCE PATIENT COMPARTMENT FUEL BURNING HEATER SYSTEM OPERATION

The ambulance patient compartment fuel burning heater in the M996, M996A1, M997, M997A1, and M997A2 vehicles are similar in that they are multi-fuel burning and heat filtered fresh air. Major components of the fuel burning heater system are:

(A) **FRESH AIR INTAKE GRILLE** — The entry point of fresh air for the heater and ventilation system. The grille stops large debris from entering the system.

(B) **FRESH AIR FILTER** — Filters out dust and dirt which could foul the system.

(C) **FUEL BURNING HEATER** — A self-contained heater/blower unit which heats filtered fresh air with a heat exchanger and forces it out to heat vents in the patient compartment.

(D) **HEATER EXHAUST PIPE** — Outlet for exhaust gases from fuel burning heater.

(E) **HEATING/VENTILATION AND AIR-CONDITIONING SYSTEM (HVAC) CONTROL BOX** — The central point of operation for fuel burning heater.

(F) **ELECTRICAL SYSTEM FUSE BOX** — Provides electrical overload protection for the HVAC system.

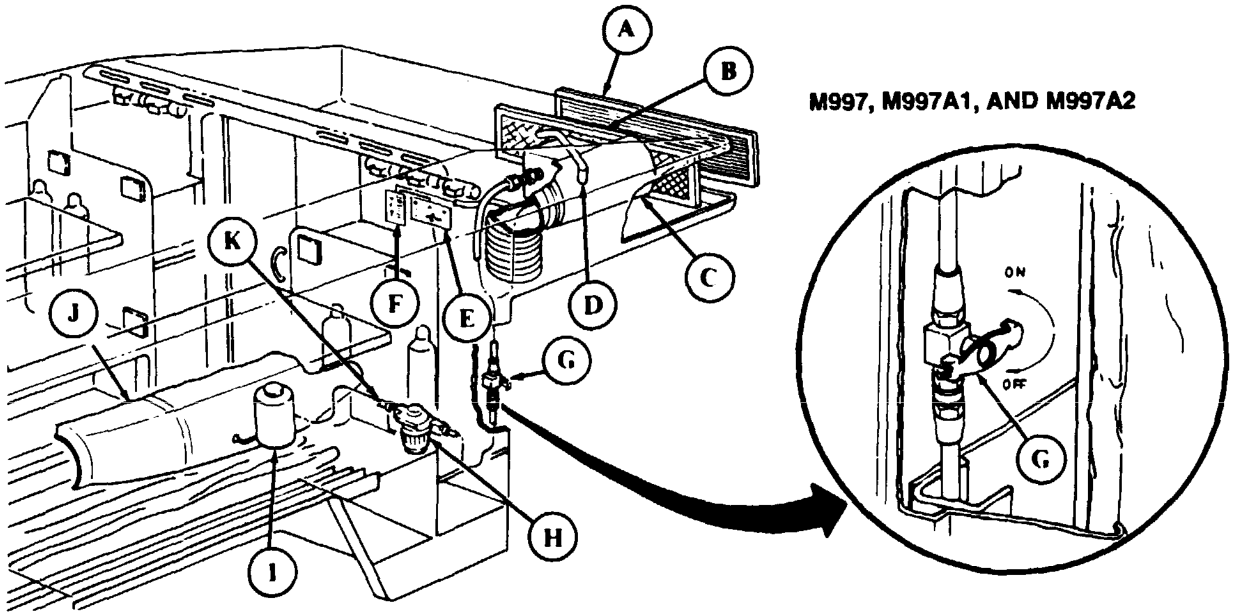
(G) **MANUAL SHUTOFF VALVE** — Stops fuel flow to heater in an emergency or when performing maintenance on the heater.

(H) **FUEL FILTER** — Filters contaminants out of the fuel for efficient burning.

(I) **FUEL PUMP** — Pumps fuel out of the fuel tank and provides fuel pressure to the rest of the system. Pump will not draw fuel if tank is below 1/4 tank.

(J) **FUEL TANK** — The supply point of fuel for fuel burning heater.

(K) **FUEL LINES** — Supply fuel to the fuel burning heater.



1-32. M997, M997A1, AND M997A2 AMBULANCE AIR-CONDITIONING SYSTEM OPERATION

The air-conditioning system covered in this manual applies only to the M997, M997A1, and M997A2 vehicles and consists of the following major components:

(A) **COMPRESSOR** - Inside the compressor, low pressure gas refrigerant is compressed into a high pressure gas that is pushed into the condenser by the compressor.

(B) **DISCHARGE LINE** - High pressure gas is carried through the discharge line from the compressor to the condenser.

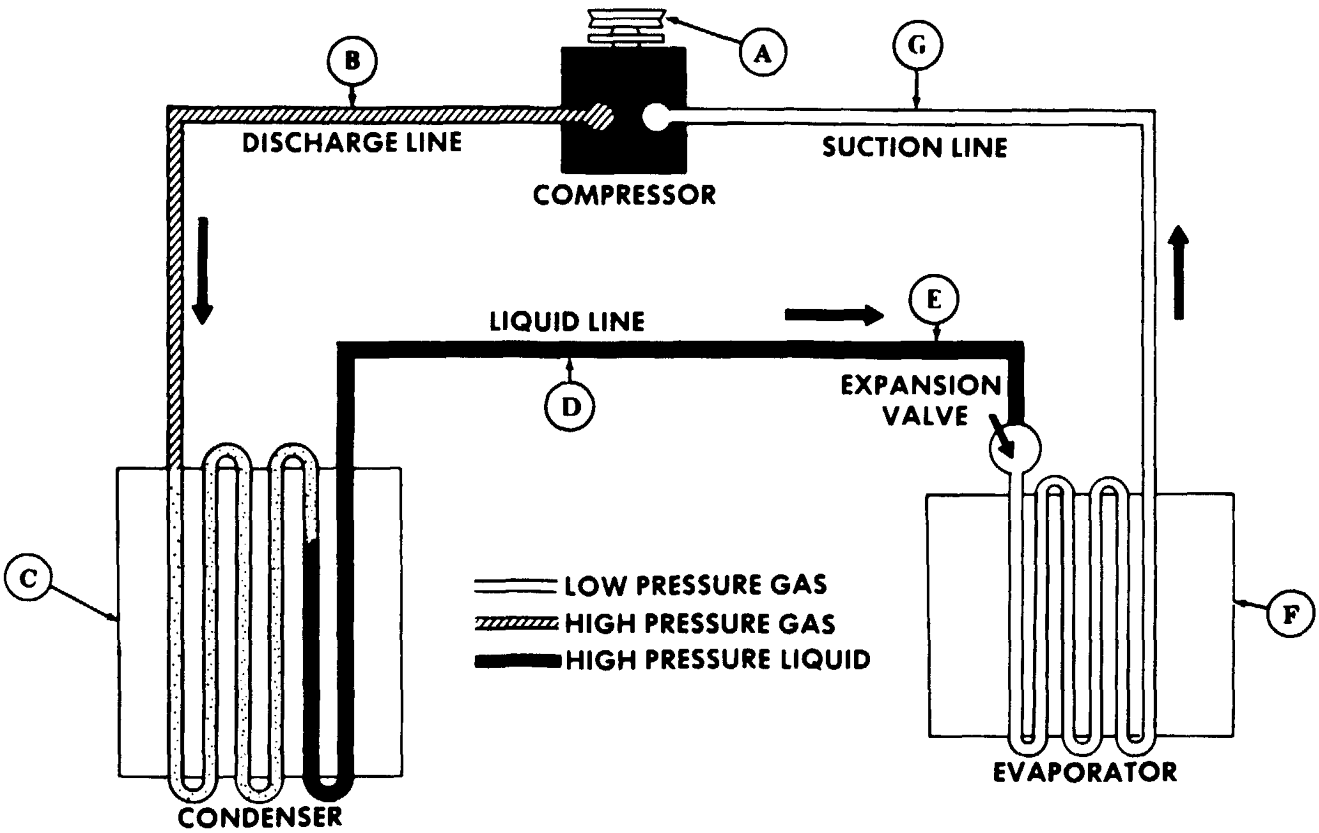
(C) **CONDENSER** - Refrigerant enters the condenser as a high pressure gas. When condensed, it gives up its heat to the outside air and becomes a high pressure liquid.

(D) **LIQUID LINE** - High pressure liquid refrigerant is carried back to the evaporator by the liquid line to repeat the evaporation/condensation cycle.

(E) **EXPANSION VALVE** - High pressure liquid refrigerant enters a non-adjustable expansion valve where the refrigerant is formed into a liquid spray.

(F) **EVAPORATOR** - Refrigerant enters evaporator as a liquid spray. It absorbs heat from the air in the patient compartment and vaporizes into a low pressure gas.

(G) **SUCTION LINE** - Refrigerant in low pressure gas form is drawn from the evaporator by the suction action of the compressor.



1-33. STOWAGE RACKS AND TIEDOWN STRAPS

The stowage racks and tiedown straps covered in this manual apply to the M1097, M1097A1, M1097A2, and M1123 vehicles and consist of the following major components:

A **AMMO STOWAGE RACK AND AMMO STRAP ASSEMBLY —** Provides stowage for twenty-two ammunition rounds during transportation and allows quick access to rounds during reload operations.

B **M60 MACHINE GUN STRAPS** (two each) — Secure M60 machine gun on top of ammo rack.

C **JACK STRUT SPRING CLIPS** (two each) — Secure jack strut on top of ammo rack.

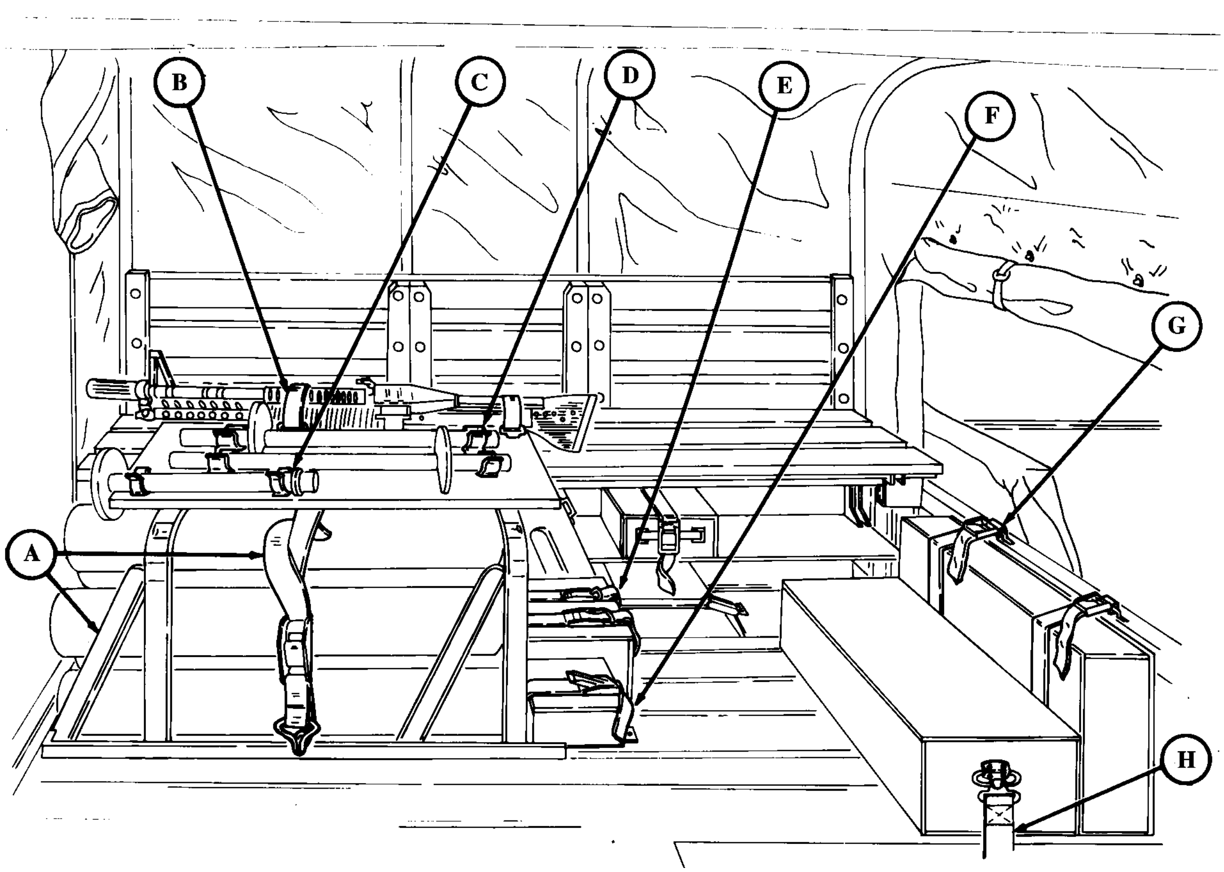
D **PARALLELOSCOPE SPIKE CLIPS** (four each) — Secure two aiming stacks on top of ammo rack.

E **SIGHT BOX #1 STRAPS** (two each) — Secure sight box #1 to cargo floor in front of ammo rack.

F **SIGHT BOX #2 STRAP —** Secure sight box #2 to cargo floor in front of ammo rack.

G **SPADE STRAPS** (two each) — Secure spade on cargo floor and against cargo bulkhead.

H **SECTION CHEST STRAPS** (two each) — Secure section box on cargo floor.



1-33. STOWAGE RACKS AND TIEDOWN STRAPS (Cont'd)

(A) **FUEL CAN STRAP** - Secures fuel cans to cargo bulkhead in front of right footwell.

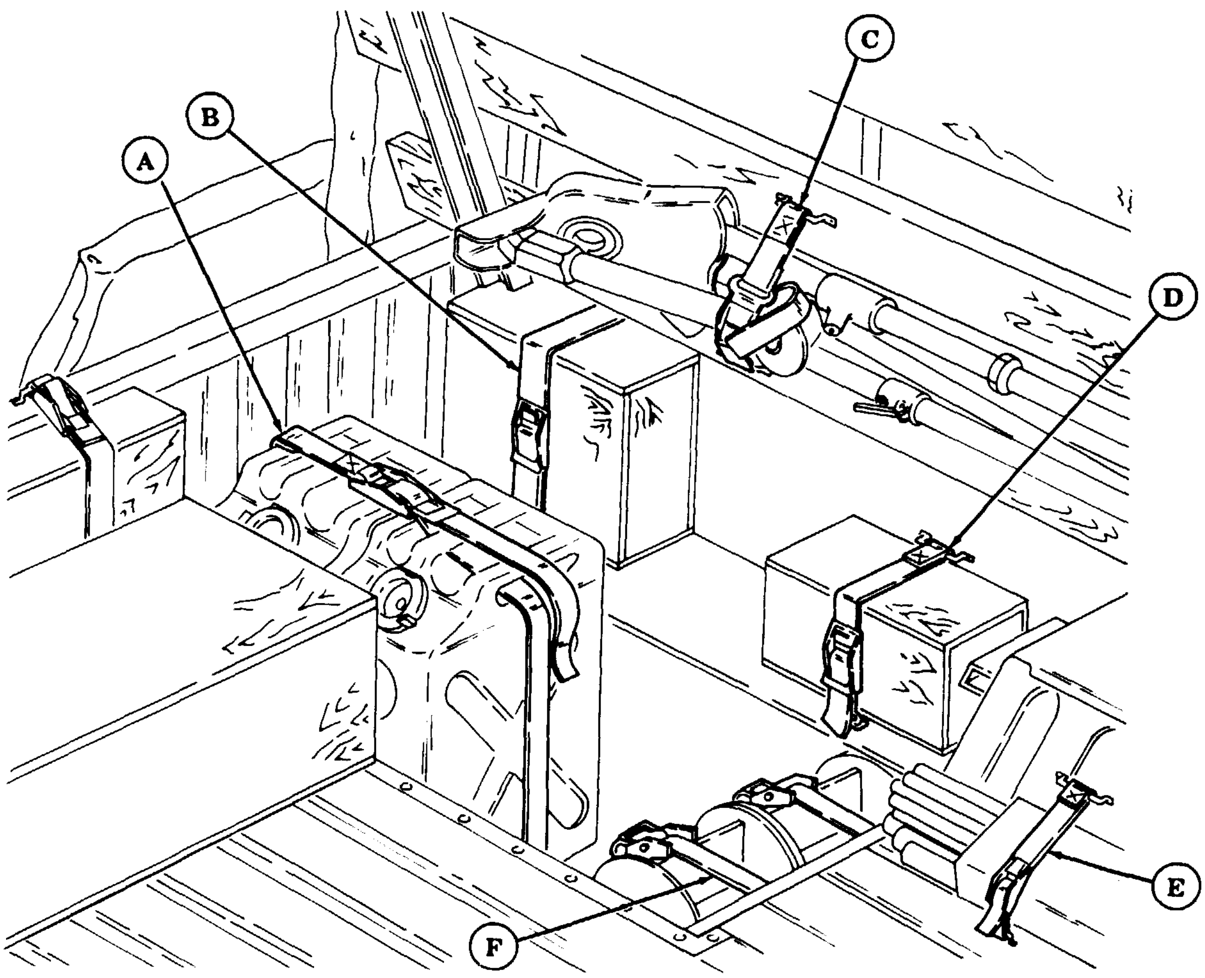
(B) **REMOTE STRAP** - Secures remote to right fixed door behind companion seat.

(C) **TRIPOD STRAPS (two each)** - Secure tripod to bottom of troop seat.

(D) **TELEPHONE STRAP** - Secures telephone to right fixed door in front of wheelhouse.

(E) **PARALLELOSCOPE AIMING POST STRAPS (three each)** - Secure paralleloscope and aiming posts to cargo floor and right wheelhouse.

(F) **CABLE REEL STRAPS (two each)** - Secure cable reels to right footwell in front of wheelhouse.

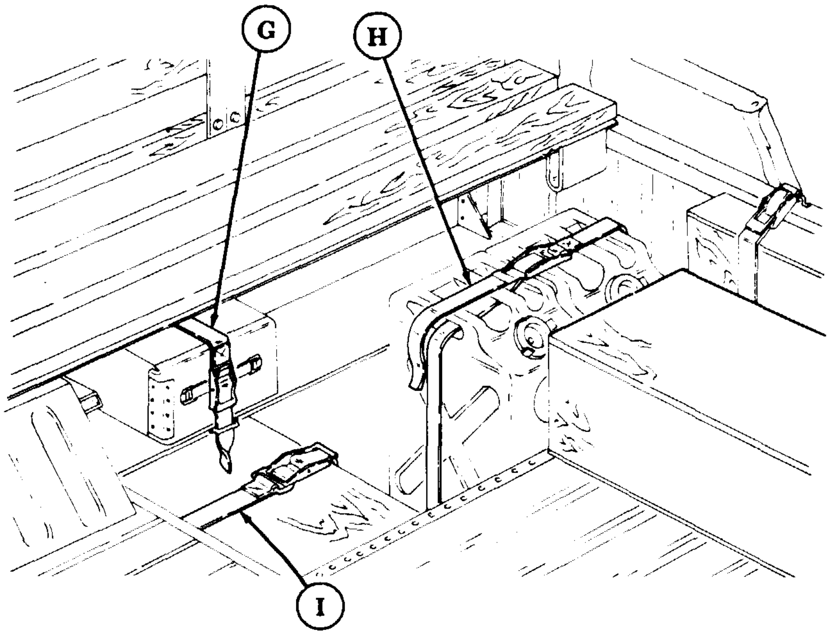


1-33. STOWAGE RACKS AND TIEDOWN STRAPS (Cont'd)

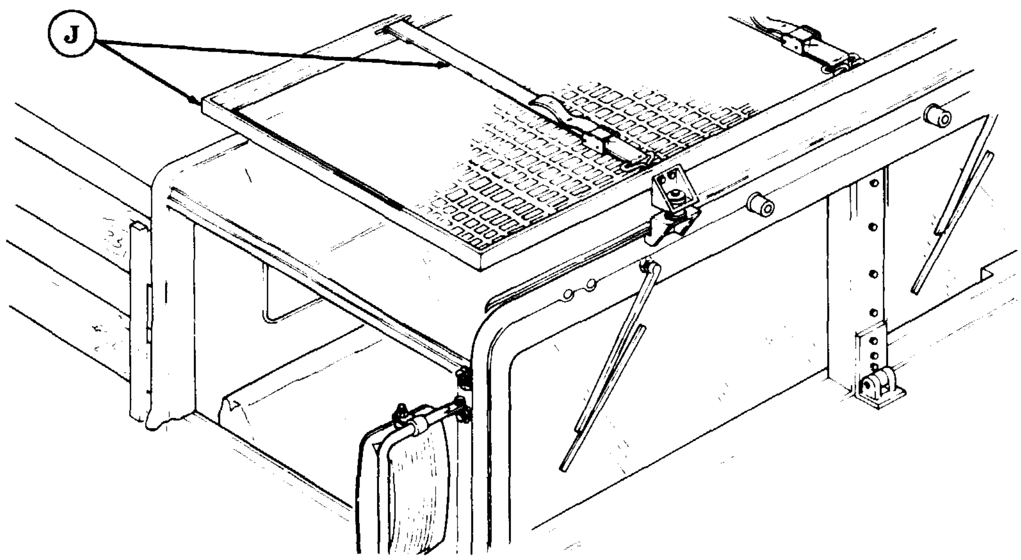
G **G.D.U. BATTERY STRAP** - Secures G.D.U. battery to left fixed door in front of wheelhouse.

H **WATER CAN STRAP** - Secures water cans to cargo bulkhead in front of left footwell.

I **G.D.U. BOX STRAP** - Secures G.D.U. to left footwell in front of wheelhouse.



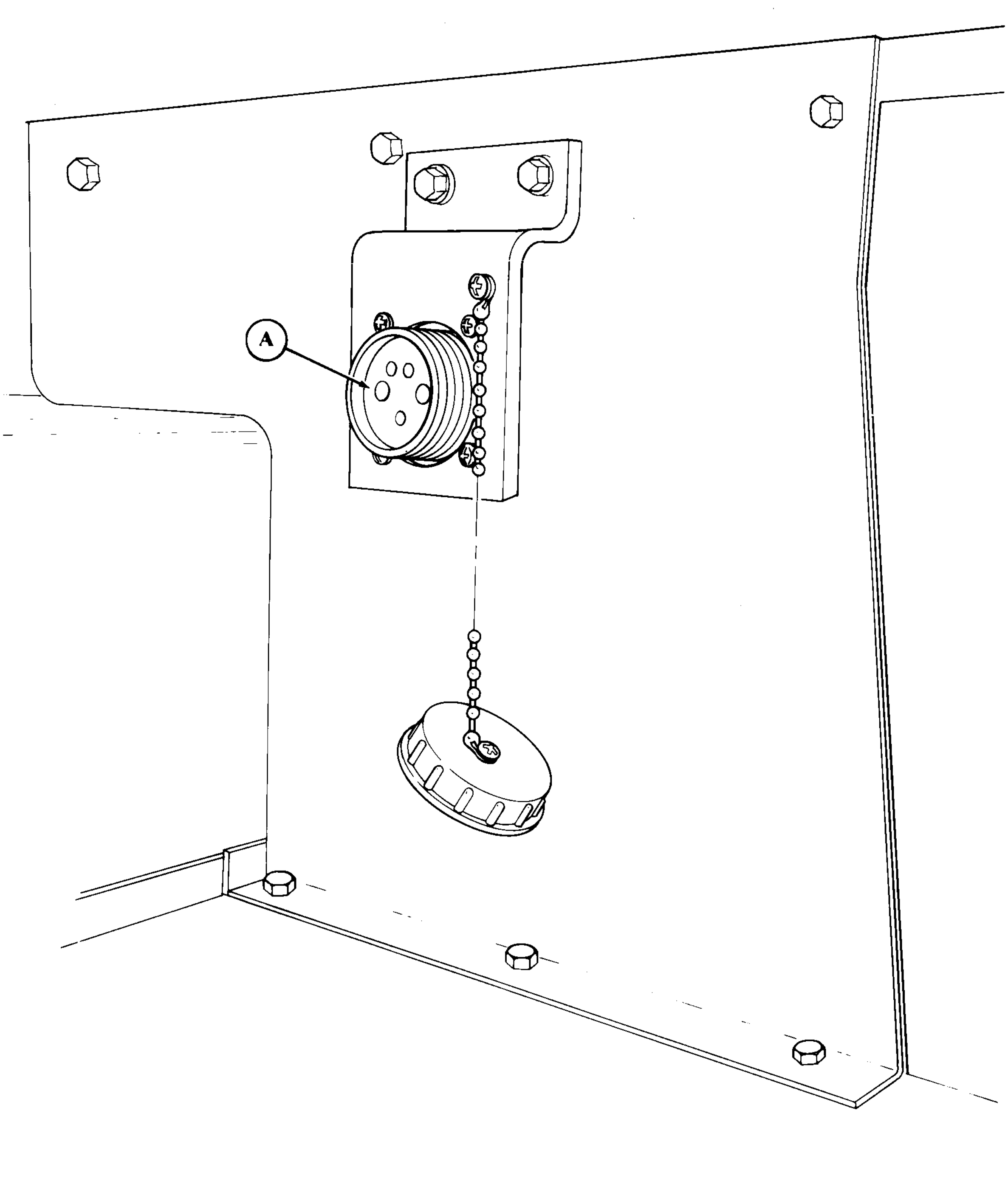
J **CAMOUFLAGE STOWAGE RACK AND STRAPS (three)** - Provide stowage for camouflage screen and support system during transportation.



1-34. 200 AMPERE UMBILICAL POWER CABLE

The 200 ampere umbilical power cable covered in this manual applies to the M1097A2 and M1123 vehicles and consists of the following major component.

(A) **POWER CABLE -** Located behind the companion seat provides power for shelter equipment.



CHAPTER 2
SERVICE AND TROUBLESHOOTING INSTRUCTIONS

Section I. REPAIR PARTS, SPECIAL TOOLS, TEST, MEASUREMENT DIAGNOSTIC EQUIPMENT (TMDE), AND SUPPORT EQUIPMENT

2-1. COMMON TOOLS AND EQUIPMENT

For authorized common tools and equipment, refer to the Modified Table of Organization and Equipment (MTOE) applicable to your unit.

2-2. SPECIAL TOOLS, TMDE, AND SUPPORT EQUIPMENT

Special Tools, Test, Measurement, Diagnostic Equipment (TMDE), and Support Equipment used to maintain the vehicles covered in this manual can be found in TM 9-2320-280-24P.

2-3. REPAIR PARTS

Repair parts are listed and illustrated in TM 9-2320-280-24P.

Section II. SERVICE UPON RECEIPT

2-4. GENERAL

a. Upon receipt of a new, used, or reconditioned vehicle, you must determine if the vehicle has been properly prepared for service. The following steps should be followed:

(1) Inspect all assemblies, subassemblies, and accessories to be sure they are in proper working order.

(2) Secure, clean, lubricate, or adjust as needed.

(3) Check all Basic Issue Items (TM 9-2320-280-10) to be sure every item is present, in good condition, and properly mounted, or stowed.

(4) Follow general procedures for all services and inspections given in TM 9-2320-280-10.

b. The operator will assist when performing service upon receipt inspections.

c. See TM 9-2320-280-10 when checking equipment for proper operation.

d. Refer to TM 9-2320-280-10 for information concerning brake-in procedures.

2-5. GENERAL INSPECTION AND SERVICING INSTRUCTIONS

The following steps should be taken while performing general inspection and services:

NOTE

Cooler fin and engine protective covers can be used to prevent damage to the vehicle components during maintenance. Refer to Appendix D for fabrication instructions.

(1) Use TM 9-2320-280-10 as well as other sections of this manual, when servicing and inspecting equipment.

WARNING

Drycleaning solvent is flammable and will not be used near an open flame. A fire extinguisher will be kept nearby when the solvent is used. Use only in well-ventilated places. Failure to do this may result in injury to personnel and/or damage to equipment.

(2) Clean all exterior surfaces coated with rust-preventive compounds. Use drycleaning solvent (Appendix C, Item 18).

(3) Clean fittings before lubrication. Clean parts with drycleaning solvent (SD), type II, or equivalent. Dry before lubricating. Relubricate all items found contaminated after fording.

WARNING

Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment such as goggles or shield, gloves, etc.

NOTE

Use compressed air to dry electrical components. Use sealing compound (Appendix C, Item 40) before reconnecting plugs.

(4) Inspect electrical connectors for corrosion and/or damage (i.e., bent pins). Clean and repair damage. Clean electrical components with clean cloth dampened with drycleaning solvent. Care must be taken not to damage protective insulation.

(5) Read "Processing and Deprocessing Record of Shipping, Storage, and Issue of Vehicles and Spare Engines," tag (DD Form 1397) and follow all precautions listed. This tag should be attached to steering wheel, steering column, or rotary switch.

2-6. SPECIFIC INSPECTION AND SERVICING INSTRUCTIONS

The following steps should be taken while performing specific inspections and services:

(1) Do the Semiannual (S) preventive maintenance checks and services listed in Section III in this chapter.

(2) Lubricate the vehicle. Do not lubricate gear cases and engine unless processing tag states that the oil is unsuitable for 500 mi (805 km) operation. If oil is suitable, just check level.

(3) Schedule semiannual service on DD Form 314 (Preventive Maintenance Schedule and Record Card).

(4) If vehicle is delivered with a dry charged battery, activate it according to TM 9-6140-200-14.

(5) Check vehicle coolant level and determine if solution is proper for climate (refer to TB 750-651 for preparation of antifreeze solutions).

(6) Remove towing brackets from their stowed position behind the bumper and install them in their proper location (para. 9-2, 9-3, or 9-4).

(7) Remove front lifting shackles from stowed position under passenger seat and install on towing brackets (para. 9-13).

Section III. PREVENTIVE MAINTENANCE CHECKS AND SERVICES

2-7. GENERAL

The best way to maintain vehicles covered by this manual is to inspect them on a regular basis so minor faults can be discovered and corrected before they result in serious damage, failure, or injury. All intervals are based on normal operation. Hard time intervals may be shortened if your lubricants are contaminated or if you are operating the equipment under adverse conditions, including longer-than-usual operating hours. Hard time intervals may be extended during periods of low activity, though adequate preservation precautions must be taken. This section contains systematic instructions of inspection, adjustment, lubrication, and correction of vehicle components to avoid costly repairs or major breakdowns. This is Preventive Maintenance Checks and Services (PMCS).

2-8. INTERVALS

a. Unit maintenance, assisted by operator/crew, will perform checks and services contained in Table 2-1 at the following intervals:

(1) Semiannually (S). Every 6 months or 3,000 miles (4,800 km), whichever comes first.

(2) Annually (A). Every 12 months or 6,000 miles (9,654 km), whichever comes first.

(3) Biennially (B). Every 24 months or 12,000 miles (19,308 km), whichever comes first.

b. Refer to following steps when performing lubrication checks and services:

(1) Intervals. Lubrication services coincide with the vehicle's Semiannual (S) Preventive Maintenance Service. For this propose, a 10% tolerance (variation) in specified lubrication point mileage is permissible. Those vehicles not accumulating 1,000 mi (1,609 km) in a 6-month period will be lubricated at the time of (S) Preventive Maintenance Service.

(2) Army Oil Analysis Program (AOAP). HMMWV engines and transmissions are enrolled in the Army Oil Analysis Program (AOAP). The sampling interval for the engine is every six months or 3,000 miles, or 100 hours (if hour meter is installed) of operation. For the transmission, the sampling interval is every 12 months or 6,000 miles, or 300 hours (if hour meter is installed) of operation.

(3) For Operation of Equipment in Protracted Cold Temperatures Below -15°F (-26°C). Remove lubricants prescribed in lubrication table for temperatures above -15°F (-26°C). Relubricate with lubricants specified in lubrication table for temperatures below -15°F (-26°C). If OEA lubricant is required, see the temperature ranges prescribed in the lubrication table. OEA lubricant is to be used in place of OE/HDO 10 lubricant for all temperature ranges where OE/HDO 10 is specified in the lubrication table.

c. Perform all (S) inspections in addition to (A) inspections at the time of the annual inspection. Perform all (A) and (S) inspections in addition to (B) inspections at the time of the biennial inspection.

2-9. REPORTING REPAIRS

All vehicle shortcomings will be reported on DA Form 2404 Equipment Inspection and Maintenance Worksheet or DA Form 5988-E (automated) (DA Pam 738-750) immediately after the PMCS, and before taking corrective action. All vehicle deficiencies will be reported in the equipment record.

2-10. GENERAL SERVICE AND INSPECTION PROCEDURES

a. While performing specific PMCS procedures, make sure items are correctly assembled, secure, not worn, serviceable, not leaking, and adequately lubricated as defined below.

(1) An item is CORRECTLY ASSEMBLED when it is in proper position and all parts are present.

(2) When wires, nuts, washers, hoses, or attaching hardware cannot be moved by hand, or wrench, they are SECURE.

(3) An item is WORN if there is too much play between joining parts or when marking data, warning, and caution plates are not readable.

(4) An item is UNSERVICEABLE if it is worn beyond repair and is likely to fail before the next scheduled inspection.

(5) LEAKS. TM 9-2320-280-10 contains definitions of Class I, II, and III leaks and their effect on vehicle operation.

(6) If an item meets the specified lubrication requirements, then it is ADEQUATELY LUBRICATED.

b. Where the instruction “tighten” appears in a procedure, you must tighten with a wrench to the given torque value even when the item appears to be secure.

WARNING

Drycleaning solvent is flammable and will not be used near an open flame. A fire extinguisher will be kept nearby when the solvent is used. Use only in well-ventilated places. Failure to do this may result in injury to personnel, and/or damage to equipment.

c. Where the instruction “clean” appears in a procedure, you must use drycleaning solvent (Appendix C, Item 18) to clean grease or oil from metal parts. After the item is cleaned, rinsed, and dried, apply a light grade of oil to unprotected surfaces to prevent rusting.

d. Clean rubber and plastic materials with soap and water. Refer to TM 9-2320-280-10 for general vehicle cleaning instructions.

2-11. SPECIFIC PMCS PROCEDURES

a. The preventive maintenance for which you are responsible is provided in Table 2-1. The checks and services listed are arranged in logical order requiring minimal time and effort on your part.

b. The following columns read across on the PMCS schedule:

(1) Item Number. Provides logical order of PMCS performance and is used as a source number for DA Form 2404, on which your PMCS results will be recorded.

(2) Intervals. Shows the interval next to each item number to indicate when that check is to be performed. The interval will be repeated when consecutive item numbers are to be inspected during the same interval. Interval columns include:

(a) Semiannual (six month) checks;

(b) Annual (yearly) checks; and

(c) Biennial (every two years) checks.

(3) Item To Be Inspected. Lists the system, common name, or location of the item to be inspected.

(4) Procedures. Provides instructions for servicing, inspection, lubrication, replacement, or adjustment, and in some cases, having item repaired at a higher level.

NOTE

Always do your preventive maintenance checks and services in the order prepared. Once it gets to be a habit, you will be able to spot anything wrong in a hurry.

(5) Not Fully Mission Capable. If vehicle meets criteria in this column, vehicle is not mission capable (NMC).

Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
			PRIOR TO ROAD TEST Ensure Operator/Crew has performed PMCS listed in TM 9-2320-280-10. ROAD TEST Maintenance personnel will be with vehicle operator to assist in performing PMCS checks and verify pre-service checks.	
1	Semi-Annual	Pre-Service Checks	**a.** Notice if starter engages smoothly and turns the engine at normal cranking speed.	**a**. Starter inoperative or makes excessive grinding sound.
			b. Listen for unusual noise at idle, at operating speed, and under acceleration. Be alert for excessive vibration and the smell of oil, fuel, and exhaust.	**b.** Engine knocks, rattles, or smokes excessively.
			c. Check for transmission response to shifting and for smoothness of operation in all gear ranges. Be alert for unusual noises and difficulty in shifting in any speed range. **NOTE** If desired range cannot be selected, turn engine off, select range, and restart engine.	**c.** Transmission shifts improperly, does not shift, or makes excessive noises.
			d. Check for transfer response to shifting and for smoothness of operation in all gear ranges. Be alert for unusual noises and difficulty in shifting in any gear range.	**d.** Lever inoperable or does not engage in all ranges with engine not running.
			e. Test for response to accelerator feed. Observe for sticking pedal.	**e.** Pedal sticking or binding.
			f. With vehicle speed approximately 5 mph (8 kph) turn steering wheel to left, then right, to detect hard steering, steering backlash, or shimmy. Vehicle should respond instantly. With vehicle moving on straight, level terrain, lightly hold steering wheel to check for pull and wandering.	**f.** Steering binds, grabs, wanders, or has excessive freeplay.
			g. Apply brake pedal with steady force. Vehicle should slow and stop without pulling to one side or jerking. Release brake pedal. The brakes should release immediately and without difficulty.	**g.** Brakes chatter, pull to one side, or inoperative. Brakes will not release.

Table 2-1. Unit Level Preventive Maintenance Checks and Semites HMMWV (Cont'd)

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
1	Semi-Annual	Pre-Service Checks (Cont'd)	**h.** Bring vehicle to full stop. Engage parking brake while transmission is still in "D" (drive) or "Ⓓ" (overdrive) for A2 series vehicles. Vehicle should remain stationary.	**h.** Parking brake doesn't hold vehicle stationary.
			i. Observe vehicle response to road shock. Side sway or continuous bouncing indicates a malfunction.	
			AFTER ROAD TEST	
2	Semi-Annual	Body	**a.** Make sure the vehicle has been cleaned of mud, gravel, etc., from the underbody, outside, and crew compartment area.	
			b. Thoroughly wash all underbody sheet metal panels and corners.	
			NOTE Lubricate vehicle in accordance with Lubrication Table.	
			c. Inspect for loose rivets, cracks, loose or missing bolts and general body damage.	**c.** Any body damage that would hinder vehicle operation.
3	Semi-Annual	Fuel System	**a.** Inspect fuel filter/water separator assembly for dents and cracks that could cause leaks.	**a.** Any class III fuel leak.
			b. Inspect fuel injection pump, nozzle lines, and fittings for leaks and damage.	**b.** Any class III leak. Any nozzle loose or damaged.
			c. Inspect rear fuel injector nozzle rubber cap for presence and condition.	**c.** Rubber cap missing or damaged.

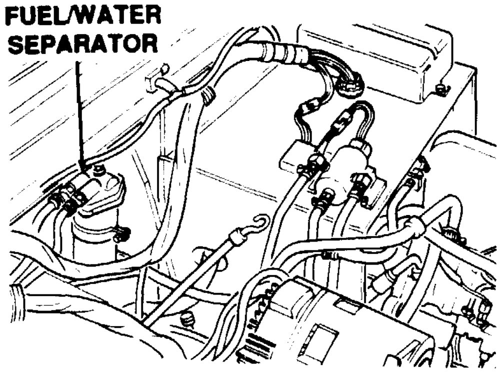


Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV (Cont'd)

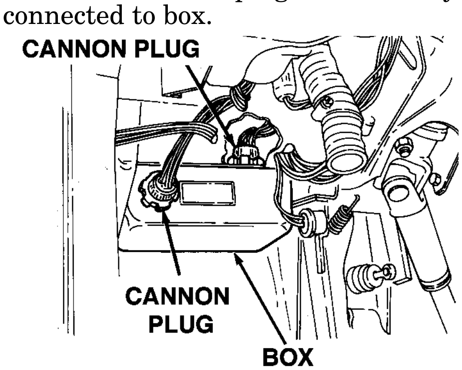
ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
3	Semi-Annual	Fuel System (Cont'd)	**d.** Inspect all fuel lines for loose connections, splits, cracks, and bends that could leak.	**d.** Any class III leak.
			e. Disconnect leads from each glow plug (paragraph 3-38) and check for resistance between glow plug terminal and ground. Continuity should be present.	**e**. Continuity is not present.
			f. Check each glow plug for looseness and damage. Tighten each plug to 8-12 lb-ft (11-16 N•m).	**f.** Glow plugs are loose or damaged.
			g. Check locknut on body mounts. Proper torque 90 lb-ft (122 N•m).	**g.** Body mounts loose.
			h. Check the fuel tank for propeller shaft rub marks and damage. Ensure straps are properly installed in fuel tank slots. Tighten strap locknuts to 23-27 lb-in. (2.6 - 3 N•m).	**h.** Any class III fuel leak or tank strap improperly installed or loose.
4	Semi-Annual Belt	Engine Accessory Drive and Serpentine	**a.** Check for missing, broken, cracked, and frayed drivebelts. Ensure serpentine drivebelt has not moved out of place on pulley.	**a.** Any drivebelt is missing, broken, frayed, or dry-rotted. Belt fiber has more than one crack 1/8 in. (3.2 mm) in depth or 50% of belt thickness) or has frays more than 2 in. (51 mm) long. Serpentine belt has moved out of place on pulleys.
			b. (All models except M1123 and “A2” vehicles). Check all drivebelts tension using belt tension gauge. Belt tension should be 70 lbs (311 N) minimum. If belt tension is not at least 70 lbs (311 N), adjust drivebelts (paragraph 3-82). Tension should not be greater than 110 lbs (489 N) for new belts; old belts 95 lbs (422 N).	**b.** Tension below 70 lbs (311 N), or greater than 110 lbs (489 N) new belt and 95 lbs (422 N) old belts.
5	Semi-Annual	Protective Control Box	**a.** Inspect four nuts for security of mounting.	**a.** Mounting not secure, four nuts loose.
			b. Ensure cannon plugs are securely connected to box.  	

Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV (Cont'd)

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
6	Semi-Annual	Cooling System	WARNING If vehicle has been operating, use extreme care to avoid being burned when removing cooling system radiator cap. Use heavy rags or gloves to protect hands. Turn radiator cap only one-half turn counterclockwise and allow pressure to be released before fully removing cap. NOTE • Coolant level is correct when coolant recovery tank is full TM 9-2320-280-10). • Use MIL-A-46153 in temperatures above 0°F (-18°C) and MIL-A-11755 in temperature below 0°F (-18°C). **a.** Check coolant condition. Test coolant to see if draining is necessary (TB 750-651). **b.** Inspect surge tank, radiator shroud, power steering cooler, oil cooler, all hoses, quick disconnects and fittings for security of mounting, leaks, and deterioration. Inspect and clean as necessary the radiator and oil cooler cores.	**a.** Coolant condition/ testing shows draining is required. **b.** Any class III water leak. Hoses cracked or dry rotted.

Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV (Cont'd)

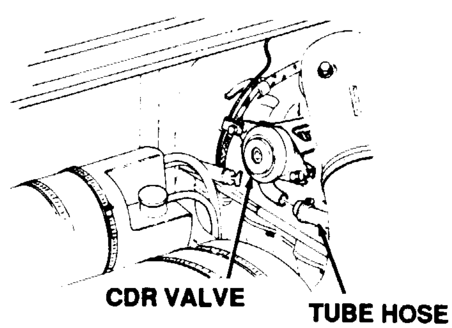
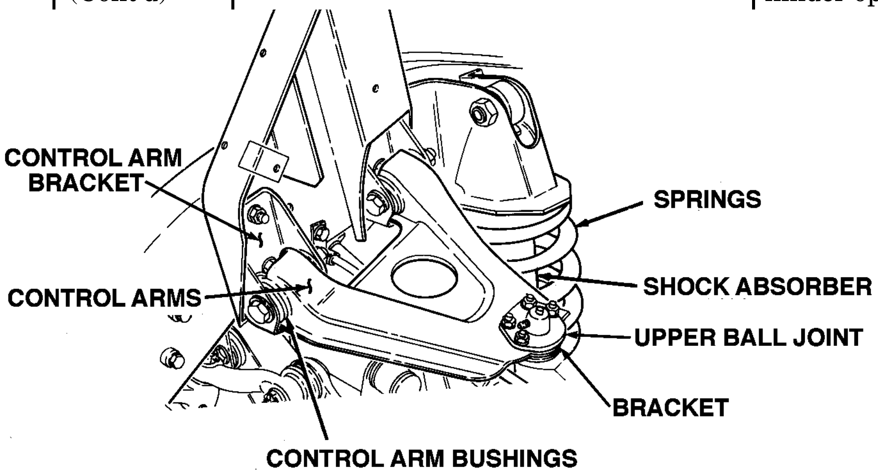
ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
			WARNING If NBC exposure is suspected, all air filter media should be handled by personnel wearing protective equipment. Consult your unit NBC officer or NBC NCO for appropriate handling or disposal instructions.	
7	Semi-Annual	Air-Intake System	**a.** Inspect and clean air cleaner element and housing (para. 3-13). **b.** Check CDR valve oil saturation. Disconnect CDR valve oil fill tube hose from CDR valve and inspect. Some oil accumulation in the CDR valve is acceptable. Correct CDR function is determined by checking vacuum with a water manometer. (para. 3-9a). CAUTION Do not clean CDR valve with solvent. This will damage the diaphragm inside the CDR valve. Wiping with a rag is the only authorized method of cleaning. **c.** Remove and wipe off the CDR valve and hoses with a rag. 	**b.** CDR fails water manometer vacuum test.

Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV (Cont'd)

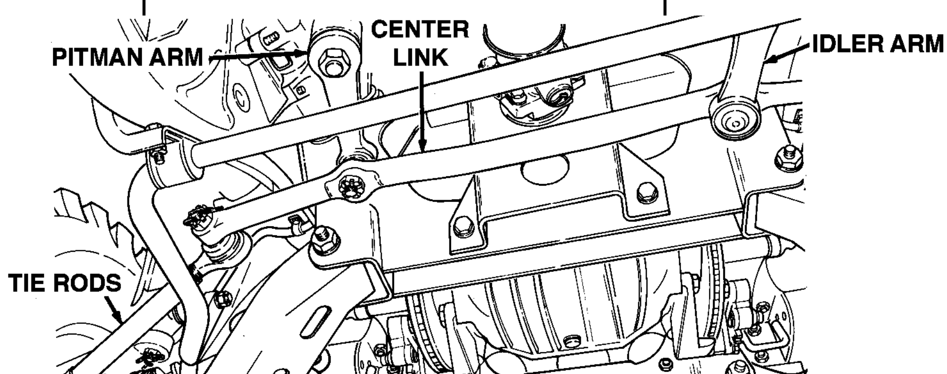
ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
8	Semi-Annual	60, 100, and 200 Amp Alternators	**a.** Inspect alternator and voltage regulator (200 amp only) for condition, proper installation, and security of mounting.	**a**. Mounting bolts missing or alternator damaged.
			b. Inspect electrical wiring for broken strands, frayed, cracked or worn insulation, and loose connections.	**b.** Wiring frayed, broken, or loose connections.
			c. Deleted	
			d. Check alternator mounting bolts for security of mounting. Tighten bolts to 40 lb-ft (54 N•m).	**d.** Any alternator mounting bolt is loose.
9	Semi-Annual	Accelerator Linkage	Inspect for bends, excessive play, cracks, and damage that could cause failure.	Linkage damaged, bent, or cracked.
10	Semi-Annual	Suspension and Steering System	**NOTE** If access to locknut is a problem, remove geared hub from control arm (para. 6-11).	
			a. Remove wheel and tire assembly (para. 8-3). Check front and rear lower ball joint mounting. For M996, M997, M1042, M1037, M1097, M1123, and "A1" and "A2" series vehicles, tighten rear lower ball joint to lower control arm locknuts to 60 lb-ft (81 N•m) and front to 35 lb-ft (48 N•m). All other models, tighten front and rear lower ball joint to lower control arm locknuts to 35 lb-ft (48 N•m) and ensure cotter pin is present. Tighten ball joint slotted nut to 73 lb-ft (99 N•m) and ensure cotter pin is present.	**a.** Capscrews or locknuts are finger or hand turnable.
			b. Check front and rear upper ball joint mounting. Tighten upper ball joint to upper control arm locknuts to 21 lb-ft 29 (N•m). Tighten upper control arm to control arm bracket locknuts to 260 lb-ft (353 N•m) . Tighten ball joint slotted nut to 65 lb-ft (88 N•m) and ensure cotter pin is present.	**b.** Capscrews or locknuts are finger or hand turnable.
			NOTE Do not over lubricate ball joints, one or two shots is adequate.	
			c. Lubricate front and rear upper ball joints with GAA.	

Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV (Cont'd)

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
			NOTE Do not lubricate shock absorber bushings, radius rod bushings, stabilizer bar bushing, or suspension arm pivot bushing.	
10	Semi-Annual	Suspension and Steering System (Cont'd)	**d.** Inspect control arms, control arm bushings, springs, shock absorbers, and bracket for damage.	**d.** Control arm bent, bushing worn or obvious damage that would hinder operation.



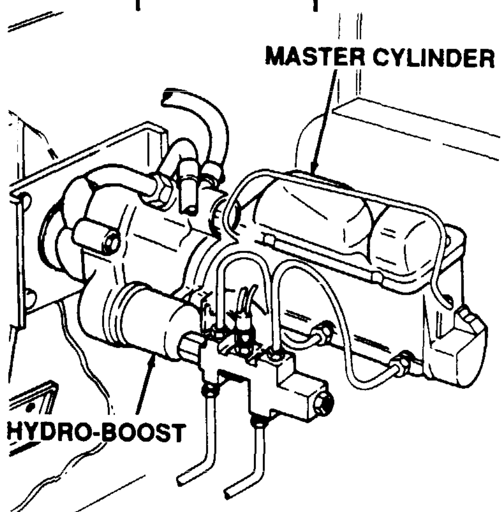
ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
			e. Inspect steering column U-joints, tie rods or radius rods, pitman arm, center link, and idler arm for breaks, cracks, and wear.	**e.** U-joints, tie rods, pitman arm or idler arm are worn or cracked.

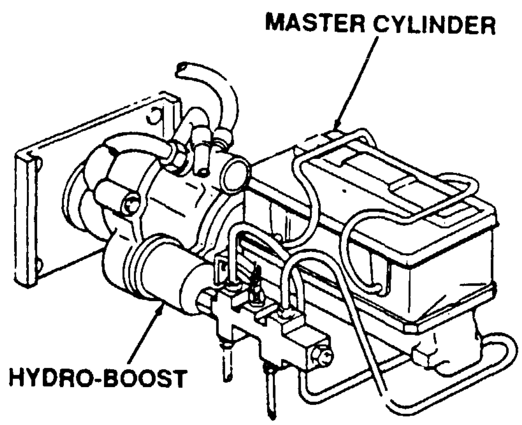


ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
			e.1. Inspect steering column for security of mounting hardware.	**e.1.** Steering column is not secure.
			f. Inspect steering gear for mounting security. Tighten mounting bolts to 60 lb-ft (81 N•m).	**f.** Any mounting bolt missing or unserviceable.

Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV (Cont'd)

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
10	Semi-Annual	Suspension and Steering System (Cont'd)	**g.** Inspect power steering pump, power steering gear, hydraulic control valve, hoses, lines, and fittings for leaks or damage.	**g.** Any class III leak Any component damaged.
11	Semi-Annual	Brake System	**a.** Inspect master cylinder, hydro-boost, lines, and fittings for leaks and damage.	**a.** Any leak. Plugged, broken, or damaged lines and fittings.





NEW CONFIGURATION

CAUTION

- Use MIL-B-46176, Silicone Brake Fluid (BFS), for filling master brake cylinder. Failure to use BFS will cause damage to brake cylinder.
- Throughly clean exterior of master cylinder cover before removing cover (table 2-1). Dirt, water, or grease will contaminate brake fluid causing brake system damage.
- Do not use screwdriver to remove cover. Damage to bail wire will result.
- To prevent excessive fluid spillage, ensure that rubber diaphragm is completely seated before installing cover to master cylinder.

NOTE

Remove cover from brake master cylinder by moving bail wire using thumb pressure only.

			b. Check master brake cylinder fluid level. Level should be 1/8 inch (3.2 mm) from top of master cylinder reservoirs. Fill with BFS as necessary.	**b.** Level below 1/8 inch (3.2 mm) from top of master cylinder reservoir.

Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV (Cont'd)

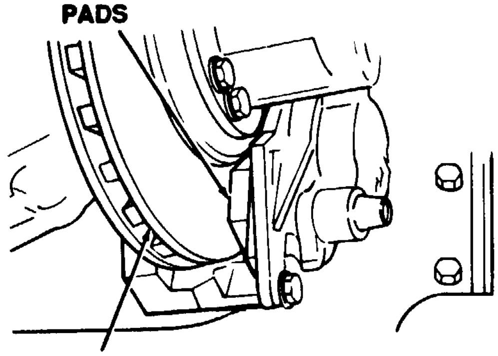
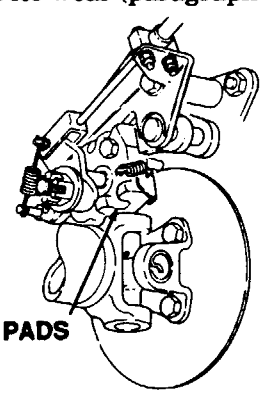
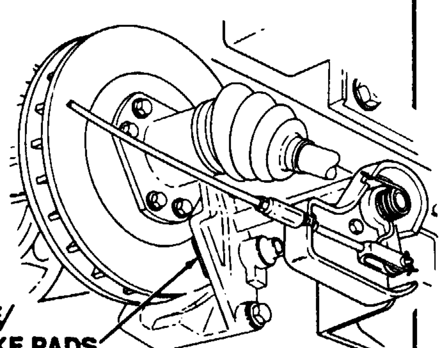
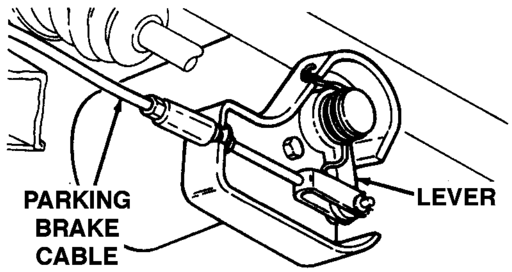
ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
11	Semi-Annual	Brake System (Cont'd)	**c.** Inspect service brake pads and rotor disks for wear (paragraph 7-11).  	**c.** Service brake pads less than 1/8 inch (3.2 mm).
			d. Inspect parking brake pads and rotor disk for wear (paragraph 7-3).   	**d.** Parking brake pads less than 1/8 inch (3.2 mm).
			e. Inspect dual service/park brake pads and rotor for wear (para. 7-21).	**e.** Brake pads less than 1/8 inch (3.2 mm).

Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV (Cont'd)

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
11	Semi-Annual	Brake System (Cont'd)	**f.** Inspect parking brake cable, cable clip, lever, spring, and pushrod/guide pin for binding and loose components. 	**f.** Parking brake binding or cable frayed or broken. Spring or cable clip missing.
			g. On vehicles equipped with a single parking brake assembly mounted between the rear prop shaft and rear differential, lubricate parking brake lever, parking brake cam, parking brake push pins, and parking brake guide pins with WTR. On vehicles equipped with a left and right parking/service brake assembly mounted between the rear axle half-shafts and rear differential, lubricate the parking brake lever with WTR. The parking/service brake assembly needs no lubrication.	
			h. Inspect rear parking brake cables for damage and/or chaffing in the area of the control arm. If cables are damaged, replace cables (paragraph 7-23 or 7-24).	**h.** Parking brake binding or cable frayed or broken.
			i. Inspect for presence of, or damage to, parking brake cable clamps.	
12	Semi-Annual	Engine and Transmission Mounts	**a.** Inspect engine mounts and insulators for loose, worn, and damaged condition.	**a**. Engine mounts or insulators cracked, damaged, loose, or worn.
			b. Check for loose or missing engine mount capscrews and locknuts. If engine mount capscrews or locknuts are loose or missing, notify DS maintenance.	**b.** Capscrews or locknuts, loose or missing.

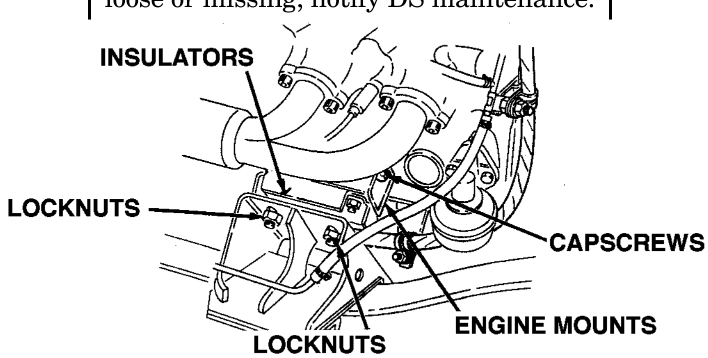


Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV (Cont'd)

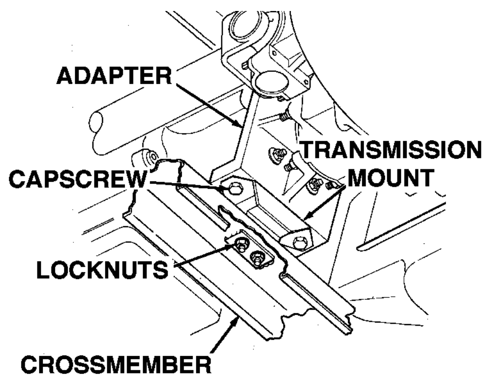
ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
12	Semi-Annual	Engine and Trans-mission Mount (Cont'd)	**c.** Using 3/4 inch torque adapter (reefer to Appendix B, Item 145), tighten two capscrews securing transmission mount to adapter to 65 lb-ft (88 N•m). Tighten two locknuts securing transmission mount to crossmember to 28 lb-ft (38 N•m).  	**c.** Transmission mount loose, cracked, or damaged.
13	Semi-Annual	Starter	**CAUTION** Disconnect negative cable. **a.** Inspect starter for mounting security. Tighten mounting bolts to 40 lb-ft (54 N•m). **b.** Inspect cables and studs for loose nuts and damage.	**a.** Mounting bolt missing or will not torque. **b.** Stud nut loose.
13.1	Semi-Annual	Neutral Start Safety Switch	**WARNING** Ensure vehicle parking brake is set, wheels are chocked, and rotary switch is in the ENG STOP position. Failure to comply may result in injury to personnel and/or damage to equipment. **a.** Disconnect wires 14A and 14B from wires 14 at neutral start safety switch. **b.** Check for continuity of neutral start safety switch. **(1)** With transmission shift lever in N (neutral), or P (park) (for M1123, A2 series, and up-armor models only), continuity should be present between wires 14 at neutral start safety switch.	Neutral start safety switch is malfunctioning.

Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV (Cont'd)

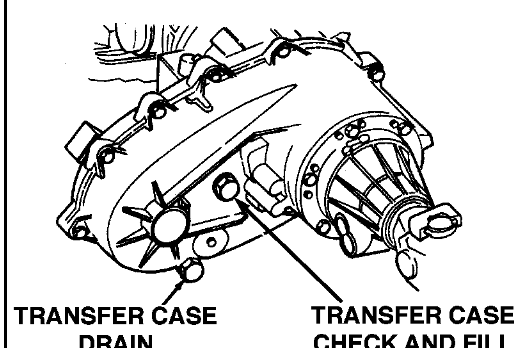
ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
13.1	Semi-Annual	Neutral Start Safety Switch (Cont'd)	**(2)** Place transmission shift lever in D (drive). There should be no continuity present between wires 14. If continuity is present, replace neutral start safety switch (para. 5-6). **c.** Connect wires 14A and 14B to wires 14 at neutral start safety switch.	
14	Semi-Annual	Trans-mission	**a.** Inspect vent lines and connectors for security, cracks, and deterioration. **b.** Inspect transmission shift linkage for bends, excessive play, cracks, and damage that could cause failure.	**a.** Vent line cracked, plugged, or missing. **b.** Shift linkage is unserviceable.
15	Semi-Annual	Transfer	**a.** Inspect transfer case vent lines and connectors for security, cracks, and deterioration. **b.** Inspect transfer case shift linkage for bends, excessive play, cracks, and damage that could cause failure. **CAUTION** Use Dexron® II for filling transfer case. Failure to use Dexron® II will cause damage to transfer case. **c.** Check transfer case fluid level every 3,000 (4,800 km) or semiannually, whichever occurs first. Remove fill plug and gasket. Level should be within 1/2 in. (12.7 mm) of fill plug opening when vehicle is on level ground. Install fill plug and gasket, and tighten to 35 lb-ft (47 N•m).  	**a.** Vent line cracked, plugged or missing. Shift linkage is unserv-iceable.

Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV (Cont'd)

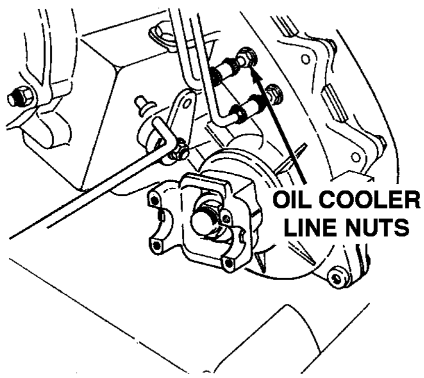
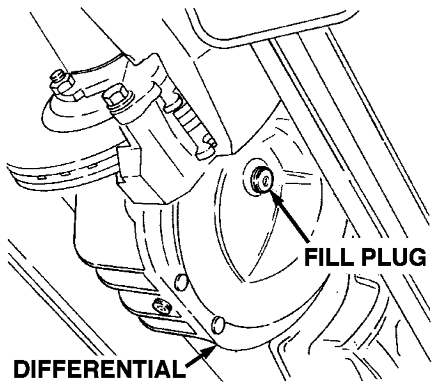
ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
15	Semi-Annual	Transfer (Cont'd)	**NOTE** Do not overtorque retaining nuts. **d.** Inspect oil cooler lines for leaks or damage. Check for loose oil cooler line nuts and damage to the spiral wrap on the cooler line. If oil cooler line nuts are loose, hold end of oil cooler stationary, and tighten line nuts to 194-212 lb-in. (22-24 N•m)  	**d.** Any class III oil leak or damage to spiral wrap.
16	Semi-Annual	Driveline Components	**a.** Inspect geared hub vent lines and connectors for security, cracks, and deterioration.	**a**. Hub vent lines cracked, plugged, or missing.
			b. Inspect geared hub for leaking seals and damage.	**b.** Class III leaks or damage.
			CAUTION Change geared hub and differential lubricants when required by maintenance repair action, contaminated by water or foreign material, or if lubricant appears by smell, feel, or visual indication to be overheated. **NOTE** • Fill each axle differential with 2 quarts (1.9 L) of GO. • Fill each geared hub with 1 pint (0.5 L) of GO.	
			c. Adjust spindle bearing (paragraph 6-14).	**c.** Bearing damaged.
			d. Inspect differential vent lines and connectors for security, cracks, and deterioration.	**d.** Differential vent line has hole, plugged, or cracked.
			e. Inspect differentials for leaking seals and cracks.	**e.** Class III leak.

Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV (Cont'd)

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
16	Semi-Annual	Driveline Compo-nents (Cont'd)	**f.** M998, M998A1, and M1121 series vehicles – Check differential lubricant level semiannually or every (3,000 miles) (4,830 km). M998A2 and M1123 series vehicles – Change differential lubricant semiannually or every 3,000 miles (4,830 km). Differential level should be within 1/4 inch (6.4 mm) of fill plug opening when lubricant is cold or to plug level when hot.  	**f.** Lube level not within 1/4 inch (6.4 mm) of fill plug opening when cold or to plug level when hot.
			g. Inspect U-joints for damage, free play, and missing or unserviceable lubrication fittings.	**g.** U-joint is damaged, unserviceable, or missing lubrication fitting.
			h. Tighten front prop shaft mounting capscrews to 13-18 lb-ft (18-24 N•m) and center support capscrews to 60 lb-ft (81 N•m). Tighten rear prop shaft capscrews to 13-18 lb-ft (18-24 N•m) and tighten U-bolt nuts to 21 lb-ft (29 N•m).	**h.** Loose, missing, or broken capscrews.

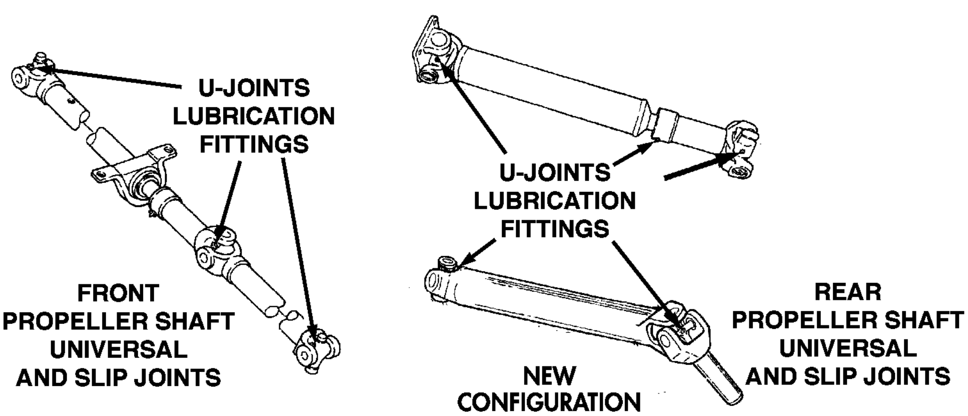


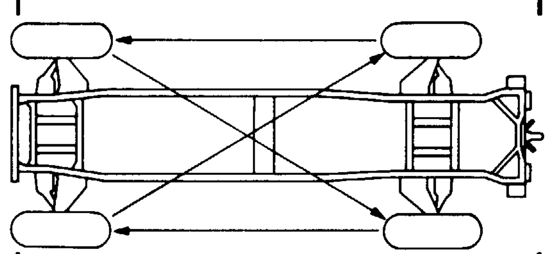
Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV (Cont'd)

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
16	Semi-Annual	Driveline Compo-nents (Cont'd)	**i.** Tighten halfshaft mounting bolts to 48 lb-ft (65 N•m).	**i.** Loose, missing, or broken bolts.
17	Semi-Annual	Exhaust Compo-nents	Inspect for cracked and loose pipes, muffler, and hangers. Check for ex-haust leaks.	Cracked, loose, or holes in pipes or muffler. Exhaust leak.
18	Semi-Annual	Frame and Cross-members	**a.** Inspect frame side rails for cracks, breaks, bends, wear, deterioration, and missing or loose fasteners.	**a.** Any loose or missing fasteners. Cracks, bends, or breaks in frame.
			b. Inspect crossmembers for cracks, breaks, bends, deterioration, and loose or missing fasteners.	**b.** Any loose or missing fasteners. Cracks, bends, or breaks in cross-members.
			c. Inspect for missing, broken, bent, or loose bumper supports before towing a trailer.	**c.** Any missing, broken, bent, or loose bumper supports.
19	Semi-Annual	Tires	**WARNING** • Changing tire pressures or wheel alignment, out of the recommended specification, may adversely affect the vehicle's handling characteristics. Loss of vehicle control may result in serious injury or death and damage to equipment. • Radial and bias ply tires should not be mixed on the same vehicle. Injury to personnel and damage to equipment may result. **NOTE** Vehicle must be up on jack stands for the following checks.	
			a. Check tread depth of tires with tire gauge. If tread depth is less than 2/32 in. (1.59 mm), replace tire in approx-imately 400 miles (644 km) bias tires will wear 1/32 in. (0.79 mm), radial tires will take approximately 1,300 miles (2092 km) to wear 1/32 in. (0.79 mm). If mission will require the vehicle to travel this distance within a month, replace tire if it measures 3/32 in. (2.38 mm).	**a.** Tread depth is less than 2/32 in. (1.59 mm).

Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV (Cont'd)

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
19	Semi-Annual	Tires (Cont'd)	**b.** Inspect tires for uneven wear and balance (paragraph 8-9). For normal wear, rotate tires as shown in rotation diagram. The vehicle's wheel alignment is optimumly designed for GVW operation. Operating the vehicle without a load can cause excessive wear on the outer edge of the tread pattern. If this pattern develops, turn tires around on the rim (para. 8-4).	**b.** Tires exhibit excessive or uneven wear or balance.
			c. Rotate tires as diagram shows.	

ROTATION DIAGRAM



			d. Tighten wheel lug nuts to 90-110 lb-ft (122-149 N•m) in tightening sequence shown.	**d.** Any broken studs, loose or missing lug nuts.

TIGHTENING SEQUENCE

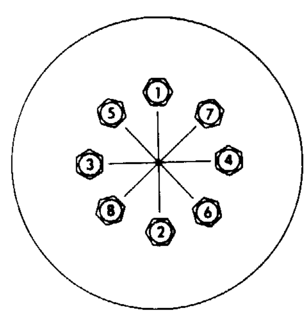


Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV (Cont'd)

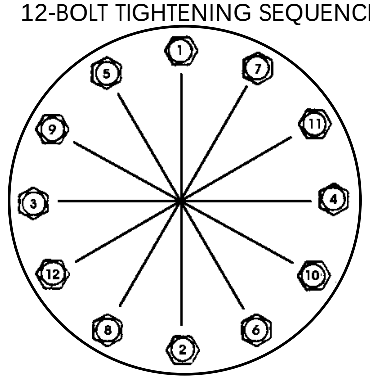
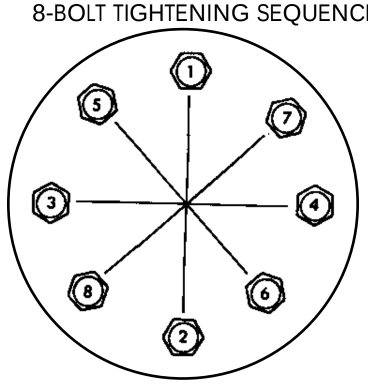
ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
19	Semi-Annual	Tires (Cont'd)	**e.** Check for loose, missing, or broken wheel studs and nuts. **CAUTION** Prior to checking torque, the tire assembly must be deflated. **(1)** Release air pressure from tire (para. 8-4 or 8-5). **CAUTION** Tighten locknuts gradually to avoid bent and broken studs, or damage to wheel components will result. **(2)** Wheel configurations: **(a)** 12-bolt configuration – Tighten locknuts to 85 lb-ft (115 N•m) in sequence shown; repeat torque sequence at 125 lb-ft (170 N•m). 12-BOLT TIGHTENING SEQUENCE  **(b)** 8-bolt configuration – Tighten locknuts to 55 lb-ft (75 N•m) in sequence shown; repeat torque sequence at 65 lb-ft (88 N•m). 8-BOLT TIGHTENING SEQUENCE  **(3)** Inflate tire to recommended tire pressure (TM 9-2320-280-10).	**e.** Any broken studs, or loose or missing wheel nuts.

Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV (Cont'd)

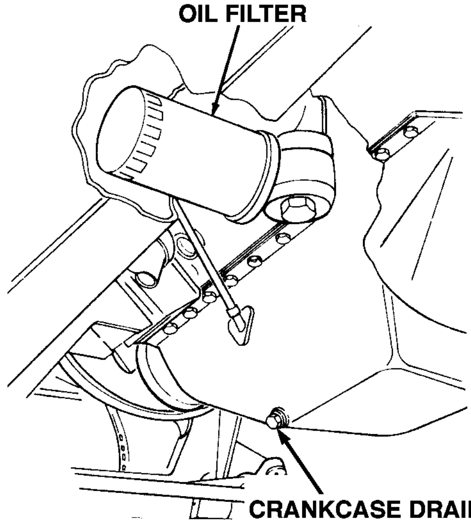
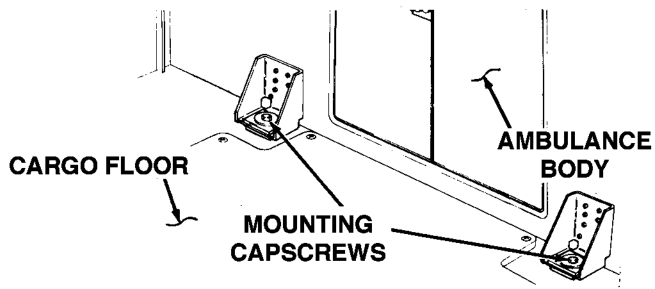
ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
19	Semi-Annual	Tires (Cont'd)	**NOTE** If vehicle is new and has been driven less than 3,000 miles (4,800 km), it is not necessary to align wheels unless abnormal handling is reported.	
			f. Check alignment of front and rear wheels (paras. 8-10 and 8-11).	**f.** Front or rear wheels are out of alignment.
20	Semi-Annual	Engine	**a.** Inspect engine for leaks or damage that could cause engine failure.	**a.** Class III leaks. Damage evident that would cause engine failure.
			NOTE Oil and oil filter will be changed when they are known to be contaminated, clogged, or when service is recommended by AOAP laboratory.	
			b. Perform AOAP sample. If AOAP is not available, change oil and oil filter at 3,000 miles (4,800 km), or 100 hours (if hour meter is installed), or every six months.  OIL FILTER AND CRANKCASE DRAIN	

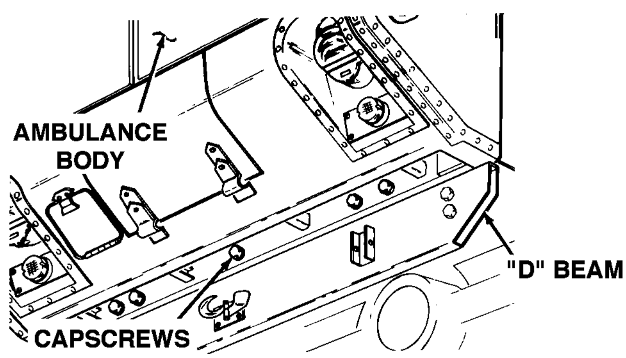
Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV (Cont'd)

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
21	Semi-Annual	Batteries	**WARNING** • Do not perform battery system checks or inspections while smoking or near fire, flames, or sparks. Batteries may explode causing damage to vehicle, injury, or death to personnel. • Remove all jewelry such as rings, dog tags, bracelets, etc. If jewelry or disconnected battery ground cable contacts battery terminal, a direct short will result, causing injury to personnel, or damage to equipment. **NOTE** Reefer to TM 9-6140-200-14 for more specific details on battery maintenance.	
			a. Inspect battery box and battery tray bolts for corrosion and debris. If any corrosion is evident, wipe bolts and/or washers clean. If corrosion cannot be removed or the surface of bolts are pitted, replace bolts and/or washers (para. 4-80).	**a.** Corrosion has made holes in metal battery box.
			b. Clean slave receptacle and coat with corrosion preventive compound (Appendix C, Item 24).	**b.** Terminals corroded.
			NOTE Add 4 points (.004) to specific gravity reading for every 10° above 80°F.	
			c. Check and record specific gravity of each cell.	**c.** If cell is below 1.225 specific gravity.
			d. Inspect battery cables for frays, splits, or looseness.	**d.** Cables frayed, split, or loose.
			SPECIAL PURPOSE KITS	
22	Semi-Annual	Cargo Shell Door	Check adjustment of cargo shell door (paragraph 11-13).	
23	Semi-Annual	Rear Cargo Door	Check rear cargo door for proper operation. Rotate gas springs (para. 11-21) 180 degrees every six months and move left spring to right side and right spring to left side.	

Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV (Cont'd)

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
24	Semi-Annual	Ambulance (M996, M996A1, M997, M997A1, and M997A2)	**a.** Check DC outlets for proper operation. Using multimeter, check for voltage at DC receptacles. If engine is running, voltage should be 27-28 volts. If engine is not running, voltage should be 24.2-25.2 volts. Reefer to para. 2-39, electrical troubleshooting, if voltage is not within the specified range.	**a.** No DC voltage at outlet, or not within range.
			b. Inspect and tighten two mounting capscrews securing ambulance body to cargo floor to 90 lb-ft (122 N•m). Tighten seven capscrews securing ambulance body to "D" beam to 90 lb-ft (122 N•m).	**b.** Body not securely mounted to floor.





ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
			c. (M997, M997A1, and M997A2 only) Inspect compressor for security of mounting and oil leakage.	**c**. Any class III leak.
25	Semi-Annual	DeepWater Fording Kit	**a.** Inspect vent tubes for bends, cracks, breaks, deterioration, and restrictions.	
			b. Inspect vent tube mounting hardware for proper installation.	
			c. Inspect intake and exhaust extensions for proper installation and leaks.	**c.** Any exhaust extension leaks.

Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV (Cont'd)

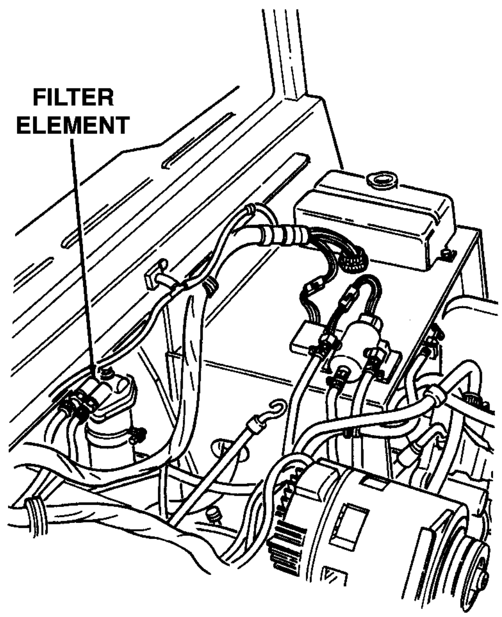
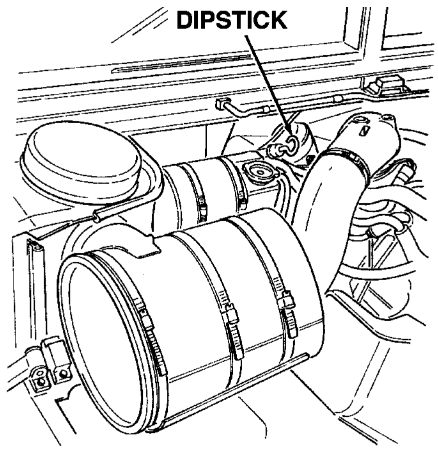
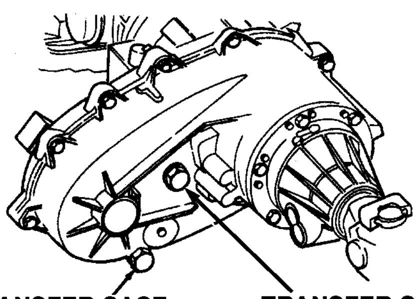
ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
26	Semi-Annual	Arctic Winterization Kit and/or Troop/Cargo Winterization Kit	Inspect all fuel lines for loose connections, splits, cracks, and bends that could cause leaks. Tighten loose connections and replace damaged parts. **NOTE** If Annual/Biennial Service is being performed, then Final Road Test will be completed after last Annual/ Biennial task is complete.	Any class III leak.
27	Semi-Annual	Final Road Test	Check vehicle for proper operation and performance.	Vehicle fails to operate properly.
28	Annually	Fuel System	Replace filter element every 6,000 miles (9,600 km) or annually, whichever occurs first. Replace water separator element if unserviceable (para. 3-33).  	
29	Annually	Air-Intake System	Test CDR valve (para. 3-9).	
29.1	Annually	Dust Unloader	Visually inspect dust unloader for presence and for cuts, tears, obstructions, worn areas, enlarged gap, or if center opening exceeds 1/8 in. (3.175 mm).	Dust unloader missing or has cuts, tears, obstructions, worn areas, enlarged gap, or if center opening exceeds 1/8 in. (3.175 mm).

Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV (Cont'd)

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
30	Annually	Electrical Wiring	Inspect all wiring and wiring harness for frays, splits, missing insulation, or poor connections. Repair any worn wiring (para. 4-85). If wiring cannot be repaired, notify DS maintenance.	Broken, frayed, split wires or harness.
30.1	Annually	Engine Running Test	Observe engine and vehicle operation for rough idle, rough running, lack of power, and unusual noise or vibration (para. 2-18).	Vehicle fails to operate properly.
30.2	Annually	Transmission	Perform AOAP sample. **CAUTION** Use Dexron® II or Dexron® III for 3L80 transmission. Use only Dexron® III for 4L80-E transmission. Failure to use only Dexron® III for 4L80E transmission will cause damage to transmission. **NOTE** • Oil and oil filter will be changed when they are known to be contaminated, clogged, or when service is recommended by AOAP laboratory. • Replace transmission oil filter each time transmission is drained. Fill 3L80 transmission with 6 quarts (5.7 L) of Dexron® II or Dexron® III. Fill 4L80-E transmission with 7.7 quarts (7.3 L) of only Dexron® III. In arctic conditions, use OEA in both model transmissions.	
31	Biennially	Transmission	**CAUTION** Use Dexron® II or Dexron® III for 3L80 transmission. Use only Dexron® III for 4L80-E transmission. Failure to use only Dexron® III for 4L80E transmission will cause damage to transmission. **NOTE** • Change fluid every 12,000 miles (19,300 km) or biennially, whichever occurs first (para. 5-2a). Inspect either 3L80 or 4L80-E transmission drainplug for metal particles. • Replace transmission oil filter each time transmission is drained. Fill 3L80 transmission with 6 quarts (5.7 L) of Dexron® II or Dexron® III. Fill 4L80-E transmission with 7.7 quarts (7.3 L) of only Dexron® III. In arctic conditions, use OEA in both model transmissions.	

Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV (Cont'd)

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
31	Biennially	Transmission (Cont'd)	 TRANSMISSION FILL AND LEVEL	
32	Biennially	Transfer Case	**CAUTION** • If water or metal particles are detected during transfer case draining, notify Direct Support Maintenance personnel before refilling transfer case. • Use Dexron® II for filling transfer case. Failure to use Dexron® II will cause damage to transfer case. **NOTE** • Fill transfer case (model 218) with 3.5 quarts (3.3 L) of Dexron® II. • Fill transfer case (model 242) with 3.35 quarts (3.17 L) of Dexron® II. Change fluid every 12,000 miles  TRANSFER CASE	Metal particles are

SEMI-ANNUAL (3,000 MILE) PMCS PARTS LIST

ITEM NO.	PART NUMBER	NSN	NOMENCLATURE	QTY
1.	MS51943-31	5305-00-061-4650	Locknut	1
2.	5593033	5310-00-252-2999	Nut and Lockwasher Assembly	4
3.	MS21245-L10	5310-00-449-2381	Locknut	4
4.	MS35756-8	5315-00-616-5526	Woodruff Key	1
5.	MS24665-355	5315-00-012-0123	Cotter Pin	1
6.	MS51943-43	5310-00-061-4651	Locknut	1
7.	MS51943-35	5310-00-935-9021	Locknut	1
8.	MS51943-39	5310-00-488-3889	Locknut	4
9.	MS51967-18	5310-00-763-8919	Locknut	2
10.	MS35338-45	5310-00-407-9566	Lockwasher	2
11.	PH13	2940-00-082-6034	Filter, Fluid, Engine Oil	1

ANNUAL (6,000 MILE) PMCS PARTS LIST

ITEM NO.	PART NUMBER	NSN	NOMENCLATURE	QTY
1.	MS51943-31	5305-00-061-4650	Locknut	1
2.	5593033	5310-00-252-2999	Nut and Lockwasher Assembly	4
3.	MS21245-L10	5310-00-449-2381	Locknut	4
4.	MS35756-8	5315-00-616-5526	Woodruff Key	1
5.	MS24665-355	5315-00-012-0123	Cotter Pin	1
6.	MS51943-43	5310-00-061-4651	Locknut	1
7.	MS51943-35	5310-00-935-9021	Locknut	1
8.	MS51943-39	5310-00-488-3889	Locknut	4
9.	MS51967-18	5310-00-763-8919	Locknut	2
10.	MS35338-45	5310-00-407-9566	Lockwasher	2
11.	PH13	2940-00-082-6034	Filter, Fluid, Engine Oil	1
12.	5589121	4330-01-190-3579	Filter Element Kit, Fuel	1

BIENNIALLY (12,000 MILE) PMCS PARTS LIST

ITEM NO.	PART NUMBER	NSN	NOMENCLATURE	QTY
1.	MS51943-31	5305-00-061-4650	Locknut	1
2.	5593033	5310-00-252-2999	Nut and Lockwasher Assembly	4
3.	MS21245-L10	5310-00-449-2381	Locknut	4
4.	MS35756-8	5315-00-616-5526	Woodruff Key	1
5.	MS24665-355	5315-00-012-0123	Cotter Pin	1
6.	MS51943-43	5310-00-061-4651	Locknut	1
7.	MS51943-35	5310-00-935-9021	Locknut	1
8.	MS51943-39	5310-00-488-3889	Locknut	4
9.	MS51967-18	5310-00-763-8919	Locknut	2
10.	MS35338-45	5310-00-407-9566	Lockwasher	2
11.	PH13	2940-00-082-6034	Filter, Fluid, Engine Oil	1
12.	12337210	4330-01-121-6350	Parts Kit, Fluid, Transmission (3L80-E)	1
13.	8655625	5330-01-148-7492	Gasket (3L80-E)	1
14.	8684221	2520-01-398-4589	Parts Kit, Fluid, Transmission (4L80-E)	1
15.	8677743	5330-01-360-5271	Gasket (4L80-E)	1

LUBRICATION TABLE

USAGE	FLUID/LUBRICANT	CAPACITIES	EXPECTED TEMPERATURE
Engine Oil	OE/HDO 30 OE/HDO 10 OEA	Crankcase: w/o filter 7 qt (6.6 L) w/filter 8 qt (7.6 L) Dry System 10 qt (9.5 L) (INC. oil cooler)	Above +15°F (-9°C) 40° to -15°F (4° to -26°C) 40° to -65°F (4° to -54°C)
Engine Coolant	Ethylene Glycol and Water 1/4 Ethylene Glycol/ 3/4 Water 2/5 Ethylene Glycol/ 3/5 Water 3/5 Ethylene Glycol/ 2/5 Water	Radiator: 5 qt (4.7 L) Complete System: 26 qt (24.6 L)	15°F (-9°C) and above 40° to -15°F (4° to -26°C) 40° to -65°F (4° to -54°C)
Brake System (All except M1097, "A1", "A2" series and M1123) (M1097, "A1", "A2" series and M1123)	Fluid Silicone BFS	Master Cylinder: 0.69 pt (0.33 L) Complete System: 1.2 pt (0.56 L) Master Cylinder: 1.12 pt (0.53 L) Complete System: 1.63 pt (0.78 L)	All Temperatures

OE/HDO 15/40 (Grade 15W-40) lubricant may be used when expected temperatures are above +5°F (-15°C).
If OEA lubricant is required to meet the temperature ranges prescribed in the table, then the OEA lubricant is to be used in place of OE/HDO 10 lubricant for all temperature ranges.
If operating conditions are severe or abnormal, service chassis lubrication points at 1,000 miles (1,600 kilometers).

LUBRICATION TABLE (Cont'd)

USAGE	FLUID/LUBRICANT	CAPACITIES	EXPECTED TEMPERATURE
Transmission (3L80)	Dexron® II or Dexron® III	Dry: 11 qt (10.4 L) Drain & Refill: 6 qt (5.7 L)	All Temperatures Except Arctic
(4L80-E)	Dexron® III only (Do not use Dexron II) OEA	Dry: 13.5 qt (12.8L) Drain & Refill 7.7 qt (7.3 L)	Arctic Temperatures
Transfer (218) Case (242)	Dexron® II or Dexron® III	3.5 qt (3.3 L) 3.35 qt (3.17 L)	All Temperatures
Steering System	Dexron® II or Dexron® III	1 qt (0.95 L) w/Cooler 1.25 qt (1.18 L)	All Temperatures
Geared Hub (4)	Multipurpose Gear GO 80/90	1 pt ea. (0.47 L)	All Temperatures
Axles (2)	Multipurpose Gear GO 80/90	2 qt ea. (1.9 L)	All Temperatures
Ball Joints, Tie Rod Ends, Pitman Arm, Propeller Shafts, etc.	GAA	As Required	All Temperatures
Hinges, Cables, and Linkages	OE/HDO	As Required	All Temperatures

Section IV. ELECTRICAL/MECHANICAL SYSTEMS TROUBLESHOOTING

2-12. GENERAL

a. This section provides information to diagnose and correct malfunctions of the electrical/mechanical system.

b. Principles of operation showing system operation can be found in chapter 1. It should be used as a reference when performing electrical/mechanical troubleshooting.

c. Each malfunction symptom given for an individual component or system is followed by step(s) you should take to determine the cause and corrective action you must take to remedy the problem.

d. Before taking any action to correct a possible malfunction, the following rules should be followed:

(1) Question operator to obtain any information that might help you determine the cause of the problem.

(2) Never over look the chance that the problem could be of simple origin. The problem could be corrected with minor adjustment.

(3) Use all senses to observe and locate troubles.

(4) Use test instruments or gauges to help you determine and isolate problem.

(5) Always isolate the system where the malfunction occurs and then locate the defective component.

(6) Use standard automotive theories and principles when troubleshooting the vehicles covered in this manual.

e. The STE/ICE-R is an integral part of these troubleshooting procedures. It should be used whenever possible, although other options are given, when available. The Vehicle Identification Number (VIN) assigned to the M998 series vehicles is 21 (14 is the temporary VIN). On page 2-753, you will find information on STE/ICE-R description and operation. Use this information to become familiar with STE/ICE-R operation and the equipment contained in the test set. On page 2-763 you will find STE/ICE-R setup and internal checks. These must be performed prior to performing tests.

2-13. ELECTRICAL / MECHANICAL SYSTEMS TROUBLESHOOTING

ELECTRICAL / MECHANICAL TROUBLESHOOTING

2-14. HOW TO USE THIS TROUBLESHOOTING GUIDE

NOTE TO THE RECIPIENT OF THIS MANUAL

There are 16 foldouts that are supplied with this manual. Take the foldouts and place them after the last page of diagnostics at the end of the paragraph. That way, the foldout will be with diagnostics for that system. Use the cross-reference information listed below to guide you in the placement of the foldouts.

SYSTEM LEVEL TESTS	PARAGRAPH	FOLDOUT NUMBER
FUEL	2-22	FO-1
AIR INTAKE/EXHAUST	2-23	FO-2
COMPRESSION/MECHANICAL	2-24	FO-3
ENGINE COOLING	2-25	FO-4
ENGINE LUBRICATION	2-26	FO-5
ALTERNATOR	2-27	FO-6
PROTECTIVE CONTROL BOX/ DISTRIBUTION BOX	2-28	
BATTERY CIRCUIT	2-29	FO-7
STARTER CIRCUIT	2-30	FO-8
GLOWPLUGS (PROTECTIVE CONTROL BOX)	2-31	FO-9
GLOWPLUGS (DISTRIBUTION BOX)	2-31.1	
INSTRUMENTS	2-32	FO-10
LIGHTS	2-33	FO-11
TRANSMISSION (3L80)	2-34	FO-12
TRANSMISSION (4L80-E)	2-35	
BRAKES	2-36	FO-13
STEERING	2-37	FO-14
DRIVETRAIN	2-38	FO-15
AMBULANCE ELECTRICAL SYSTEM	2-39	
AMBULANCE MECHANICAL SYSTEM	2-40	
WINCH SYSTEM	2-41	
DCA TROUBLESHOOTING	2-42	FO-16

2-14. HOW TO USE THIS TROUBLESHOOTING GUIDE (CONT'D)

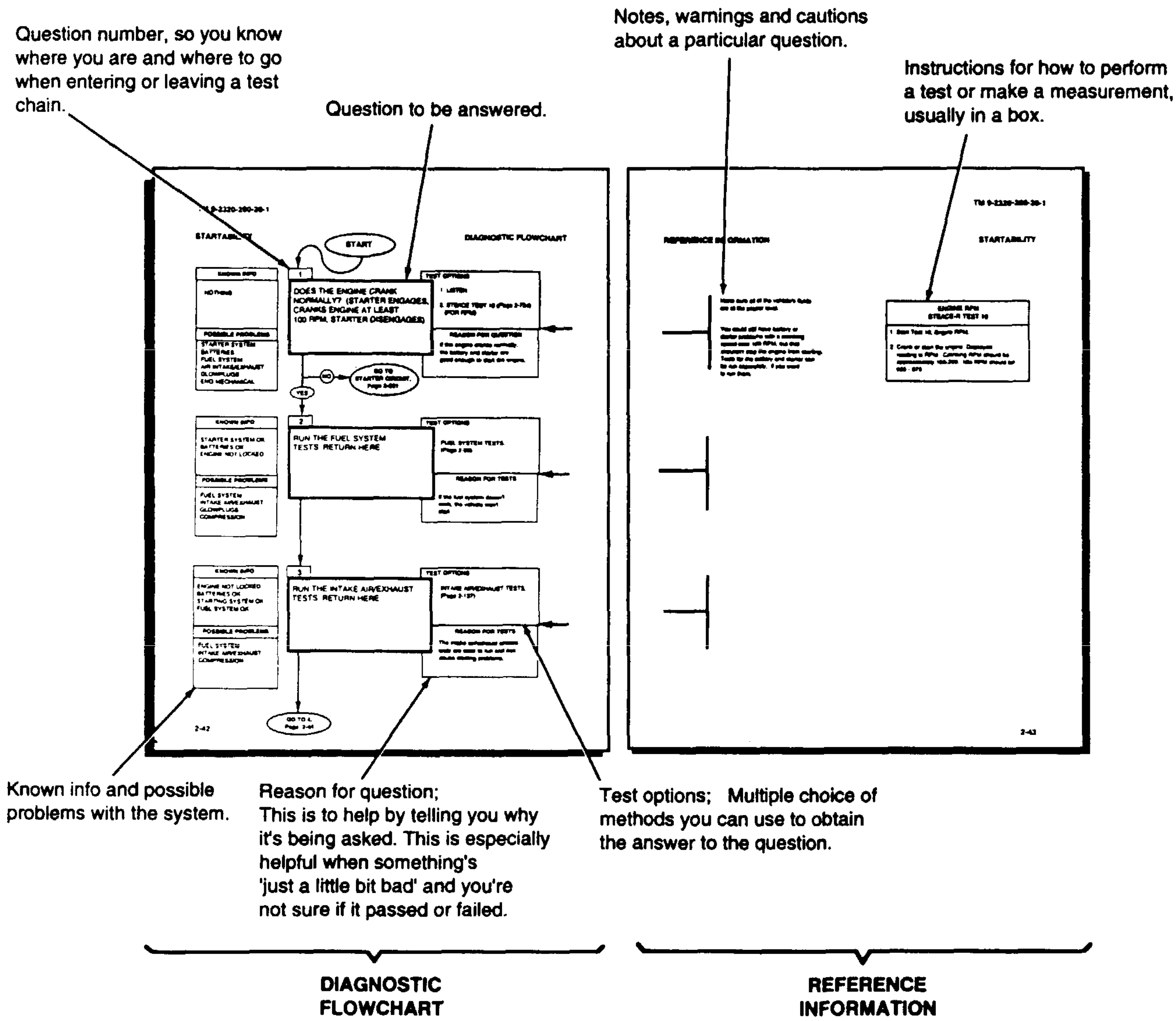
THERE ARE 5 TOP LEVEL TESTS. USE THESE FOR GENERAL SYMPTOMS (HARD-TO-START, RUNS ROUGH, ETC).

THERE ARE 21 SYSTEM LEVEL TESTS. THESE ARE USED BY THE TOP LEVEL TESTS BUT YOU CAN GO STRAIGHT TO THEM IF YOU KNOW WHAT YOU'RE DOING.

TROUBLESHOOTING PAGES. THE LAYOUT IS SHOWN ON THE NEXT PAGE. THEY ARE SET UP SO THAT YOU DON'T READ ANY MORE THAN YOU HAVE TO. AFTER YOU HAVE FOUND THE FAULT, CORRECT IT AND MAKE SURE THE SYSTEM IS WORKING PROPERLY. CONTINUE IF THERE ARE ADDITIONAL PROBLEMS.

2-14. HOW TO USE THIS TROUBLESHOOTING GUIDE (CONT'D)

PAGE LAYOUT All diagnostic logic and flowcharts are on the left hand page, with supporting information, help, test, instructions and vehicle operation on the right.



HOW TO TROUBLESHOOT

PICK THE TESTS: Select either a top level or a system level test.

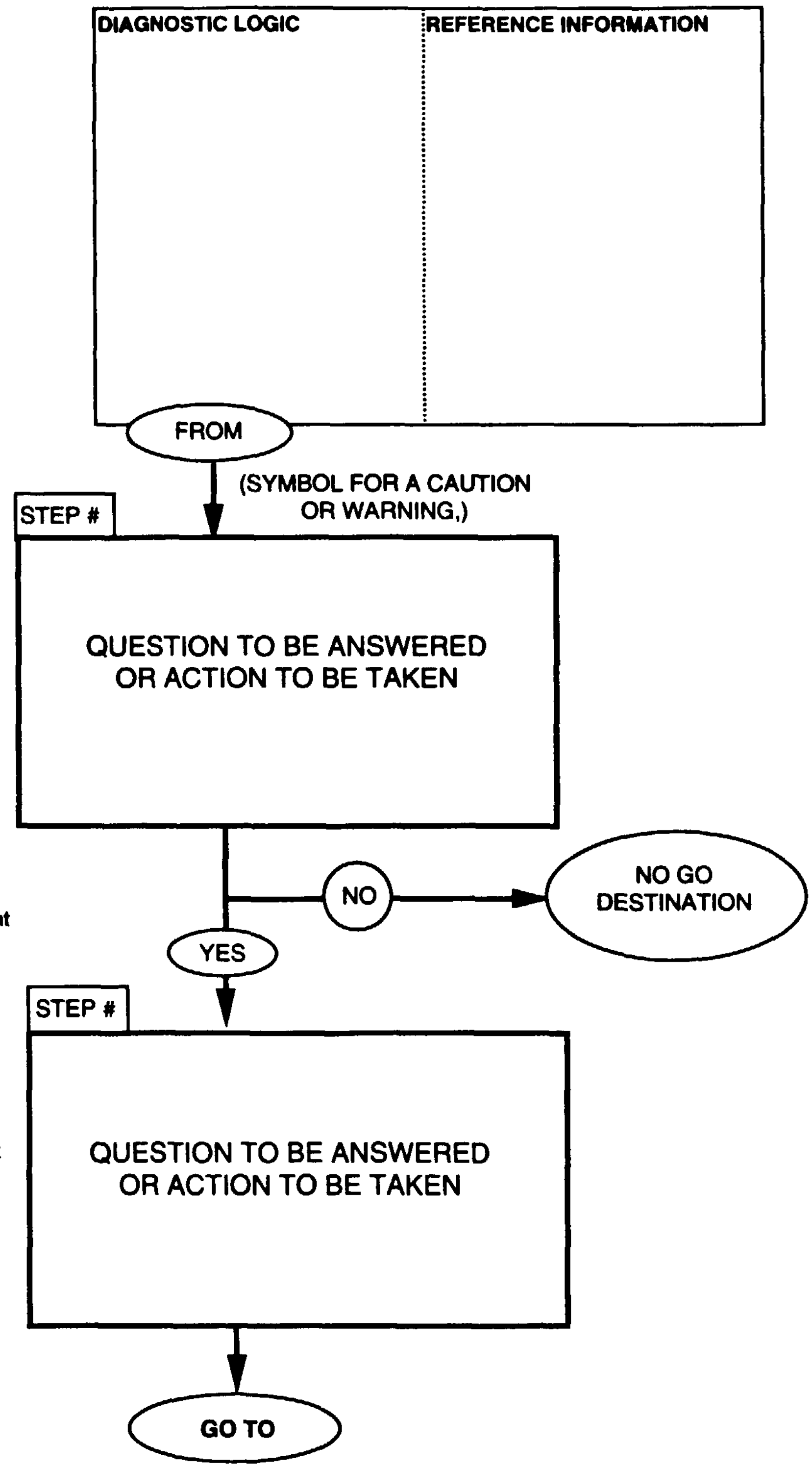
DIAGNOSTIC PROCEDURE Just answer the questions on the left hand page and follow the YES or NO path. Helpful information about the question is also on the right hand page. If you aren't sure about a question or procedure, look on the right page for notes, instructions and help.

2-14. HOW TO USE THIS TROUBLESHOOTING GUIDE (CONT'D)

PAGE LAYOUT

Diagnostic logic is on the left hand page.

Related and helpful information is on the right hand page.



DIAGNOSTIC PROCEDURE

Just answer the questions on the left hand page. Follow the YES or NO path to the next step. Everything else on both pages is information to support the question. As a rule, the most important information (warnings, cautions, etc) is closest to the question, less important information is farther away.

Is the symbol for a WARNING statement. If you see this symbol above a question, look on the right hand page for the text of the message. The WARNING message on the right hand page will also have the symbol above it.

Is the symbol for a CAUTION statement. If you see this symbol above a question, look on the right hand page for the text of the message. The CAUTION message on the right hand page will also have the symbol above it.

2-14. HOW TO USE THIS TROUBLESHOOTING GUIDE (CONT'D)

INFORMATION ABOUT THE QUESTION

TEST OPTIONS:

This box lists at least one way of getting the answer to the question. When there is more than one way to get the answer, the different options will be given. Usually the easiest or best option is first.

TEST OPTIONS

REASON FOR QUESTION

REASON FOR QUESTION:

If you know why the question is being asked, it should be easier to understand the diagnostic logic and easier to answer the question. This is especially helpful when a measurement is 'just a little bad'. Knowing why the question is being asked should help you decide if the answer should be 'YES' or 'NO'.

INFORMATION ABOUT THE DIAGNOSTIC LOGIC

KNOWN INFO

This box indicates what is known about the vehicle's condition. As you follow a test chain, parts will be listed here after they have checked ok. Sometimes this box will indicate a fault that you know exists, such as a shorted or open circuit, or a component that doesn't work. DO NOT USE THIS BOX TO PICK A 'JUMP-IN' POINT. ALWAYS RUN A COMPLETE CHAIN WHEN INSTRUCTED TO DO SO.

KNOWN INFO

POSSIBLE PROBLEMS

This box is the opposite of 'KNOWN INFO'. Possible causes of the problem are listed here until tested and shown to be ok.

POSSIBLE PROBLEMS

2-14. HOW TO USE THIS TROUBLESHOOTING GUIDE (CONT'D)

INFORMATION ABOUT THE QUESTION

All warnings and cautions are given next to (or as close as possible to) the arrow pointing to the particular question. Look for the symbol that is in the box for the question in order to locate the particular note. Helpful notes, test procedures, or other information related to the question are provided here. These notes are provided as supporting information only, you don't usually need them to answer the question. The more skilled you become, the less you'll have to read these.

Any cross references to other manuals will be located in this area.

NOTES, WARNINGS AND CAUTIONS ARE IN BOLD FACE TYPE.

Additional information, notes and/or suggestions are in normal type so as not to draw too much attention.

TEST PROCEDURES

These are special notes about how to make measurements with the test equipment. Ocassionally, if space is limited on a page, the easiest procedure will be listed with a page reference for the other procedures if you would rather use them. The procedures presume a basic working knowledge of the equipment to be used, but references are included for the less experienced operator.

TYPE OF MEASUREMENT TYPE OF EQUIPMENT
Procedure for performing the measurement using the type of equipment listed above.

PICTURES

The pictures are supposed to make it easier to find what you're looking for, such as a pin in a connector or a particular wire or component.

PICTURES ARE PROVIDED WHEREVER POSSIBLE.

2-15. GLOSSARY OF ABBREVIATIONS AND COMMONLY USED TERMS

PCB - Protective Control Box, located on the firewall above the brake pedal.

STE/ICE-R - Simplified Test Equipment for Internal Combustion Engines - Reprogrammable, a testing system used for performing tests and measurements on the vehicle. In addition to acting as a conventional digital multimeter to measure voltage, current and resistance, it is also capable of measuring pressure, speed, compression unbalance, engine power, and some specialized battery and starter evaluations. It is powered from the vehicle batteries. The complete system includes a vehicle test meter (VTM), a transducer kit (TK), cables, transit case and technical publications.

DCA - Diagnostic Connector Assembly, an electrical harness on the vehicle which allows the STE/ICE-R to be powered and to make measurements of key vehicle signals from a single connection. In addition to many basic electrical signals such as starter voltage and current, it includes engine speed and fuel supply pressure. The STE/ICE-R can make TK measurements at the same time that it is connected to the DCA.

VTM - Vehicle Test Meter, a box which performs the measurement and analysis functions of the STE/ICE-R systems.

TK (and TK mode) - Transducer Kit, a collection of transducers, adapters and fittings which permit the STE/ICE-R to be used as a general purpose measurement system for any application. This allows the STE/lCE-R to be used anywhere that you want to measure voltage, current, resistance, pressure, or speed. TK mode of operation is what you are doing when you use this kit (as opposed to DCA mode where you are using the vehicle's built-in sensors to make measurements).

Compression unbalance - A STE/ICE-R test that gives an indication of any engine cylinders that have lower compression then the average. It does this by monitoring the battery voltage during cranking. As each cylinder goes into compression, the extra load on the starter shows up as a drop in voltage. This works well for finding one or more cylinders that have a compression problem, but don't forget that it doesn't give the average compression. If all cylinders are low by the same amount, this test doesn't find it.

Troubleshooting - the process of making measurements and observing the operation of the vehicle to find out if anything is wrong with it and then to locate any problem that exists.

Diagnostics - Troubleshooting by following an exact procedure.

Test Chain - a series of tests to be followed in a particular order or sequence. It is referred to as a "chain" of tests because they are all connected one after another like the links of a chain.

System - a collection of devices which are all related to each other because they depend on each other to do some function or job. For instance, the function of the fuel system is to inject fuel into the cylinders at the correct time in the correct amount and with the correct quality. The collection of devices that are required to do this include the fuel pump, fuel lines, lift pump, fuel filter, injection pump, and injectors.

2-15. GLOSSARY OF ABBREVIATIONS AND COMMONLY USED TERMS (CONT'D)

Functional flow schematic - a diagram which is much like a normal electrical circuit diagram, except that its purpose is to show the flow of information through the system (or the flow of a signal or the flow of some material such as the fuel). This kind of diagram shows how each component or device depends on the others. It is called functional flow because it shows the function (purpose of each component) and how the output of one component “flows" into the next. For troubleshooting, the functional flow schematic is better than the usual circuit diagram because it allows you to quickly see how the system works and what to expect when you make measurements on a system that has faults. You can't expect the output of a device to be good when it has a bad input.

2-16. ELECTRIC CIRCUIT DESCRIPTION

An electrical circuit is a collection of electrical devices which are connected in a loop from a positive voltage source (the battery positive) to a negative source (the battery negative). It must be continuous, with no breaks (no opening in the loop) so that electrical current can flow from the positive to the negative. You can think of it like the plumbing in your house. There must be a source of water under pressure or nothing will flow through the pipes. Water pressure is like the positive voltage of the battery. There may be branches (tees) in the pipes going to several different places, but if you don't connect the pipes, you don't get water. The same thing is true with the electrical circuit. If the wires aren't connected, no electricity will flow through them.

In the plumbing of a house, all of the water must go to the drain (you won't permit it to be spilled on the floor). With the vehicle electrical circuit, the drain is the negative terminal of the battery. With the water pipes, the water always flows from high pressure to low pressure (another way of saying that water always flows downhill). The electrical current is the same as the water flow - it always goes from positive to negative voltage. Voltage is to electricity what pressure is to water. Just like the pressure in the water pipe, the greater the voltage, the more electricity will flow through the wires. Unlike the water pipes that will spill the water if they break, you can't "spill” the electricity. The closest thing to this in an electrical circuit is when two wires touch that aren't supposed to and the current flows to some place that it shouldn't (this is called a “short circuit” or a “short"). Shorts often happen where the wire touches the vehicle body (the body is connected to the negative terminal of the battery). Since the current always flows through the easiest path to negative, it will bypass the rest of the circuit where it was supposed to go, and go through the short directly to the battery. Because this new path to the battery negative is shorter the malfunction is called a “short circuit” or a “short”.

If you put a valve in a water pipe, you can control how much water flows by closing the valve. What you are doing is pinching off the pipe with the valve which restricts the flow. If you shut it off completely, you can stop all water from flowing. In the electrical circuit, a resistor acts like a valve. If you make the resistor extremely large, you can stop the current from flowing. The resistance is measured in “ohms”.

2-16. ELECTRIC CIRCUIT DESCRIPTION (CONT'D)

When there is no electrical connection, such as when a wire is disconnected, the resistance is infinite (too large to be measured). No current will flow through the wires, because the circuit is no longer continuously connected. This is referred to as an “open circuit” or simply an "open”. Remember that an electrical circuit is formed by continuous loops of devices connected together. When you are troubleshooting you are often asked to check for “continuity", which simply means that you need to find out if there is a continuous path from one place in the circuit to another. Since you are trying to see if the path is continuous, you must check wires and switches rather than any special or active devices. You will usually just measure the resistance between two points. If the resistance is zero (or the value of any resistance that is supposed to be there), then there is continuity. In the case of looking for a short, this may mean that you have found the short. If the resistance is off-scale on the meter (infinite resistance) then there is no connection and you have found an open. A continuity test is the same whether you are looking for an open or a short, the only difference being what resistance values you are looking for and where you make the measurements.

You are familiar with the typical light switch which allows you to turn a light on and off. A switch of any kind in an electrical circuit is simply a way of opening the loop so that no current will flow through it. Something to remember while troubleshooting is that everything on the positive side of the switch still has full battery voltage while everything from the switch on through the rest of the circuit is (or should be) connected to the battery negative terminal and you will measure zero volts. This is easy to remember if you think of the faucet on a sink. If you shut off the faucet, there is no water flowing into the sink, but the water in the pipe is still under pressure.

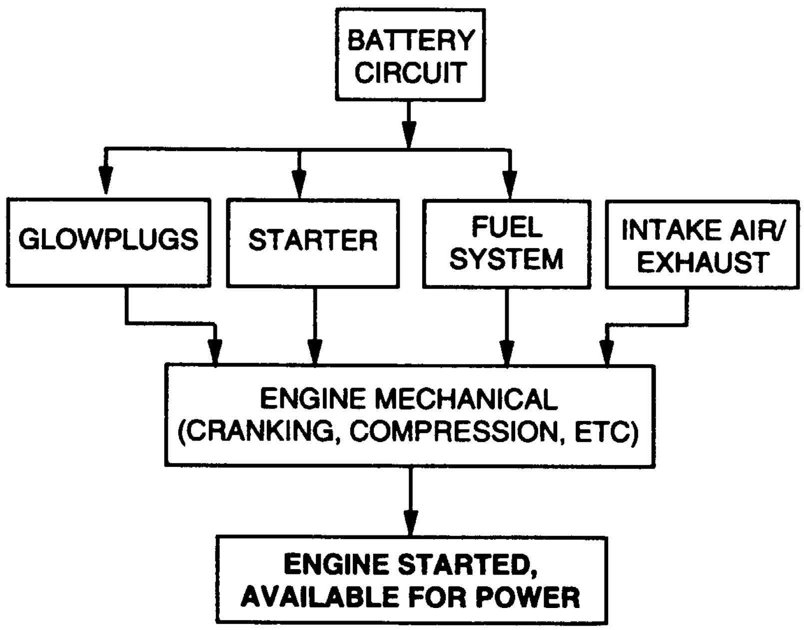
Sometimes a switch is turned on and off automatically. An example is a “circuit breaker" which is a device that measures how much current is flowing through it. If the current goes too high (possibly damaging equipment or melting the wires) then it opens an internal switch to stop the current flow. A “relay” is another form of switch that is turned on and off under remote control using a signal in another wire. When a device which requires a very large amount of current (such as the starter motor), must be turned on and off, a “power relay” is used. The idea is to use a small switch to turn on a larger switch. Thus, you don’t have very large wires going all over the vehicle or large switches on the instrument panel. In the case of the starter’s power relay, it is also called a “solenoid”. A solenoid is any device that changes the electrical current into a forward and backward motion. It is something like an electrical motor except that instead of continuously going around in the same direction, it goes in or out. For the starter, the solenoid is used to "push” a very large switch into the “on” position.

When testing a circuit, you will need to know how much current is flowing. Current is easilly measured with the STE/ICE-R. A device called a “shunt" is connected to the negative terminal of the battery. A shunt is a very precise resistor designed so that for every 1000 amps of current that flow through it there is a drop of .1 volts from one side of it to the other (different shunts may have different values). By measuring the voltage across the shunt you know how much current is flowing through the circuit. The shunt is placed on the negative side because it is safer (less chance of accidents which may short out the batteries). Since all of the current eventually goes through the negative battery terminal anyway, the shunt gives the same measurement as if it were connected to the positive terminal. You can think of the shunt as doing the same thing as the water meter in your house. As you turn devices such as lights on or off, you can use the shunt to measure how much current they are using.

2-17. STARTABILITY TESTS

This is a top level test for problems with an engine that doesn't start, or starts but immediately stops, or is very hard to start. If the engine starts but doesn't run well after starting, try the "STARTABILITY" tests first.

FOR THE ENGINE TO START, ALL OF THE BASIC SYSTEMS SHOWN BELOW MUST BE WORKING. THESE STARTABILITY TESTS WILL HELP YOU TO VERIFY THE CONDITION OF EACH OF THESE SYSTEMS.



A functional flow schematic is not applicable to this section. However, so that you may refer to sections as you need them, a quick index to the systems required for starting is given here.

PARAGRAPH	PAGE
BATTERY CIRCUIT	2-251
GLOWPLUGS CIRCUIT	2-303
STARTER CIRCUIT	2-261
FUEL SYSTEM	2-95
INTAKE AIR/EXHAUST	2-137
COMPRESSION/MECHANICAL	2-143

STARTABILITY **DIAGNOSTIC FLOWCHART**

START

KNOWN INFO

NOTHING

POSSIBLE PROBLEMS

STARTER SYSTEM
BATTERIES
FUEL SYSTEM
AIR INTAKE/EXHAUST
GLOWPLUGS
ENG MECHANICAL

1

DOES THE ENGINE CRANK NORMALLY? (STARTER ENGAGES, CRANKS ENGINE AT LEAST 100 RPM, STARTER DISENGAGES)

TEST OPTIONS

1. LISTEN
2. STE/ICE TEST 10 (Page 2-734) (FOR RPM)

REASON FOR QUESTION

If the engine cranks normally, the battery and starter are good enough to start the engine.

NO → **GO TO STARTER CIRCUIT, Page 2-261**

YES ↓

KNOWN INFO

STARTER SYSTEM OK
BATTERIES OK
ENGINE NOT LOCKED

POSSIBLE PROBLEMS

FUEL SYSTEM
INTAKE AIR/EXHAUST
GLOWPLUGS
COMPRESSION

2

RUN THE FUEL SYSTEM TESTS. RETURN HERE.

TEST OPTIONS

FUEL SYSTEM TESTS, (Page 2-95)

REASON FOR TESTS

If the fuel system doesn't work, the vehicle won't start

KNOWN INFO

ENGINE NOT LOCKED
BATTERIES OK
STARTING SYSTEM OK
FUEL SYSTEM OK

POSSIBLE PROBLEMS

FUEL SYSTEM
INTAKE AIR/EXHAUST
COMPRESSION

3

RUN THE INTAKE AIR/EXHAUST TESTS. RETURN HERE.

TEST OPTIONS

INTAKE AIR/EXHAUST TESTS, (Page 2-137)

REASON FOR TESTS

The intake air/exhaust system tests are easy to run and can cause starting problems.

GO TO 4, Page 2-44

REFERENCE INFORMATION

STARTABILITY

Make sure all of the vehicle's fluids are at the proper level.

You could still have battery or starter problems with a cranking speed over 100 RPM, but that shouldn't stop the engine from starting. Tests for the battery and starter can be run separately, if you want to run them.

ENGINE RPM STE/ICE-R TEST 10
1. Start Test 10, Engine RPM. 2. Crank or start the engine. Displayed reading is RPM. Cranking RPM should be approximately 100-200. Idle RPM should be 625 - 675.

STARTABILITY **DIAGNOSTIC FLOWCHART**

FROM 3, PAGE 2-42

4

KNOWN INFO

ENGINE NOT LOCKED
BATTERIES OK
STARTING SYSTEM OK
FUEL SYSTEM OK
INTAKE AIR/EXHAUST OK

POSSIBLE PROBLEMS

GLOWPLUGS
COMPRESSION

!!

RUN THE GLOWPLUGS TESTS. (PAGE 2-303) RETURN HERE.

TEST OPTIONS

1. GLOWPLUGS TESTS

REASON FOR QUESTION

If the engine is hard to start it may be the glowplugs.

5

KNOWN INFO

ENGINE NOT LOCKED
BATTERIES OK
STARTING SYSTEM OK
GLOWPLUGS OK
INTAKE AIR/EXHAUST
FUEL SYSTEM OK

POSSIBLE PROBLEMS

COMPRESSION

RUN COMPRESSION UNBALANCE (6.2L ONLY). IS THE COMPRESSION UNBALANCE OK?

TEST OPTIONS

STE/ICE-R TEST 14
(Page 2-737)

REASON FOR QUESTION

If cylinder compression is far enough out of balance, it could prevent the vehicle from starting. The lower the unbalance, the better.

NO → NOTIFY DS MAINTENANCE

NO FAULTS FOUND.

WARNING

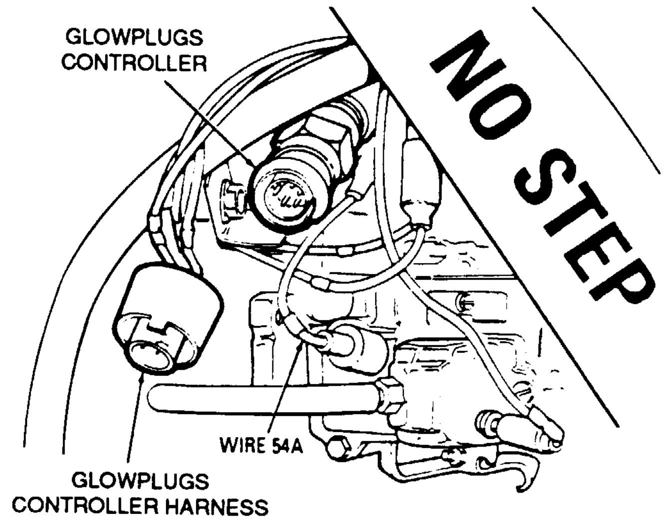
A HOT ENGINE MAY CAUSE SERIOUS BURNS. Always use caution when approaching a hot engine.

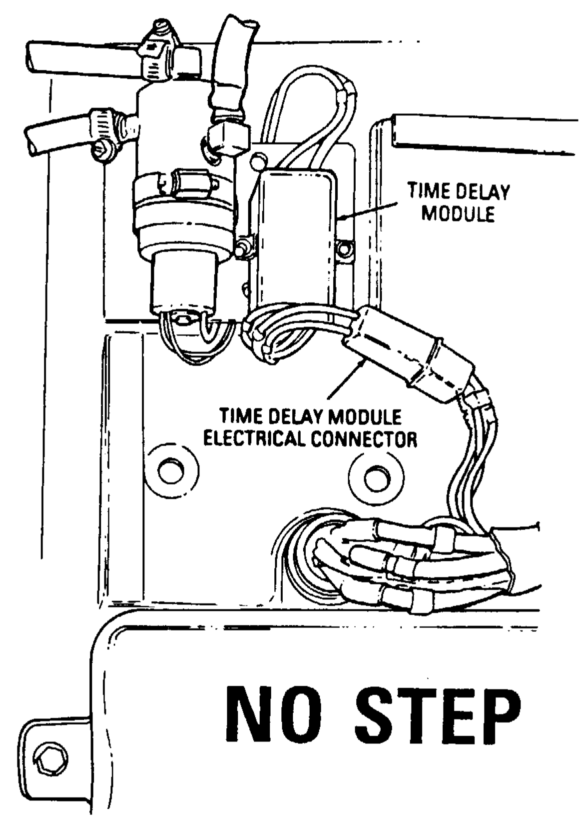
NOTE

When using the vehicle's temperature gage to determine engine temperature, don't forget to turn the rotary switch to "RUN". The gages don't work when power is off.

The colder the engine (and air temperature), the more you need the glowplugs for starting. There are some times when you don't need to run the glowplugs test. If the engine is warm and the problem is there on a hot day, then the problem is probably NOT the glowplugs or cold start advance, and these tests may be bypassed. If it's colder than 50°F, run the glowplugs test, because just a few bad glowplugs can make a minor starting problem much worse.

If the vehicle passes the STE/ICE-R compression unbalance test, it may still have a compression problem, but it would mean that every cylinder has low compression. This is possible, but not too likely. If you're confident that everything else is working properly, notify DS maintenance.





COMPRESSION UNBALANCE STE/ICE-R TEST 14
1. Run tests 72,73 and 74 to verify that the batteries are OK. **CAUTION** THE GLOWPLUGS CONTROLLER AND THE CONTROL VALVE ELECTRICAL CONNECTOR MUST BE DISCONNECTED PRIOR TO RUNNING THIS TEST. 2. Disconnect wire 54A at injection pump to prevent starting. 3. Disconnect glowplugs controller and control valve electrical connector. (to keep waveform clean). 4. Start Test 14, compression unbalance. 5. Wait for the GO message. Crank the engine. 6. Release the rotary switch when the VTM displays OFF. A number less than 25% is passing.

2-18. ENGINE RUNNING TESTS

This is a top level test for problems with an engine that starts but doesn't run well after starting. This includes an engine that starts but doesn't stay running for very long. If the engine doesn't start, or starts but immediately stops, or is very hard to start, try the "STARTABILITY" tests first.

A functional flow schematic is not applicable to this section. However, so that you may refer to sections as you need them, a quick index to the systems relating to engine running is given here.

ENGINE RUNNING **DIAGNOSTIC FLOWCHART**

START

1

THIS SECTION IS FOR PROBLEMS SUCH AS ROUGH IDLE, ROUGH RUNNING, LACK OF POWER, UNUSUAL NOISE OR VIBRATIONS.
IF THE VEHICLE WON'T START, RUN THE STARTABILITY TESTS.

KNOWN INFO

ENGINE STARTS

POSSIBLE PROBLEMS

FUEL SYSTEM
INTAKE/EXHAUST
MECHANICAL
ELECTRICAL
GLOWPLUGS
COOLING
LUBRICATION

2

DOES THE ENGINE RUN WITHOUT STALLING?

TEST OPTIONS

OBSERVE THE ENGINE AND VEHICLE OPERATION.

REASON FOR QUESTION

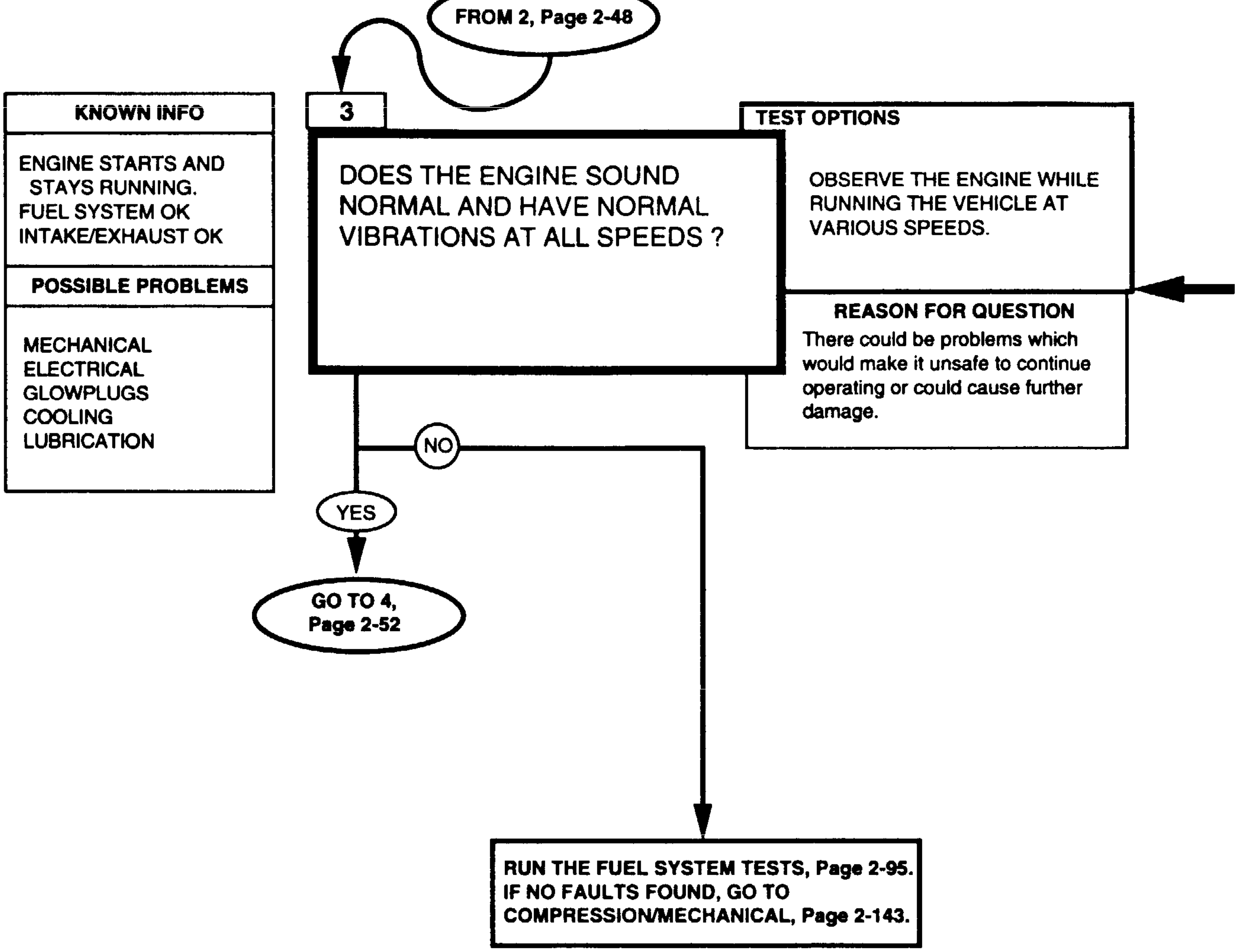
To detect and fix minor problems before looking for major problems.

NO — GO TO FUEL SYSTEM, Page 2-95

YES — GO TO 3, Page 2-50

This is a check for all of those problems which can cause the engine to stop when it shouldn't. This includes fuel, air, and electrical problems. If the engine starts and then stops immediately, run the STARTABILITY tests first.

ENGINE RUNNING **DIAGNOSTIC FLOWCHART**



Listen for noises from the engine that aren't usually there when the engine is running normally. Also be alert for unusual vibrations while the engine is idling and while you accelerate to a safe and reasonable speed.

ENGINE RUNNING **DIAGNOSTIC FLOWCHART**

FROM 3, Page 2-50

4

KNOWN INFO

ENGINE STARTS AND STAYS RUNNING WITH NO ABNORMAL SOUNDS OR VIBRATIONS.

POSSIBLE PROBLEMS

MECHANICAL
FUEL SYSTEM

DOES THE ENGINE PRODUCE RATED POWER ?

TEST OPTIONS

1. STE/ICE-R TESTS 13, 12 (Page 2-736 & 2-735)
2. ACCELERATE ON A LEVEL SURFACE.

REASON FOR QUESTION

If the engine produces rated power now, then it is probably ok to use.

NO → GO TO FUEL SYSTEM, Page 2-95

YES ↓

5

KNOWN INFO

ENGINE STARTS AND STAYS RUNNING WITH NO ABNORMAL SOUNDS OR VIBRATIONS.

POSSIBLE PROBLEMS

MECHANICAL
FUEL SYSTEM

IS THE EXHAUST COLORLESS?

TEST OPTIONS

LOOK AT EXHAUST WHILE ENGINE IS RUNNING.

REASON FOR QUESTION

Abnormal exhaust is a sign of a fuel, air or mechanical problem.

NO → GO TO FUEL SYSTEM, Page 2-95

YES ↓

6

KNOWN INFO

ENGINE STARTS AND STAYS RUNNING WITH NO ABNORMAL SOUNDS OR VIBRATIONS.
EXHAUST OK

POSSIBLE PROBLEMS

FUEL SYSTEM
COOLING SYSTEM
ELECTRICAL SYSTEM

DOES THE ENGINE PASS COMPRESSION UNBALANCE? (6.2L ONLY)

TEST OPTIONS

1. STE/ICE-R TEST 14 (Page 2-737)

REASON FOR QUESTION

Bad compression can make other systems look bad. The lower the compression unbalance number, the better the engine.

NO → NOTIFY DS MAINTENANCE

YES ↓

GO TO 7, Page 2-54

REFERENCE INFORMATION **ENGINE RUNNING**

If STE/ICE-R is not available, accelerate under full power to a safe and reasonable speed on a level surface.
For STE/ICE-R test #12, a number higher than 6700 is passing. For test #13, a number higher than 75 is passing.

ENGINE POWER TEST (PERCENT)
STE/ICE-R TEST #13

1. Set TEST SELECT switches to 13.
2. Press and release TEST button.
3. Wait for prompting message CIP to appear.
4. When CIP appears on display, press down sharply on engine accelerator and hold it to the floor. When VTM displays OFF, release accelerator.
5. A number will be displayed after the engine has returned to idle speed. This number is the test result in units of per cent of nominal rated power.

It is normal for the engine to emit some black smoke when accelerating after idling for a while. Under most other conditions, exhaust smoke is usually from one of three sources;

BLUE smoke is usually oil.
BLACK smoke is too much fuel or too little air. (Often caused by advanced injection timing).
WHITE smoke is usually water. (Often caused by retarded injection timing).

If the smoking is continuous or appears under a particular condition, the smoke probably indicates a problem and should be investigated.

ENGINE POWER TEST (RPM/SEC)
STE/ICE-R TEST #12

1. Set TEST SELECT switches to 12.
2. Press and release TEST button.
3. Wait for prompting message CIP to appear.
4. When CIP appears on display, press down sharply on engine accelerator and hold it to the floor. When VTM displays a number, release accelerator.
5. A number will be displayed after the engine has returned to idle speed. This number is the test result in units of rpm's per second.

If STE/ICE-R is not available, there is no easy way to test compression. In this case, go on to the next step but remember that compression may be a problem.

COMPRESSION UNBALANCE
STE/ICE-R TEST 14

1. Run tests 72,73 and 74 to verify that the batteries are ok.
2. THE GLOWPLUG CONTROLLER AND THE CONTROL VALVE ELECTRICAL CONNECTOR MUST BE DISCONNECTED PRIOR TO RUNNING THIS TEST.
3. Disconnect wire 54A at injection pump to prevent starting.
4. Disconnect glowplug controller and control valve electrical connector. (to keep waveform clean).
5. Start Test 14, compression unbalance.
6. Wait for the GO message. Crank the engine.
7. Release the rotary switch when the VTM displays OFF. A number less than 25% is passing.

ENGINE RUNNING **DIAGNOSTIC FLOWCHART**

FROM 6, Page 2-52

KNOWN INFO
ENGINE RUNS
NO ABNORMAL NOISES OR VIBRATIONS
EXHAUST OK
COMPRESSION OK

POSSIBLE PROBLEMS
FUEL SYSTEM
COOLING SYSTEM
ELECTRICAL SYSTEM

7

DOES THE ENGINE OPERATE AT NORMAL TEMPERATURE ?

TEST OPTIONS
1. CHECK TEMPERATURE GAUGE
2. RUN COOLING SYSTEM TESTS, Page 2-155

REASON FOR QUESTION
A hot or cold engine may run rough and cause problems later (at very inconvenient times).

NO → GO TO COOLING SYSTEM, Page 2-155

YES ↓

KNOWN INFO
ENGINE RUNS
NO ABNORMAL NOISES OR VIBRATIONS
EXHAUST OK
COMPRESSION OK
ENGINE POWER OK

POSSIBLE PROBLEMS
COOLING SYSTEM
FUEL SYSTEM

8

DOES THE ENGINE STOP WHEN THE ROTARY SWITCH IS TURNED TO "STOP"?

TEST OPTIONS
LISTEN

REASON FOR QUESTION
If the engine stops then the fuel and electrical systems are ok.

NO → GO TO FUEL SYSTEM, Page 2-95

YES ↓

KNOWN INFO
MOST SYSTEMS SEEM TO BE RUNNING OK.

POSSIBLE PROBLEMS
DRIVETRAIN

9

IF YOU STILL HAVE AN ENGINE RUNNING PROBLEM, TRY RERUNNING THIS CHAIN OF TESTS.
IF EVERYTHING CHECKS OUT OK, GO TO PARAGRAPH 2-38, DRIVETRAIN.

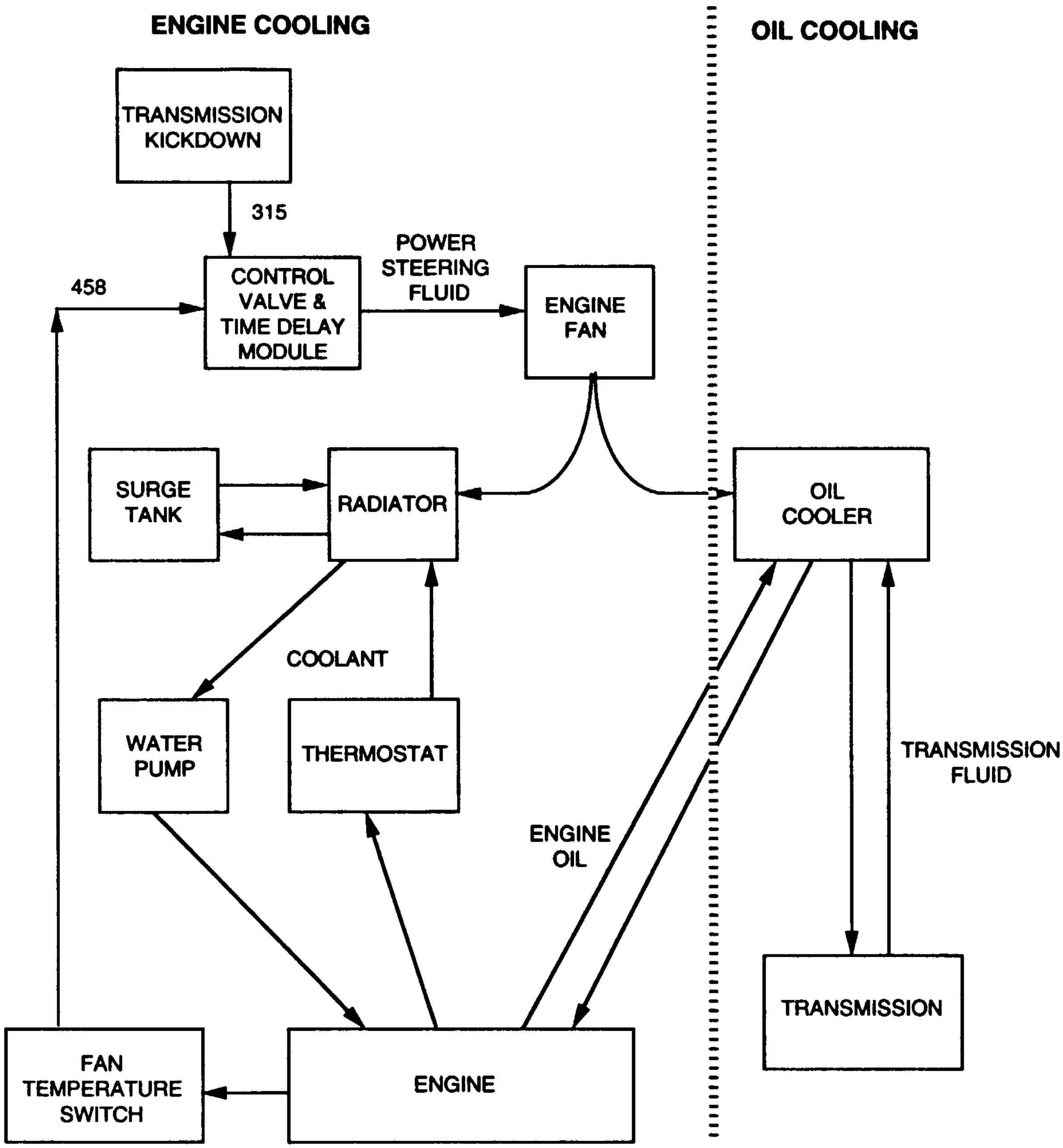
TEST OPTIONS
1. RE-RUN THIS CHAIN
2. DRIVETRAIN, Page 2-479

REASON FOR QUESTION
We've checked just about everything that could cause an engine running problem.

Because the Cooling System tests can take a long time (mostly letting a cold engine warm up), you don't have to run them unless there is or may be a problem in the cooling system.

2-19. COOLING SYSTEM TESTS

This paragraph is a top level test for problems with either the watercooling system or the oil cooling system. Just follow the path, answering the questions. Additional information and notes are given on the facing page when necessary. The Cooling System consists of the oil and water radiators, the engine fan and its controller, the water pump, and the internal coolant passages in the engine.



COOLING SYSTEM DIAGNOSTIC FLOWCHART

START

1

KNOWN INFO
NONE

POSSIBLE PROBLEMS
TEMPERATURE GAUGE
TEMPERATURE SENDER
ENGINE COOLING SYSTEM
OIL COOLING SYSTEMS
FAN BELTS
CONTROL VALVE

IS THE ENGINE TEMPERATURE GAUGE BELOW FULL SCALE AT ALL TIMES?

TEST OPTIONS
LOOK.

REASON FOR QUESTION
The engine should not reach temperatures over 240° F.

NO → GO TO A, Page 2-62

YES ↓

2

KNOWN INFO
TEMPERATURE GAUGE IS BELOW 240°F AT ALL TIMES.

POSSIBLE PROBLEMS
TEMPERATURE GAUGE
TEMPERATURE SENDER
ENGINE COOLING SYSTEM
OIL COOLING SYSTEMS
FAN BELTS
CONTROL VALVE

DOES THE TEMPERATURE GAUGE READ BELOW 120°F WHEN THE ENGINE IS COLD AND THEN INDICATE HIGHER TEMPERATURES AS THE ENGINE WARMS?

TEST OPTIONS
VISUAL INSPECTION.

REASON FOR QUESTION
You want to know if the gauge is working properly.

NO → GO TO INSTRUMENTS, Page 2-319

YES ↓

3

KNOWN INFO
TEMPERATURE GAUGE SEEMS TO WORK OK

POSSIBLE PROBLEMS
TEMPERATURE GAUGE
TEMPERATURE SENDER
ENGINE COOLING SYSTEM
OIL COOLING SYSTEMS
FAN BELTS
CONTROL VALVE

DOES THE ENGINE APPEAR TO BE PROPERLY COOLED? THAT IS, IS THERE NO EVIDENCE OF OVERHEATING?

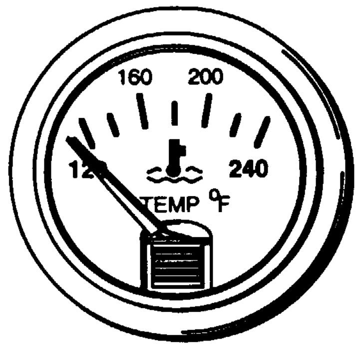
TEST OPTIONS
LOOK.

REASON FOR QUESTION
If the engine is overheating with the temperature gauge below full scale, both the temperature sending system and the engine cooling are faulty.

NO → GO TO ENGINE COOLING, Page 2-155 AND THEN INSTRUMENTS, Page 2-319

YES ↓

GO TO 4, Page 2-60

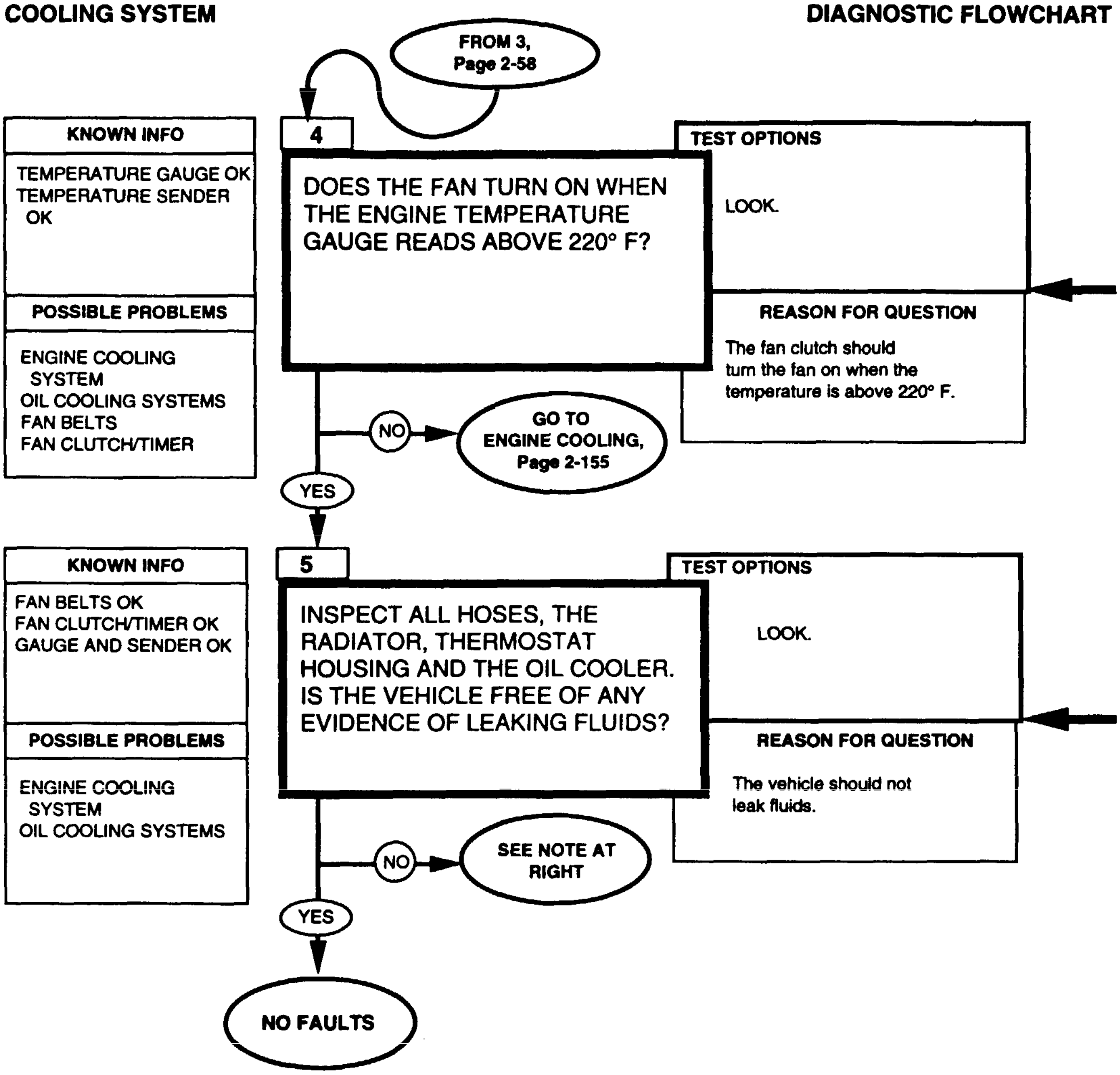


TEMPERATURE GAUGE

The question describes how the gauge should work. If you aren't sure if its working properly, you may want to run the instruments test anyway.

Look for boiling coolant, a blown surge tank pressure cap or leaking hoses to tell you if the engine is overheating.

COOLING SYSTEM DIAGNOSTIC FLOWCHART



220° F Is the approximate temperature at which the fan should turn itself on.

The fan will turn on and off as the engine temperature varies.

NOTE

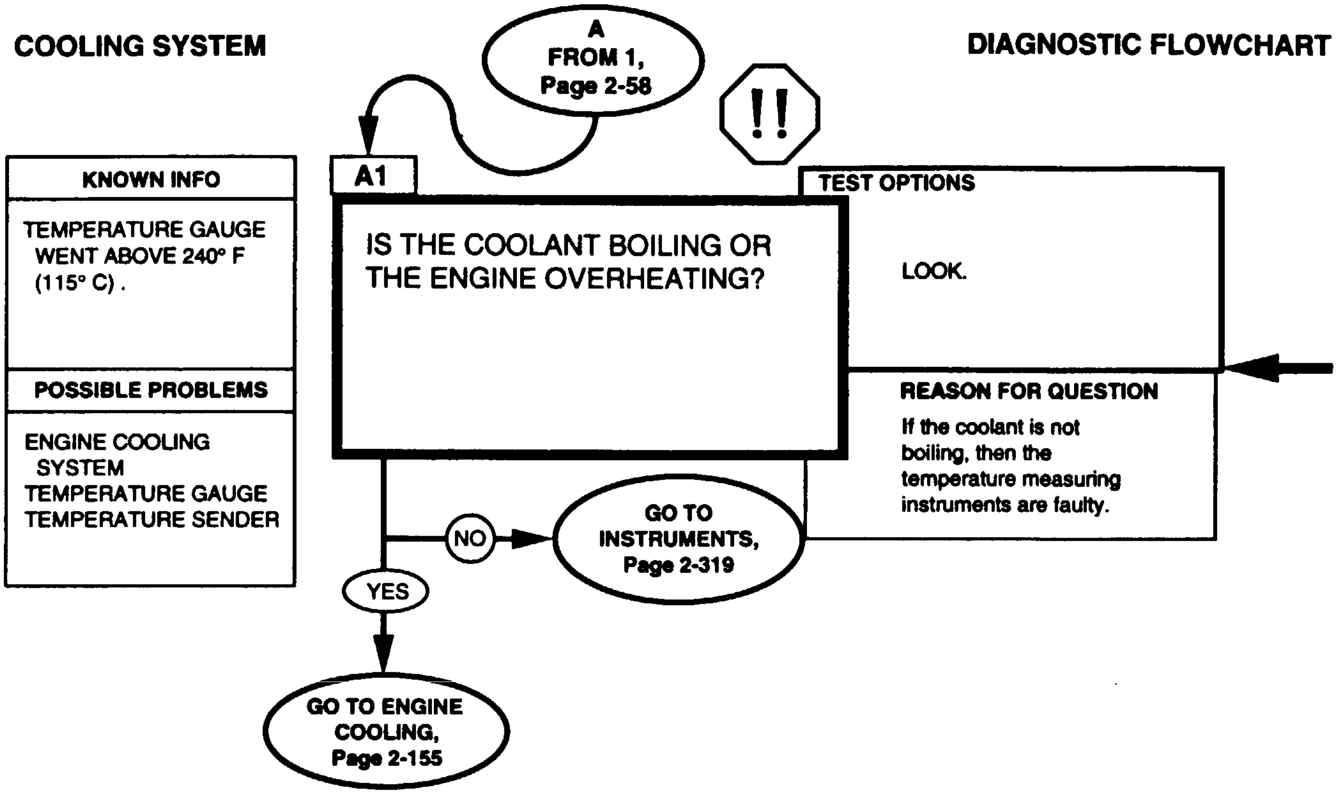
If the leaking fluid is red, go to the transmission Paragraph 2-34, Page 2-399 or Paragraph 2-35, Page 2-411.

If the leaking fluid is yellow/green, go to engine cooling, Paragraph 2-25, Page 2-155.

If the oil cooler is leaking, try to determine where the leak is coming from. The oil cooler in front of the radiator cools both engine oil and transmission fluid (top half-transmission fluid, bottom half-engine oil). If the leak is in the oil cooler, go to transmission or engine cooling. If the leak is elsewhere, go to lubrication, Paragraph 2-20, Page 2-65.

COOLING SYSTEM

DIAGNOSTIC FLOWCHART

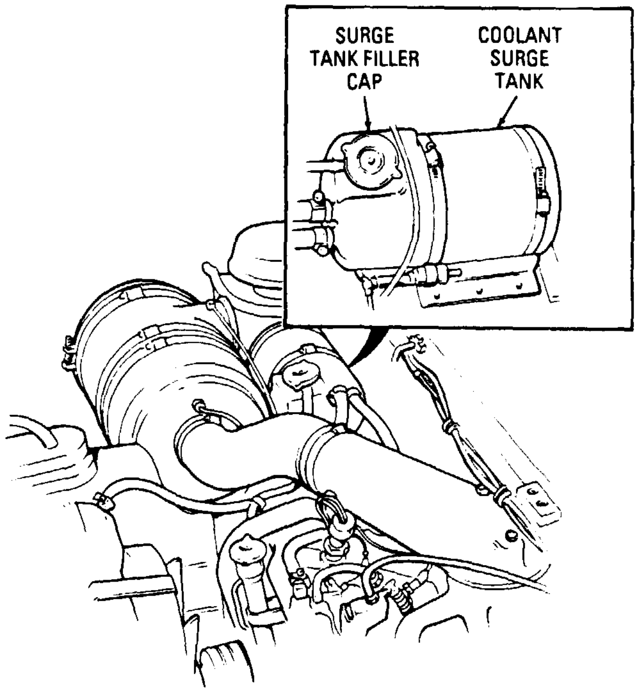


COOLING SYSTEM

WARNING

USE CAUTION WHEN INSPECTING HOT ENGINE PARTS TO AVOID BURNS. NEVER REMOVE THE PRESSURE CAP OF A HOT ENGINE.

The coolant surge tank is clear, so you can see what is happening.



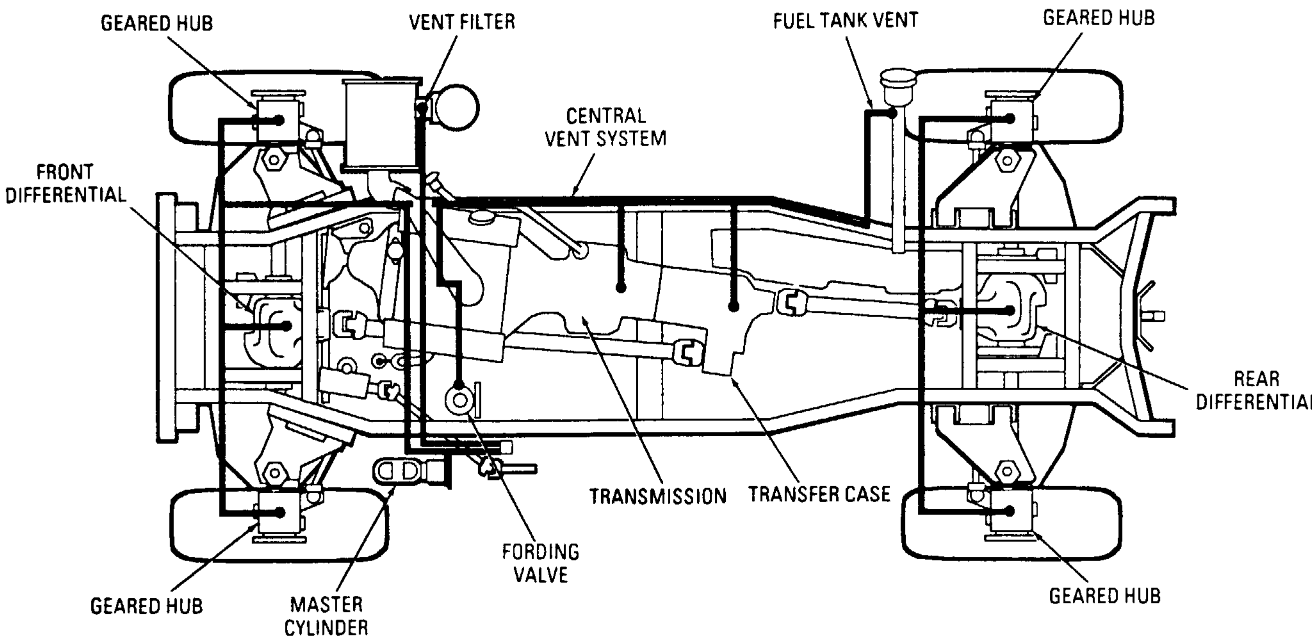
2-20. LUBRICATION SYSTEM TESTS

This paragraph is a top level test for all of the lubrication systems in the vehicle. Just follow the path, answering the questions. Additional information and notes are given on the facing page when necessary.

The HMMWV includes a venting system that is also checked in this paragraph. The purpose of the vent system is to allow vapor to escape to the atmosphere under normal operation, and to prevent venting during deep water fording operations. If the vents were left open, water would enter the engine and other systems and cause damage. The location of the vent lines is shown below. The location of the other parts in the lubrication system are shown in other lower level paragraph as required.

NOTE

Bold lines represent ventilation system.



LUBRICATION SYSTEM **DIAGNOSTIC FLOWCHART**

START

1

RUN THE ENGINE LUBRICATION TESTS IN PARAGRAPH 2-26. WERE YOU ABLE TO CORRECT ALL OF THE FAULTS?

NO → NOTIFY DS MAINTENANCE

YES ↓

KNOWN INFO

NONE

POSSIBLE PROBLEMS

ENGINE LUBRICATION
TRANSMISSION LUBRICATION
CHASSIS LUBRICATION
VENTING SYSTEM

TEST OPTIONS

SEE PARAGRAPH 2-26, PAGE 2-187.

REASON FOR QUESTION

The tests in Paragraph 2-26 are easy to run and will test out the engine lubrication system.

2

CHECK THE TRANSMISSION FLUID. IS IT O.K. ?

NO → SEE NOTE AT RIGHT

YES ↓

KNOWN INFO

ENGINE LUBRICATION OK

POSSIBLE PROBLEMS

TRANSMISSION LUBRICATION.
CHASSIS LUBRICATION
VENTING SYSTEM

TEST OPTIONS

VISUAL - SEE NOTE AT RIGHT. IF YOU SUSPECT PROBLEMS WITH THE TRANSMISSION YOU CAN RUN THE TESTS IN PARAGRAPH 2-34, PAGE 2-399 OR PARAGRAPH 2-35, PAGE 2-411.

REASON FOR QUESTION

Transmission fluid level and appearance give a good indication of the system's condition.

3

CHECK ALL OF THE REMAINING VEHICLE LUBRICATION POINTS. ARE THEY ALL PROPERLY LUBRICATED AND IN GOOD REPAIR?

NO → LUBRICATE OR REPAIR AS NEEDED.

YES ↓

KNOWN INFO

ENGINE LUBRICATION OK
TRANSMISSION LUBRICATION OK

POSSIBLE PROBLEMS

CHASSIS LUBRICATION
VENTING SYSTEM

TEST OPTIONS

SEE TM 9-2320-280-10 FOR LOCATION AND LUBRICATION INSTRUCTIONS.

REASON FOR QUESTION

The chassis and drivetrain need to be properly lubricated in order to keep the vehicle in good repair.

GO TO 4, Page 2-68

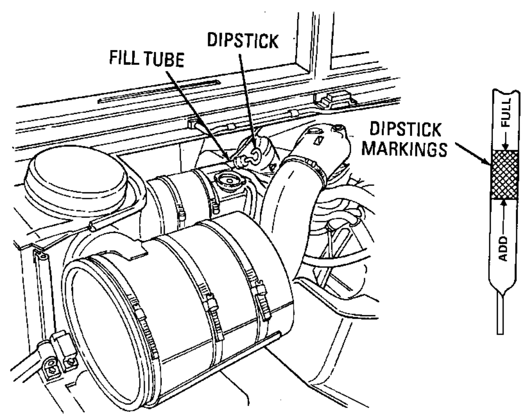
The tests in para. 2-26 test the oil level, cleanliness, leaks in the system, and the CDR valve. Return here when you've fixed everything you can or if no faults were found.

PROCEDURE FOR CHECKING TRANSMISSION FLUID

1. Start engine.
2. Hold down brake pedal and move transmission shift lever through all ranges including reverse.
3. Engage parking brake and place shift lever in neutral. Check fluid level on dipstick.
4. Proper level is between "FULL" and "ADD" marks on dipstick.

NOTE

CHECK FLUID FOR A BURNT SMELL, GRIT, DISCOLORATION, AIR BUBBLES, OR A MILKY APPEARANCE.



- Burnt smell, discoloration, or grit indicates worn or damaged internal components. Notify DS maintenance.
- Bubbles indicate an overfilled system or air leaks in the system. Drain the fluid and refill to proper level. Refer to (para. 5-2).
- Milky appearance is due to water in the system. Drain the fluid from the entire transmission and transmission cooling system and install a new filter. Refer to (para 5-2).
- Check fill tube for indications of fluid being blown out. If fluid is being blown out, check vent line for obstructions, and refill transmission to proper level. Refer to (para. 5-2).
- Transmission fluid coming out of dipstick filler tube indicates a restriction in the ventilation system. Check for clogged, melted, or crushed lines and/or fittings between transmission and atmosphere vent on air cleaner canister. Replace where needed. Refer to (para. 5-16).

Among the items are the driveshafts, suspension, differentials, and geared hubs.

LUBRICATION SYSTEM — DIAGNOSTIC FLOWCHART

FROM 3, Page 2-66

KNOWN INFO

ENGINE LUBRICATION OK
TRANSMISSION LUBE OK
CHASSIS AND DRIVELINE LUBE OK

POSSIBLE PROBLEMS

VENT SYSTEM
FORDING VALVE

4

CHECK ALL OF THE VENT LINES IN THE VEHICLE.
ARE THEY ALL OK?

TEST OPTIONS

SEE THE FOLDOUT PAGE IN THIS PARAGRAPH FOR LOCATIONS OF THE VENT LINES.

REASON FOR QUESTION

Make sure that the vent system is intact. The vent system is used during deep fording operations.

NO → REPAIR AS NEEDED

YES ↓

KNOWN INFO

ENGINE LUBRICATION OK
TRANSMISSION LUBE OK
CHASSIS AND DRIVE LINE LUBE OK
VENT LINES OK

POSSIBLE PROBLEMS

VENT FILTER
FORDING VALVE

5

CHECK THE VENT FILTER.
IS IT OK?

TEST OPTIONS

VISUAL INSPECTION - THE VENT FILTER IS LOCATED BEHIND THE COOLANT SURGE TANK.

REASON FOR QUESTION

A clogged vent filter will cause the fuel tank to be at a vacuum. This could lead to problems with the fuel system.

NO → REPLACE FILTER

YES ↓

KNOWN INFO

ENGINE LUBRICATION OK
TRANSMISSION LUBE OK
CHASSIS AND DRIVE LINE LUBE OK
VENT LINES OK
VENT FILTER OK

POSSIBLE PROBLEMS

FORDING VALVE

6

CHECK THE FORDING VALVE FOR PROPER OPERATION (IF YOUR VEHICLE HAS ONE).
IS IT OK?

TEST OPTIONS

VISUAL INSPECTION - TEST OPERATION IN BOTH POSITIONS.

REASON FOR QUESTION

The fording control valve regulates the venting of vapors to the atmosphere.

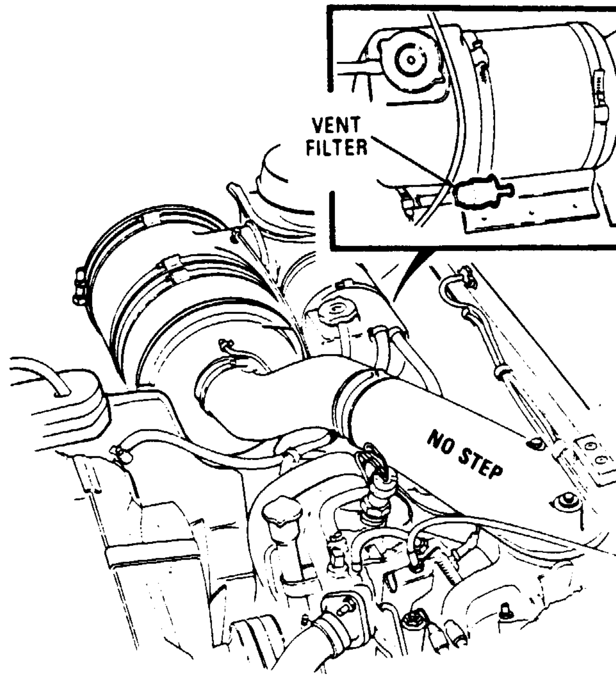
NO → REPAIR AS NEEDED

YES ↓

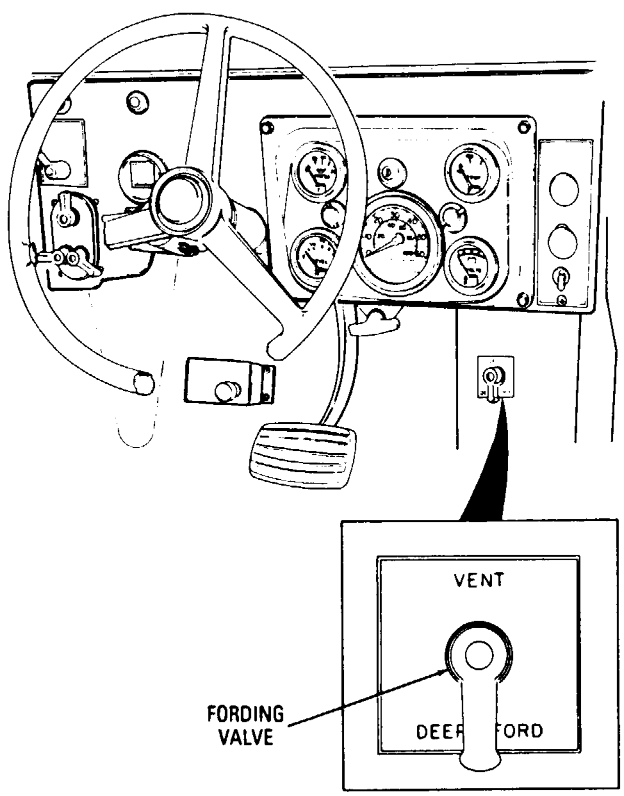
NO FAULTS

REFERENCE INFORMATION **LUBRICATION SYSTEM**

There are vent lines attached to all parts of the vehicle with a lubrication reservoir. These parts are the engine, transmission, transfer case, differentials, geared hubs, and the fuel tank. Removal procedures for the vent lines are given in the repair procedure for the particular component to which the line is attached.



Replace the fording valve. Refer to (para 12-9).



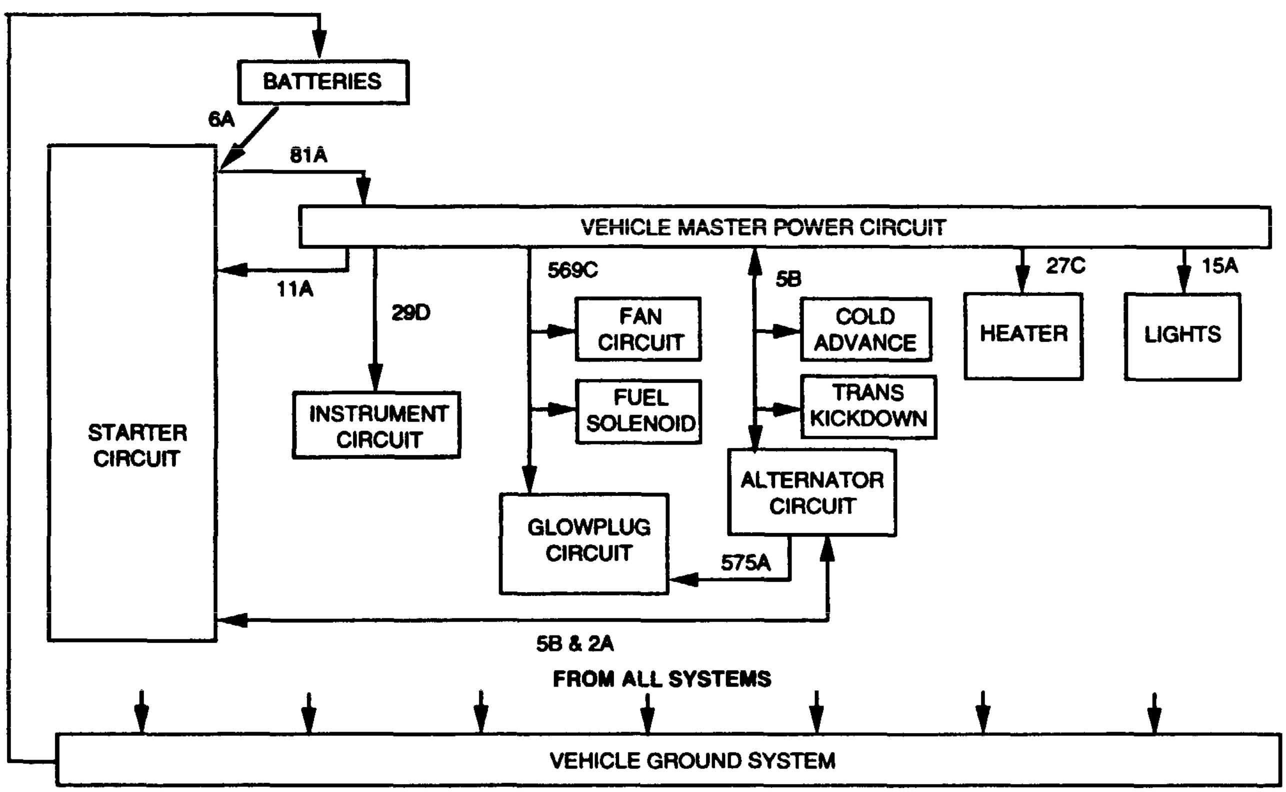
2-21. ELECTRICAL TESTS

Most of the electrical circuits in the vehicle are included in one of the major systems covered by this manual. This is a top level paragraph to help you pick the right one. A number of schematics are also included to help you find the problem. If you go through the flowchart and can't solve the problem, use the schematics to find wires which may be causing trouble.

The Electrical System consists of the batteries, which produce electrical power by a chemical reaction between the lead plates and the electrolyte solution (a mixture of acid and water). This power is carried by wires and cables to those parts of the vehicle which require electrical power. The batteries get recharged by the alternator, which generates electrical power by using some of the engine's mechanical power, produced when the engine is running. If you are not too confident about electrical concepts and terminology, you should read Paragraph 2-16, page 2-39.

All electrical systems require a connection to ground (called grounding), which is the completion of the circuit to the battery negative. Pages 2-66, 2-67 and 2-68 are diagrams of the grounding. If your vehicle exhibits strange symptoms that seem to defy all efforts to fix them, the vehicle may have a grounding problem. Grounding problems cause strange symptoms usually because more than one circuit is using the same ground, or because a circuit has more than one ground. For example, looking at the body ground diagram, if wire 58D (a ground for the instruments) is disconnected from the left side cylinder head, the instruments may still function due to the separate ground, but they would probably be erratic and inaccurate. Usually the problem will be a loose or corroded connection between the circuit, through body ground to battery negative terminal. Be sure to check continuity to battery negative cable rather than simply to the vehicle body or engine block.

After the grounding diagrams are functional flow schematics of the major systems in the vehicle. The shaded areas are the wires and components of the vehicle master power distribution. These are designed to help you find the system giving you problems.



ELECTRICAL **DIAGNOSTIC FLOWCHART**

START

1

KNOWN INFO	QUESTION	TEST OPTIONS
NOTHING	WITH THE ROTARY SWITCH TURNED TO "STOP", ARE ALL CIRCUITS EXCEPT THE LIGHTS UNPOWERED?	1. LOOK 2. STE/ICE-R TEST 90 (Page 2-751)
POSSIBLE PROBLEMS		**REASON FOR QUESTION**
SHORTS OPENS		It's important to verify that there are no shorts which could cause things to be powered when they shouldn't be.

NO → GO TO A, Page 2-78

YES ↓

2

KNOWN INFO	QUESTION	TEST OPTIONS
POWER IS OFF WHEN IT SHOULD BE	DO ANY OF THE LIGHTS WORK WITH THE ROTARY SWITCH IN THE "STOP" POSITION?	TURN LIGHTS ON AND LOOK
POSSIBLE PROBLEMS		**REASON FOR QUESTION**
OPENS		The lights should work with the rotary switch at STOP. If the lights work, power is making it from the batteries through the PCB to the light circuit.

NO → GO TO C, Page 2-82

YES ↓

3

KNOWN INFO	QUESTION	TEST OPTIONS
POWER TO THE LIGHT CIRCUIT IS OK	DO ALL OF THE LIGHTS WORK WITH THE ROTARY SWITCH IN ANY POSITION?	TURN LIGHTS ON AND LOOK
POSSIBLE PROBLEMS		**REASON FOR QUESTION**
INDIVIDUAL LIGHTS MAY HAVE BURNT BULBS, BAD WIRES, ETC.		There may be problems which only effect one light, rather than all of them.

NO → GO TO LIGHTS, Page 2-389

YES ↓

GO TO 4, Page 2-74

The lights are the only circuit on the vehicle which should work or be drawing any power when the switch is in the STOP position. Check the instruments, try turning on the heater fan, listen for any relay clicking or other sign (includes engine running) that power is on when it should't be.
It's best if you use the STE/ICE-R in TK mode to verify that there is no current draw from the batteries. You can't use the DCA mode for this because it will measure this current during the calibration part of the test and think that this is just an offset in the sensor.

0-1500 AMPS DC
STE/ICE-R TEST 90

1. Connect probe.
2. Start Test 90, DC amps.
3. Displayed reading is in amps.

The lights should work with the rotary switch in any position.

ELECTRICAL **DIAGNOSTIC FLOWCHART**

FROM 3, Page 2-72

KNOWN INFO

POWER CAN BE TURNED OFF

POSSIBLE PROBLEMS

PCB
ROTARY SWITCH
BATTERY
STARTER
CIRCUIT BREAKERS
WIRING

4

WITH THE ROTARY SWITCH IN THE "RUN" POSITION, IS THE INSTRUMENT CLUSTER VOLTMETER IN THE YELLOW OR GREEN ZONE?

TEST OPTIONS

TRY IT.

LOOK.

REASON FOR QUESTION

This quickly verifies that power is getting from the batteries to the rotary switch and the batteries aren't discharged.

NO → GO TO D, Page 2-84

YES ↓

KNOWN INFO

ROTARY SWITCH OK

POSSIBLE PROBLEMS

CIRCUIT BREAKER 2 OK
PCB
ALTERNATOR
WIRING

5

DO ALL OF THE GAUGES WORK PROPERLY WITH THE ENGINE RUNNING?

TEST OPTIONS

LOOK

REASON FOR QUESTION

Power may not be making it through circuit breaker 2 to the instrument panel.

NO → GO TO INSTRUMENTS, Page 2-319

YES ↓

KNOWN INFO

ROTARY SWITCH OK
CIRCUIT BREAKER 2 OK

POSSIBLE PROBLEMS

PCB
ALTERNATOR
WIRING

6

DOES THE HEATER FAN WORK WITH THE ROTARY SWITCH IN THE "RUN" POSITION?

TEST OPTIONS

TURN HEATER ON AND CHECK FOR AIRFLOW.

REASON FOR QUESTION

The heater fan should work with the rotary switch in the run position.

NO → GO TO INSTRUMENTS, Page 2-319

YES ↓

GO TO 7, Page 2-76

With engine off, turn switch. If the voltmeter is slightly in the yellow zone, you can continue down the YES path, but beware of possible test failures due to the low battery charge.

ELECTRICAL **DIAGNOSTIC FLOWCHART**

FROM 6, Page 2-74

KNOWN INFO
ROTARY SWITCH OK CIRCUIT BREAKER-1 OK
POSSIBLE PROBLEMS
BATTERY ALTERNATOR PCB RUN WIRING ACCESSORY WIRING

7

START THE ENGINE. WHEN THE ENGINE STARTED, DID THE BATTERY VOLTAGE INCREASE SO THE VOLTMETER IS IN THE GREEN ZONE?

TEST OPTIONS

1. VOLTS GAGE
2. STE/ICE-R TEST 67 (Page 2-740)
3. MULTIMETER

REASON FOR QUESTION

If the voltage increases, the alternator is connected and working.

NO → GO TO ALTERNATOR, Page 2-195

YES ↓

KNOWN INFO
BATTERY OK START WIRING OK ROTARY SWITCH OK ALTERNATOR OK.
POSSIBLE PROBLEMS
PCB RUN WIRING ACCESSORY WIRING

8

DOES THE ENGINE COOLING FAN WORK?

TEST OPTIONS

TRY IT.

REASON FOR QUESTION

The cooling fan should work when the rotary switch is turned to run.

NO → GO TO COOLING, Page 2-155

YES ↓

KNOWN INFO
BATTERY OK START WIRING OK ROTARY SWITCH OK ALTERNATOR OK.
POSSIBLE PROBLEMS
PCB RUN WIRING ACCESSORY WIRING

9

DOES THE WINDSHIELD WIPER WORK WITH THE ROTARY SWITCH IN THE "RUN" POSITION?

TEST OPTIONS

TRY IT.

REASON FOR QUESTION

The windshield wiper should work with the rotary switch in the run position.

NO → GO TO INSTRUMENTS, Page 2-319

YES ↓

NO FAULTS

BATTERY VOLTAGE STE/ICE-R TEST 67
1. Start Test 67, battery voltage. 2. Displayed reading is in volts. Batteries should be 23-25.5 volts. Batteries voltage will drop when glowplugs turn on.

ELECTRICAL **DIAGNOSTIC FLOWCHART**

A
FROM 1,
Page 2-72

!!

KNOWN INFO

SHORT CIRCUIT IN POWER LINES

POSSIBLE PROBLEMS

BODY CONNECTOR HARNESS
ENGINE CONNECTOR HARNESS
ROTARY SWITCH

A1

DISCONNECT THE PCB/DISTRIBUTION BOX BODY CONNECTOR. KEEP THE ROTARY SWITCH IN THE "STOP" POSITION. IS THERE STILL POWER AT ANY CIRCUITS OTHER THAN THE LIGHTS?

TEST OPTIONS

1. STE/ICE-R TEST 90 (Page 2-751)
2. VISUAL CHECK

REASON FOR QUESTION

If the problem goes away, the short is in the body connector harness or the rotary switch

NO → **GO TO B, Page 2-80**

YES ↓

KNOWN INFO

BODY CONNECTOR HARNESS OK

POSSIBLE PROBLEMS

ENGINE CONNECTOR HARNESS
ROTARY SWITCH

A2

RECONNECT THE BODY CONNECTOR.
DISCONNECT THE ENGINE CONNECTOR HARNESS. KEEP THE ROTARY SWITCH AT "STOP". IS THERE POWER AT ANY CIRCUITS OTHER THAN THE LIGHTS?

TEST OPTIONS

1. STE/ICE-R TEST 90 (Page 2-751)
2. VISUAL CHECK

REASON FOR QUESTION

If the problem stays, it has to be a short in the engine connector harness.

NO → **REPLACE PCB/DISTRIBUTION BOX**

YES ↓

A3

REPAIR OR REPLACE THE ENGINE CONNECTOR HARNESS. GO TO STEP 1, PAGE 2-72 TO CONTINUE TESTING.

WARNING

DISCONNECT NEGATIVE BATTERY CABLE BEFORE DISCONNECTING AND RECONNECTING PROTECTIVE CONTROL BOX/DISTRIBUTION BOX HARNESS.

There is battery voltage at the PCB/distribution box at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

0-1500 AMPS DC STE/ICE-R TEST 90
1. Connect probe. 2. Start Test 90, DC amps. 3. Displayed reading is in amps.

Replace PCB, refer to (para. 4-5).
Replace distribution box, refer to (para. 4-5.1).

Repair harness, refer to (para. 4-85).
Replace harness. Notify DS maintenance.

ELECTRICAL **DIAGNOSTIC FLOWCHART**

B FROM A1, Page 2-78

B1

IS THERE AN OPEN CIRCUIT FROM PIN B TO PIN R AND FROM PIN B TO PIN S ON THE ROTARY SWITCH (WITH THE SWITCH IN THE "STOP" POSITION)?

KNOWN INFO

SHORT ON BODY CONNECTOR SIDE OF PCB/DISTRIBUTION BOX

POSSIBLE PROBLEMS

ROTARY SWITCH
PCB/DISTRIBUTION BOX
BODY CONNECTOR
BODY CONNECTOR CABLE HARNESS

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION

Checking the rotary switch first makes it easier to check the other possible problems.

NO → **REPLACE ROTARY SWITCH**

YES ↓

B2

IS THERE ABOUT 0 VOLTS AT PINS A,B,D,G AND H OF THE PCB/DISTRIBUTION BOX BODY CONNECTOR?

KNOWN INFO

ROTARY SWITCH OK

POSSIBLE PROBLEMS

PCB/DISTRIBUTION BOX BODY CONNECTOR
BODY CONNECTOR CABLE HARNESS

TEST OPTIONS

1. STE/ICE-R TEST 89 (Page 2-750)
2. MULTIMETER

REASON FOR QUESTION

If there is voltage at any of these pins then the PCB/distribution box must have a short in it.

NO → **REPLACE PCB/DISTRIBUTIION BOX** !!

YES ↓

B3

REPAIR OR REPLACE THE BODY CONNECTOR HARNESS.
GO TO A2, PAGE 2-78,
TO CONTINUE TESTING.

Replace rotary switch. Refer to (para. 4-7).

0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the terminations indicated in the question. RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

Replace PCB. Refer to (para. 4-5).
Replace distribution box. Refer to (para. 4-5.1).

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

Repair or replace harness.
Notify DS maintenance.

WARNING

DISCONNECT NEGATIVE BATTERY CABLE BEFORE DISCONNECTING AND RECONNECTING PROTECTIVE CONTROL BOX/DISTRIBUTION BOX HARNESS.

There is battery voltage at the PCB/distribution box at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

ELECTRICAL **DIAGNOSTIC FLOWCHART**

C
FROM 2, Page 2-72

C1

KNOWN INFO
NO SHORTS LIGHTS DON'T WORK

POSSIBLE PROBLEMS
BAD CONNECTIONS BATTERIES WIRES LIGHTS CIRCUIT

CHECK ALL CONNECTIONS FROM THE BATTERIES TO THE LIGHT SWITCH. ARE THEY CLEAN AND TIGHT?

TEST OPTIONS

LOOK AND TOUCH

REASON FOR QUESTION

Loose or dirty connections won't conduct current.

NO → CLEAN AND TIGHTEN

YES ↓

C2

KNOWN INFO
NO SHORTS CONNNECTIONS OK

POSSIBLE PROBLEMS
BATTERIES WIRES LIGHT CIRCUIT

TURN THE ROTARY SWITCH TO "RUN". DO ANY ELECTRICAL SYSTEMS WORK (LIGHTS, INSTRUMENTS, HEATER FAN)?

TEST OPTIONS

LOOK.

REASON FOR QUESTION

This will check if the batteries have enough power to run the lights.

NO → GO TO BATTERY CIRCUIT. Page 2-251

YES ↓

C3

GO TO LIGHTS, PARAGRAPH 2-33, PAGE 2-389, THEN CONTINUE TESTING AT STEP 3, PAGE 2-72.

REFERENCE INFORMATION

Battery cables to starter.
Bus bar to solenoid
PCB engine & body connector
Light switch

ELECTRICAL

DIAGNOSTIC FLOWCHART

D
FROM 4, Page 2-74

KNOWN INFO

POWER CAN BE TURNED OFF

POSSIBLE PROBLEMS

BATTERIES
INSTRUMENT CIRCUIT

D1

IS THE BATTERY VOLTAGE 23.5 TO 25.5 VOLTS?

TEST OPTIONS

1. STE/ICE-R TEST 67 (Page 2-740)
2. MULTIMETER

REASON FOR QUESTION

If the battery is supplying full voltage, then there is something wrong with the instrument circuit.

NO → GO TO BATTERY, Page 2-251

YES ↓

D2

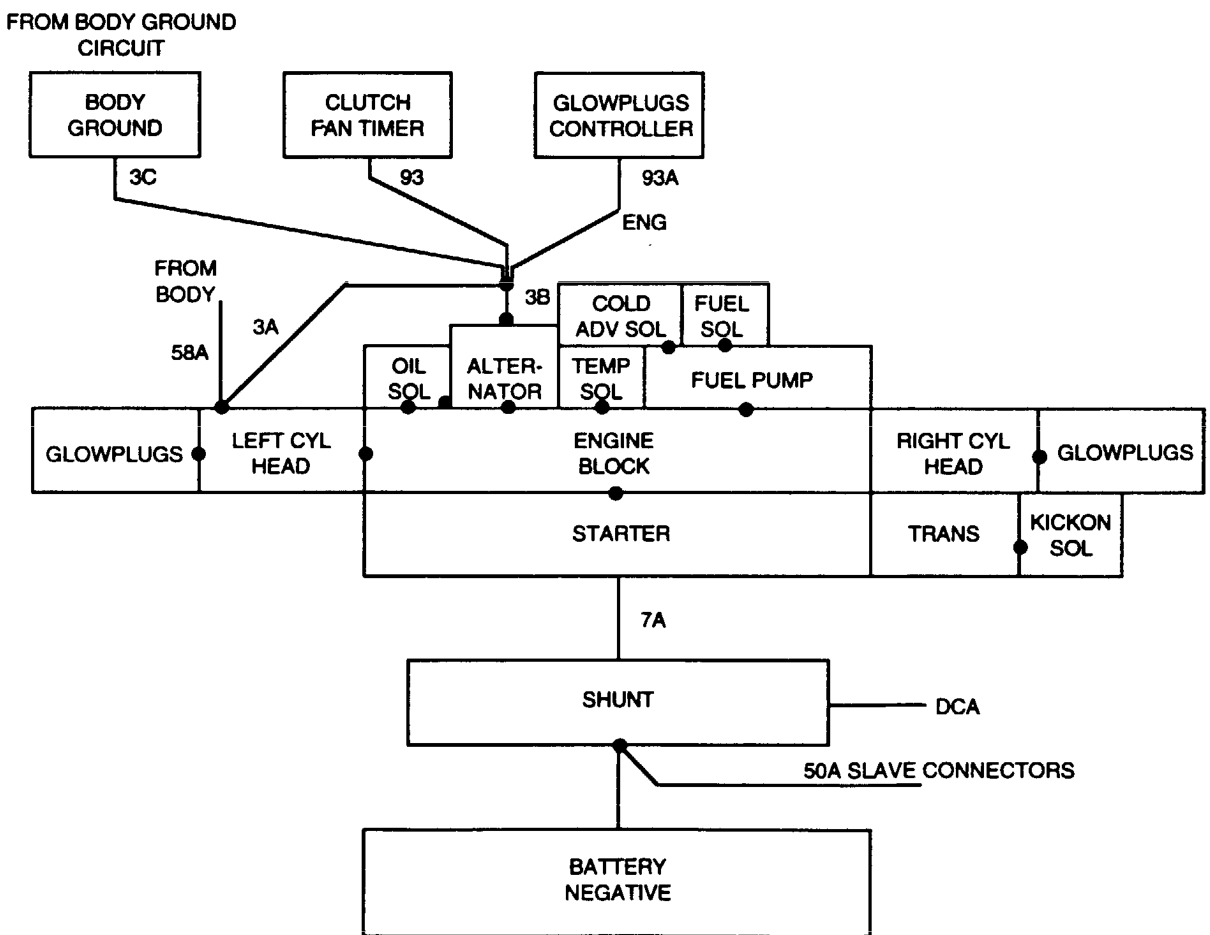
GO TO INSTRUMENTS, PAGE 2-319, THEN CONTINUE TESTING AT STEP 4, PAGE 2-74.

BATTERY VOLTAGE STE/ICE-R TEST 67
1. Start Test 67, battery voltage. 2. Displayed reading is in volts. Batteries should be 23-25.5 volts. Batteries' voltage will drop when glowplugs turn on.

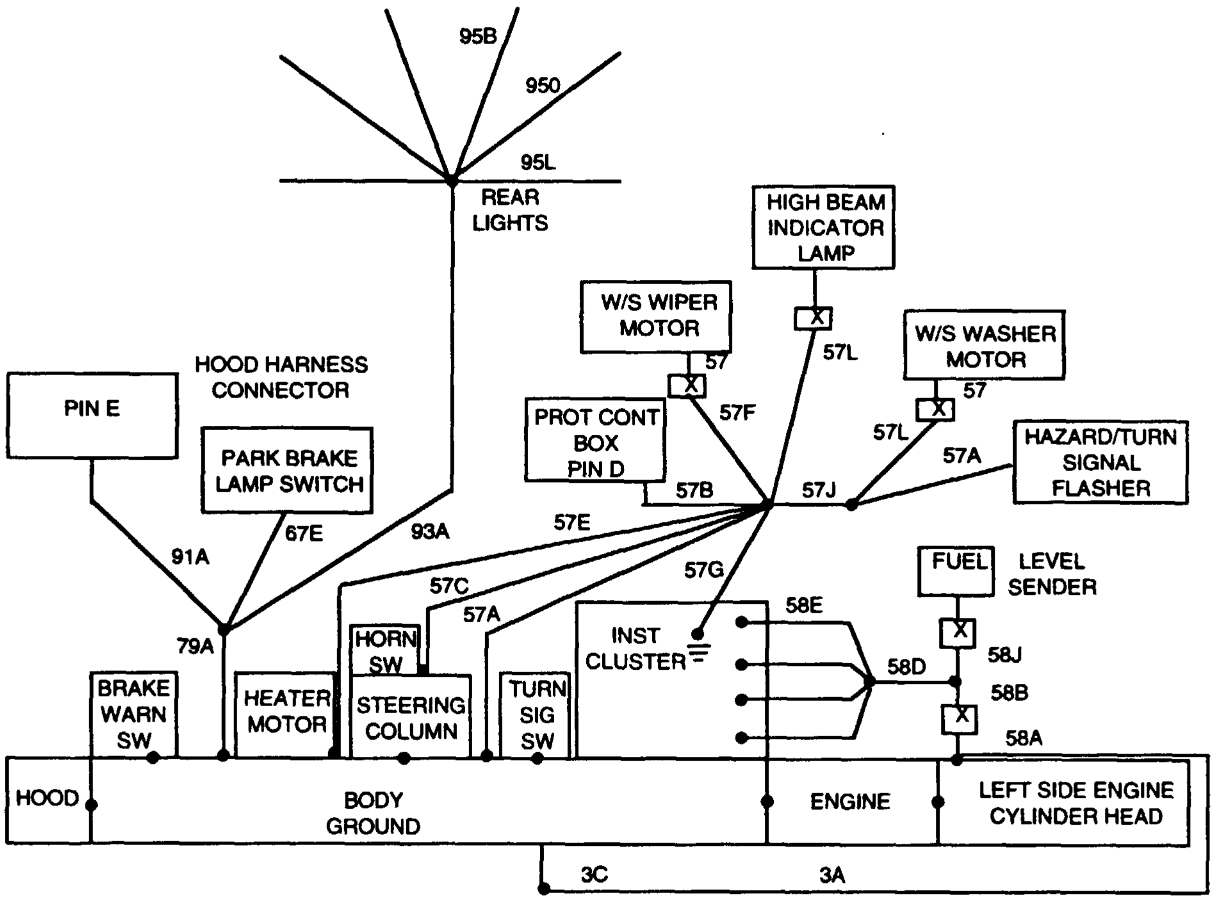
BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.

ELECTRICAL

BATTERY/ENGINE GROUND CIRCUIT

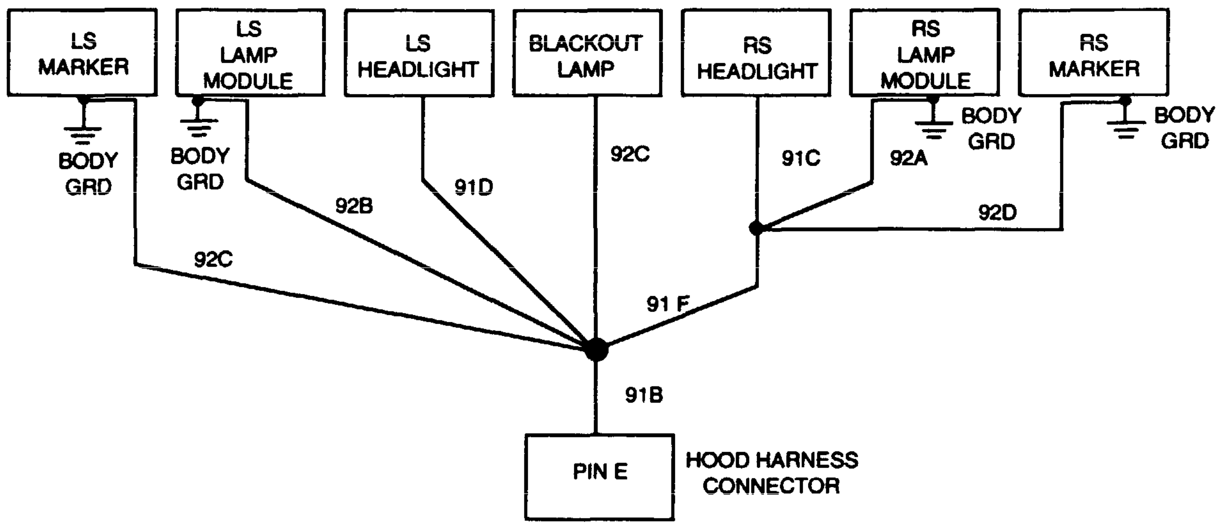


BODY GROUND CIRCUIT



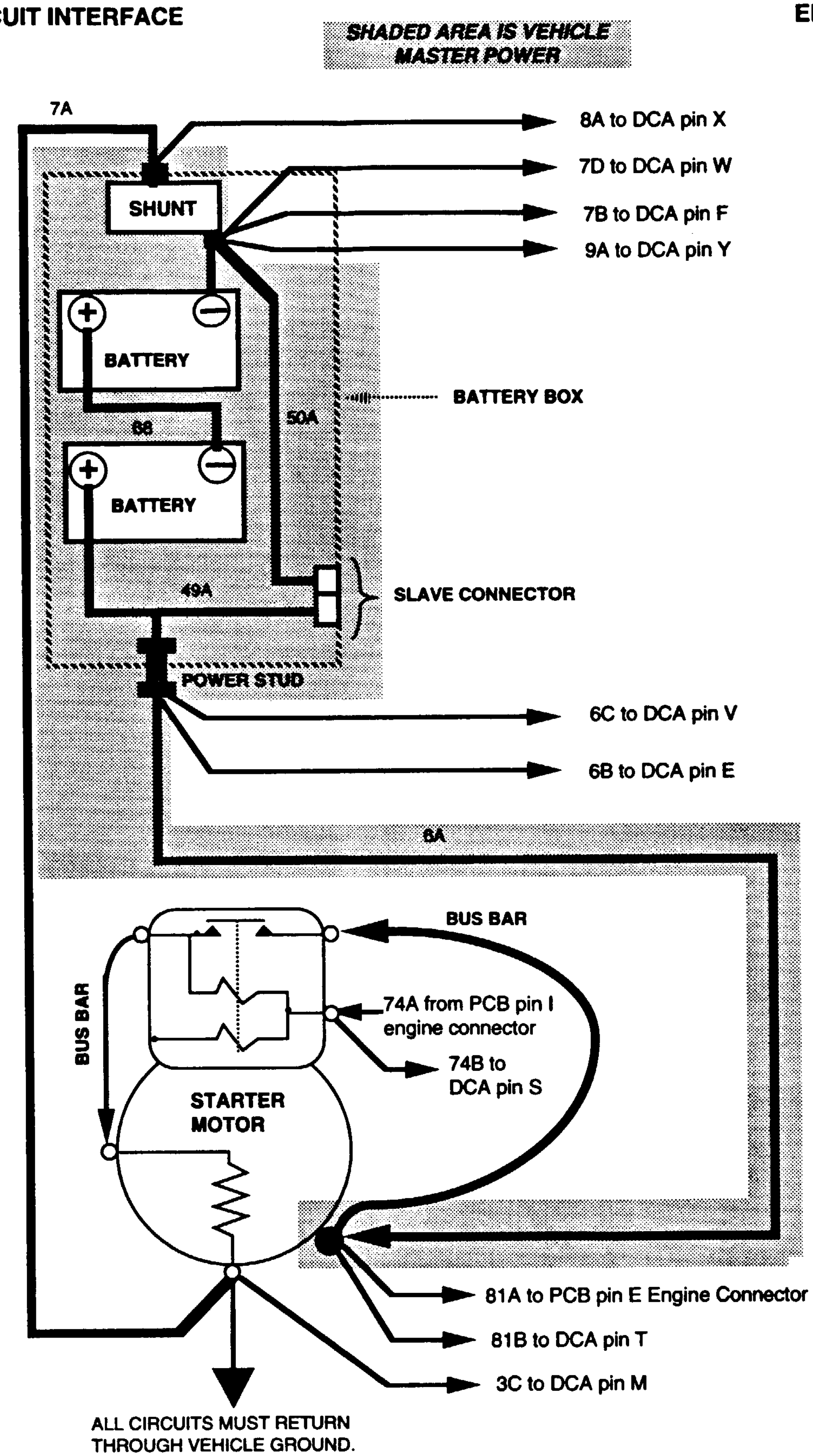
ELECTRICAL

FRONT HOOD/LIGHTS GROUND CIRCUIT



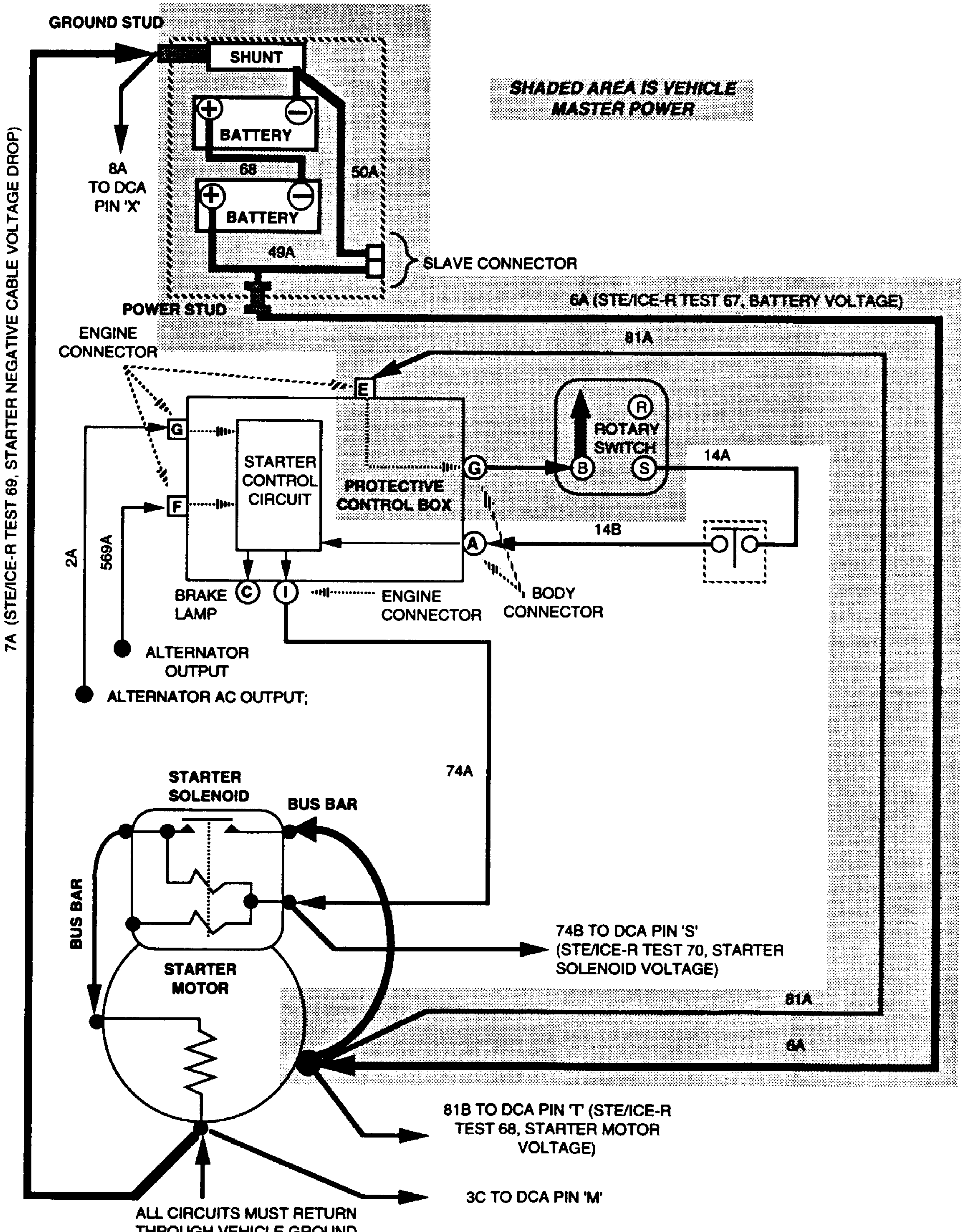
BATTERY CIRCUIT INTERFACE

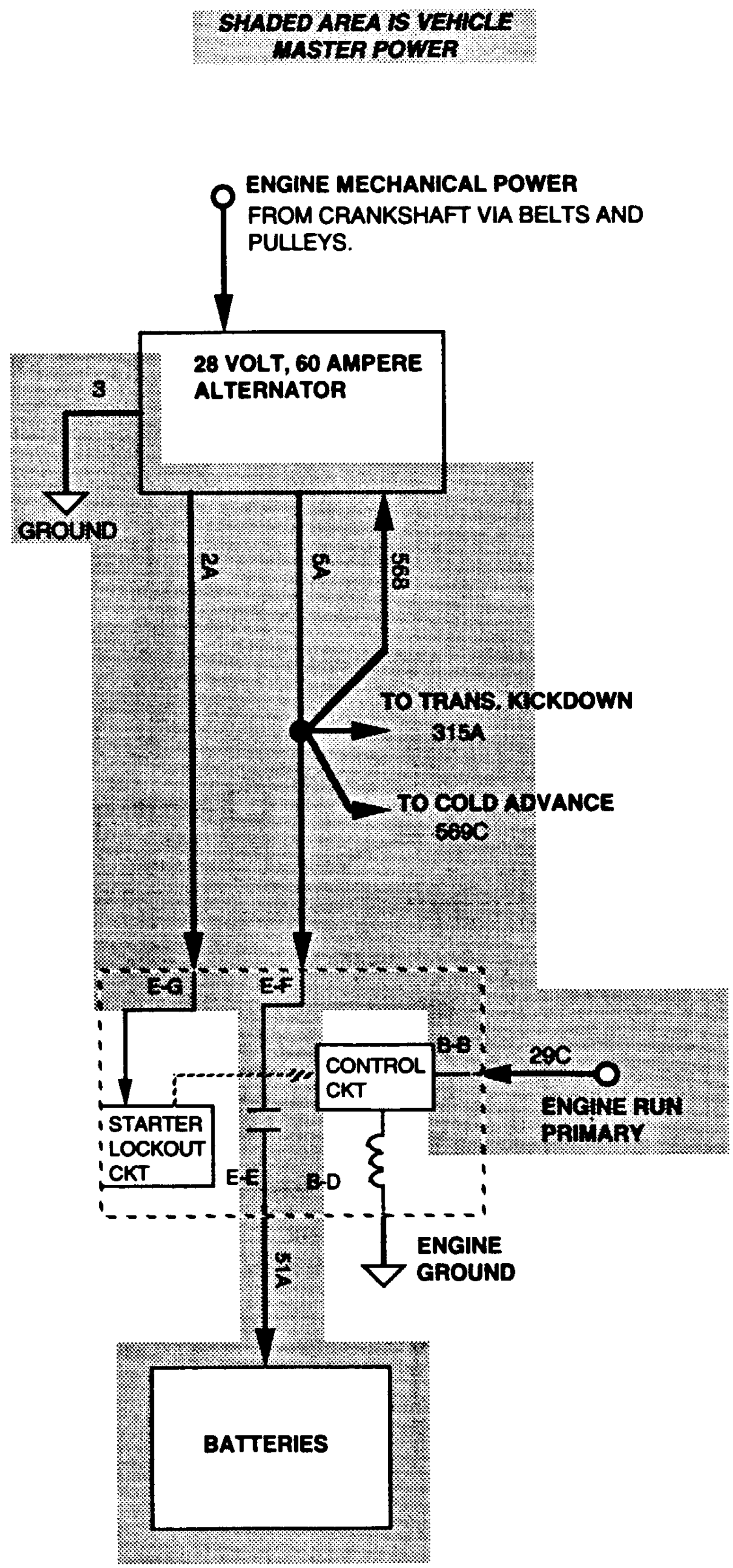
ELECTRICAL

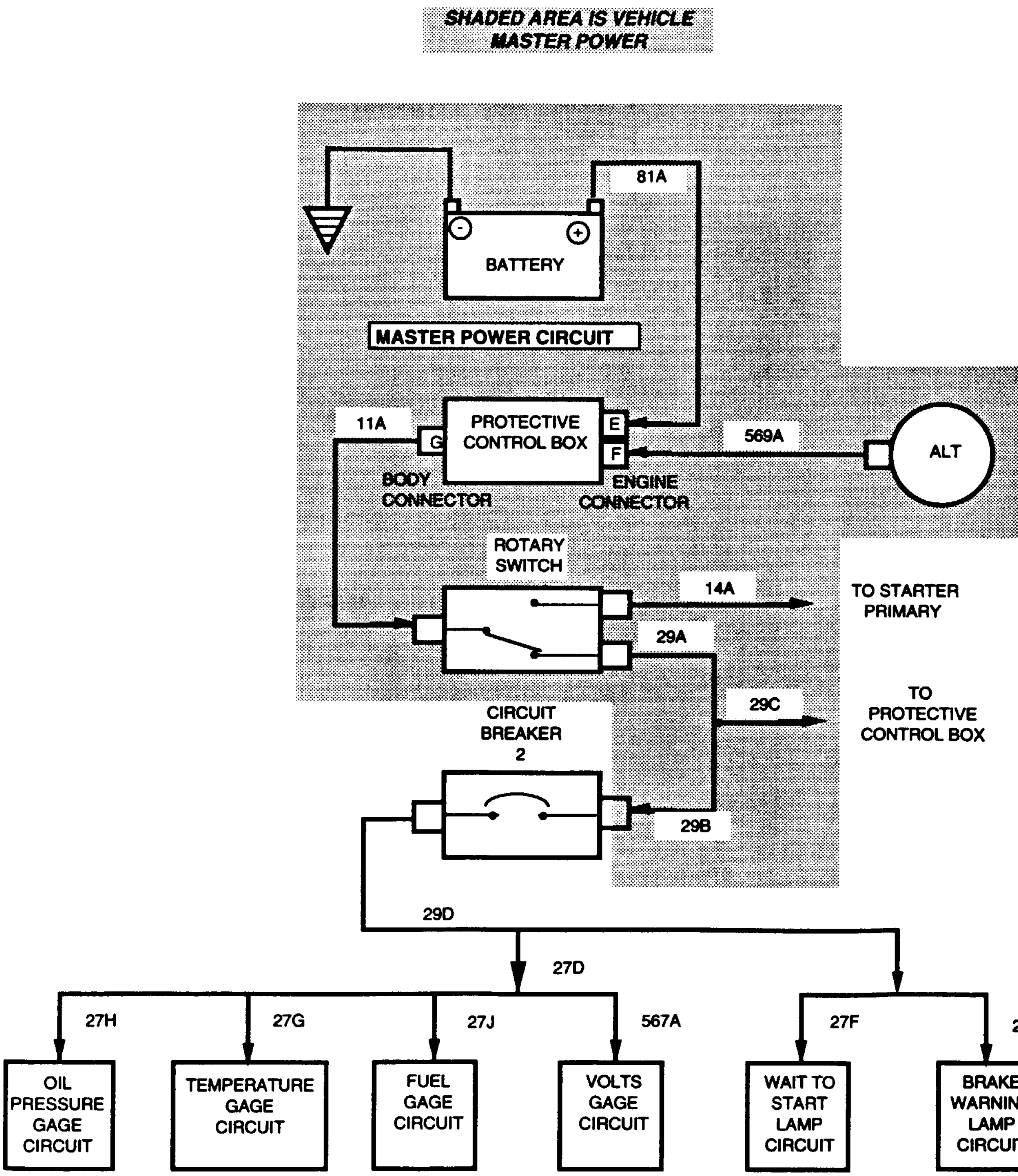


ELECTRICAL

STARTER CIRCUIT INTERFACE

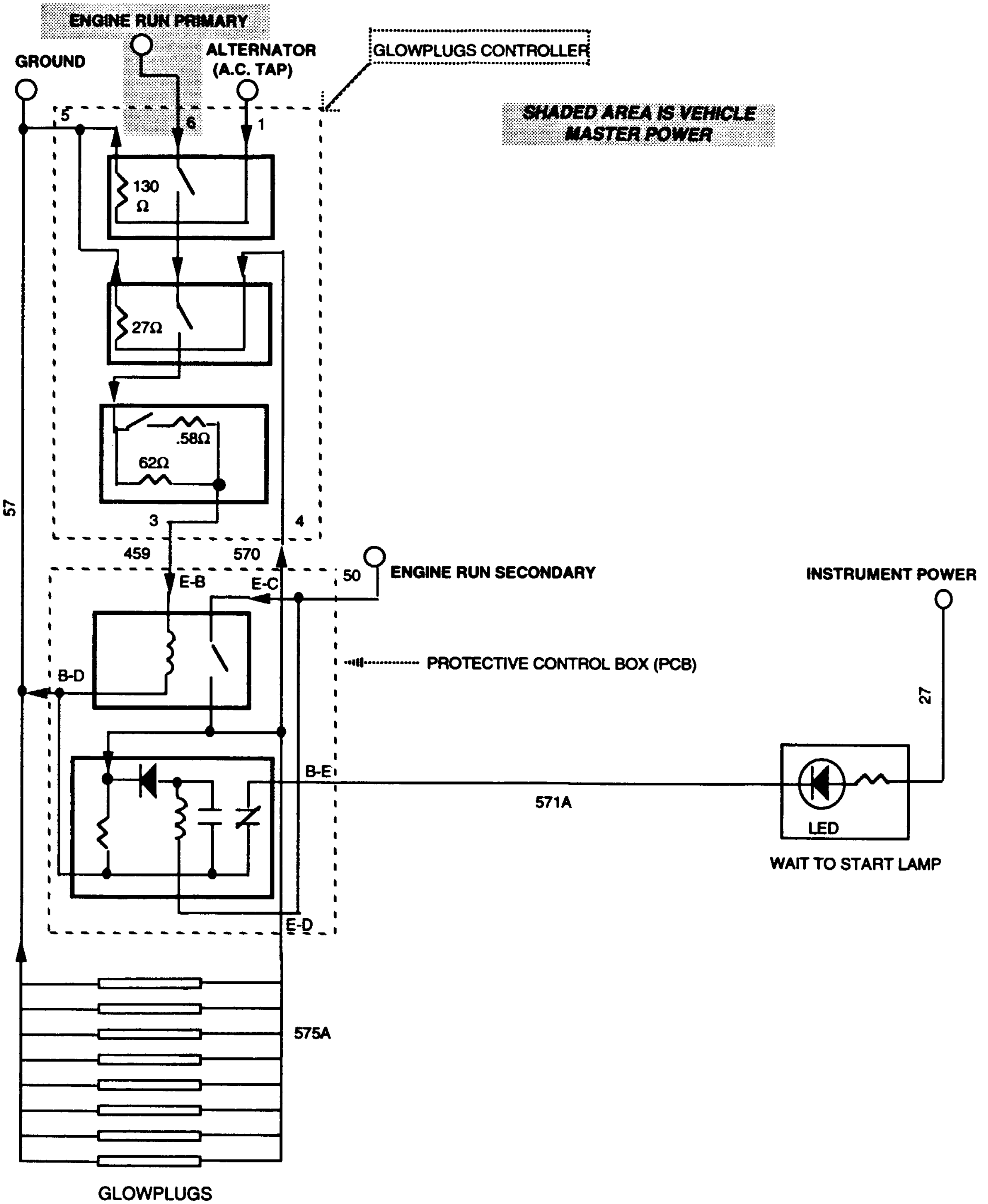



SHADED AREA IS VEHICLE MASTER POWER
ENGINE MECHANICAL POWER
FROM CRANKSHAFT VIA BELTS AND PULLEYS.
28 VOLT, 60 AMPERE ALTERNATOR
3
GROUND
2A
5A
568
TO TRANS. KICKDOWN
315A
TO COLD ADVANCE
569C
E-G
E-F
B-B
29C
CONTROL CKT
ENGINE RUN PRIMARY
STARTER LOCKOUT CKT
E-E
B-D
ENGINE GROUND
51A
BATTERIES


SHADED AREA IS VEHICLE MASTER POWER
81A
BATTERY
MASTER POWER CIRCUIT
11A
G
PROTECTIVE CONTROL BOX
E
F
569A
ALT
BODY CONNECTOR
ENGINE CONNECTOR
ROTARY SWITCH
14A
TO STARTER PRIMARY
29A
29C
TO PROTECTIVE CONTROL BOX
CIRCUIT BREAKER 2
29B
29D
27D
27H
27G
27J
567A
27F
27L
OIL PRESSURE GAGE CIRCUIT
TEMPERATURE GAGE CIRCUIT
FUEL GAGE CIRCUIT
VOLTS GAGE CIRCUIT
WAIT TO START LAMP CIRCUIT
BRAKE WARNING LAMP CIRCUIT

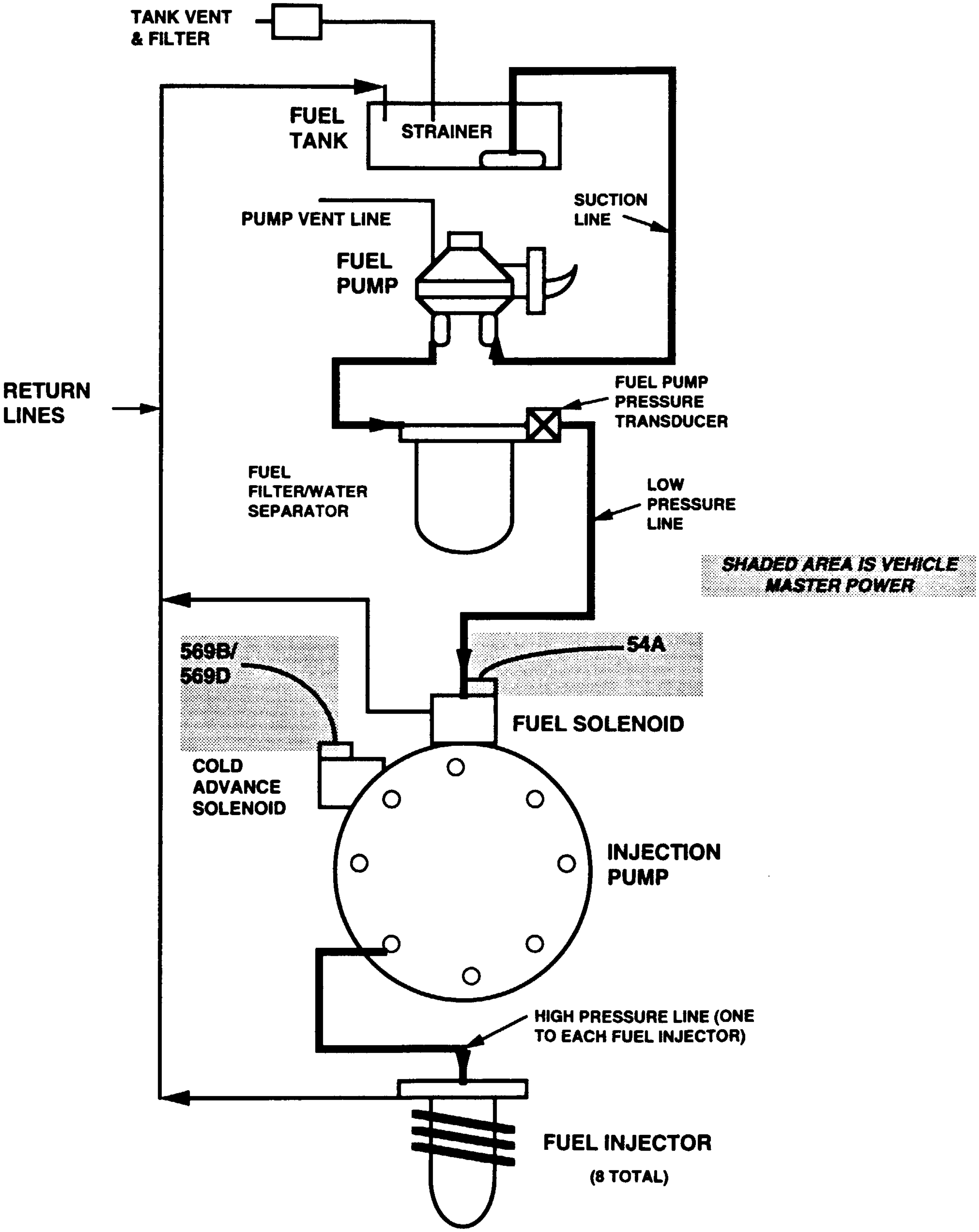
GLOWPLUG CKT INTERFACE

ELECTRICAL



ELECTRICAL

FUEL SYSTEM INTERFACE

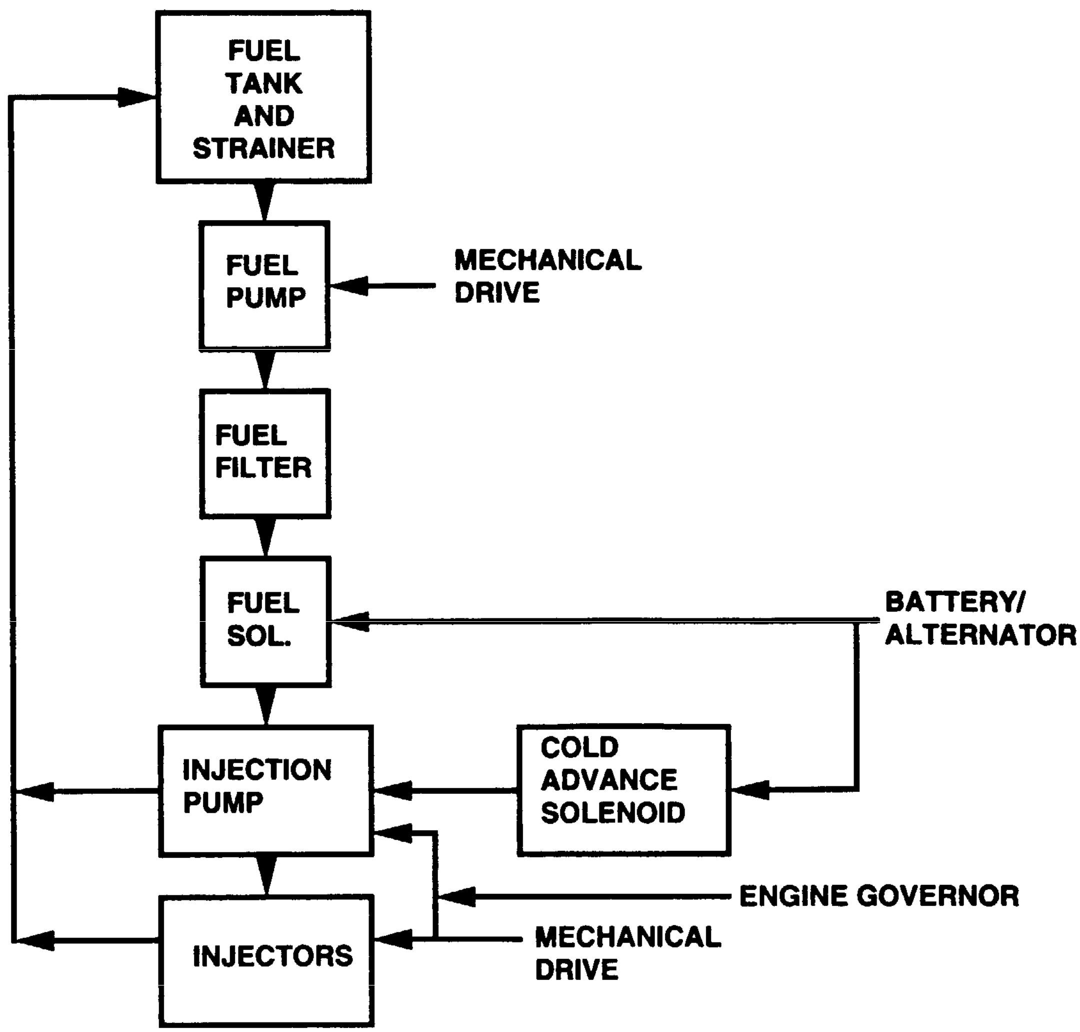


2-22. FUEL SYSTEM TESTS

These Fuel System tests can be run any time you think there maybe a problem with the fuel system or if you were sent here from another test.

If you are running this test because the engine runs rough remember that air intake and exhaust as well as internal mechanical problems can also cause this condition.

At the bottom of this page is a simplified block diagram which shows how the different fuel system components relate to each other. Refer to fold-out page FO-1, leave open for reference while you are testing.



General Information

This set of tests maybe used when the engine is hard starting, has low power or runs rough. Just follow the path, answering the questions. Additional information and notes are given on the facing page (like this one) when necessary. It is recommended that you refer to your fold-out diagram now because it will help you follow the testing.

FUEL SYSTEM

DIAGNOSTIC FLOWCHART

START

1

KNOWN INFO

NOTHING

POSSIBLE PROBLEMS

FUEL LINES
FUEL FILTER
FUEL PUMP
FUEL SOLENOID
INJECTION PUMP
INJECTORS

IS THE FUEL SUPPLY AND QUALITY O.K.?

TEST OPTIONS

VISUAL INSPECTION, SAMPLED WHILE CRANKING OR RUNNING. THIS QUESTION ONLY CHECKS THE SUPPLY OF FUEL IN THE TANK AND TESTS TO SEE IF IT IS GETTING TO THE INJECTOR PUMP. THIS IS NOT A TEST OF FUEL PRESSURE.

REASON FOR QUESTION

Without a supply of good fuel, none of the components in the fuel system can be expected to work properly.

NO → GO TO A, Page 2-104

YES ↓

2

KNOWN INFO

FUEL AVAILABLE AND NOT CONTAMINATED

POSSIBLE PROBLEMS

COLD ADVANCE
GLOWPLUGS
FUEL LINES
FUEL FILTER
FUEL PUMP
INJECTION PUMP
FUEL SOLENOID
RETURN CHECK VALVE

DOES THE ENGINE START AND STAY RUNNING?

TEST OPTIONS

TRY STARTING THE ENGINE.

REASON FOR QUESTION

If it starts, you know that there is fuel available and the fuel solenoid is working.

NO → GO TO B, Page 2-106

YES ↓

3

KNOWN INFO

FUEL SOLENOID OK
FUEL OK

POSSIBLE PROBLEMS

COLD ADVANCE
FUEL LINES
FUEL FILTER
FUEL PUMP
INJECTION PUMP
INJECTORS

DOES THE ENGINE START EASILY WHEN COLD?

TEST OPTIONS

TRY STARTING THE ENGINE WHILE IT'S COLD.

REASON FOR QUESTION

Problem may be the cold advance circuit.

NO → GO TO C, Page 2-110

YES ↓

GO TO 4, Page 2-98

REFERENCE INFORMATION

FUEL SYSTEM

MAKE SURE ALL ELECTRICAL CONNECTIONS ARE CLEAN AND TIGHT. CHECK FUEL SOLENOID, COLD ADVANCE SOLENOID, BATTERIES, ROTARY SWITCH, ETC.

1. While cranking or running the engine open the drain fitting end drain some fuel into a clear container.
2. The fuel should come out of the open drain valve in a steady stream, if it doesn't, than ANSWER NO TO THIS QUESTION.
   - NOTE: Nothing will come out unless the engine is running or cranking.
3. Close the drain valve and turn the rotary switch to STOP.
4. Check the fuel that came out to be sure that it isn't contaminated with water or dirt.
5. If the fuel didn't come out in a steady stream or if it is contaminated then ANSWER NO TO THIS QUESTION.

If you have trouble starting the engine you should have entered here byway of the Statability tests. If you didn't begin there, go beck to Page 2-41 and the the Startability top level teat.

At this point you don't care how well it starts or runs but just that it will run.

THE ANSWER TO THIS QUESTION IS NO if the engine seems to start but stops almost immediately.

Engine temperature may be determined from vehicle temp. gauge (Rotary Switch must be in RUN position) or by touching **the enaine. If it is too hot to touch com-** fortably than it is above 120° F (49° C).

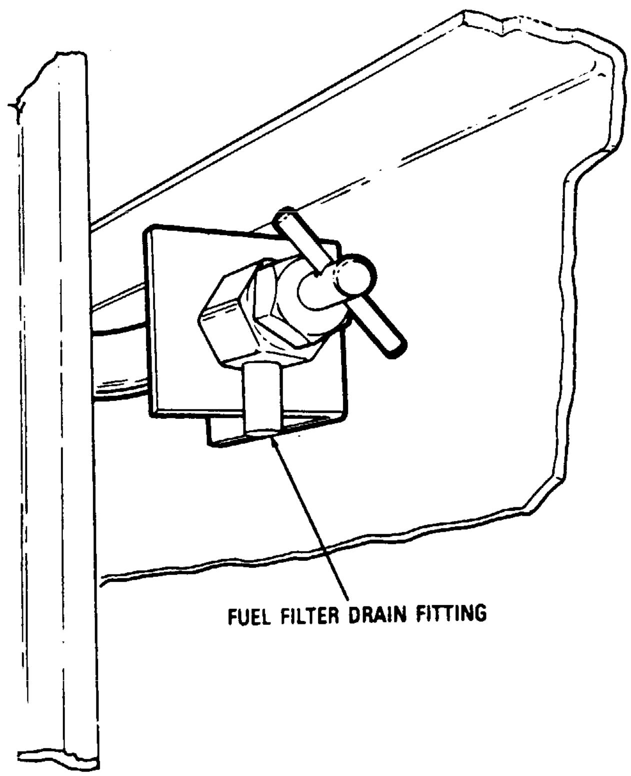
Hard stating can be caused by other things such as fuel in the lines leaking back into the tank while the engine is shut down. This will occur if there is an air leak in the lines.

WARNING

Diesel fuel is highly flammable. Do not perform any procedures near fire, flames, or sparks. Severe injury ordeath will result

WARNING

A hot engine may cause serious bums. Always use caution when approaching a hot engine.



FUEL SYSTEM DIAGNOSTIC FLOWCHART

FROM 3, Page 2-96

KNOWN INFO

FUEL SOLENOID OK
COLD ADVANCE OK

POSSIBLE PROBLEMS

FUEL LINES
FUEL FILTER
FUEL PUMP

4 IS THE FUEL SUPPLY PRESSURE GREATER THAN 3 PSI (20.69 kPa) AT ALL SPEEDS?

NO → GO TO D, Page 2-112

YES ↓

TEST OPTIONS

1. STE/ICE-R TEST 24 (Page 2-738)
2. PRESSURE GAUGE

REASON FOR QUESTION

This is to verify that the fuel supply lines, fuel pump, and fuel filter are OK.

KNOWN INFO

FUEL SOLENOID OK
COLD ADVANCE OK

POSSIBLE PROBLEMS

FUEL LINES
FUEL FILTER
FUEL PUMP

5 IS THE FUEL VOLUME AT THE INJECTION PUMP INLET 1 PINT IN 30 SECONDS WHILE CRANKING ?

NO → GO TO D, Page 2-112

YES ↓

TEST OPTIONS

Fuel pump volume test

REASON FOR QUESTION

This is to verify that the fuel supply lines, fuel pump, and fuel filter are OK.

KNOWN INFO

FUEL PUMP AND FILTER OK

POSSIBLE PROBLEMS

INJECTION PUMP
INJECTORS
FUEL SUPPLY LINES
FUEL RETURN LINES
RETURN CHECK VALVE

6 DOES THE ENGINE RUN SMOOTHLY?

NO → GO TO E, Page 2-116

YES ↓

TEST OPTIONS

WATCH AND LISTEN TO ENGINE

REASON FOR QUESTION

If it runs smoothly then it is not an individual cylinder fault such as a bad injector.

KNOWN INFO

FUEL LINES, PUMP AND FILTER OK

POSSIBLE PROBLEMS

INJECTION PUMP
INJECTORS
EXHAUST RESTRICTED

7 IS THE IDLE SPEED 625 TO 675 RPM?

NO → SEE NOTE AT RIGHT

YES → GO TO 8, Page 2-100

TEST OPTIONS

STE/ICE-R TEST 10 (Page 2-734)

REASON FOR QUESTION

This is to verify that the idle speed is adjusted properly.

Watch the fuel pump pressure while slowly accelerating the angina from idle to maximum speed. The pressure should always be greater than zero. If

pressure, check to be sure it is still above zero even during maximum acceleration (maximum engine power). You can use STE/ICE test 24 with control function 02 (minimum).

NOTE

Rapidly accelerating the engine with the transmission in neutral doesn't work for this engine because the fuel supply can't increase as fast as the engine can accelerate so you won't get good test results.

FUEL PUMP VOLUME TEST
1. Disconnect fuel line at injection pump inlet and route fuel line into a suitable, 1 quart container. 2. Crank the engine for 30 seconds. 3. If the pump and lines are ok, you should get about 1 pint (1/2 quart) (.5 L) in 30 seconds.

Proper engine performance is dependent upon the availability of the correct fuel volume to the injection pump.

FUEL PUMP PRESSURE STE/ICE-R TEST#24
(STE/ICE already connected to DCA and turned on) 1. Select Fuel Supply Pressure test, Test 24. 2. Perform CAL. 3. Crank (or start) the engine. NOTE : STE/ICE-R can display a pressure below 0. Be sure to notice if the display is negative.

Pay attention to when the engine runs rough. If it runs rough only while warming up after a cold start it may be a glowplug problem and you should run the Glowplug Circuit tests.

Rough running may also be caused by air leaks in the fuel supply lines. Air in the fuel should purge itself while idling. If rough running occurs after a period of high speed or high power running but seems to go away after idling, then look for air leaks in the fuel supply lines and fittings. if rough running occurs while driving but idles ok, check the fuel return check valve for any malfunctions (refer to para. 3-35).

FUEL PUMP PRESSURE TEST PRESSURE GAGE
1. Connect a Tee into the fuel line between the fuel filter outlet and the injection pump inlet. 2. Attach gauge to Tee. 3. Crank (or Start) engine.

NOTE

Try to adjust the engine idle speed by turning the idle speed screw (refer to para 3-44). Continue testing if you can adjust the speed properly. If you cannot, notify DS maintenance.

Engine must be at normal operating temperature when making speed checks. Air fitter must be in place and all accessories (lights, heater fan, etc...) must be turned off.

This engine has a min-max governor which controls engine speed at both idle and full throttle.

ENGINE RPM STE/ICE-R TEST 10
1. Start Test 10, Engine RPM. 2. Crank or start the engine. Displayed reading is RPM. Cranking RPM should be at least 100 RPM. Idle RPM should be 625 - 675.

FUEL SYSTEM DIAGNOSTIC FLOWCHART

FROM 7, Page 2-98

8

KNOWN INFO

FUEL LINES, PUMP AND FILTER OK.

POSSIBLE PROBLEMS

INJECTION PUMP
INJECTORS
EXHAUST RESTRICTED

IS MAXIMUM GOVERNOR SPEED
4000 RPM NO LOAD?
3600 LOADED?

TEST OPTIONS

STE/ICE-R TEST 10 (Page 2-734)

REASON FOR QUESTION

Verify governor speed

NO → GO TO F, Page 2-120

YES ↓

9

KNOWN INFO

FUEL PUMP OK
FUEL FILTER OK

POSSIBLE PROBLEMS

INJECTION PUMP
INJECTORS
RETURN CHECK VALVE

IS ENGINE POWER OK?

TEST OPTIONS

1. STE/ICE-R TEST 13 (Page 2-736)
2. ROAD TEST

REASON FOR QUESTION

Some fuel system faults and bad fuel may cause low power and have passed the earlier tests.

NO → GO TO F, Page 2-120

YES ↓

10

KNOWN INFO

INJECTION PUMP OK

POSSIBLE PROBLEMS

INJECTORS
AIR CLEANER
PUMP TIMING
CDR VALVE
RETURN CHECK VALVE

IS THE EXHAUST COLORLESS?

TEST OPTIONS

VISUAL INSPECTION

REASON FOR QUESTION

Exhaust smoke may indicate conditions such as oil, water or excessive fuel entering the cylinders.

NO → SEE NOTE AT RIGHT

YES ↓

GO TO 11, Page 2-102

Governor no-load speed is with the transmission in neutral. Loaded speed is with the transmission in gear and the vehicle moving. It is the maximum rpm's the engine will develop. The engine will surge at governor speed since the governor will try to lower the engine speed and the accelerator is trying to increase it.

ENGINE RPM
STE/ICE-R TEST 10

1. Start Test 10, Engine RPM.

2. Crank or start the engine. Displayed reading is RPM. Cranking RPM should be approximately 100-200. Idle RPM should be 625 - 675.

A number over 75 is passing for STE/ICE-R test 13. tf the vehicle seems to be low on power while driving you have to check for other things which could cause this such as the transmission.
To try a road test, accelerate the vehicle from 0 to a safe and reasonable speed on a reasonably level road.

ENGINE POWER TEST (PERCENT)
STE/ICE-R TEST #13

1. Set TEST SELECT switches to 13.
2. Press and release TEST button.
3. Wait for prompting message CIP to appear.
4. When CIP appears on display, press down sharply on engine accelerator and hold it to the floor. When VTM displays OFF, release accelerator.
5. A number will be displayed after the engine has returned to idle speed. This number is the test result in units of per cent of nominal rated power.

NOTE

If the exhaust is not colorless it must be either white, blue or black. If exhaust color is:

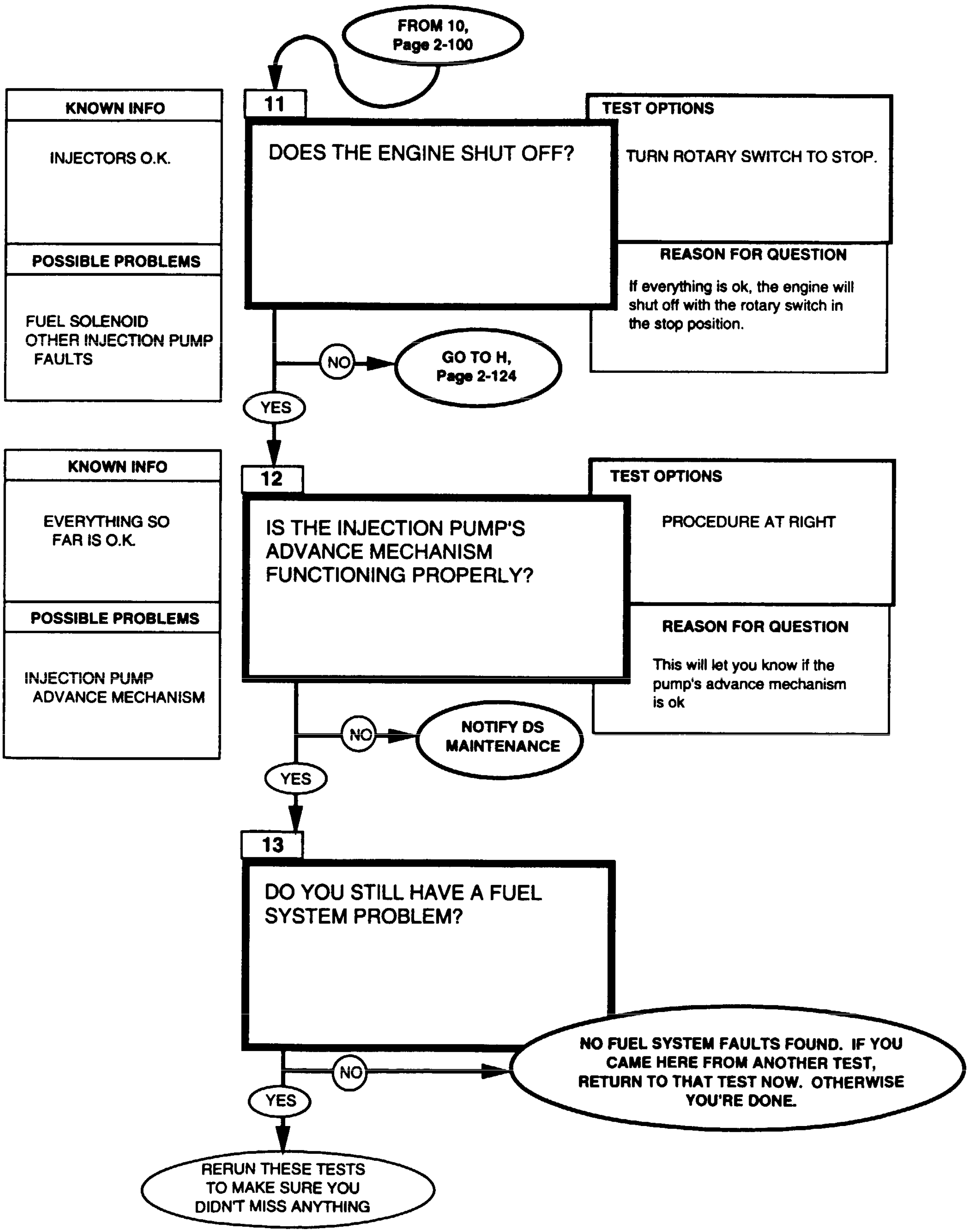
WHITE .... Go to G, Page 2-122. Also could be injector timing. Notify DS maintenance.

BLUE .... Blue smoke is a sign of oil entering the combustion chambers. It usually enters pest the piston rings or intake valve stem seals. This is an internal engine problem that can't be handled at this level of maintenance. You may want to run the Engine Running Mechanical tests, Page 2-47, before you notify DS Maintenance.

BLACK .... Air lntake/exhaust, Page 2-137.

FUEL SYSTEM

DIAGNOSTIC FLOWCHART

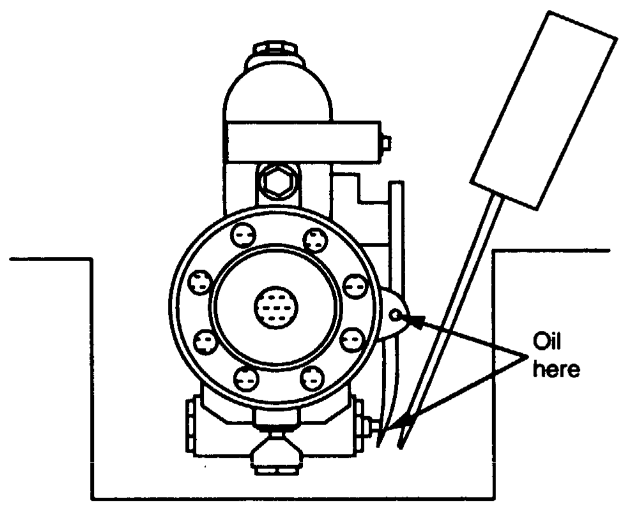


1. Note engine rpm reading (STE/ICE-R TEST 10)

2. Gently depress rocker arm on pump towards injection pump

3. If mechanism is functioning properly rpms will decrease.

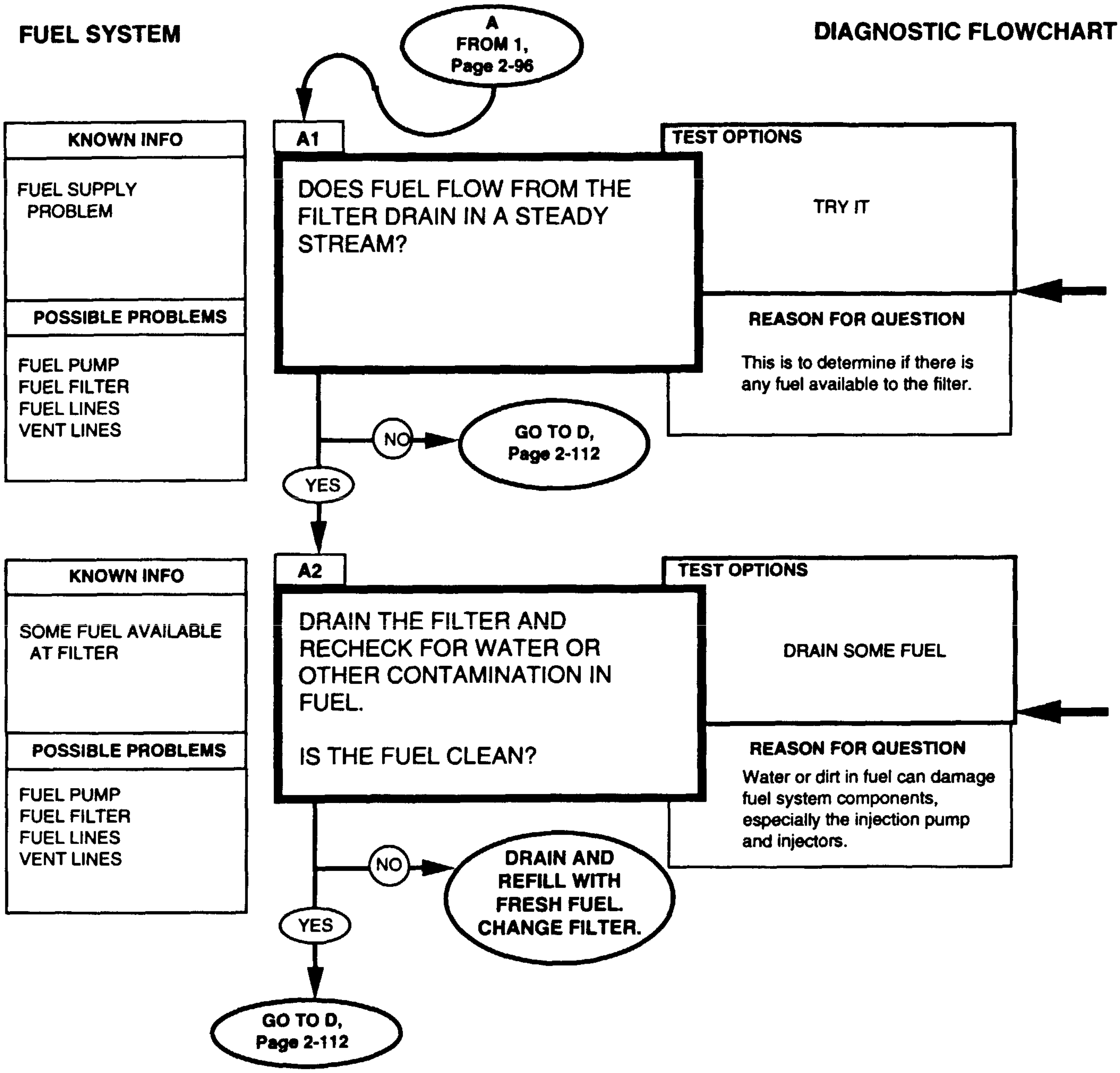
4. If mechanism doesn't move freely, try putting a drop of oil in the two spots indicated. Gently try to depress rocker arm again.



Injection pump as seen from rear of engine. Gently press screwdriver against arm. Use a ten inch screwdriver

FUEL SYSTEM

DIAGNOSTIC FLOWCHART



If no fuel arrives when cranking engine, the diaphragm in the lift pump may be ruptured, allowing the fuel to drain back into the tank.

There may be some water or dirt trapped in the filter already that didn't come from the fuel that is in the tank now.
Open the filter drain valve and sank the engine for approximately 5 seconds to purge the filter, then take a fuel sample in a clear container.
Inspect the sample for water and dirt.
Replace fuel fitter, refer to (para 3-33).

FUEL SYSTEM — DIAGNOSTIC FLOWCHART

B
FROM 2,
Page 2-96

B1

KNOWN INFO

ENGINE DOESN'T STAY RUNNING

POSSIBLE PROBLEMS

FUEL PUMP
FUEL SUPPLY LINES
FUEL RETURN LINES
FUEL FILTER
FUEL SOLENOID/WIRING
HIGH PRESSURE SYSTEM

DISCONNECT THE GLOWPLUG CONTROLLER AND WIRE 569B/569D FROM THE INJECTOR PUMP. MAKE SURE THAT WIRE 54A IS PROPERLY CONNECTED TO THE INJECTOR PUMP. WITH THE ROTARY SWITCH IN "RUN" POSITION, DO YOU HAVE AT LEAST 0.5 AMPS DC FLOWING THROUGH WIRE 54A?

TEST OPTIONS

STE/ICE-R TEST 90
(Page 2-751)

MULTIMETER

REASON FOR QUESTION

Current through the wire quickly checks the integrity of the fuel system wiring. The normal reading will be about 1.3 to 1.5 amps.

NO → GO TO N, Page 2-132

YES ↓

B2

KNOWN INFO

OTHER SYSTEMS LISTED ABOVE OK

POSSIBLE PROBLEMS

FUEL PUMP
FUEL SUPPLY LINES
FUEL RETURN LINES
FUEL FILTER
FUEL SOLENOID/WIRING
HIGH PRESSURE SYSTEM

RECONNECT THE ABOVE WIRES. CHECK FUEL PUMP PRESSURE AND VOLUME DURING CRANKING. IS PUMP PRESSURE GREATER THAN 3 PSI (20.69 kPa) AND FUEL VOLUME AT THE INJECTION PUMP INLET 1 PINT IN 30 SECONDS?

TEST OPTIONS

STE/ICE-R TEST 24
(Page 2-738) FUEL PUMP VOLUME TEST

REASON FOR QUESTION

Positive pressure and volume indicate that fuel is present and supply lines and filter are not plugged. This is a test of the lift pump.

NO → GO TO D, Page 2-112

YES ↓

!!

B3

KNOWN INFO

FUEL PUMP OK
FUEL SUPPLY LINES OK
FUEL FILTER OK

POSSIBLE PROBLEMS

FUEL RETURN LINES
FUEL SOLENOID/WIRING
HIGH PRESSURE SYSTEM

DOES THE ENGINE START AND STAY RUNNING WITH THE FUEL RETURN LINE (THE SHORT RUBBER LINE AT THE INJECTOR PUMP) DISCONNECTED?

TEST OPTIONS

PUT THE RETURN LINE IN A SUITABLE CONTAINER AND TRY STARTING THE ENGINE.

REASON FOR QUESTION

A restricted fuel return line will cause a pressure imbalance in the pump and prevent the engine from running.

NO → GO TO I, Page 2-126

YES ↓

GO TO B4, Page 2-108

REFERENCE INFORMATION

FUEL SYSTEM

NOTE

When using a multimeter to measure current through wire 54A, disconnect the wire. Set the ammeter to a scale of at least 5 amps DC. Connect the red lead of the multimeter to wire 54A and the black lead to ground. With the rotary switch in the RUN position, measure current. Be sure to read the correct scale. Return the switch to the STOP position. Disconnect the multimeter and reconnect wire 54A.

5 AMPS DC STE/ICE-R TEST 90
1. Connect RED clip to the indicated test point; BLACK clip to negative or ground. 2. Start Test 90. 3. Displayed reading is in amps.

FUEL PUMP PRESSURE STE/ICE-R TEST#24
1. Select Fuel Supply Pressure Test (Test #24). Perform CAL. 2. Crank (or start) engine.

FUEL PUMP PRESSURE TEST PRESSURE GAUGE
1. Connect a tee into the fuel line between the fuel filter outlet and the injection pump inlet. 2. Attach gauge to tee. 3. Crank (or start) engine.

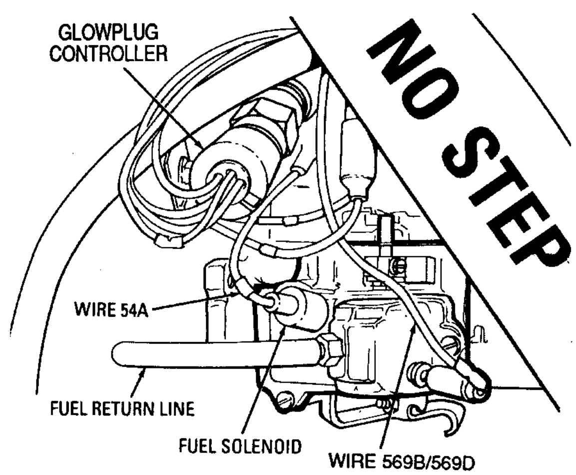
FUEL PUMP VOLUME TEST
1. Disconnect fuel line at injection pump inlet and route fuel line into a suitable, 1 quart container. 2. Crank the engine for 30 seconds. 3. If the pump and lines are ok, you should get about 1 pint (1/2 quart) (0.5 L) in 30 seconds.

!!

WARNING

Diesel fuel is highly flammable. Do not perform any procedures near fire, flames, or sparks. Severe injury or death will result.

1. Disconnect the return line and direct it into a suitable container.
2. Watch the fuel flow from the return line as you or an assistant try to start the engine.



FUEL SYSTEM DIAGNOSTIC FLOWCHART

FROM B3, Page 2-106

KNOWN INFO

FUEL SOLENOID AND WIRING OK

POSSIBLE PROBLEMS

FUEL RETURN LINES
INJECTION PUMP
INJECTORS
RETURN CHECK VALVE

B4

DOES THE ENGINE RUN POORLY WITH THE RETURN LINE DISCONNECTED?

TEST OPTIONS

VISUAL INSPECTION

REASON FOR QUESTION

Plugged fuel return lines cause back pressure which prevents injection pump from working properly.

NO → REPAIR/ REPLACE FUEL INJECTOR RETURN LINES.

YES ↓

KNOWN INFO

RETURN LINES OK

POSSIBLE PROBLEMS

INJECTION PUMP
INJECTORS

B5

RUN THE INTAKE/EXHAUST TESTS.
RETURN HERE IF NO FAULTS FOUND.

TEST OPTIONS

RUN INTAKE/EXHAUST TESTS PAGE 2-137.

REASON FOR TESTS

There is still a possible Intake/Exhaust fault. If you came here from Startability then this wasn't tested.

KNOWN INFO

RETURN LINES OK

POSSIBLE PROBLEMS

INJECTION PUMP
INJECTORS

B6

COULD NOT VERIFY IF THERE IS AN INJECTOR OR INJECTION PUMP PROBLEM.
NOTIFY DS MAINTENANCE.

REASON FOR TESTS

A complete test of the fuel pump and injectors can't be done at this level of maintenance but most fuel problems that would keep the engine from starting have been checked.

Return lines should be inspected for kinks or crushed lines or anything that might restrick fuel flow.
Inspect fuel return check valve for any restrictions. Replace valve (para. 3-35).
Replace fuel lines. Refer to (para 3-25).

If you came here from the Startability Tests, return to STEP 5, Page 2-44.
If you haven't run the Startability Tests yet, Go to STEP 1, Page 2-42.

FUEL SYSTEM **DIAGNOSTIC FLOWCHART**

C
FROM 3,
Page 2-96

KNOWN INFO

HARD COLD STARTING

POSSIBLE PROBLEMS

COLD ADVANCE CIRCUIT
GLOWPLUG CIRCUIT
FUEL SYSTEM

C1

DISCONNECT WIRE 569B/569D FROM COLD ADVANCE SOLENOID. WITH ROTARY SWITCH IN "RUN" POSITION, IS THERE BATTERY VOLTAGE AT WIRE 569B/569D?

TEST OPTIONS

1. STE/ICE-R TEST 89 (Page 2-750)
2. MULTIMETER

REASON FOR QUESTION

Need battery voltage to energize cold advance solenoid.

NO → GO TO M, Page 2-130

YES ↓

KNOWN INFO

POWER TO COLD ADVANCE SOLENOID

POSSIBLE PROBLEMS

COLD ADVANCE CIRCUIT
GLOWPLUG CIRCUIT
FUEL SYSTEM

C2

RECONNECT WIRE 569B/569D. IS THE COLD ADVANCE CIRCUIT WORKING?

TEST OPTIONS

PERFORM CHECKS AT RIGHT (Page 2-111)

REASON FOR QUESTION

Cold advance circuit can cause hard cold starting.

NO → NOTIFY DS MAINTENANCE

YES ↓

KNOWN INFO

COLD ADVANCE CIRCUIT OK

POSSIBLE PROBLEMS

GLOWPLUG CIRCUIT
FUEL SYSTEM

C3

PERFORM GLOWPLUG TESTS, Page 2-303.
IF NO FAULTS FOUND, CONTINUE FUEL SYSTEM TESTS.

TEST OPTIONS

FUEL SYSTEM TESTS

REASON FOR TESTS

The glowplug circuit operates during cold start.

The engine temperature must be below 90° F (32°C) to get voltage here. If the engine is warm, either wait for it to cool, or go to step C3 at the bottom of the pegs and remember that the cold advance maybe the problem if everything else checks out OK.

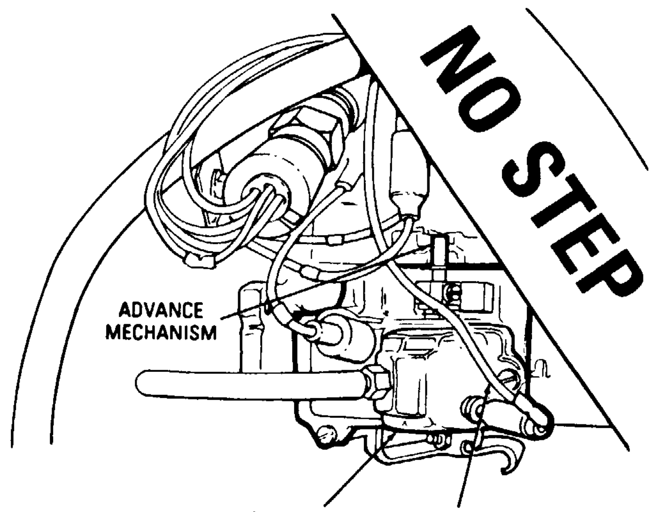
The Glowplugs or the Intake/Exhaust System may be faulty, so you should test them first.

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to positive, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

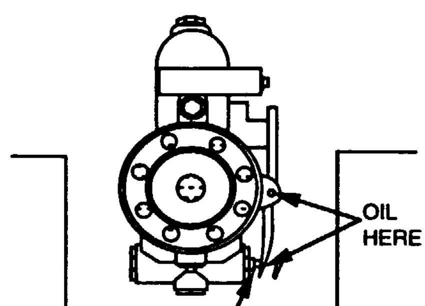
BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.

The cold advance circuit advances the fuel injection pump timing approximately 3 to 5 degrees during cold start up. If engine temperature is less than 90°F (32°C), then Advance circuit operation maybe checked as follows:

1. Start the engine.
2. Disconnect wire 569B/569D from the Advance Solenoid. If the circuit is working correctly, then engine RPM should decrease.
3. Look at the advance mechanism on the right side of the fuel injection pump while you connect and disconnect 569D/569B with the engine running. The advance mechanism should move about 1/4 inch.
4. If the advance mechanism is stuck, apply some oil at the points shown and try again.



Remember to reconnect any wires that were disconnected during troubleshooting.



INJECTION PUMP AS SEEN FROM REAR OF ENGINE

FUEL SYSTEM

DIAGNOSTIC FLOWCHART

D
FROM 4, 5, Page 2-98;
A1, A2, Page 2-104;
B2, Page 2-106

D1

KNOWN INFO

LOW FUEL PUMP PRESSURE

POSSIBLE PROBLEMS

FUEL PUMP
FUEL FILTER
FUEL LINES
VENT LINES
FUEL PRESSURE TRANSDUCER

LISTEN FOR A HISS WHEN YOU REMOVE THE FILLER CAP.

CAN YOU REMOVE THE FILLER CAP WITHOUT HEARING A HISS?

TEST OPTIONS

VISUAL INSPECTION

REASON FOR QUESTION

A plugged vent line will eventually cause enough negative pressure in the tank to prevent fuel flow.

NO → **REPLACE VENT FILTER/ REPAIR LINE**

YES ↓

D2

KNOWN INFO

VENT LINES OK
LOW FUEL PUMP PRESSURE

POSSIBLE PROBLEMS

FUEL PUMP
FUEL LINES
FUEL FILTER
FUEL PRESSURE TRANSDUCER

IS THE TEMPERATURE ABOVE 20°F (-7°C) ?

TEST OPTIONS

VISUAL INSPECTION

REASON FOR QUESTION

When the temperature is less than 20°F (-7°C) wax flakes can build up on the fuel tank strainer or in the fuel filter.

NO → CHECK FOR A WAX BUILDUP IN TANK STRAINER OR FILTER. USE AN ANTIWAX AGENT IF AVAILABLE. BLEED FUEL SYSTEM AND CONTINUE TESTING

YES ↓

D3

KNOWN INFO

FUEL FILTER OK
NO WAX BUILD-UP
VENT LINES OK
LOW FUEL PUMP PRESSURE
FUEL LINES

POSSIBLE PROBLEMS

FUEL PUMP
FUEL PRESSURE TRANSDUCER

IF YOU USED THE DCA TO MEASURE FUEL SUPPLY PRESSURE, IS THE STE/ICE-R, DCA AND TRANSDUCER OK?

TEST OPTIONS

DCA TROUBLESHOOTING (Page 2-723)

USE A PRESSURE GAUGE TO MEASURE FUEL SUPPLY

REASON FOR QUESTION

Before condemning fuel pump, make sure that the pressure transducer is working.

NO → **REPAIR/REPLACE AS NECESSARY**

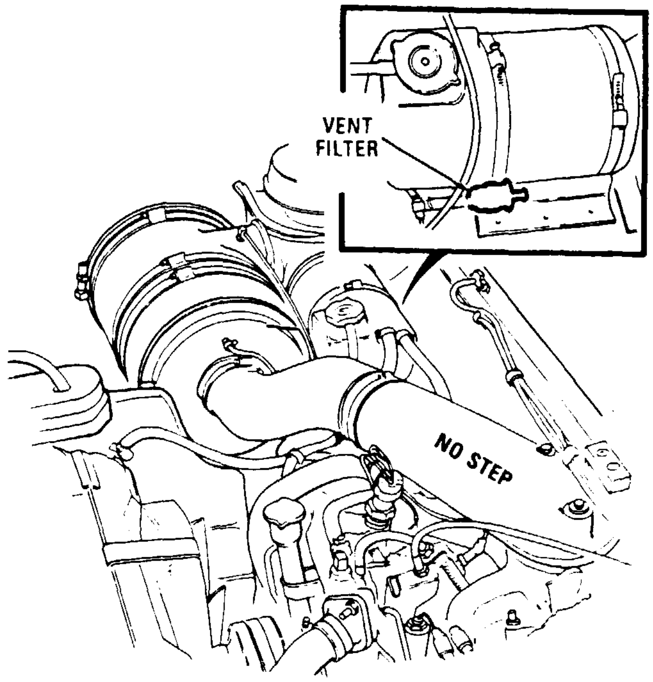
YES ↓

GO TO D4, Page 2-114

If you hear a hissing noise while removing the fuel filter cap then either the vent filter is plugged, the vent line is restricted, or the vent valve is restricted. The vent filter is located behind the coolant surge tank.

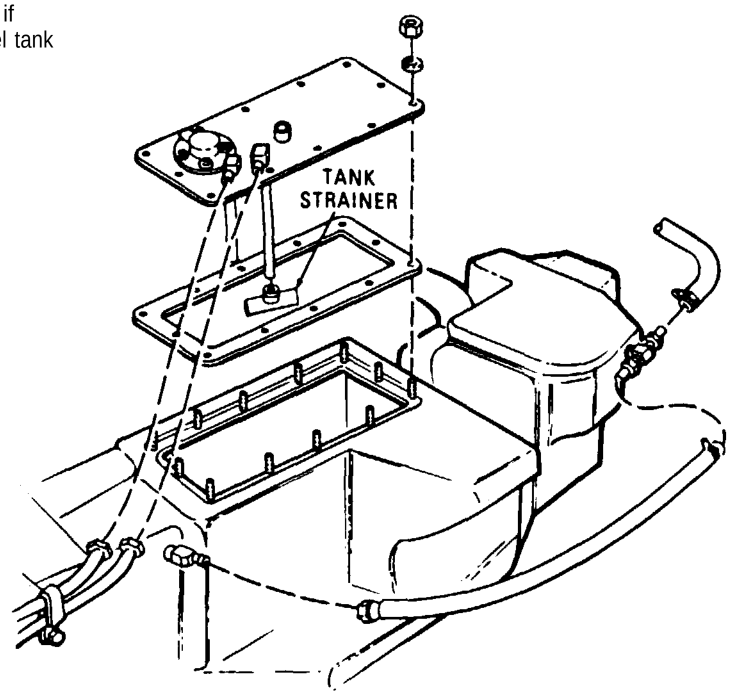
Replace vent lines or vent line filter, refer to (para. 3-27.)

Replace vent valve, refer to (para. 3-24.)



Diesel fuel is sensitive to temperature. All diesel fuel has a certain amount of paraffin-like components which have high energy value and help improve fuel economy. When temperatures are less than 20°F (-7°C) these components begin turning into wax flakes that can build upon the fuel tank strainer or in the fuel filter. If wax build-up is found, replace the fuel in the tank with a winter grade of fuel if available. You will have to remove the fuel tank if you need to inspect the tank strainer.

Replace fuel tank, refer to (para. 3-24.)



FUEL SYSTEM

DIAGNOSTIC FLOWCHART

FROM D3, Page 2-112

D4

KNOWN INFO
FUEL FILTER OK NO WAX BUILD-UP VENT LINES OK LOW FUEL PUMP PRESSURE
POSSIBLE PROBLEMS
FUEL PUMP FUEL LINES FUEL PRESSURE TRANSDUCER

INSPECT THE FUEL LINES.
ARE THE LINES OK?

TEST OPTIONS

VISUAL INSPECTION

REASON FOR QUESTION

Kinked fuel lines will restrict fuel flow.

NO → **REPAIR/ REPLACE LINES.**

YES ↓

D5

KNOWN INFO
NO WAX BUILD-UP VENT LINES OK LOW FUEL PUMP PRESSURE
POSSIBLE PROBLEMS
FUEL PUMP FUEL LINES FUEL FILTER FUEL PRESSURE TRANSDUCER

INSPECT THE FUEL FILTER.
REMOVE THE FILTER ELEMENT AND CHECK IT FOR DIRT AND OTHER CONTAMINATION.

IS THE FILTER ELEMENT CLEAN?

TEST OPTIONS

VISUAL INSPECTION

REASON FOR QUESTION

A dirty filter will restrict fuel flow.

NO → **REPLACE FUEL FILTER.**

YES ↓

D6

KNOWN INFO
FUEL LINES OK FUEL FILTER OK NO WAX BUILD-UP VENT LINES OK LOW FUEL PUMP PRESSURE TRANSDUCER OK
POSSIBLE PROBLEMS
FUEL PUMP

REMOVE FUEL PUMP.
INSPECT FUEL PUMP PUSHROD AND CAMSHAFT LOBE.
ARE ALL OF THESE PARTS IN GOOD CONDITION?

TEST OPTIONS

VISUAL INSPECTION

REASON FOR QUESTION

If the components that drive the fuel pump are worn, then the pump will not operate properly.

NO → **SEE NOTE AT RIGHT**

YES ↓

REPLACE THE FUEL PUMP. RETURN TO THE TEST YOU CAME FROM AND CONTINUE TESTING

REFERENCE INFORMATION

FUEL SYSTEM

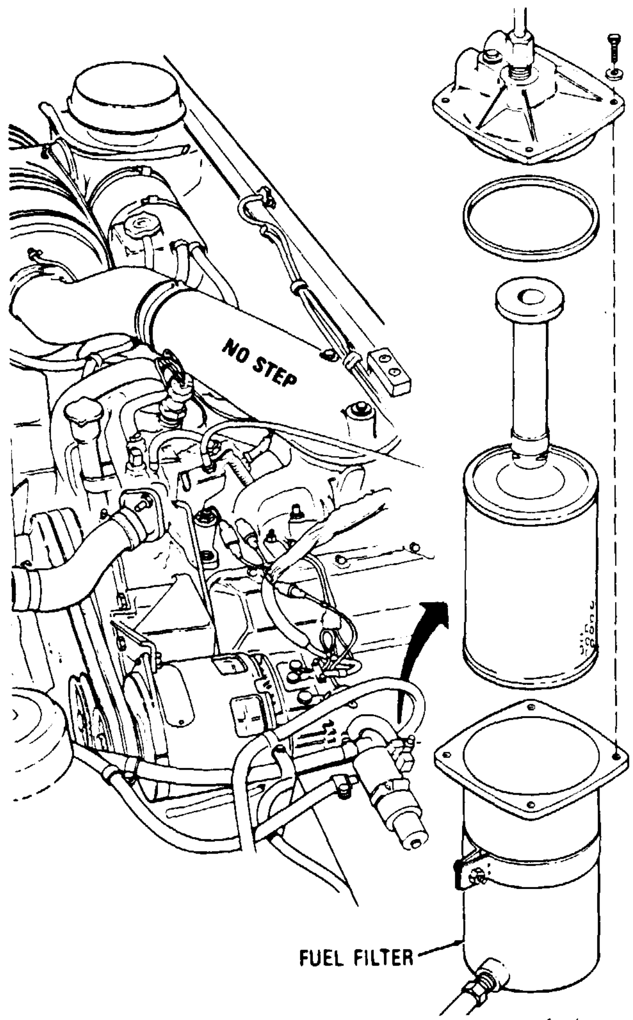
Fuel lines should be inspected for kinks, cracks or anything that would restrict fuel flow or allow air to enter the lines. Be sure to check the lines all the way beck to the tank and remember that there is a strainer inside the tank which can become plugged. You will have to remove the tank if it becomes necessary to check this.

Replace fuel lines, refer to (para 3-25)

Poor starting and excessive smoke after start up can be the result of a restricted fuel supply. This restriction most likely will be from a plugged fuel filter but can also be caused by a pinched or kinked fuel line. After the engine warms up, it generally will run satisfactorily. If the restriction gets progressively worse, top speed and performance will be affected also.

FUNGUS
In warm or humid weather, fungi and/or bacteria in the fuel can cause fuel system damage by plugging the fuel lines, filter, or injection nozzles.

For removal, replacement and torques, refer to (para 3-33) or notify DS maintenance.



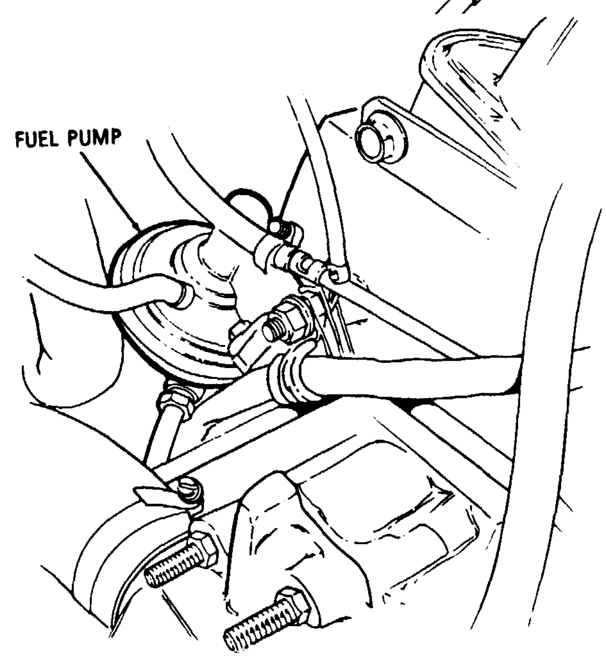
Excessive roughness on any of these parts is an indication of wear. The pushrod should slide smoothly in the engine block. If you notice any roughness on the end of the pushrod be sure to check the lobe on the camshaft.

NOTE

If the pump or rod is worn, replace. Refer to (para 3-23). If the lobe on the camshaft is worn, notify DS maintenance.

Rerun Test Chain
You may have corrected some problems but there may be others including the fuel pump.

For removal, replacement and torques, refer to (para 3-23).



FUEL SYSTEM

DIAGNOSTIC FLOWCHART

E
FROM 6,
Page 2-98

KNOWN INFO

RUNNING ROUGH

POSSIBLE PROBLEMS

GLOWPLUGS
COLD ADVANCE
FUEL LINES
FUEL PUMP
FUEL FILTER
INJECTION PUMP
INJECTORS

E1

RUN THE GLOWPLUG TESTS. RETURN HERE IF NO FAULTS FOUND.

TEST OPTIONS

RUN GLOWPLUG TESTS (Page 2-303). IF YOU ARE SURE THAT THE PROBLEM EXISTS WHEN THE ENGINE IS WARM, YOU CAN SKIP THIS QUESTION.

REASON FOR QUESTION

Glowplugs failures can cause rough running when cold.

KNOWN INFO

GLOWPLUGS OK

POSSIBLE PROBLEMS

COLD ADVANCE
FUEL LINES
FUEL PUMP
FUEL FILTER
INJECTION PUMP
INJECTORS

E2

CHECK COLD ADVANCE CIRCUIT.

GO TO STEP C2, PAGE 2-110. RETURN HERE IF NO FAULTS FOUND.

TEST OPTIONS

RUN COLD ADVANCE TESTS Page 2-110.

REASON FOR QUESTION

A faulty cold advance circuit can cause rough running.

GO TO E3,
Page 2-118

Injection pump timing that is too far advanced can cause glowplugs failure because it increases cylinder temperature. Usually several but not all glowplugs will fail.

FUEL SYSTEM **DIAGNOSTIC FLOWCHART**

FROM E2, Page 2-116

KNOWN INFO

COLD ADVANCE OK

POSSIBLE PROBLEMS

FUEL LINES
FUEL PUMP
FUEL FILTER
INJECTION PUMP
INJECTORS
RETURN CHECK VALVE

E3

ARE THE FUEL SUPPLY LINES OK?

TEST OPTIONS

VISUAL INSPECTION

REASON FOR QUESTION

Air leaks, lack of fuel or restricted check valve can cause rough running at different speeds.

NO → **REPAIR/ REPLACE LINES**

YES

KNOWN INFO

SUPPLY LINES OK

POSSIBLE PROBLEMS

FUEL LINES
FUEL PUMP
FUEL FILTER
INJECTION PUMP
INJECTORS
RETURN CHECK VALVE

E4

ARE THE FUEL RETURN LINES OK?

TEST OPTIONS

VISUAL INSPECTION

REASON FOR QUESTION

Restricted return lines or restricted check valve can cause the injection pump to malfunction.

NO → **REPAIR/ REPLACE LINES**

YES

KNOWN INFO

FUEL PUMP OK

POSSIBLE PROBLEMS

INJECTION PUMP
INJECTORS

E5

A COMPLETE CHECK OF THE INJECTION PUMP AND INJECTORS CANNOT BE DONE AT THIS LEVEL OF MAINTENANCE, BUT YOU HAVE COVERED MOST FUEL SYSTEM PROBLEMS THAT WOULD CAUSE THIS CONDITION. IF YOU STILL HAVE A PROBLEM YOU MAY WANT TO RUN THE ENGINE MECHANICAL TESTS BEFORE YOU NOTIFY DS MAINTENANCE.

TEST OPTIONS

RUN ENGINE MECHANICAL TESTS Page 2-143

CAUTION

Be sure to keep the line clear of moving engine parts (fan, pulleys, etc...) and DO NOT place the line on the exhaust manifold.

Replace fuel lines (refer to para 3-25).

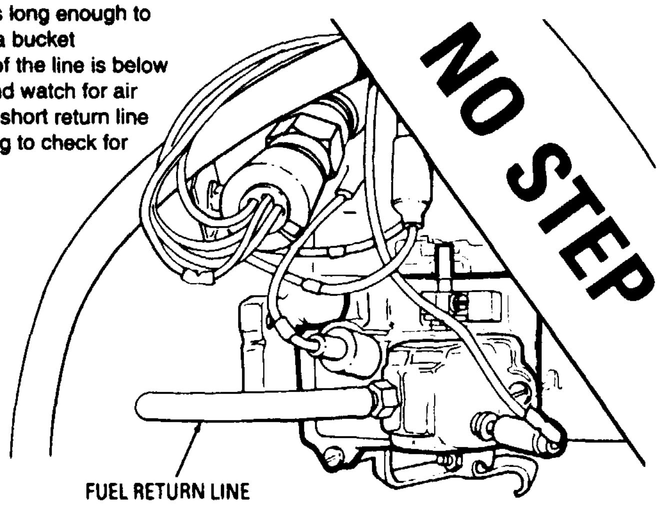
Check the fitter vent screw for tightness.

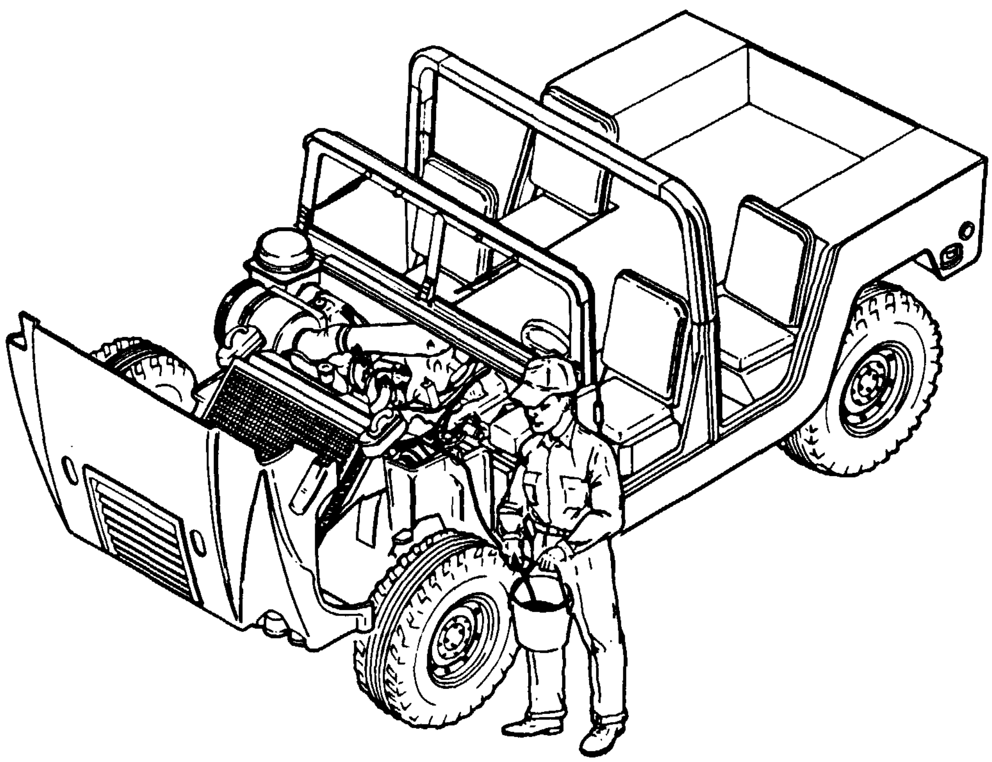
Check the supply lines for kinks, cracks, leaks, or loose connections that could restrict fuel flow or allow air to enter the system. Remember that under certain operating conditons parts of the fuel system can be under vacuum so that loose connections that may not leak fuel can let air in.

To test for air leaks in the supply lines, disconnect the return line **from the injection pump and connect a line that is long enough to reach the ground. Place the end of the line into a bucket containing diesel fuel, making sure that the end of the line is below the level of fuel in the bucket. Run the engine and watch for air bubbles in the bucket. You can also replace the short return line from the injector pump with a clear piece of tubing to check for bubbles.**

Inspect the return lines for kinks or any other blockage that may restrict fuel flow.
Inspect fuel return check valve for any restrictions (refer to para. 3-25).

Replace fuel line (refer to para 3-25).





FUEL SYSTEM — DIAGNOSTIC FLOWCHART

F
FROM 8 or 9,
Page 2-100

F1

KNOWN INFO

FUEL FILTER OK

POSSIBLE PROBLEMS

FUEL PUMP
ACCELERATOR LINKAGE
FUEL LINES
INJECTION PUMP
INJECTORS
INTAKE/EXHAUST
RETURN CHECK VALVE

INSPECT FUEL SUPPLY AND RETURN LINES.
ARE THE LINES OK?

TEST OPTIONS

VISUAL INSPECTION

REASON FOR QUESTION

Kinked fuel lines will restrict fuel flow. Partially blocked return lines may cause the Injection Pump to malfunction. Air leaking into the fuel will also cause loss of power.

NO → REPAIR/ REPLACE LINES.

YES ↓

F2

KNOWN INFO

FUEL LINES OK
FUEL FILTER OK

POSSIBLE PROBLEMS

INTAKE/EXHAUST
FUEL PUMP
ACCELERATOR LINKAGE
INJECTION PUMP
INJECTORS

ARE THE INTAKE AND EXHAUST SYSTEMS OK?

TEST OPTIONS

RUN AIR INTAKE/EXHAUST TESTS.

REASON FOR QUESTION

The intake and exhaust systems affect vehicle operation under all conditions.

NO → GO TO AIR INTAKE/EXHAUST TESTS, Page 2-137

YES ↓

F3

KNOWN INFO

FUEL PUMP OK
FUEL LINES OK
FUEL FILTER OK

POSSIBLE PROBLEMS

ACCELERATOR LINKAGE
INJECTION PUMP
INJECTORS

WITH ENGINE NOT RUNNING CHECK MOVEMENT OF ACCELERATOR PEDAL.

DOES PEDAL HAVE FULL TRAVEL?

TEST OPTIONS

VISUAL INSPECTION

REASON FOR QUESTION

If the pedal sticks you may not be able to fully open the throttle.

NO → SEE NOTE AT RIGHT

YES ↓

NOTIFY DS MAINTENANCE

CAUTION

Be sure to keep the line clear of moving engine parts (fan, pulleys, etc...) and DO NOT place the line on the exhaust manifold.

Fuel lines should be inspected for kinks, cracks, or anything that would restrict fuel flow or allow air into the lines. Be sure to check the lines all the way back to the tank and remember that there is a strainer inside the tank which can also become plugged.

To teat for air leaks in the supply lines, disconnect the return line from the injection pump and connect a line that is long enough to reach the ground. Place the end of the line into a bucket containing diesel fuel, making sure that the end of the line is below the level of fuel in the bucket. Run the engine and watch for air bubbles in the bucket. Replace fuel line, refer to (para 3-25).

An important function of all hoses, lines and fittings is to carry fuel without admitting air to the system. When the fuel tank cap is in place and the fuel pump and injection pump are drawing fuel through the lines a low vacuum of 0-1 PSI is created. This occurs because the fuel which the engine uses must be replaced by air. During this vacuum condition, the slightest leak, which may not leak fuel out, could draw air into the system and, depending on the volume of air, cause a wide variety of engine malfunctions.

COLD WEATHER OPERATION

Diesel fuel is sensitive to temperature. All diesel fuel has a certain amount of wax-like components which have high energy value and help improve fuel economy. When temperatures are less than 20°F (-7°C) these components begin turning into flakes that can build up on the fuel tank strainer or in the fuel filter.

FUNGUS

In warm or humid weather, fungi and/or bacteria can cause fuel system damage by plugging the fuel lines, filter, or injection nozzles.

ODOR

Old fuel smells like varnish.

Check the accelerator pedal for full movement with no sticking or binding. It you have sticking or binding, lubricate accelerator pedal bushing and bearing with seasonal grade OE oil (TM 9-2320-280-10). If you do not have full pedal travel then disconnect the accelerator linkage from the fuel injection pump and recheck the travel. It you now have full travel then the problem is in the fuel injection pump and cannot be handled at this level of maintenance.

Operation of the injection pump and injectors cannot be verified at this level of maintenance.

FUEL SYSTEM **DIAGNOSTIC FLOWCHART**

G
FROM 10,
Page 2-100

!!

G1

KNOWN INFO
WHITE SMOKE
POSSIBLE PROBLEMS
INJECTION TIMING INTERNAL ENGINE PROBLEMS FUEL QUALITY

DOES THE EXHAUST SMELL LIKE RAW FUEL?

TEST OPTIONS

PUT A PIECE OF PAPER IN THE EXHAUST STREAM THEN LOOK AT AND SMELL IT FOR SIGNS OF UNBURNT FUEL.

REASON FOR QUESTION

White smoke indicates fuel not being burned in the cylinders, or possible loss of coolant to the exhaust.

NO → GO TO J1, Page 2-128

YES ↓

G2

KNOWN INFO
WHITE SMOKE
POSSIBLE PROBLEMS
INJECTION TIMING INTERNAL ENGINE PROBLEMS FUEL QUALITY RETURN CHECK VALVE

DOES THE EXHAUST SMOKE FOR MORE THAN 2 OR 3 MINUTES AFTER STARTING THE ENGINE?

TEST OPTIONS

VISUAL INSPECTION

REASON FOR QUESTION

Some white smoke after a cold start is normal. The colder it is, the more white smoke you'll see. The glowplugs keep cycling after the engine starts which will reduce this smoking. If you think that there is too much smoke after a cold start, run the Glowplug Tests (Page 2-303), paying special attention to the afterglow operation.

NO → GO TO STEP 10, Page 2-100

YES ↓

G3

KNOWN INFO
GLOWPLUGS OK WHITE SMOKE
POSSIBLE PROBLEMS
ENGINE MECHANICAL

RUN THE GLOWPLUG TESTS. IF NO FAULTS FOUND, NOTIFY DS MAINTENANCE

TEST OPTIONS

RUN GLOWPLUG TESTS (Page 2-303)

REASON FOR QUESTION

If the glowplugs are not functioning properly then the cylinders will not warm up as rapidly as they should.

WARNING

Be careful when performing this test. Exhaust gas can be extremely hot end severe bums can result.

Put a piece of paper in the exhaust stream for a few moments with the engine at idle. Then look at the paper to see if there is any condensed fuel on it. Then smell the paper to see if it smells like raw fuel. If it smells like fuel then the engine could be very cold or else it has a DS level fuel system fault or compression fault.

White smoke for a short time after start up, especially on a cold day, is a normal condition. It is caused by incomplete combustion of the fuel because of low cylinder temperature. It should clear up in a few minutes. If not you may have a bed head gasket, cracked block, or a restricted check valve. Check for restricted check valve (para. 3-35).

FUEL SYSTEM **DIAGNOSTIC FLOWCHART**

H
FROM 11
Page 2-102

H1

KNOWN INFO
ENGINE WON'T SHUT OFF

POSSIBLE PROBLEMS
FUEL SOLENOID SOLENOID WIRING ROTARY SWITCH CONTROL BOX

DISCONNECT WIRE 54A FROM FUEL SOLENOID.
DOES THE ENGINE SHUT OFF?

TEST OPTIONS
LISTEN

REASON FOR QUESTION
If the engine doesn't shut off then the solenoid is mechanically stuck open.

NO → GO TO K, Page 2-128

YES ↓

H2

KNOWN INFO
FUEL SOLENOID OK ENGINE WON'T SHUT OFF

POSSIBLE PROBLEMS
SOLENOID WIRING ROTARY SWITCH CONTROL BOX

TURN ROTARY SWITCH TO STOP. DISCONNECT BODY CONNECTOR AT PROTECTIVE CONTROL BOX.
IS VOLTAGE 0 AT WIRE 54A AT FUEL SOLENOID?

TEST OPTIONS
1. STE/ICE-R TEST 89 (Page 2-750) 2. MULTIMETER

REASON FOR QUESTION
If voltage is 0 then the problem is in the wiring harness to the switch or in the switch.

NO → GO TO L, Page 2-128

YES ↓

H3

KNOWN INFO
CONTROL BOX OK FUEL SOLENOID OK ENGINE WON'T SHUT OFF

POSSIBLE PROBLEMS
SOLENOID WIRING ROTARY SWITCH

RECONNECT BODY CONNECTOR.
DISCONNECT WIRE 11A FROM ROTARY SWITCH.
IS VOLTAGE 0 AT WIRE 54A AT FUEL SOLENOID?

TEST OPTIONS
1. STE/ICE-R TEST 89 (Page 2-750) 2. MULTIMETER

REASON FOR QUESTION
This wire supplies power to the rotary switch. There should be no power to the solenoid with it disconnected.

NO → REPAIR SHORT IN BODY CONNECTOR HARNESS.

YES ↓

REPLACE ROTARY SWITCH. RERUN FUEL SYSTEM TEST TO VERIFY THERE ARE NO OTHER FAULTS.

WARNING

Keep hands away from engine fan! Moving fan blades can cause serious injury. Use extreme caution when engine is running.

WARNING

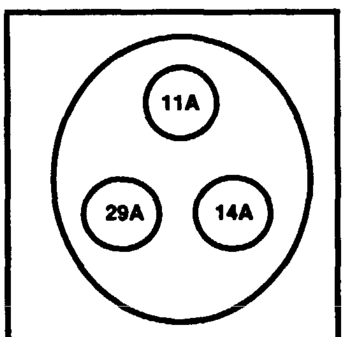
Disconnect negative battery cable before disconnecting and reconnecting protective control box harness.

There is battery voltage at the PCB at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to positive, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

DC VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.

Rotary Switch must remain in STOP position for the rest of these tests.



REAR OF ROTARY SWITCH

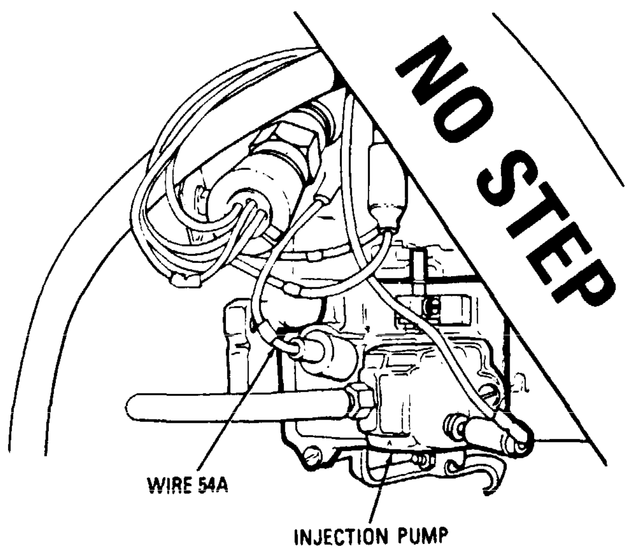
NOTE

Carefully inspect the body connector end of the harness for a short. Check for pushed out pins, broken or stripped insulation or any other bare wires. If everything checks out OK, you have to replace the harness.

Remember to reconnect any wires that may have been disconnected during troubleshooting.

For repair instructions (HARNESS REPAIR), refer to (para 4-85).

For repair/replace instructions (ROTARY SWITCH), refer to (para 4-7).



FUEL SYSTEM **DIAGNOSTIC FLOWCHART**

I
FROM B3,
Page 2-106

I1

KNOWN INFO
FUEL SUPPLY OK FUEL RETURN OK SOLENOID WIRING
POSSIBLE PROBLEMS
FUEL SOLENOID INJECTION PUMP INJECTORS

DID A STREAM OF FUEL COME OUT OF THE INJECTOR PUMP RETURN LINE WHILE IT WAS CRANKING?

TEST OPTIONS

VISUAL INSPECTION

REASON FOR QUESTION

To see if there is fuel available to the injection pump.

NO → SEE NOTE AT RIGHT

YES ↓

I2

KNOWN INFO
FUEL AVAILABLE TO THE INJECTION PUMP
POSSIBLE PROBLEMS
FUEL SOLENOID INJECTION PUMP INJECTORS GLOWPLUGS COLD ADVANCE

IS THE GLOWPLUG CIRCUIT OK? (IF YOU DON'T KNOW, RUN THE GLOWPLUG TESTS, RETURN HERE IF NO FAULTS FOUND).

TEST OPTIONS

GLOWPLUGS TEST (Page 2-303)

REASON FOR QUESTION

On a cool day a faulty glowplug circuit will prevent the engine from starting.

NO → GO TO GLOWPLUGS, Page 2-303

YES ↓

I3

KNOWN INFO
GLOWPLUGS OK
POSSIBLE PROBLEMS
FUEL SOLENOID INJECTION PUMP INJECTORS COLD ADVANCE

DISCONNECT WIRE 569B FROM THE COLD ADVANCE SOLENOID.

WITH ROTARY SWITCH IN THE "RUN" POSITION, DO YOU HAVE BATTERY VOLTAGE AT WIRE 569B?

TEST OPTIONS

STE/ICE-R TEST 89 (Page 2-750)

MULTIMETER

REASON FOR QUESTION

On a cold day a faulty cold advance circuit will prevent the engine from starting.

NO → REPAIR 569B or REPLACE HARNESS

YES ↓

FAULTY INJECTION PUMP
NOTIFY DS MAINTENANCE

REFERENCE INFORMATION

FUEL SYSTEM

NOTE

Check the rubber return line from the injection pump to the steel tubing return line.

If the rubber line is not clogged go to D1, page 2-112.

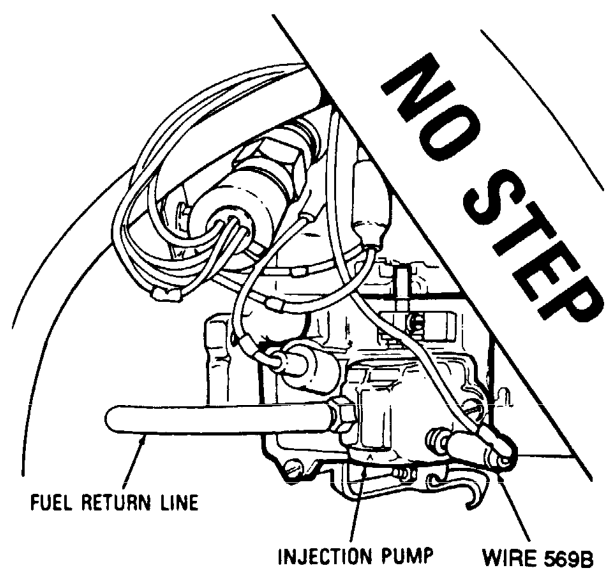
If the line is clogged, then replace it. Start the engine and see if it stays running. If it doesn't start or stay running then return to J1 and continue testing. There may be another fuel system fault preventing fuel from reaching this point.

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.

If the cold advance solenoid is getting power then the only possibilities that would keep the engine from starting are that fuel is not reaching the cylinders due to a fault in the high pressure side of the fuel system or nearly all the cylinders have very low compression. It is unlikely that all the cylinders would lose compression at the same time, but you may want to run a Compression Unbalance test (STE/ICE-R Test #14) to check this.

For repair/replace instructions, refer to (para 4-85).



FUEL SYSTEM — DIAGNOSTIC FLOWCHART

J
FROM G1,
Page 2-122

KNOWN INFO

WHITE SMOKE

POSSIBLE PROBLEMS

COOLANT IN CYLINDERS

J1

DOES THE ENGINE LOSE EXCESSIVE COOLANT?

TEST OPTIONS

LOOK AT COOLANT LEVEL IN SURGE TANK.

REASON FOR QUESTION

If the engine loses coolant but not from leaks in the lines, hoses, heater or radiator then it may have a crack or blown gasket in the engine.

NO → SEE NOTE AT RIGHT

YES → NOTIFY DS MAINTENANCE

K
FROM H1,
Page 2-124

KNOWN INFO

ENGINE WON'T SHUT OFF

POSSIBLE PROBLEMS

FUEL SOLENOID

K1

USE PLIERS TO SQUEEZE FUEL RETURN LINE AT INJECTION PUMP.

REASON FOR TEST STEP

There is an internal injector pump problem that is preventing shutting off the engine. This procedure will cause it to stall.

→ NOTIFY DS MAINTENANCE

L
FROM H2,
Page 2-124

KNOWN INFO

ROTARY SWITCH OK

POSSIBLE PROBLEMS

CONTROL BOX
SOLENOID WIRING

L1

RECONNECT BODY CONNECTOR.
DISCONNECT ENGINE CONNECTOR FROM PROTECTIVE CONTROL BOX.
IS VOLTAGE 0 AT WIRE 54A AT THE FUEL SOLENOID?

TEST OPTIONS

1. STE/ICE-R TEST 89 (Page 2-750)
2. MULTIMETER

REASON FOR QUESTION

If there is a voltage reading then there is a short in the wiring harness.

NO → REPAIR SHORT IN ENGINE CONNECTOR HARNESS.

YES → REPLACE PROTECTIVE CONTROL BOX

NOTE

If you are getting white smoke due to coolant entering the cylinders then you should notice a loss of coolant in the radiator or bubbles in the radiator tank while the engine is running. You may need to fill the radiator to proper level and recheck a day later to determine if there is a coolant loss.

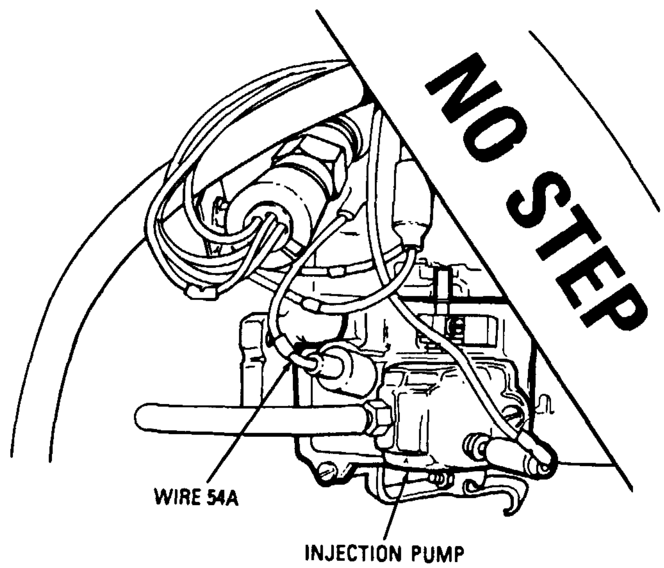
If you don't detect coolant loss then you may have missed a fuel problem. Rerun the fuel system tests paying attention for a raw exhaust smell.

If you still find nothing you may have a small or inconsistant leak. Notify DS maintenance.

WARNING

Keep hands away from engine fan! Moving fan blades can cause serious injury. Use extreme caution when engine is running.

If the engine doesn't shut off with the solenoid disconnected then fuel is still reaching the cylinders- probably because the fuel solenoid is stuck open. When you squeeze the return line tight enough to prevent fuel flowing through it, you create a pressure imbalance inside the injection pump that will cause the engine to stall.



WARNING

Disconnect negative battery cable before disconnecting and reconnecting protective control box harness.

There is battery voltage at the PCB at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

Remember to reconnect any wires that may have been disconnected during troubleshooting.

For repair/replace instructions (HARNESS), refer to (para 4-85).

For repair/replace instructions (PCB), refer to (para 4-5).

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.

FUEL SYSTEM — DIAGNOSTIC FLOWCHART

M
FROM C1,
Page 2-110

M1

KNOWN INFO
ENGINE CRANKS NO VOLTAGE AT ADVANCE SOLENOID.
POSSIBLE PROBLEMS
PCB COLD ADVANCE SWITCH WIRING

WITH ROTARY SWITCH IN "RUN" POSITION, DO YOU HAVE BATTERY VOLTAGE AT WIRE 5A AT THE ALTERNATOR OUTPUT?

TEST OPTIONS

1. STE/ICE-R TEST 89 (Page 2-750)
2. MULTIMETER

REASON FOR QUESTION

With rotary switch in run position, W5A is connected to battery voltage through the PCB and it supplies power to the cold advance switch.

NO → RUN ALTERNATOR DIAGNOSTICS

YES ↓

M2

KNOWN INFO
PCB OK ENGINE CRANKS NO VOLTAGE AT ADVANCE SOLENOID
POSSIBLE PROBLEMS
COLD ADVANCE SWITCH WIRING

DISCONNECT WIRE 569C AT COLD ADVANCE SWITCH. WITH ROTARY SWITCH IN "RUN" POSITION, DO YOU HAVE BATTERY VOLTAGE AT WIRE 569C?

TEST OPTIONS

1. STE/ICE-R TEST 89 (Page 2-750)
2. MULTIMETER

REASON FOR QUESTION

If you have no voltage here then the problem may be the cold advance switch

NO → REPAIR 569C/ REPLACE HARNESS

YES ↓

M3

KNOWN INFO
PCB OK ENGINE CRANKS NO VOLTAGE AT ADVANCE SOLENOID
POSSIBLE PROBLEMS
COLD ADVANCE SWITCH WIRING

RECONNECT WIRE 569C. DISCONNECT WIRE 569B FROM COLD ADVANCE SWITCH WITH ROTARY SWITCH IN "RUN" POSITION. DO YOU HAVE BATTERY VOLTAGE AT SWITCH LEAD?

TEST OPTIONS

1. STE/ICE-R TEST 89 (Page 2-750)
2. MULTIMETER

REASON FOR QUESTION

If you don't have voltage here then the problem is the switch.

NO → REPLACE COLD ADVANCE SWITCH

YES → REPAIR 569B/ REPLACE HARNESS

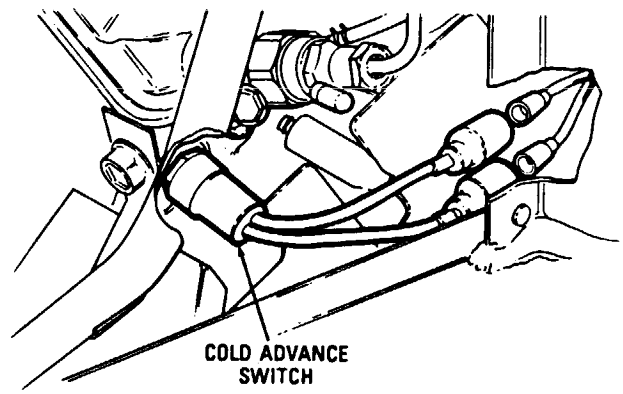
REFERENCE INFORMATION

FUEL SYSTEM

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to positive, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

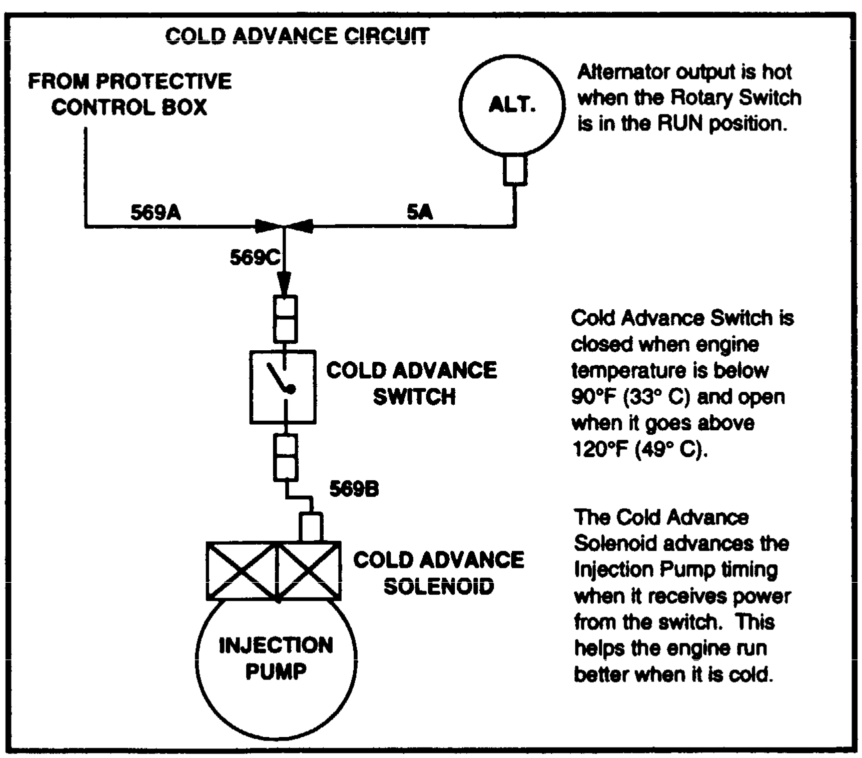
You should only run the engine long enough to determine the gage reading because engine temperature must stay below 90° F (33° C) for the Cold Advance Circuit to function.

BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.



1. Shut off engine
2. Disconnect wire 569C at Cold Advance Switch.
3. Turn Rotary Switch to Run position.
4. Check for battery voltage at wire 569C.

Repair wire or replace harness, refer to (para 4-85).



NOTE

Engine temp must be less than 90°F (33° C) when testing the switch.

For repair/replace instructions, (COLD ADVANCE SWITCH), refer to (para 4-27).

For repair/replace instructions, (HARNESS), refer to (para 4-85).

FUEL SYSTEM **DIAGNOSTIC FLOWCHART**

FROM B1, Page 2-106

N1

KNOWN INFO
NO VOLTAGE AT FUEL SOLENOID

POSSIBLE PROBLEMS
PCB
ROTARY SWITCH
WIRING

DISCONNECT ENGINE CONNECTOR HARNESS FROM THE PCB.

DO YOU HAVE CONTINUITY FROM SOCKET A IN THE CONNECTOR HARNESS TO WIRE 54A LOCATED AT THE FUEL SOLENOID?

TEST OPTIONS
1. STE/ICE-R TEST 91(Page 2-752)
2. MULTIMETER

REASON FOR QUESTION
If you have continuity here then the problem may be the PCB.

NO → REPAIR 54A, 569C, OR REPLACE HARNESS

YES ↓

N2

KNOWN INFO
WIRING TO FUEL SOLENOID OK

POSSIBLE PROBLEMS
PCB
ROTARY SWITCH
WIRING

DISCONNECT THE BODY CONNECTOR FROM THE PCB. WITH THE ROTARY SWITCH IN THE "RUN" POSITION DO YOU HAVE AN OPEN CIRCUIT BETWEEN SOCKET B & SOCKET G IN THE CONNECTOR HARNESS?

TEST OPTIONS
1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION
If you have continuity, then you may have a problem with the rotary switch or the wiring.

NO → GO TO N6, Page 2-134

YES ↓

N3

KNOWN INFO
WIRING TO FUEL SOLENOID OK

POSSIBLE PROBLEMS
PCB
ROTARY SWITCH
WIRING

DISCONNECT WIRE 29A AT THE ROTARY SWITCH.
DO YOU HAVE CONTINUITY BETWEEN WIRE 29A AT THE ROTARY SWITCH AND SOCKET B IN THE BODY CONNECTOR HARNESS?

TEST OPTIONS
1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION
You need to find the open circuit between the PCB and rotary switch.

NO → REPAIR 29A OR REPLACE HARNESS

YES ↓

GO TO N4, Page 2-134

REFERENCE INFORMATION

FUEL SYSTEM

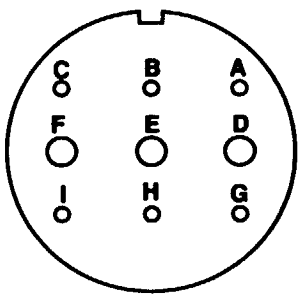
WARNING

Disconnect negative battery cable before disconnecting and reconnecting protective control box harness.

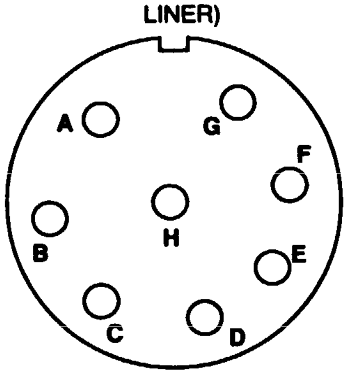
There is battery voltage at the PCB at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

Repair wiring, refer to (para 4-85).

Inspect wiring to be sure that all the wires are connected in their proper places.



PCB ENGINE CONNECTOR (ON LEFT FENDER LINER)

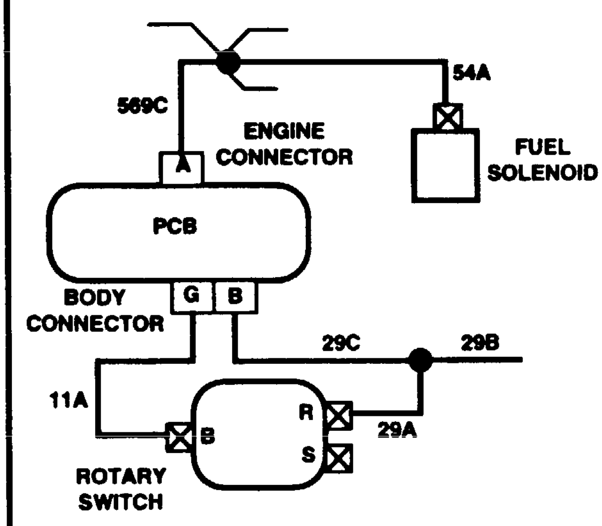


PCB BODY CONNECTOR (LOCATED UNDER DASHBOARD)

Repair wiring, refer to (para 4-85).

Remember to reconnect any wires that were disconnected during troubleshooting.

FUEL SOLENOID WIRING

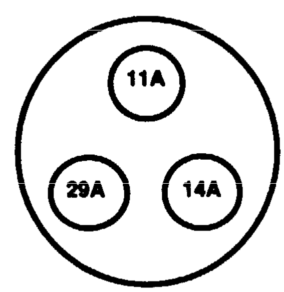


0-4500 OHMS STE/ICE-R TEST 91

1. Connect RED clip and BLACK clip to the terminations indicated in the question. RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

CONTINUITY (RESISTANCE) MULTIMETER

1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).



REAR OF ROTARY SWITCH

FUEL SYSTEM

DIAGNOSTIC FLOWCHART

FROM N3, Page 2-132

KNOWN INFO

29C OK

POSSIBLE PROBLEMS

PCB
ROTARY SWITCH
WIRING

N4

DISCONNECT WIRE 11A FROM THE ROTARY SWITCH.

DO YOU HAVE CONTINUITY BETWEEN WIRE 11A AT THE SWITCH AND SOCKET G IN THE BODY CONNECTOR HARNESS?

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION

If this wire is ok then the problem may be in the rotary switch.

NO → REPAIR W11A OR REPLACE HARNESS.

YES ↓

KNOWN INFO

WIRING OK

POSSIBLE PROBLEMS

PCB
ROTARY SWITCH

N5

WITH THE ROTARY SWITCH IN THE "RUN" POSITION, DO YOU HAVE CONTINUITY BETWEEN THE TERMINALS FOR WIRES 11A & 29A ON THE ROTARY SWITCH?

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION

If the rotary switch is ok then the problem is the PCB.

NO → REPLACE ROTARY SWITCH

YES ↓

!!

KNOWN INFO

ROTARY SWITCH OK

POSSIBLE PROBLEMS

PCB

N6

RECONNECT THE BODY CONNECTOR HARNESS THEN THE ENGINE CONNECTOR HARNESS.

DO YOU HAVE CONTINUITY BETWEEN WIRE 29A AT THE ROTARY SWITCH AND WIRE 54A AT THE FUEL SOLENOID?

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION

If there is no continuity then there is an open inside the PCB.

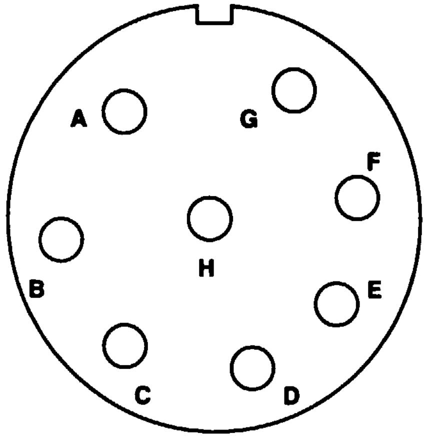
NO → REPLACE PCB

YES ↓

NO FAULTS

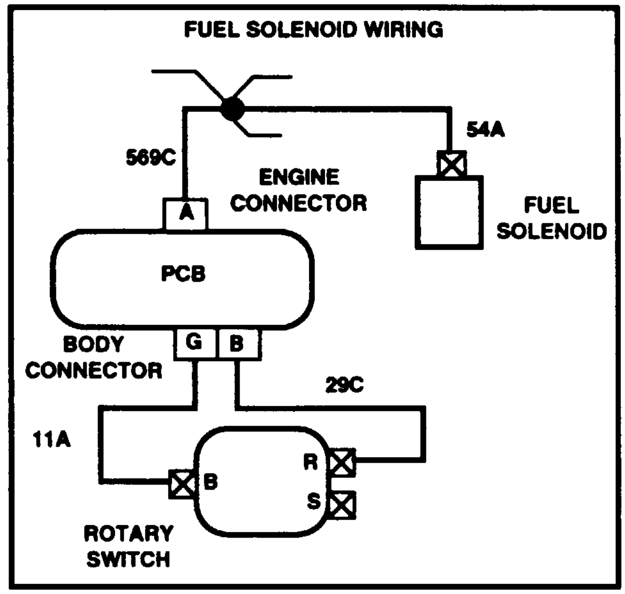
REFERENCE INFORMATION

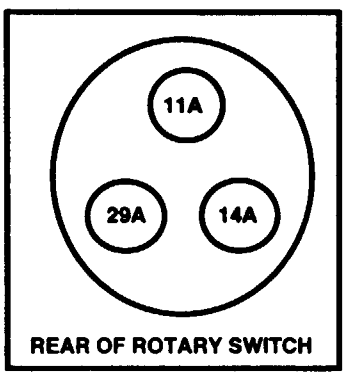
FUEL SYSTEM



PCB BODY CONNECTOR

For repair/replace instructions (HARNESS), refer to (para 4-85).





For repair/replace instructions (ROTARY SWITCH), refer to (para 4-7).

0-4500 OHMS
STE/ICE-R TEST 91

1. Connect RED clip and BLACK clip to the terminations indicated in the question.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

WARNING

Disconnect negative battery cable before disconnecting and reconnecting protective control box harness.

There is battery voltage at the PCB at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

Be sure to reconnect the wires at the rotary switch and the fuel solenoid.

For repair/replace instructions (PCB), refer to (para 4-5).

CONTINUITY (RESISTANCE)
MULTIMETER

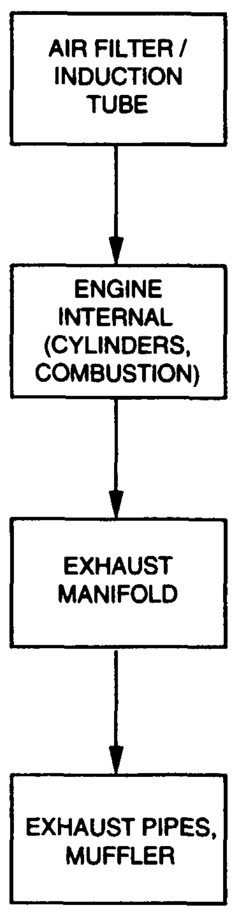
1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

2-23. AIR INTAKE/EXHAUST TESTS

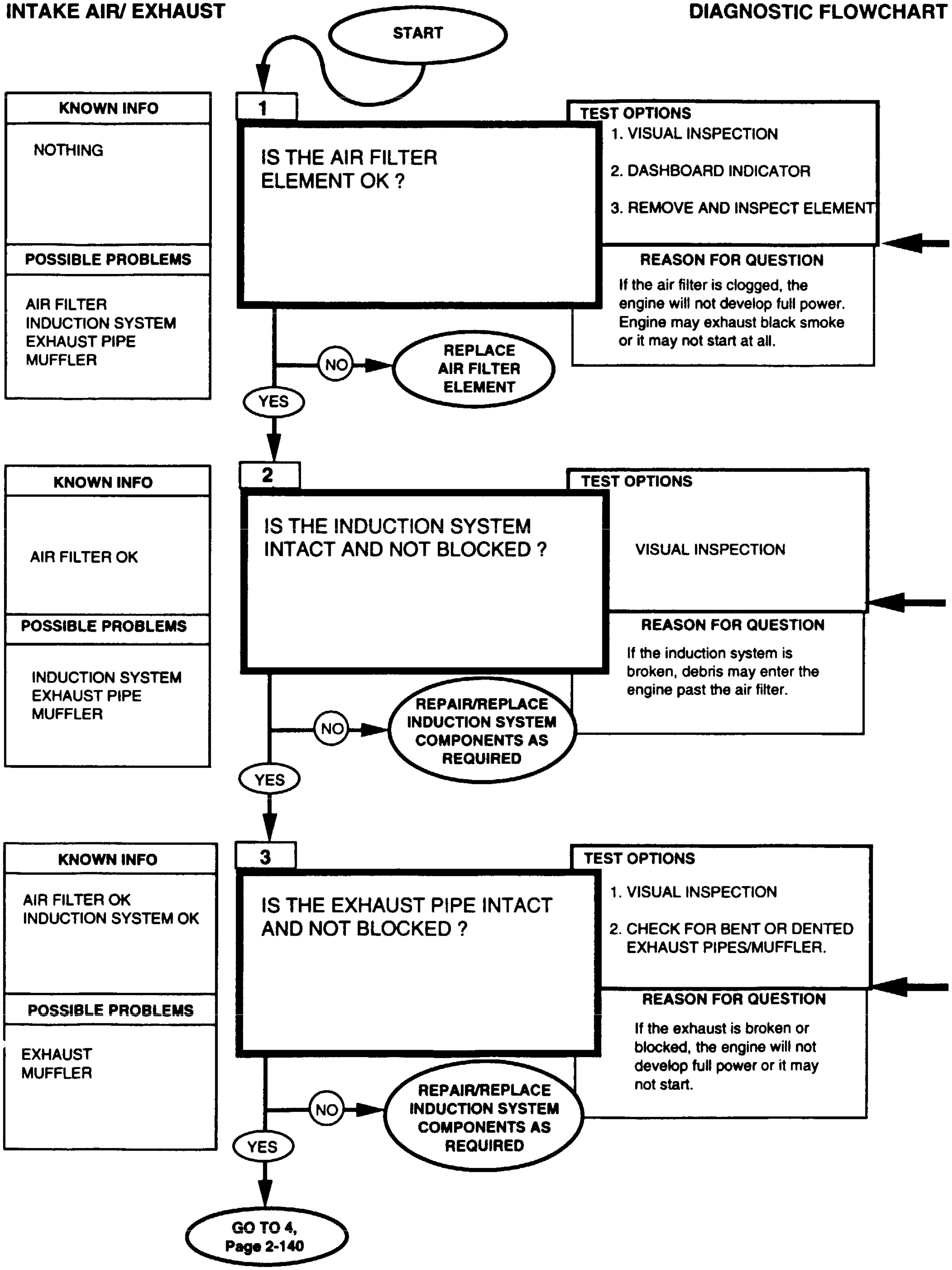
These Air Intake/Exhaust System tests can be run anytime you think there maybe a problem with the air intake or exhaust systems, or if you were sent here from another test.

At the bottom of this page is a simplified block diagram of the Intake Air/Exhaust System. A detailed functional flow is not applicable to this system.

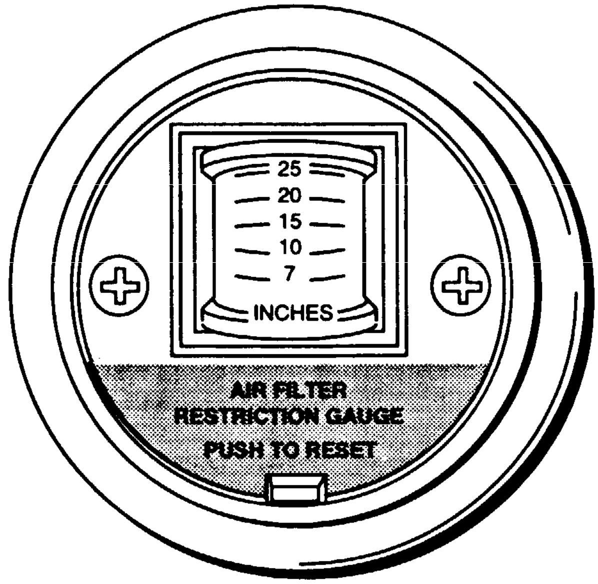
The Air Intake/Exhaust System is a very simple system that can cause very annoying problems. Whether the vehicle is hard to start or runs rough or never develops full power, it's worth the few minutes that it takes to check the components of this system. You can run through the diagnostic logic for this system almost anytime you open the hood or check the underside of your vehicle.



INTAKE AIR/ EXHAUST **DIAGNOSTIC FLOWCHART**



REFERENCE INFORMATION **INTAKE AIR/ EXHAUST**



First, check the Air Filter Restriction gauge on the dashboard, just to the left of the steering wheel and make a note of its reading. Open the air cleaner cannister, remove the air cleaner element and inspect it for dirt and other contaminants. Replace air filter, refer to (para 3-13). A clean air filter is white. If the condition of the filter does not agree with the gauge on the dashboard, make a note to check the gauge, see Instruments section, page 2-319.

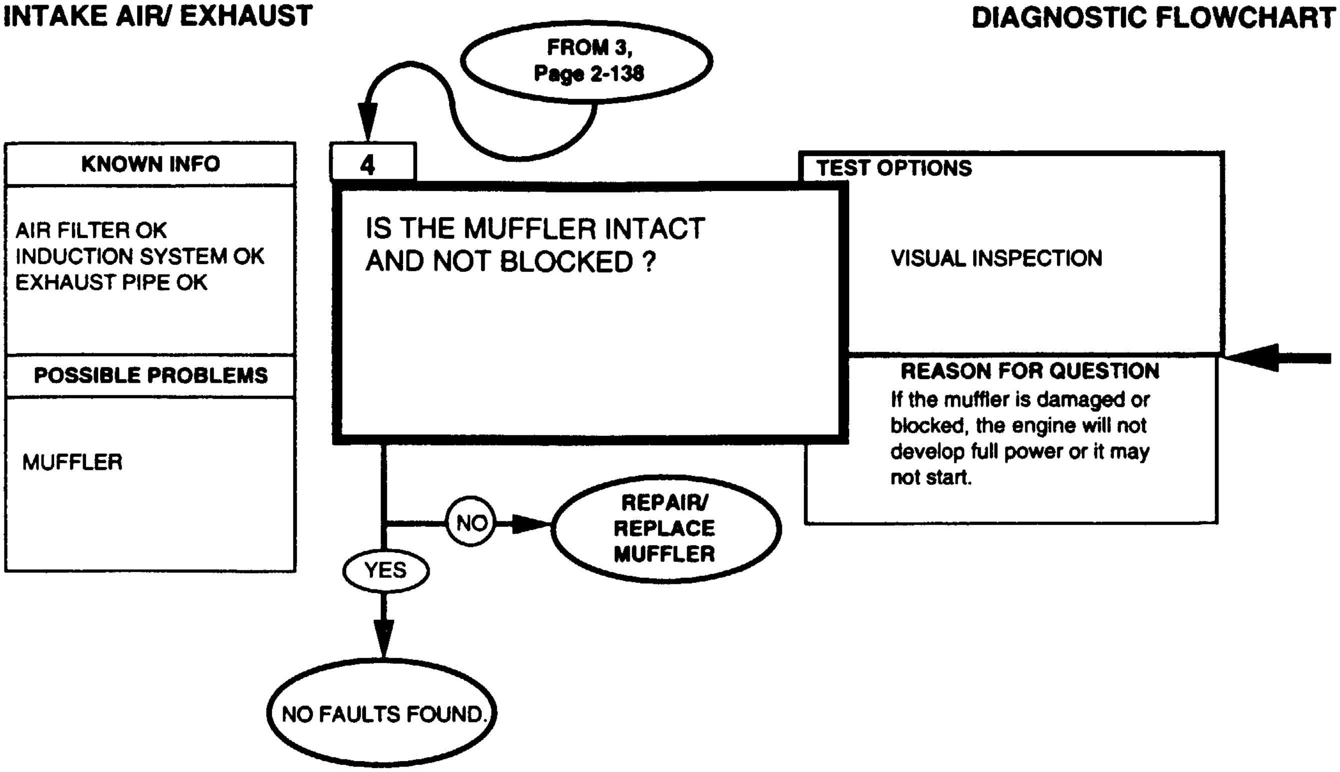
Make sure that all mounting bolts are in place and tight. Look for obvious things like a crushed or cracked air filter or air induction tube, check gaskets where possible. Replace induction system components, refer to (para 3-12).

Look for damage caused by rocks such as bent pipes or holes and loose or broken clamps.

Small dents (depth less than 1/4 the diameter of the exhaust pipes) should not cause the pipes to be replaced as long as the pipes are intact.

Replace induction system components, refer to (para 3-12).

INTAKE AIR/ EXHAUST **DIAGNOSTIC FLOWCHART**



REFERENCE INFORMATION **INTAKE AIR/ EXHAUST**

Look for damage caused by rocks such as bent pipes or holes, loose or broken clamps.

Replace muffler, refer to (para 3-48).

2-24. COMPRESSION/MECHANICAL TESTS

The main intent of this paragraph is to determine if the engine has internal compression or mechanical problems and to fix everything possible without having to notify DS maintenance.

COMPRESSION / MECHANICAL DIAGNOSTIC FLOWCHART

START

1

KNOWN INFO

NOTHING

POSSIBLE PROBLEMS

ENGINE
FUEL SYSTEM
INTAKE/EXHAUST
BATTERY CIRCUIT
STARTER CIRCUIT
LUBRICATION

DOES THE ENGINE CRANK AT NORMAL SPEED?

TEST OPTIONS

STE/ICE-R TEST 10 (Page 2-734)

REASON FOR QUESTION

No cranking or slow cranking may indicate a seized or tight engine, weak batteries or a bad starter circuit.

NO → GO TO A, page 2-148

YES ↓

2

KNOWN INFO

BATTERY CIRCUIT OK
STARTER CIRCUIT OK
ENGINE NOT SEIZED

POSSIBLE PROBLEMS

FUEL SYSTEM
ENGINE
INTAKE/EXHAUST

DOES THE VEHICLE START ?

TEST OPTIONS

FOLLOW NORMAL STARTING PROCEDURE

REASON FOR QUESTION

If the engine starts, then most of the fuel system is ok and the intake/exhaust system is probably ok.

NO → GO TO STARTABILITY, Page 2-41

YES ↓

3

KNOWN INFO

BATTERY CIRCUIT OK
STARTER CIRCUIT OK
ENGINE NOT SEIZED
AIR & FUEL TO CYLINDERS

POSSIBLE PROBLEMS

LUBRICATION
ENGINE
FUEL SYSTEM
INTAKE/EXHAUST

IS THE ENGINE OIL PRESSURE 40-45 PSI AT 2000 RPM AND THE ENGINE WARM ?

TEST OPTIONS

1. OIL PRESSURE GAUGE
2. STE/ICE-R TEST 50 (Page 2-739)

REASON FOR QUESTION

Without proper oil pressure the engine won't be lubricated properly.

NO → GO TO LUBRICATION, Page 2-65

YES ↓

GO TO 4, Page 2-146

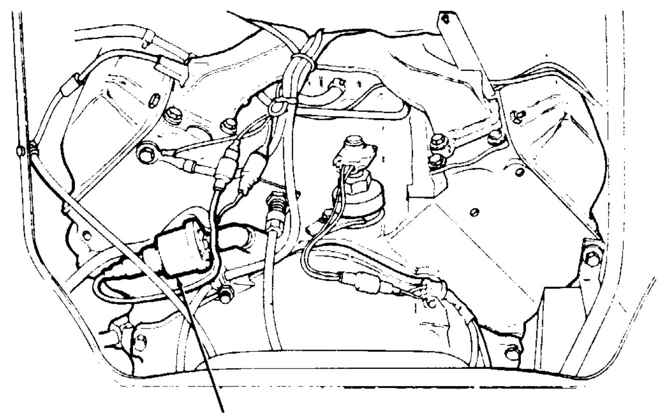
REFERENCE INFORMATION

COMPRESSION / MECHANICAL

ENGINE RPM STE/ICE-R TEST 10
1. Start Test 10, Engine RPM. 2. Crank or start the engine. Displayed reading is RPM. Cranking RPM should be approximately 100-200. Idle RPM should be 625 - 675.

A healthy engine should crank at least 100 RPM when it's cold and at least 180-200 RPM when it's warm.

If the engine doesn't crank at normal speed then it could be due to a Starter or Battery Circuit fault or it may be due to an internal engine problem.



Oil pressure may go as high as 80 psi if the engine is cold and should be 10 psi minimum at idle speed. You should check the oil pressure with the STE/ICE-R (test 50) using 1000 psi transducer (blue stripe). Check pressure at idle and at 2000 RPM. If pressure is low, check oil level and condition. Add or change oil as required.

OIL PRESSURE STE/ICE-R TEST 50
1. Install STE/ICE-R 0 to1000 PSI transducer (blue stripe) in place of oil pressure sending unit. 2. Connect to STE/ICE-R TK connector J2 or J3. 3. CAL with engine off. 4. Start engine. Run test 50. With the engine warm, oil pressure should be 10 psi minimum at idle and 40-45 psi at 2000 RPM. Pressure may go as high as 80 psi when the engine is cold.

COMPRESSION / MECHANICAL DIAGNOSTIC FLOWCHART

FROM 3, Page 2-144

4

KNOWN INFO

BATTERY CIRCUIT OK
STARTER CIRCUIT OK
ENGINE NOT SEIZED
AIR AND FUEL TO CYLINDERS

POSSIBLE PROBLEMS

INTAKE/EXHAUST
FUEL SYSTEM
ENGINE

DOES THE ENGINE SOUND NORMAL AND HAVE NORMAL VIBRATIONS AT ALL SPEEDS ?

TEST OPTIONS

REV THE ENGINE. DRIVE THE VEHICLE.

REASON FOR QUESTION

The first indication of a mechanical problem is an abnormal noise or vibration. Before running other tests to check for engine problems, this is to try to make sure that you don't make a bad problem worse.

NO → **GO TO B, Page 2-150**

YES ↓

5

KNOWN INFO

BATTERY CIRCUIT OK
STARTER CIRCUIT OK
ENGINE NOT SEIZED
AIR AND FUEL TO CYLINDERS
FUEL SYSTEM OK
INTAKE/EXHAUST OK

POSSIBLE PROBLEMS

ENGINE

DOES THE ENGINE PASS THE COMPRESSION UNBALANCE TEST?

TEST OPTIONS

STE/ICE-R TEST 14 (Page 2-737).

REASON FOR QUESTION

If the engine fails the cylinder unbalance test then it indicates an individual cylinder problem such as a bad fuel injector, excessive blowby, etc.

NO → **RUN THE TRANSMISSION AND STEERING TESTS. IF NO FAULTS FOUND, NOTIFY DS**

YES ↓

6

KNOWN INFO

BATTERY CIRCUIT OK
STARTER CIRCUIT OK
ENGINE NOT SEIZED
AIR AND FUEL TO CYLINDERS

POSSIBLE PROBLEMS

ENGINE
FUEL SYSTEM
INTAKE/EXHAUST

DOES THE ENGINE PASS THE POWER TEST?

TEST OPTIONS

STE/ICE-R TEST 13 (Page 2-736).

REASON FOR QUESTION

Loss of power can be caused by internal engine problems, fuel system, air intake/exhaust, or drivetrain problems.

NO → **GO TO C, PAGE 2-152**

YES ↓

NO FAULTS FOUND. IF YOU WERE SENT HERE FROM ANOTHER TEST, RETURN TO IT.

This is not to evaluate driving performance. If the engine or the vehicle makes strange noises or vibrations at idle speed, don't rev the engine. If there is a problem internal to the engine, revving the engine could cause major damage (like a rod coming through the engine block).

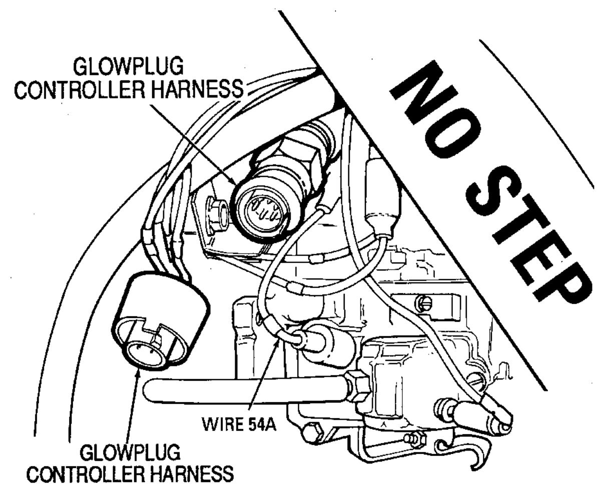
COMPRESSION UNBALANCE
STE/ICE-R TEST 14

1. Run tests 72, 73, and 74 to verify that the batteries are ok.
2. Disconnect wire 54A at injection pump to prevent starting.

CAUTION

The glowplug controller and the control valve electrical connector must be disconnected prior to running this test.

3. Disconnect glowplug controller and control valve electrical connector.
4. Start Test 14, Compression Unbalance.
5. Wait for the GO message. Crank the engine.
6. Release the rotary switch when the VTM displays OFF. A number less than 25% is passing.

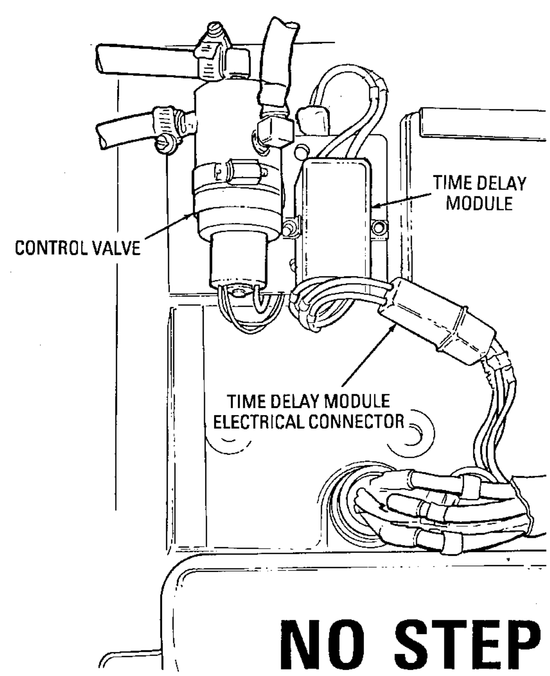


If the vehicle passes the STE/ICE-R Compression Unbalance Test, it may still have a compression problem, but it would mean that every cylinder has low compression. This is possible, but not too likely. If you don't find a problem and suspect compression, notify DS maintenance to measure compression.

If STE/ICE-R is not available, accelerate under full power to a reasonable speed on a flat, level, paved surface. You have to decide from your own experience whether or not the engine is developing full power. A number greater than 75 is passing for test # 13.

POWER TEST (% POWER)
STE/ICE-R TEST 13

1. Start and idle engine.
2. Run STE/ICE-R test #10 to set idle and governor speed as necessary.
3. Start STE/ICE-R test #13.
4. When CIP appears on the display, press down sharply on the accelerator and hold it to the floor until the VTM displays OFF.
5. Displayed value is % POWER.



COMPRESSION / MECHANICAL **DIAGNOSTIC FLOWCHART**

A
FROM 1,
Page 2-144

A1

IS THE BATTERY CIRCUIT OK?

KNOWN INFO
ENGINE DOESN'T CRANK PROPERLY

POSSIBLE PROBLEMS
ENGINE
STARTER CIRCUIT
BATTERY CIRCUIT

TEST OPTIONS
1. STE/ICE-R TEST 67, 73, 75 (page 2-740, 746, 748)
2. RUN BATTERY CIRCUIT TESTS, Page 2-251.

REASON FOR QUESTION
A faulty Battery Circuit can cause slow or no cranking.

NO → RUN BATTERY CIRCUIT TESTS, Page 2-251.

YES ↓

A2

IS THE STARTER CIRCUIT OK?

KNOWN INFO
ENGINE DOESN'T CRANK PROPERLY
BATTERY CIRCUIT OK

POSSIBLE PROBLEMS
ENGINE
STARTER CIRCUIT

TEST OPTIONS
1. STE/ICE-R TESTS 71, 72, 74 (page 2-744, 745, 747)
2. RUN STARTER CIRCUIT TESTS, Page 2-261

REASON FOR QUESTION
A faulty Starter Circuit can cause slow or no cranking.

NO → RUN STARTER CIRCUIT TESTS, Page 2-261.

YES ↓

!!

A3

CAN YOU TURN THE CRANKSHAFT MANUALLY?

KNOWN INFO
ENGINE DOESN'T CRANK PROPERLY
BATTERY CIRCUIT OK
STARTER CIRCUIT OK

POSSIBLE PROBLEMS
ENGINE
DRIVETRAIN

TEST OPTIONS
USE A BREAKER BAR AND SOCKET ON CRANKSHAFT PULLEY BOLT

REASON FOR QUESTION
If you can't turn the engine by hand then the engine is probably seized.

NO → NOTIFY DS MAINTENANCE

YES ↓

NO FAULTS FOUND, GO TO STEP 2 OF THE GO CHAIN, PAGE 2-144.

REFERENCE INFORMATION

BATTERY VOLTAGE
STE/ICE-R TEST 67

1. Start Test 67, Battery Voltage.

2. Displayed reading is in volts. Batteries should be 23-25.5 volts. Batteries voltage will drop when glowplugs turn on.

STARTER AVERAGE CURRENT
STE/ICE-R TEST 71

1. Start Test 71, Starter Average Current.

2. Displayed reading is in amps. The starter should draw at least 200 amps with a peak of over 400 amps.

The Starter Circuit Tests begin on page 2-261.
Internal engine problems (tight main or rod bearings for example) or drivetrain problems could still cause the engine to crank slowly even if the Starter and Battery Circuits are OK.

WARNING

Be sure to disconnect fuel solenoid (wire 54A) to prevent accidental starting. Failure to do so may result in injury to personnel or damage to equipment.

A breaker bar and socket placed on the crankshaft pulley can be used to try to turn the crankshaft. The crankshaft pulley is located directly under the engine cooling fan. It can be reached from under the HMMWV.

If the engine won't turn, remove the glowplugs and try again. If the engine turns now, try cranking it and look for fuel at the eight glowplug holes. If you see fuel at any of the holes then the engine may have had hydrostatic lock. Crank the engine for about 15 seconds to clear the fuel then re-install the glowplugs and try to start the engine. If it still won't crank, notify DS maintenance.

COMPRESSION / MECHANICAL

STARTER FIRST PEAK CURRENT
STE/ICE-R TEST 72

1. Disconnect wire 54A at injection pump to prevent starting.

2. Disconnect glowplugs controller and fan solenoid.

3. Start Test 72, starter first peak current.

4. Wait for the GO message. Crank the engine.

5. Result is displayed in amps. Starter first peak should be over 400 amps.

BATTERY INTERNAL RESISTANCE
STE/ICE-R TEST 73

1. Disconnect wire 54A at injection pump to prevent starting.

2. Disconnect glowplugs controller and fan solenoid.

3. Start Test 73, Battery Internal Resistance.

4. Wait for the GO message. Crank the engine.

5. Result is displayed in milliohms. Battery resistance should be 25 milliohms max.

STARTER CIRCUIT RESISTANCE
STE/ICE-R TEST 74

1. Disconnect wire 54A at injection pump to prevent starting.

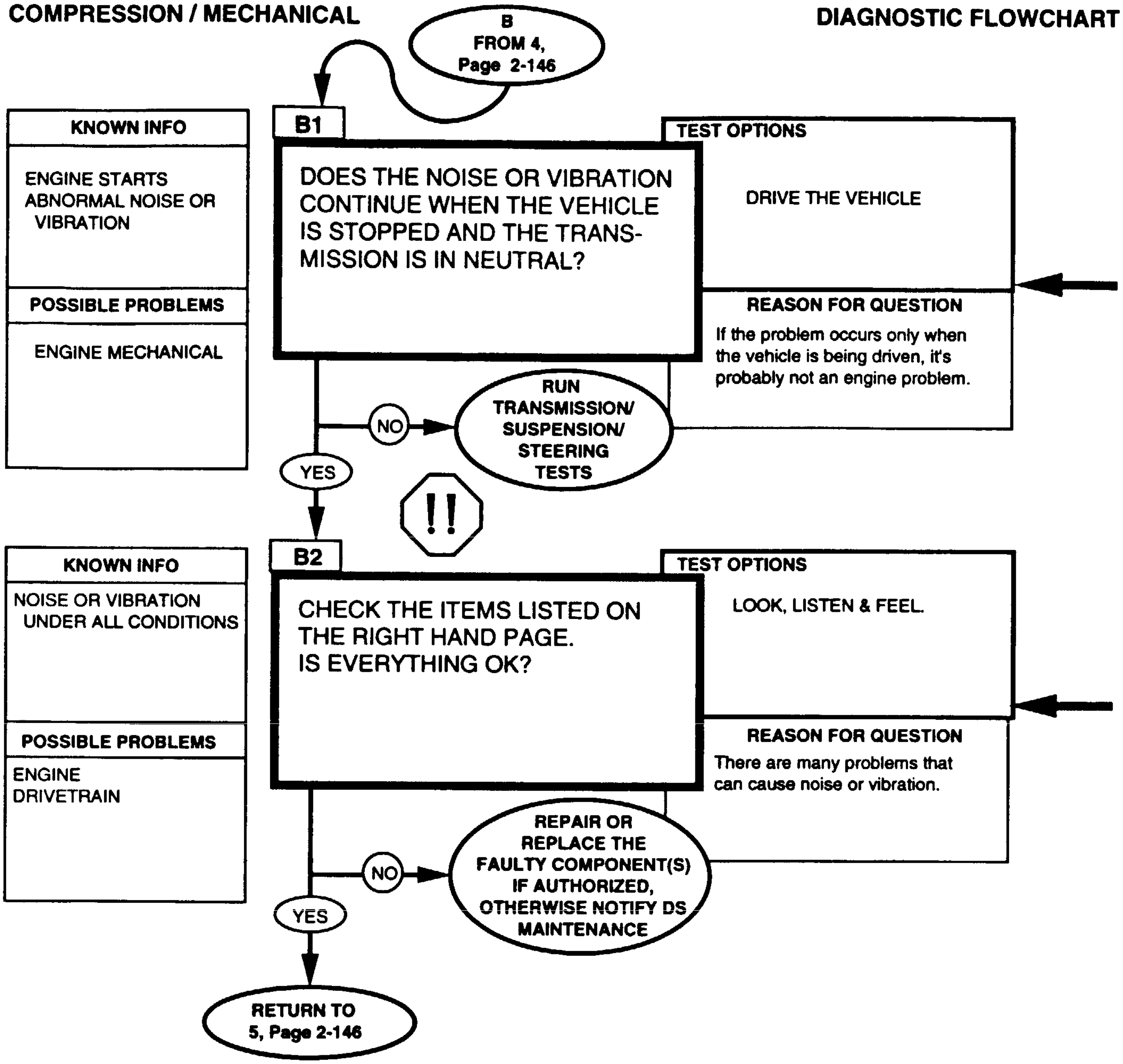
2. Disconnect glowplugs controller and fan solenoid.

3. Start Test 74, Starter Circuit Resistance.

4. Wait for the GO message. Crank the engine.

5. Result is displayed in milliohms. Starter circuit resistance should be 25 milliohms max.

COMPRESSION / MECHANICAL DIAGNOSTIC FLOWCHART



Try the following steps:

1. Determine what noises or vibrations are there when the engine is running with the transmission in neutral.

2. Keep the engine running, put the transmission in drive and take note of any changes in the noises or vibrations.

3. If it's safe to drive, drive the vehicle and take note of any changes in the noises or vibrations. Drive vehicle through all gears and ranges within speed rates listed in TM 9-2320-280-10.

WARNING

A hot engine may cause serious burns. Always use caution when approaching a hot engine.

Engine Mounts
Transmission Mounts
Cooling Fan
Belts
Water Pump
Power Steering Pump
Fuel Pump
Alternator
Air Induction Components
Exhaust Components

COMPRESSION / MECHANICAL DIAGNOSTIC FLOWCHART

C
FROM 6,
Page 2-146

KNOWN INFO

BATTERY AND STARTER CIRCUITS OK

POSSIBLE PROBLEMS

ENGINE
DRIVETRAIN
FUEL SYSTEM
INTAKE/EXHAUST

C1

RUN A POWER TEST WITH THE AIR FILTER REMOVED. DOES THE TEST STILL FAIL?

TEST OPTIONS

AIR INTAKE/EXHAUST TESTS
PAGE 2-137

REASON FOR QUESTION

Intake or exhaust restrictions will prevent the engine from producing full power. A NO answer means the test passed with no air filter.

NO → GO TO AIR INTAKE/EXHAUST TESTS, Page 2-137

YES ↓

KNOWN INFO

BATTERY AND STARTER CIRCUITS OK

AIR INTAKE/EXHAUST OK

POSSIBLE PROBLEMS

ENGINE
DRIVETRAIN
FUEL SYSTEM

C2

HAVE YOU RUN THE FUEL SYSTEM TESTS YET?

TEST OPTIONS

FUEL SYSTEM TESTS
PAGE 2-95

REASON FOR QUESTION

Many fuel system faults will allow the engine to start and run but prevent it from producing full power.

NO → GO TO FUEL SYSTEM TESTS, Page 2-95

YES ↓

KNOWN INFO

BATTERY AND STARTER CIRCUITS OK

AIR INTAKE/EXHAUST OK

FUEL SYSTEM OK

POSSIBLE PROBLEMS

ENGINE
DRIVETRAIN

C3

IF EVERYTHING CHECKS OUT OK TO THIS POINT, THEN YOU PROBABLY HAVE AN ENGINE MECHANICAL PROBLEM THAT CAN'T BE HANDLED AT THIS LEVEL OF MAINTENANCE.

REFERENCE INFORMATION

COMPRESSION / MECHANICAL

If faults are found and corrected go to STEP 2 of the GO CHAIN.

If no faults are found go to B2, page 2-150.

If faults are found and corrected go to STEP 2 of the GO CHAIN.

If no faults are found go to B2, page 2-150.

2-25. ENGINE COOLING TESTS

These Engine Cooling tests may be run any time you think you have an engine cooling problem or if you were sent here by another test chain. Just follow the path, answering the questions. Additional information and notes are given on the facing page when necessary. Please note that this paragraph is NOT for diagnoses of problems with the temperature sending unit or the gauge.

Once you are sure that the cooling system is OK, run the instruments test in Paragraph 2-32 to find out if the gauge is OK.

Fold-out FO-4 contains a functional diagram of the engine cooling system. This page may be left open for reference while testing.

The engine cooling system is a pressure type cooling system with thermostatic control of coolant circulation. The cooling system dissipates heat generated from combustion and maintains the engine operating temperature at its most efficient level. When the engine is cold and the thermostat is closed, coolant is recirculated through the water pump and engine. As the engine coolant reaches 190°F (87.7°C), the thermostat opens allowing coolant to flow through the radiator before returning to the water pump and engine. Any air or vapor in the cooling system will be forced to the surge tank under the liquid level and leave through a vent tube. As the system cools, the extra coolant in the tank will be drawn back to the radiator. Normally a 50-50 mixture of water and ethylene glycol base antifreeze will be used. The fan is activated when coolant temperature reaches 215°F (102°C). A separate oil cooler is mounted in front of the radiator. This cooler is divided into two parts. The top half is for transmission oil. The bottom half is for engine oil. When the cooling system pressure reaches approximately 15 psi (103 kPa), a valve in the surge tank cap opens and lets excess pressure escape to the atmosphere.

ETHYLENE GLYCOL MIXTURE TABLE

LOWEST EXPECTED AMBIENT TEMPERATURE		ETHYLENE GLYCOL (-60°F, -51.1°C) INHIBITED (MIL-A-46153)		ARCTIC GRADE ANTIFREEZE (-90°F) (-67.7°C) MIL-A-11755
°F	**°C**	**PINTS PER GALLON OF COOLANT CAPACITY**	**SPECIFIC GRAVITY (68°F) (20°C)**	
+20	-6.7	1-1/2	1.022	Freezing point of -90°F (-67.7°C). Issued ready for use and must not be mixed with any other liquid.
+10	-12.2	2	1.036	
0	-17.7	2-3/4	1.047	
-10	-23.3	3-1/4	1.055	
-20	-28.8	3-1/2	1.062	
-30	-34.4	4	1.067	
-40	-40.0	4-1/4	1.073	
-50	-45.5	4-1/2		
-55	-48.3	4-3/4		
BELOW -60	BELOW -51.1	USE ARCTIC GRADE ANTIFREEZE (-90°F) (-67.7°C)		

ENGINE COOLING — DIAGNOSTIC FLOWCHART

START

1

KNOWN INFO

NONE

POSSIBLE PROBLEMS

COOLING COMPONENTS
ENGINE FAN BELTS
WATER PUMP AND PULLEY

IS THE COOLANT MIXTURE CORRECT?
(SEE CHART ON PAGE 2-155.)

TEST OPTIONS

COOLANT MIXTURE TEST KIT
NSN 6630-00-169-1506.

COOLANT TESTER
NSN 6630-00-105-1418.

REASON FOR QUESTION

The cooling system will not operate properly if the mixture is incorrect.

NO → **DRAIN & REFILL COOLANT**

YES ↓

2

KNOWN INFO

COOLANT QUALITY OK

POSSIBLE PROBLEMS

COOLANT LEVEL
COOLING COMPONENTS
ENGINE FAN BELTS
WATER PUMP AND PULLEY

IS THE COOLANT AT THE CORRECT LEVEL?

TEST OPTIONS

VISUAL INSPECTION.

REASON FOR QUESTION

Low coolant levels may cause overheating.

NO → **FILL TO PROPER LEVEL**

YES ↓

3

KNOWN INFO

COOLANT OK

POSSIBLE PROBLEMS

THERMOSTAT
COOLING COMPONENTS
ENGINE FAN BELTS
WATER PUMP AND PULLEY

IS THE THERMOSTAT WORKING PROPERLY?

TEST OPTIONS

FEEL FOR COOLANT IN UPPER RADIATOR HOSE WHEN ENGINE IS HOT, OR REMOVE THERMOSTAT. EXPOSE IT TO 190°F (88° C) AND SEE IF IT OPENS.

REASON FOR QUESTION

An improperly functioning thermostat can cause operating temperatures that are either too hot or too cold.

NO → **REPLACE THERMOSTAT**

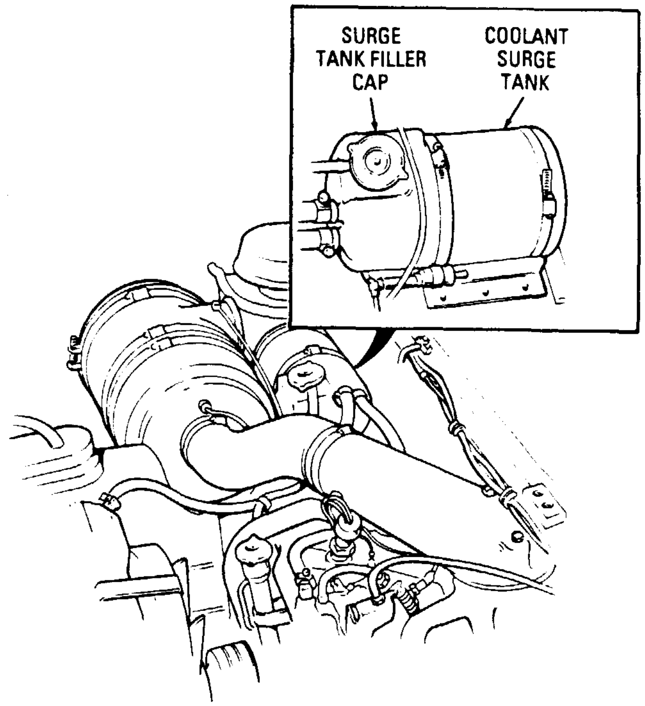
YES ↓

GO TO 4, Page 2-158

WARNING

Do not remove surge tank filler cap before releasing internal pressure when engine temperature is above 190 °F (88°C). Steam or hot coolant under pressure will cause injury.

Drain and refill coolant, refer to (para 3-60).



WARNING

Do not remove surge tank filler cap before releasing internal pressure when engine temperature is above 190 °F (88°C). Steam or hot coolant under pressure will cause injury.

Fill coolant to proper level , refer to (para 3-60).

WARNING

Always use caution when approaching a hot engine. Failure to do so may result in serious burns.

Remove and replace the thermostat, refer to (para 3-75).

ENGINE COOLING — DIAGNOSTIC FLOWCHART

FROM 3, Page 2-156

4

KNOWN INFO

COOLANT OK
THERMOSTAT OK

POSSIBLE PROBLEMS

COOLING COMPONENTS
ENGINE FAN BELTS
WATER PUMP & PULLEY

INSPECT THE PRESSURE CAP. IS IT IN GOOD CONDITION?

TEST OPTIONS

PRESSURE TESTER.

REASON FOR QUESTION

A defective pressure cap may cause overheating.

NO → REPLACE PRESSURE CAP

YES ↓

5

KNOWN INFO

COOLANT OK
PRESSURE CAP OK
THERMOSTAT OK

POSSIBLE PROBLEMS

HOSES
SURGE TANK
RADIATOR
THERMOSTAT
ENGINE FAN
WATER PUMP & PULLEY

INSPECT ALL RADIATOR HOSES, COOLANT HOSES, SURGE TANK, RADIATOR, OIL COOLER, AND FITTINGS FOR DAMAGE, BLOCKAGE OR LARGE LEAKS IS EVERYTHING IN GOOD SHAPE?

TEST OPTIONS

LOOK.

REASON FOR QUESTION

Physical damage and blocked passages can cause cooling problems.

NO → REPAIR/REPLACE AS AUTHORIZED. (FLUSH SYSTEM IF BLOCKED), OTHERWISE NOTIFY DS MAINTENANCE.

YES ↓

6

KNOWN INFO

COOLANT OK
PRESSURE CAP OK
THERMOSTAT OK
HOSES OK
SURGE TANK OK
OIL COOLER OK

POSSIBLE PROBLEMS

RADIATOR
ENGINE FAN
WATER PUMP & PULLEY

IS THE ENGINE FAN WORKING PROPERLY?

TEST OPTIONS

LOOK – SEE DESCRIPTION OF OPERATION AT RIGHT.

REASON FOR QUESTION

The engine fan helps cool the engine.

NO → GO TO A, Page 2-164

YES → GO TO 7, Page 2-160

REFERENCE INFORMATION

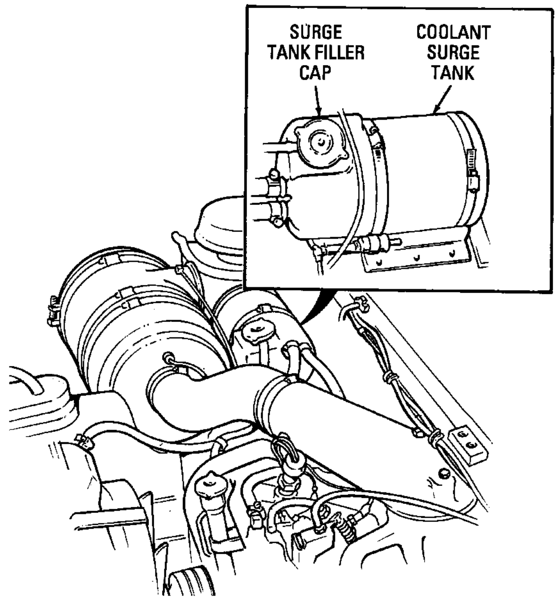
ENGINE COOLING

WARNING

Do not remove surge tank filler cap before releasing internal pressure when engine temperature is above 190 °F (88°C). Steam or hot coolant under pressure will cause injury.

Check seal and spring on pressure cap.

Replace pressure cap, refer to (para. 3-60).



Flush cooling system, refer to (para. 3-60).

For surge tank and radiator support replacement procedures, refer to (paras. 3-63 and 3-64).

For oil cooler and oil cooler hose replacement procedures, refer to (paras. 3-7 and 3-8).

Notify DS maintenance to repair radiators.

ENGINE COOLING FAN DESCRIPTION OF OPERATION

An external line from the power steering gear brings hydraulic fluid to the clutch fan solenoid through control valve (normally open) and then to the fan drive, keeping it disengaged. The action of the valve is controlled by the time delay module and the fan temperature switch.

During normal operation, the fan timer switch is closed. This keeps the control valve in the open position and the drive disengaged.

As the engine reaches a temperature of 215°F (102°C), the temperature switch opens and the control valve closes. This engages the fan. If the fan is engaged and the accelerator is floored, the transmission kickdown system disengages the fan drive for 20 seconds.

The easiest way to determine if the fan is engaged is to stand outside the driver's door and gently work the accelerator. If the fan is engaged, you will feel a breeze from the engine area. If the fan is not engaged, you won't feel the breeze.

If the vehicle's serial number is 68555 through 72541 or 100000 through 112867, and you see ADCO stamped on top of the time delay module, replace the module with part NSN 5945-01-193-7175, refer to (para. 4-31).

ENGINE COOLING — DIAGNOSTIC FLOWCHART

FROM 6, Page 2-158

KNOWN INFO

COOLANT OK
PRESSURE CAP OK
HOSES OK
SURGE TANK OK
OIL COOLER OK
ENGINE FAN OK

POSSIBLE PROBLEMS

RADIATOR
WATER PUMP & PULLEY
BELTS

7

INSPECT THE RADIATOR. IS IT IN GOOD CONDITION (FINS NOT BADLY BENT OR BLOCKED)?

TEST OPTIONS

LOOK.

REASON FOR QUESTION

Bent or blocked fins prevent efficient cooling of the coolant.

NO → STRAIGHTEN AND CLEAN

YES ↓

KNOWN INFO

COOLANT OK
PRESSURE CAP OK
RADIATOR/HOSES OK
SURGE TANK OK
OIL COOLER OK
ENGINE FAN OK

POSSIBLE PROBLEMS

WATER PUMP & PULLEY
BELTS

8

INSPECT THE WATER PUMP AND PULLEY. ARE THEY IN GOOD CONDITION?

TEST OPTIONS

LOOK AND LISTEN.

REASON FOR QUESTION

A bad pulley and water pump won't cool the engine efficiently.

NO → REPLACE PULLEY OR PUMP

YES ↓

KNOWN INFO

RADIATOR/HOSES OK
SURGE TANK OK
OIL COOLER OK
ENGINE FAN OK
PUMP & PULLEY OK

POSSIBLE PROBLEMS

BELTS
INTERNAL ENGINE LEAKS

9

ARE THE FAN DRIVEBELTS TIGHT AND IN GOOD CONDITION?

TEST OPTIONS

VISUAL INSPECTION.
USE BELT TENSION GAUGE.

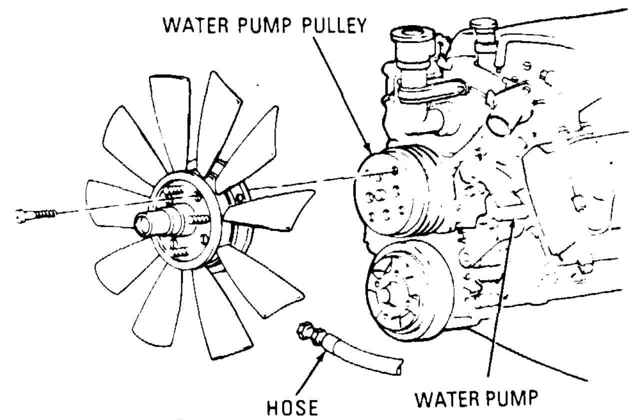
REASON FOR QUESTION

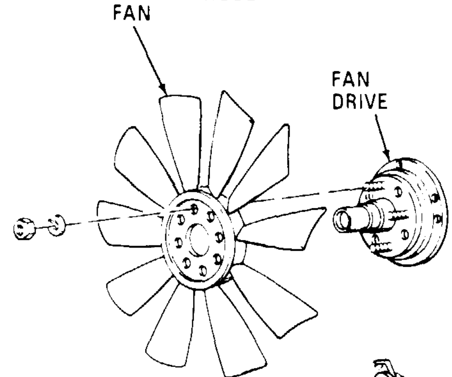
Loose belts will not drive the fan properly.

NO → REPLACE OR TIGHTEN BELTS

YES ↓

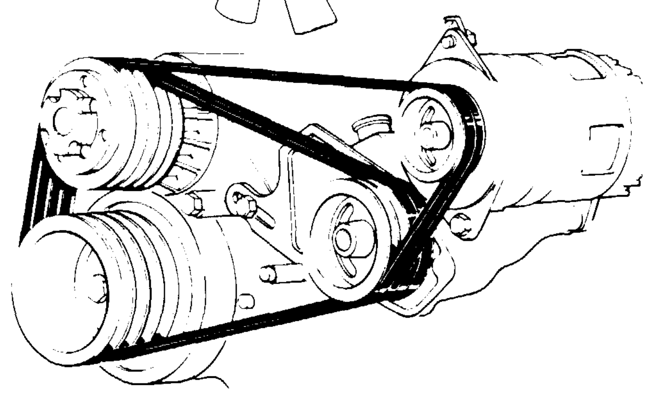
GO TO 10, Page 2-162



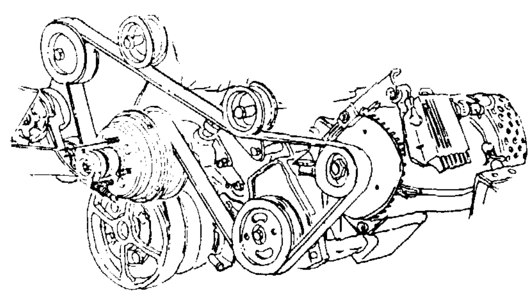


Listen for noisy bearings in the water pump, or an in and out motion to the fan.
You can also check the pump and pulley by trying to move it in and out or laterally with the engine off.

Replace the water pump pulley, refer to (para 3-76).
A bad water pump needs to be replaced by DS maintenance.

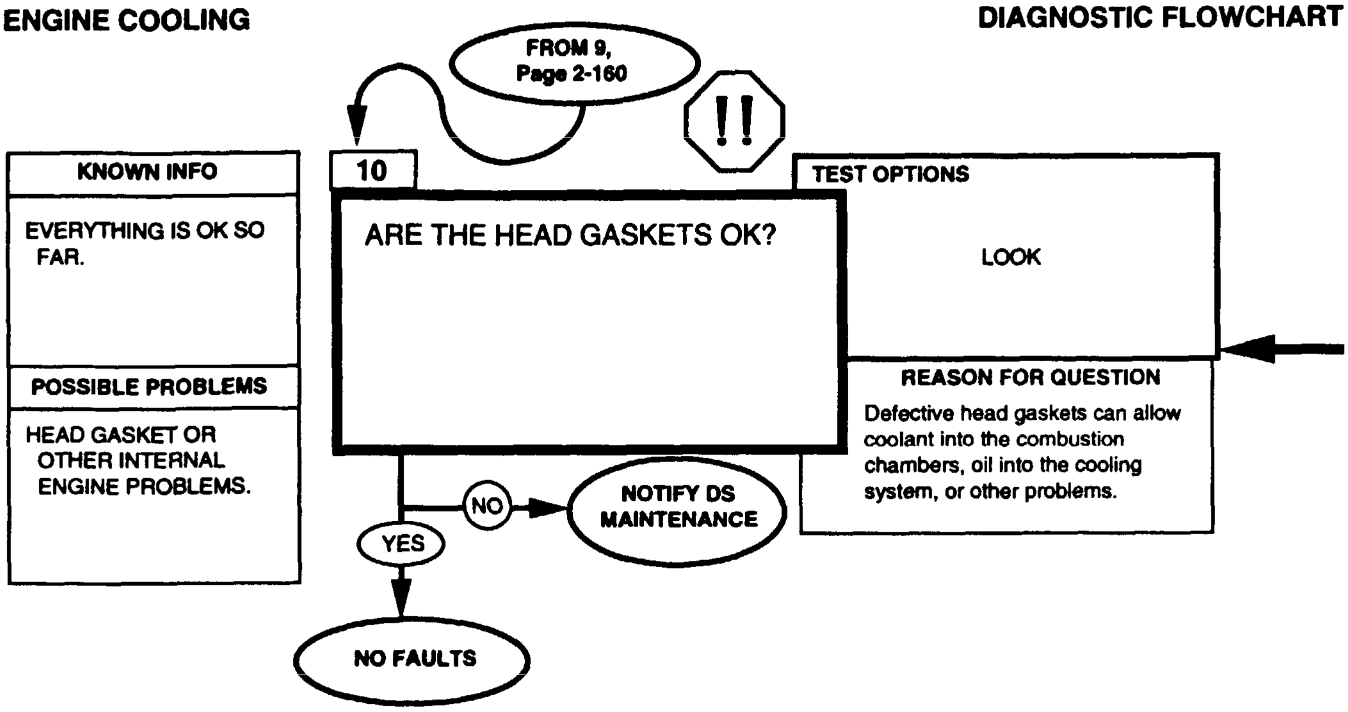


Replace belts, refer to (para. 3-81, all except "A2" vehicles) (para. 3-83, "A2" vehicles) or tighten belts, refer to (para. 3-82, all except "A2" vehicles).



"A2"
CONFIGURATION

ENGINE COOLING **DIAGNOSTIC FLOWCHART**



WARNING

Always use caution when approaching a hot engine. Failure to do so may result in serious bums.

Look for excessive white exhaust smoke, steam leaks in the engine compartment oil in the coolant. Other signs include excess condensation in the exhaust system, or white joints in the exhaust system. You can also feel the coolant hoses to see if they have high pressure caused by leaking combustion gasses. Also, if the glowplugs tum off very quickly after starting the engine, or if the engine overheats, or has excessive coolant consumption, you may have a head gasket problem.

ENGINE COOLING

DIAGNOSTIC FLOWCHART

A
FROM 6, Page 2-158

A1

KNOWN INFO

ENGINE FAN NOT WORKING PROPERLY

POSSIBLE PROBLEMS

FAN OR FAN BELTS
WIRING
FAN TIMER
FAN SOLENOID
FAN TEMPERATURE SWITCH
PCB

INSPECT THE COOLING FAN. ARE THE FAN BLADES ALL INTACT?

TEST OPTIONS

LOOK FOR CRACKED OR BROKEN BLADES.

REASON FOR QUESTION

A damaged fan does not cool efficiently and could be dangerous to bystanders.

NO → REPLACE FAN

YES ↓

A2

KNOWN INFO

FAN OK

POSSIBLE PROBLEMS

BELTS
FAN WIRING
FAN TIMER
FAN SOLENOID
FAN TEMPERATURE SWITCH
PCB

ARE THE FAN DRIVEBELTS TIGHT?

TEST OPTIONS

USE BELT TENSION GAUGE.

REASON FOR QUESTION

Loose belts will not drive the fan properly.

NO → TIGHTEN BELTS

YES ↓

A3

KNOWN INFO

FAN OK
BELTS OK

POSSIBLE PROBLEMS

FAN DRIVE
FAN WIRING
FAN TIMING
FAN SOLENOID
FAN TEMPERATURE SWITCH
PCB

WITH THE VEHICLE OFF, TRY TO TURN THE FAN BY HAND. ARE YOU UNABLE TO TURN IT?

TEST OPTIONS

TRY IT.

REASON FOR QUESTION

You should not be able to turn the fan by hand. If you can, the fan drive is bad.

NO → REPLACE FAN DRIVE

YES ↓

GO TO A4, Page 2-166

REFERENCE INFORMATION **ENGINE COOLING**

Replace fan, refer to (para 3-78).

Tighten belts, refer to (para 3-82)
(All except "A2" vehicles).

Replace fan drive, refer to (para 3-78).

A YES answer to this question means that you were not able to turn the fan by hand.

ENGINE COOLING

DIAGNOSTIC FLOWCHART

FROM A3, Page 2-164

A4

KNOWN INFO

FAN BLADES OK
BELTS OK
FAN DRIVE OK

POSSIBLE PROBLEMS

FAN WIRING
TIME DELAY MODULE
CONTROL VALVE
FAN TEMPERATURE SWITCH
PCB

DISCONNECT WIRE 458B FROM THE FAN TEMPERATURE SWITCH. WITH THE ENGINE RUNNING, IS THE FAN ENGAGED?

TEST OPTIONS

LOOK.

REASON FOR QUESTION

Disconnecting 458B from the switch simulates a hot engine.

NO → GO TO B, Page 2-170

YES ↓

A5

KNOWN INFO

FAN BLADES OK
BELTS OK
DRIVE ENGAGES.

POSSIBLE PROBLEMS

FAN WIRING
TIME DELAY MODULE
CONTROL VALVE
PCB

DISCONNECT WIRE 458A FROM THE FAN TEMPERATURE SWITCH. JUMPER 458A TO 458B. DOES THE FAN DISENGAGE?

TEST OPTIONS

TRY IT. JUMP THE WIRES USING A SHORT PIECE OF WIRE WITH TWO MALE CONNECTORS.

REASON FOR QUESTION

Having battery voltage on 458A simulates a cold engine.

NO → GO TO C, Page 2-174

YES ↓

A6

KNOWN INFO

FAN OK
BELTS OK
FAN ENGAGES AND DISENGAGES

POSSIBLE PROBLEMS

FAN WIRING
TIME DELAY MODULE
FAN TEMPERATURE SWITCH

MEASURE THE CONTINUITY THROUGH THE FAN TEMPERATURE SWITCH. THE SWITCH SHOULD BE OPEN AT TEMPERATURES ABOVE 215°F (102° C) AND CLOSED BELOW. IS THE SWITCH OK?

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION

To check the switch operation. Ideally, check the switch for open and closed operation.

NO → REPLACE FAN TEMPERATURE SWITCH

YES ↓

GO TO A7, Page 2-168

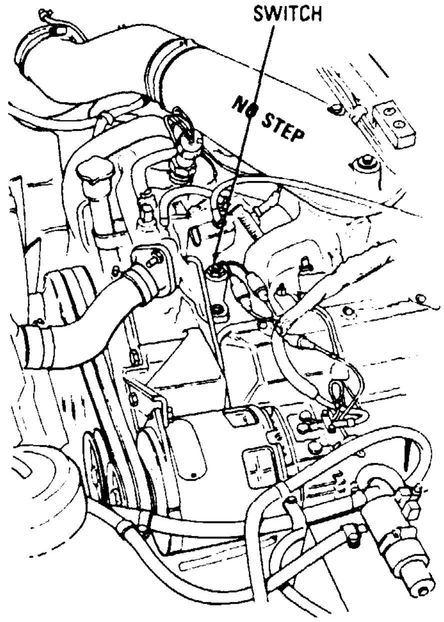
REFERENCE INFORMATION

ENGINE COOLING

WARNING

Keep hands and arms away from fan blades and drive belts when engine is running or serious injury may result.

See page 2-159 for a description of the operation of the fan system and an easy way to tell if it's engaged or not.



See page 2-159 for a description of the operation of the fan system and an easy way to tell if it's engaged or not.

If you know the engine is cold and the fan temperature switch is good, you can reconnect 458B to the switch and see if the fan disengages.

0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the terminations indicated in the question. RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

Replace the switch, refer to (para 4-30).

You can also remove the switch to test it hot and cold.

CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms. 2. Connect the RED and BLACK leads to the connections stated in the question. 3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

ENGINE COOLING **DIAGNOSTIC FLOWCHART**

FROM A6, Page 2-166

KNOWN INFO

FAN BLADES OK
BELTS OK
FAN TEMPERATURE SWITCH OK
FAN DRIVE OK

POSSIBLE PROBLEMS

KICK DOWN WIRING (3L80)
TIME DELAY MODULE
FAN CUT-OFF WIRING (4L80-E)

A7

IS THERE CONTINUITY FROM WIRE 315D AT THE TIME DELAY MODULE TO WIRE 315B AT THE TRANSMISSION KICKDOWN SWITCH (3L80), FAN CUT-OFF SWITCH (4L80-E)? (DISCONNECT THE WIRES TO MAKE THE MEASUREMENT)

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER.

REASON FOR QUESTION

The transmission kickdown switch (3L80) and fan cut-off switch (4L80-E) will disengage the fan for 20 seconds.

NO → REPAIR/REPLACE WIRES 315D AND 315B

YES ↓

KNOWN INFO

FAN OK
BELTS OK
FAN TEMPERATURE SWITCH OK
PCB OK
KICKDOWN WIRING (3L80) OK
FAN CUT-OFF WIRING (4L80-E)

POSSIBLE PROBLEMS

TIME DELAY MODULE

A8

HOLD THE INJECTOR PUMP WIDE OPEN WITH THE ROTARY SWITCH IN "RUN". IS THERE BATTERY VOLTAGE ON THE TIMER END OF WIRE 315D?

TEST OPTIONS

1. STE/ICE-R TEST 89 (Page 2-750)
2. MULTIMETER.

REASON FOR QUESTION

This will simulate the kickdown system's (3L80) and fan cut-off system's (4L80-E) ability to disengage the fan.

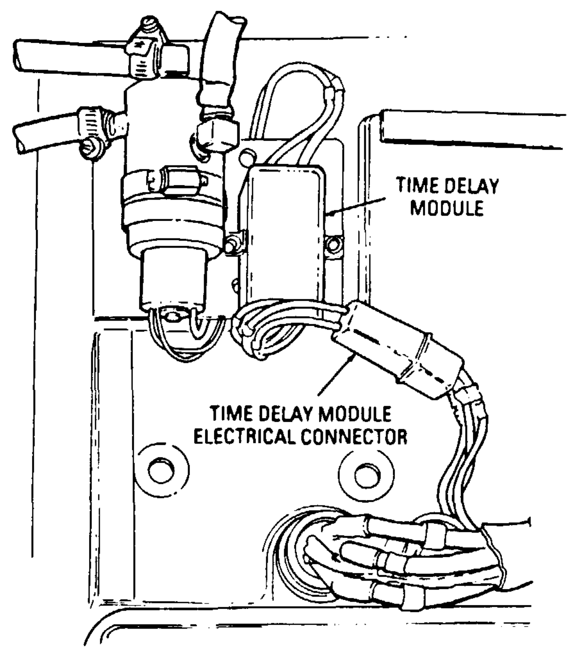
NO → GO TO E, Page 2-184

YES ↓

NO FAULTS

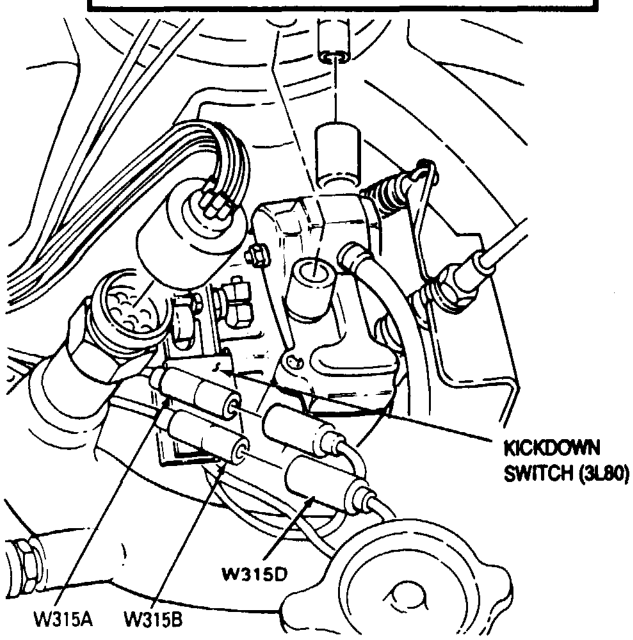
CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms. 2. Connect the RED and BLACK leads to the connections stated in the question. 3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

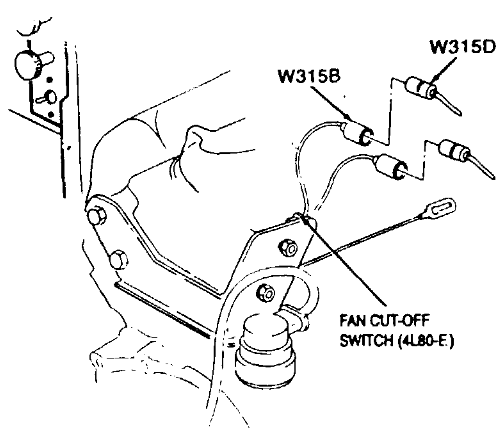
0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the terminations indicated in the question. RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."



Disconnect the four-way connector at the time delay module and measure the voltage on wire 315D.

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.





ENGINE COOLING — DIAGNOSTIC FLOWCHART

B
FROM A4, Page 2-166

B1

KNOWN INFO

FAN DRIVE OK
FAN DOESN'T ENGAGE VIA WIRE 458

POSSIBLE PROBLEMS

FAN WIRING
TIME DELAY MODULE
FAN CONTROL VALVE
PCB/DISTRIBUTION BOX

DISCONNECT THE CONTROL VALVE ELECTRICAL CONNECTOR AT THE TIME DELAY MODULE. DOES THE FAN ENGAGE?

TEST OPTIONS

TRY IT.

REASON FOR QUESTION

With no power to the solenoid, the fan should engage.

NO → **REPLACE CONTROL VALVE**

YES ↓

B2

KNOWN INFO

FAN ENGAGES
CONTROL VALVE OK

POSSIBLE PROBLEMS

WIRING

DISCONNECT THE 4-WIRE CONNECTOR AT THE TIME DELAY MODULE. IS THERE CONTINUITY FROM 458B AT THE 4-WIRE HARNESS TO 458B AT THE FAN TEMPERATURE SWITCH?

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION

Wire 458B connects the switch and the timer.

NO → **REPAIR/REPLACE WIRE 458B**

YES ↓

B3

KNOWN INFO

FAN ENGAGES
CONTROL VALVE OK

POSSIBLE PROBLEMS

WIRING

WITH THE ROTARY SWITCH ON "RUN," IS THERE BATTERY VOLTAGE AT THE HARNESS SIDE OF WIRE 583B IN THE 4-WAY CONNECTOR OF THE TIME DELAY MODULE?

TEST OPTIONS

1. STE/ICE-R TEST 89 (Page 2-750)
2. MULTIMETER

REASON FOR QUESTION

Wire 583B connects battery voltage to the delay module.

NO → **REPAIR/REPLACE WIRE 583B**

YES ↓

GO TO B4, Page 2-172

0-4500 OHMS
STE/ICE-R TEST 91

1. Connect RED clip and BLACK clip to the terminations indicated in the question. RED to the first, BLACK to the second.

2. Start Test 91, 0-4500 ohms.

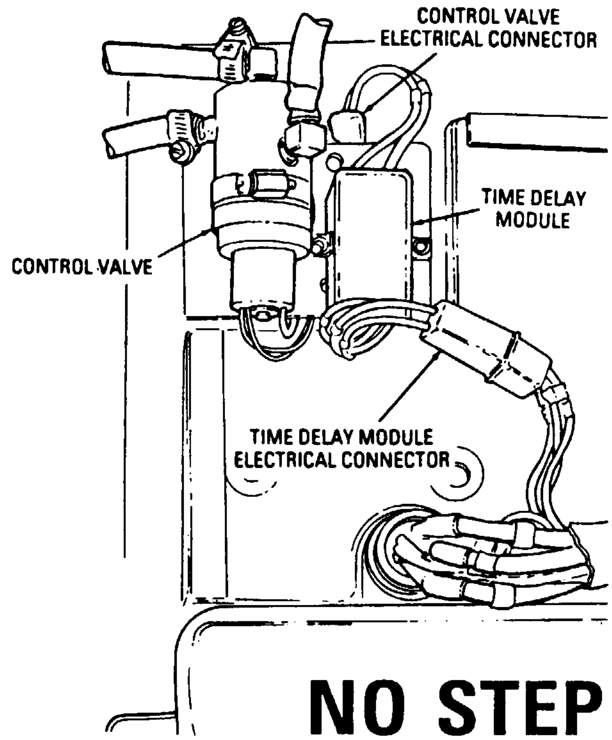
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

CONTINUITY (RESISTANCE)
MULTIMETER

1. Set the voltmeter to an ohms scale of about 1000 ohms.

2. Connect the RED and BLACK leads to the connections stated in the question.

3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).



0-45 DC VOLTS
STE/ICE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.

2. Start Test 89, DC volts.

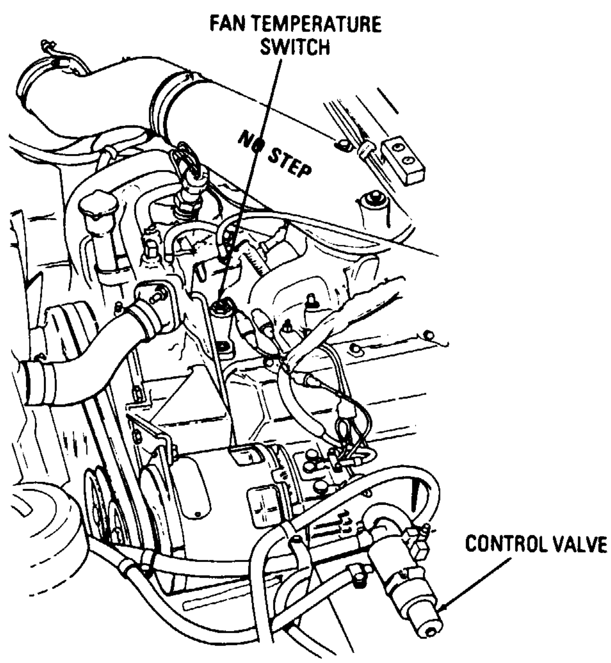
3. Displayed reading is in volts.

VOLTAGE
MULTIMETER

1. Set the voltmeter to a DC volts scale of at least 40 volts.

2. Connect the RED lead to positive and the BLACK lead to negative.

3. Be sure to read the correct scale.



ENGINE COOLING | **DIAGNOSTIC FLOWCHART**

FROM B3, Page 2-170

B4

KNOWN INFO
FAN ENGAGES CONTROL VALVE OK

POSSIBLE PROBLEMS
WIRING

IS THERE CONTINUITY FROM WIRE 93B IN THE 4-WAY CONNECTOR TO ENGINE GROUND?

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER.

REASON FOR QUESTION

Wire 93 provides the time delay module's connection to ground.

NO → REPAIR/REPLACE WIRES 93 AND 93B

YES ↓

B5

KNOWN INFO
FAN ENGAGES CONTROL VALVE OK

POSSIBLE PROBLEMS
WIRING

IS THERE CONTINUITY FROM WIRE 315D AT THE TIME DELAY MODULE HARNESS TO WIRE 315B AT THE KICKDOWN SWITCH (3L80-E) OR FAN CUT-OFF SWITCH (4L80-E)?

TEST OPTIONS

1. STE/ICE-R TEST 91(Page 2-752)
2. MULTIMETER.

REASON FOR QUESTION

The transmission kickdown (3L80) and fan cut-off (4L80-E) has some control of the engine fan.

NO → REPAIR/REPLACE WIRES 315D AND 315B

YES ↓

B6

KNOWN INFO
FAN ENGAGES CONTROL VALVE OK

POSSIBLE PROBLEMS
WIRING

IS THERE ABOUT ZERO VOLTAGE ON THE TIMER END OF WIRE 458B WITH WIRE 458A DISCONNECTED FROM THE FAN TEMPERATURE SWITCH?

TEST OPTIONS

1. STE/ICE-R TEST 89 (Page 2-750)
2. MULTIMETER.

REASON FOR QUESTION

If wire 458B is shorted to some other live wire, the fan will not engage.

NO → REPAIR/REPLACE WIRE 458B OR HARNESS

YES ↓

NO FAULTS

0-4500 OHMS
STE/ICE-R TEST 91

1. Connect RED clip and BLACK clip to the terminations indicated in the question. RED to the first, BLACK to the second.

2. Start Test 91, 0-4500 ohms.

3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

CONTINUITY (RESISTANCE)
MULTIMETER

1. Set the voltmeter to an ohms scale of about 1000 ohms.

2. Connect the RED and BLACK leads to the connections stated in the question.

3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

0-45 DC VOLTS
STE/ICE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.

2. Start Test 89, DC volts.

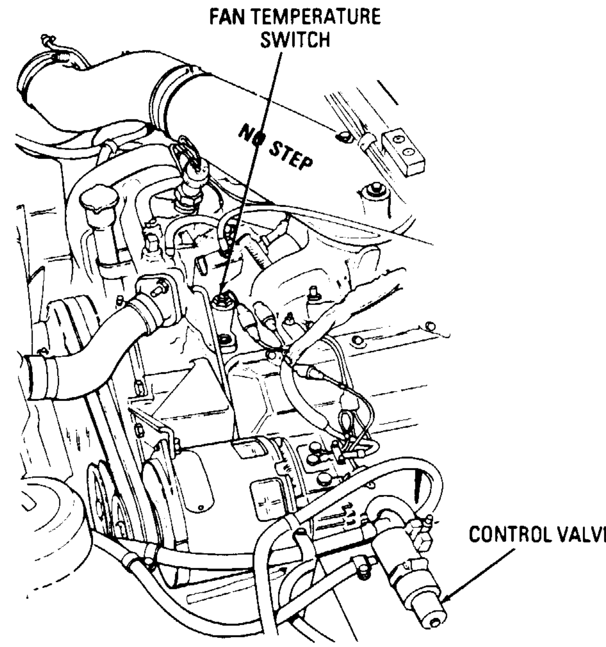
3. Displayed reading is in volts.

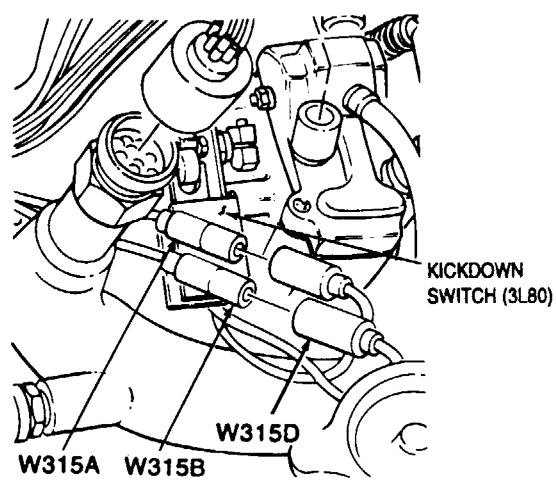
VOLTAGE
MULTIMETER

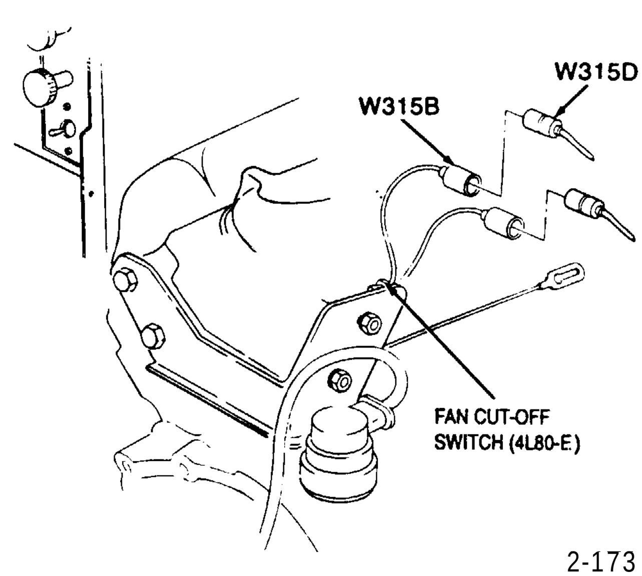
1. Set the voltmeter to a DC volts scale of at least 40 volts.

2. Connect the RED lead to positive and the BLACK lead to negative.

3. Be sure to read the correct scale.







ENGINE COOLING — DIAGNOSTIC FLOWCHART

C, FROM A5, Page 2-166

C1

KNOWN INFO
DRIVE OK FAN ENGAGES BUT WON'T DISENGAGE
POSSIBLE PROBLEMS
PCB/DISTRIBUTION BOX TIME DELAY MODULE WIRING HYDRAULIC SYSTEM

REMOVE THE JUMPER BETWEEN WIRE 458A AND WIRE 458B. TURN THE ROTARY SWITCH TO THE "RUN" POSITION. DOES WIRE 458A HAVE BATTERY VOLTAGE?

TEST OPTIONS

1. STE/ICE-R TEST 89 (Page 2-750)
2. MULTIMETER

REASON FOR QUESTION

Wire 458A connects battery voltage to the switch.

NO → GO TO D, Page 2-182

YES ↓

C2

KNOWN INFO
DRIVE OK FAN ENGAGES BUT WON'T DISENGAGE
POSSIBLE PROBLEMS
PCB/DISTRIBUTION BOX TIME DELAY MODULE WIRING HYDRAULIC SYSTEM

IS THERE CONTINUITY FROM WIRE 458B AT THE HARNESS SIDE OF THE TIME DELAY MODULE 4-WAY CONNECTOR TO WIRE 458B AT THE FAN TEMPERATURE SWITCH?

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION

Wire 458B connects the switch and the time delay module.

NO → REPAIR/REPLACE WIRES 458 & 458B

YES ↓

C3

KNOWN INFO
DRIVE OK FAN ENGAGES BUT WON'T DISENGAGE
POSSIBLE PROBLEMS
PCB/DISTRIBUTION BOX TIME DELAY MODULE WIRING HYDRAULIC SYSTEM

TURN THE ROTARY SWITCH TO RUN. IS THERE BATTERY VOLTAGE AT THE HARNESS SIDE OF WIRE 583B IN THE 4-WAY CONNECTOR OF THE TIME DELAY MODULE?

TEST OPTIONS

1. STE/ICE-R TEST 89 (Page 2-750)
2. MULTIMETER

REASON FOR QUESTION

Wire 583B connects battery voltage to the time delay module.

NO → REPAIR/REPLACE WIRE 583B

YES ↓

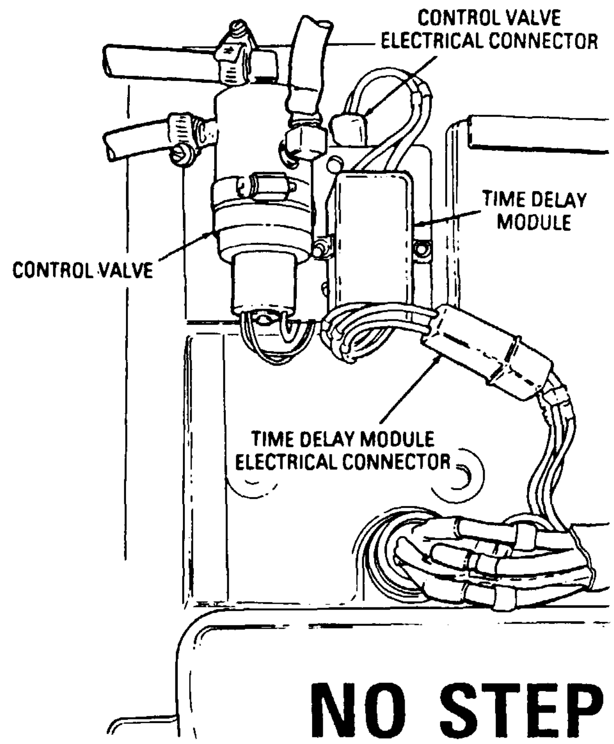
GO TO C3.1, Page 2-176

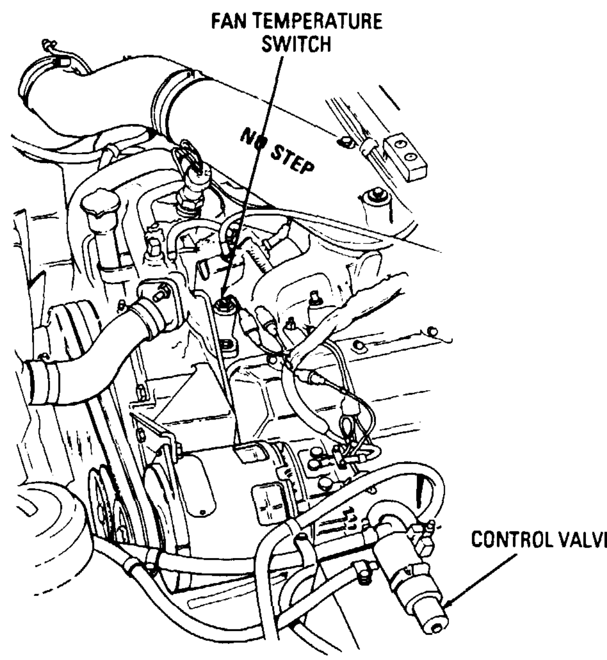
0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.

0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the terminations indicated in the question. RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms. 2. Connect the RED and BLACK leads to the connections stated in the question. 3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).





ENGINE COOLING — DIAGNOSTIC FLOWCHART

FROM C3, Page 2-174

C3.1

KNOWN INFO

ENGINE COOLANT TEMPERATURE BELOW NORMAL (215°F) (102°C)

POSSIBLE PROBLEMS

TIME DELAY MODULE

TURN THE ROTARY SWITCH TO "RUN" POSITION. MEASURE THE VOLTAGE AT WIRE 583 ON THE 2-WAY HARNESS OF THE TIME DELAY MODULE (DO NOT DISCONNECT HARNESS). IS THERE BATTERY VOLTAGE?

TEST OPTIONS

MULTIMETER

REASON FOR QUESTION

WIRE 583 SHOULD INDICATE BATTERY VOLTAGE.

NO → **REPLACE TIME DELAY MODULE**

YES ↓

C3.2

KNOWN INFO

ENGINE COOLANT TEMPERATURE BELOW NORMAL (215°F) (102°C)

POSSIBLE PROBLEMS

TIME DELAY MODULE

MEASURE THE VOLTAGE AT WIRE 93 ON THE 2-WIRE HARNESS OF THE TIME DELAY MODULE (DO NOT DISCONNECT HARNESS). IS THERE BATTERY VOLTAGE?

TEST OPTIONS

MULTIMETER

REASON FOR QUESTION

WIRE 93 SHOULD INDICATE 0 VOLTAGE.

NO → **REPLACE TIME DELAY MODULE**

YES ↓

C4

KNOWN INFO

FAN DRIVE OK
FAN WON'T DISENGAGE

POSSIBLE PROBLEMS

TIME DELAY MODULE
WIRING
CONTROL VALVE
HYDRAULIC SYSTEM

DISCONNECT THE 2-WIRE COUPLING AT THE TIMER. MEASURE THE RESISTANCE THROUGH THE CONTROL VALVE ELECTRICAL CONNECTOR.
IS IT ABOUT 65 OHMS?

TEST OPTIONS

MULTIMETER – WITH AN ANALOG MULTIMETER, YOU MAY GET 65 TO 100 OHMS ONE WAY AND UNDER 30 OHMS THE OTHER WAY. THIS IS OK.

REASON FOR QUESTION

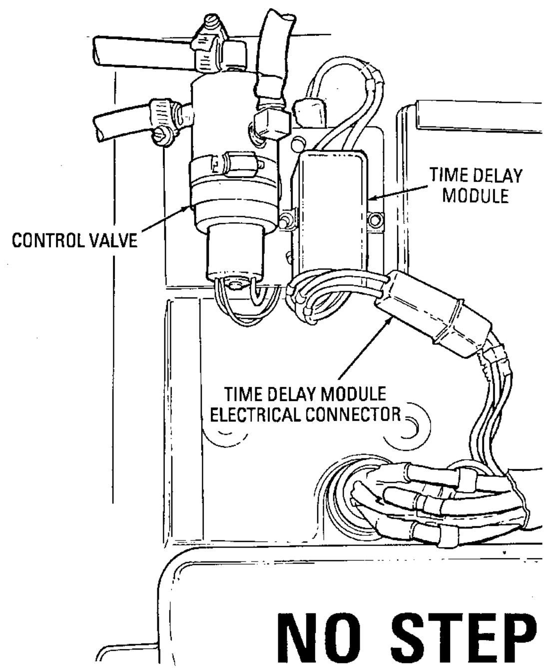
The need to check out the windings in the control valve to see if they're OK.

NO → **REPLACE CONTROL VALVE**

YES ↓

GO TO C5, Page 2-178

Replace time delay module, refer to (para. 4-31).



Replace time delay module, refer to (para. 4-31).

When checking coil resistance, use an analog type multimeter.

For an accurate ohms reading, perform this check when the system is at room temperature. Heat will increase resistance, resulting in a higher ohms reading.

Replace the control valve, refer to (para. 8-26).

CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms. 2. Connect the RED and BLACK leads to the connections stated in the question. 3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

ENGINE COOLING

DIAGNOSTIC FLOWCHART

FROM C4, Page 2-176

KNOWN INFO

FAN DRIVE OK
FAN WON'T DISENGAGE
CONTROL VALVE OK

POSSIBLE PROBLEMS

TIME DELAY MODULE
WIRING
HYDRAULIC SYSTEM

C5

DISCONNECT THE 4-WIRE CONNECTOR ON THE TIMER. IS THERE CONTINUITY FROM WIRE 93B ON THE HARNESS SIDE OF THE 4-WAY CONNECTOR TO ENGINE GROUND?

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION

The need to test out the ground connection of the time delay module and control valve.

NO → REPLACE WIRING (93B)

YES ↓

KNOWN INFO

FAN DRIVE OK
FAN WON'T DISENGAGE
CONTROL VALVE OK

POSSIBLE PROBLEMS

TIME DELAY MODULE
WIRING
HYDRAULIC SYSTEM

C6

RECONNECT THE 4-WIRE CONNECTOR. IS THERE ABOUT 580Ω FROM WIRE 93B ON THE TIMER SIDE OF THE 2-WIRE COUPLING TO ENGINE GROUND?

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION

This measurement will help to tell you if the time delay module is OK.

NO → REPLACE TIME DELAY MODULE

YES ↓

KNOWN INFO

FAN DRIVE OK
FAN WON'T DISENGAGE
CONTROL VALVE OK

POSSIBLE PROBLEMS

TIME DELAY MODULE
WIRING
HYDRAULIC SYSTEM

C7

IS THERE CONTINUITY FROM WIRE 458B IN THE 4-WIRE CONNECTOR HARNESS TO WIRE 458B AT THE FAN TEMPERATURE SWITCH?

TEST OPTIONS

1. STE/ICE-R TEST 91 (page 2-752)
2. MULTIMETER

REASON FOR QUESTION

This measurement will help tell you if the time delay module is OK.

NO → REPLACE TIME DELAY MODULE

YES ↓

GO TO C8, Page 2-180

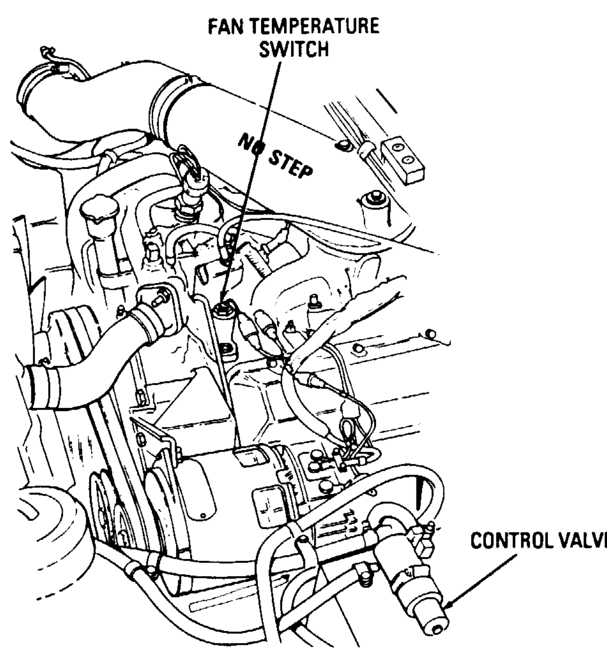
Repair wire refe to (para. 4-85) or notify DS maintenance.

0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the terminations indicated in the question. RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays “9.9.9.9.”

Replce the time delay rnodule, refer to (para 4-31).

CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms. 2. Connect the RED and BLACK leads to the connections stated in the question. 3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit the meter should peg full scale (needle all the way to the left).

Replace the time delay module, refer to (para 4-31).



ENGINE COOLING **DIAGNOSTIC FLOWCHART**

FROM C7, Page 2-178

KNOWN INFO

FAN WON'T DISENGAGE
WIRING OK

POSSIBLE PROBLEMS

LOW POWER
STEERING
PRESSURE
LEAKS
CONTROL VALVE

C8

LOOK FOR LEAKY HOSES GOING TO AND FROM THE CONTROL VALVE AND FAN DRIVE. ARE ALL OF THE HOSES LEAK-FREE?

TEST OPTIONS

VISUAL INSPECTION.

REASON FOR QUESTION

Leaky hydraulic hoses may prevent the drive from disengaging.

NO → **REPAIR AS REQUIRED**

YES ↓

KNOWN INFO

FAN WON'T DISENGAGE
WIRING OK
HOSES ARE LEAK-FREE

POSSIBLE PROBLEMS

LOW POWER
STEERING
PRESSURE
CONTROL VALVE

C9

IS THE PRESSURE IN THE CONTROL VALVE SUPPLY HOSE AT LEAST 90 PSI?

TEST OPTIONS

1. STE/ICE-R TEST 50 (Page 2-739)
2. PRESSURE GAUGE.

REASON FOR QUESTION

90 PSI is the minimum required to disengage the drive.

NO → **GO TO STEERING, Page 2-459**

YES ↓

KNOWN INFO

FAN WON'T DISENGAGE
WIRING OK
HOSES ARE LEAK-FREE

POSSIBLE PROBLEMS

LOW POWER
STEERING
PRESSURE
CONTROL VALVE
FAN DRIVE

C10

CONNECT BOTH TIME DELAY MODULE ELECTRICAL CONNECTORS, JUMPER 458A TO 458B. IS THE PRESSURE IN THE FAN DRIVE HOSE AT LEAST 90 PSI?

TEST OPTIONS

1. STE/ICE-R TEST 50 (Page 2-739)
2. PRESSURE GAUGE.

REASON FOR QUESTION

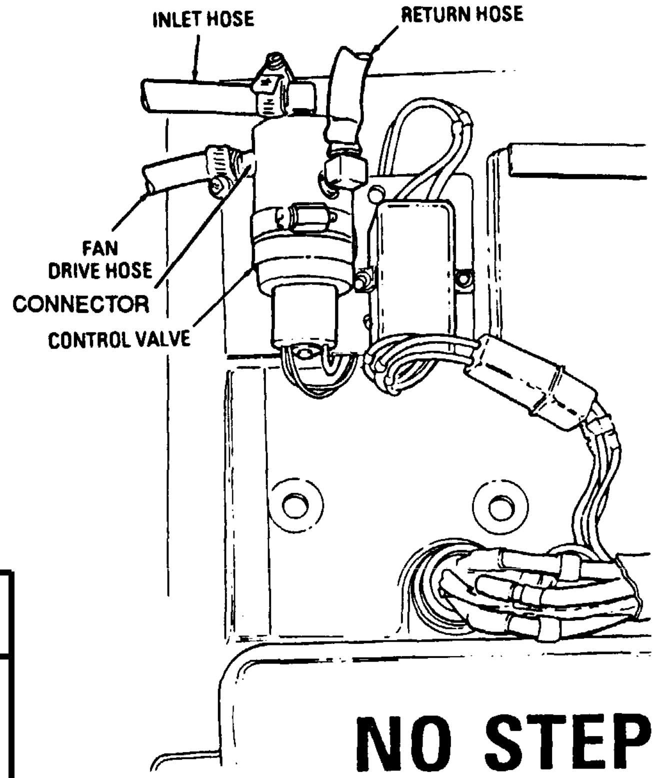
Check to see if control valve is open.

NO → **SEE NOTE ON RIGHT OF PAGE**

YES ↓ **SEE NOTE ON RIGHT OF PAGE**

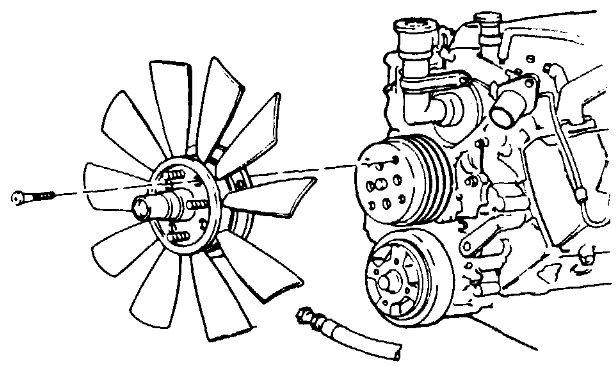
REFERENCE INFORMATION

ENGINE COOLING

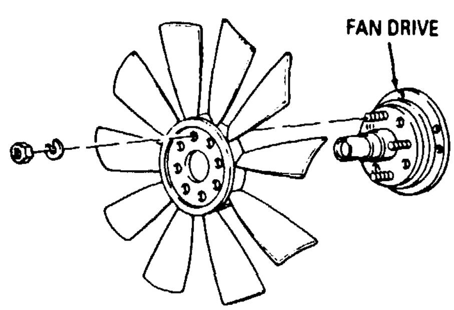


Replace hoses, refer to (para 8-26).

STE/ICE-R TEST #50 0 TO 1000 PSIG PRESSURE
1. Connect transducer to valve after removing connector, refer to (para 8-26). Do offset test. 2. Connect BLUE pressure transducer to A W4 cable. Make sure the system under testis not pressurized. 3. Turn on system and read pressure.



Measure the pressure at the valve outlet. Remove the fan drive hose and connector from the valve body and screw transducer into the valve. Start the engine and look for leaks.

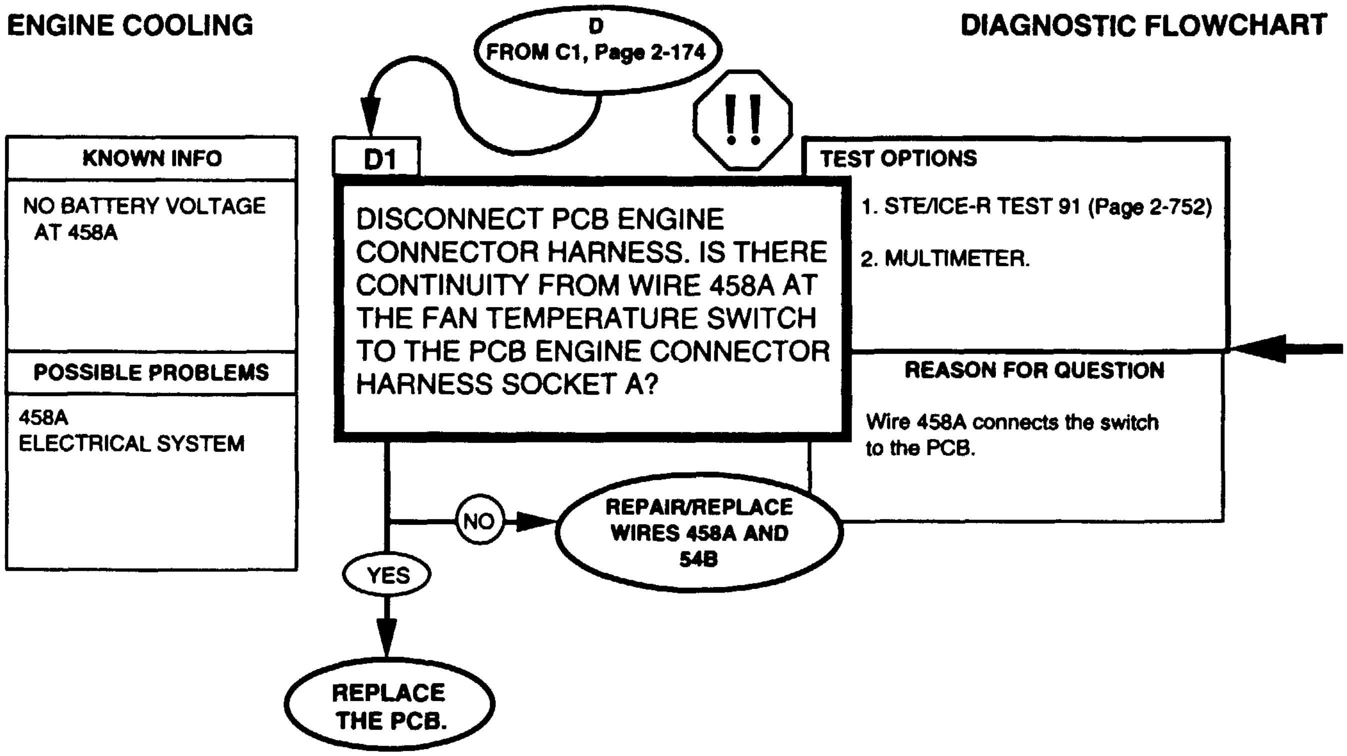


Replace control valve and/or fan drive, refer to (para 8-26 or 3-78). Check to sea if hoses are blocked prior to replacing parts, and perform back flush procedure (para 8-26).

If pressure in the fan drive hose is not at least 90 psi, (620.5 kPa) perform back flush procedure (para 8-26). Recheck pressure. If pressure is not at least 90 psi, replace control valve.

If pressure in the fan drive hose is at least 90 psi, (620.5 kPa) check for blockage in hose between the control valve and fan drive. If hose is not blocked, replace fan drive (para. 3-78).

ENGINE COOLING DIAGNOSTIC FLOWCHART



REFERENCE INFORMATION

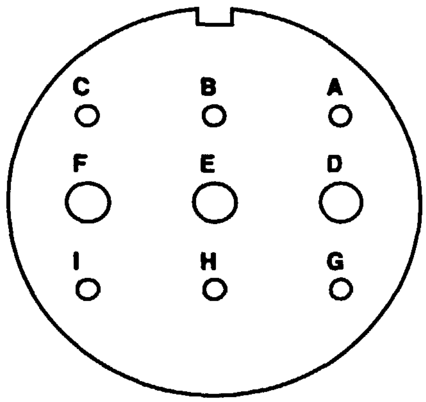
ENGINE COOLING

WARNING

DISCONNECT NEGATIVE BATTERY CABLE BEFORE DISCONNECTING AND RECONNECTING PROTECTIVE CONTROL BOX HARNESS.

There is battery voltage at the PCB at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

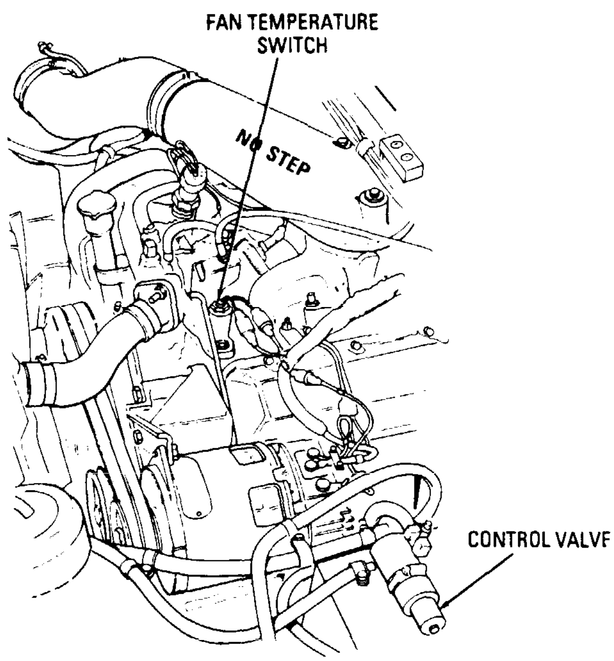
Replace PCB, refer to (para 4-5).



PCB ENGINE CONNECTOR

0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED dip and BLACK clip to the terminations indicated in the question. RED to the first, BLACK to the second. 2. Start Teat 91,0-4500 ohms. 3. Displayed reading is in ohms. Leas than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays “9.9.9.9.”

CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms. 2. Connect the RED and BLACK leads to the connections stated in the question. 3. Be sure to read the correct scale. Leas than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).



E
FROM A8,
Page 2-168

KNOWN INFO

FAN DOESN'T DISENGAGE WHEN KICKDOWN (3L80), OR FAN CUT-OFF(4L80-E) ACTIVATES

POSSIBLE PROBLEMS

KICKDOWN SWITCH (3L80)
TIME DELAY MODULE
WIRING FAN CUT-OFF SWITCH (4L80-E)

E1

WITH THE VEHICLE OFF AND THE ROTARY SWITCH IN "RUN," HOLD THE INJECTOR PUMP WIDE OPEN. IS THERE BATTERY VOLTAGE IN THE WIRE 315B END OF THE KICKDOWN SWITCH (3L80) OR FAN CUT-OFF SWITCH (4L80E)?

TEST OPTIONS

STE/ICE-R TEST 89 (Page 2-750)
MULTIMETER

REASON FOR QUESTION

This will tell you if the time delay module is getting an input from the kickdown system (3L80) or fan cut-off system (4L80-E).

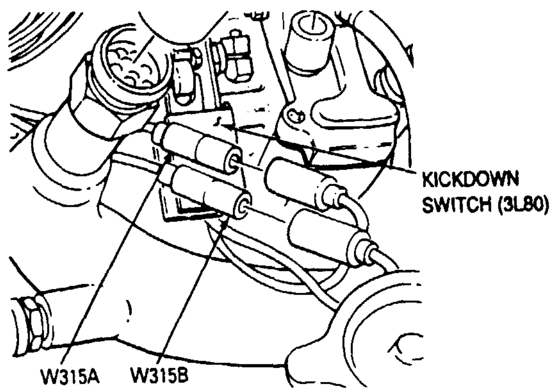
NO: GO TO TRANSMISSION, Page 2-399 (3L80) or Page 2-411 (4L80-E)

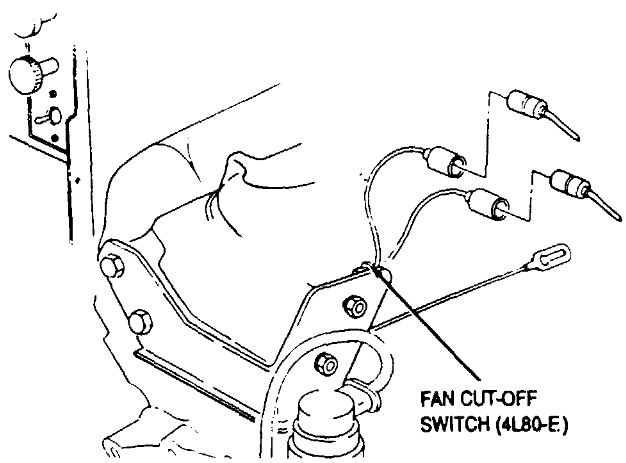
YES: REPLACE TIME DELAY MODULE

Replace time delay module, refer to (para 4-31).

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.





2-26. ENGINE LUBRICATION TESTS

These Engine Lubrication tests may be run any time there is an engine lubrication problem or if you were sent here by another test chain. Just follow the path, answering the questions. Additional information and notes are given on the facing page when necessary.

Fold-out page FO-5 shows the location of the major components of the Engine Lubrication system in case you are not familiar with them. This page may be left open for reference while testing.

ENGINE LUBRICATION DIAGNOSTIC FLOWCHART

START

1

KNOWN INFO
NONE

POSSIBLE PROBLEMS
OIL
OIL FILTER
LEAKS
ENGINE PROBLEMS
OIL PRESSURE SENSING SYSTEM

IS THE CRANKCASE FILLED TO THE CORRECT LEVEL WITH OIL THAT IS CLEAN AND OF THE RIGHT TYPE, AND IS THE OIL FILTER CLEAN?

TEST OPTIONS
CHECK DIPSTICK.
SEE TABLE 2-1, (PAGE 2-22) FOR OIL AND FILTER CHANGE REQUIREMENTS.

REASON FOR QUESTION
To make sure the engine has the right oil, and it's clean.

NO → CHANGE OR ADD AS REQUIRED

YES ↓

2

KNOWN INFO
OIL OK
FILTER OK

POSSIBLE PROBLEMS
LEAKS
ENGINE PROBLEMS
OIL PRESSURE SENSING SYSTEM

IS THE VEHICLE FREE FROM LARGE OIL LEAKS?

TEST OPTIONS
CHECK THE LIST OF ITEMS TO THE RIGHT.

REASON FOR QUESTION
Any large oil leaks could affect oil pressure. Small leaks should be taken care of after you make sure everything else is OK.

NO → REPAIR AS REQUIRED

YES ↓

3

KNOWN INFO
OIL LEVEL AND TYPE OK
FILTER OK
NO OIL LEAKS.

POSSIBLE PROBLEMS
OIL PRESSURE GAUGE
OIL PRESSURE SENSOR
ENGINE PROBLEMS

IS THE OIL PRESSURE AT THE CORRECT VALUE? (SEE CHART AT RIGHT.)

TEST OPTIONS
1. STE/ICE-R TEST 50 (Page 2-739) INTERLEAVED WITH RPM.
2. LOOK AT THE GAUGE AND USE STE/ICE-R TEST 10 (Page 2-734)

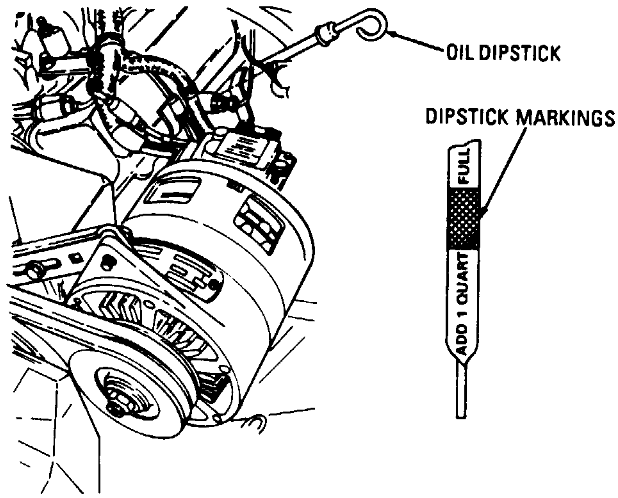
REASON FOR QUESTION
Low oil pressure will cause excessive wear on the engine. High pressure could indicate clogs in the system. If you use the gauge, you can let the engine run a few minutes to make sure the gauge is OK.

NO → GO TO A, Page 2-192

YES ↓

GO TO 4, Page 2-190

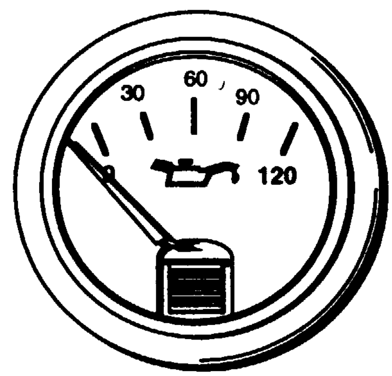
REFERENCE INFORMATION **ENGINE LUBRICATION**



Incorrect oil level and type can cause pressure problems, leaks, excessive blowby, and other problems.

Inspect the oil cooler, oil cooler supply return lines, CDR valve hoses, oil pan, and oil filter. Test CDR valve, (para 3-9). See the location on parts page to find the these parts.

ENGINE RPM STE/ICE-R TEST 10
1. Start Test 10, Engine RPM. 2. Crank or start the angina. Displayed reading is RPM. Cranking RPM should be approximately 200. Idle RPM should be 625-675.



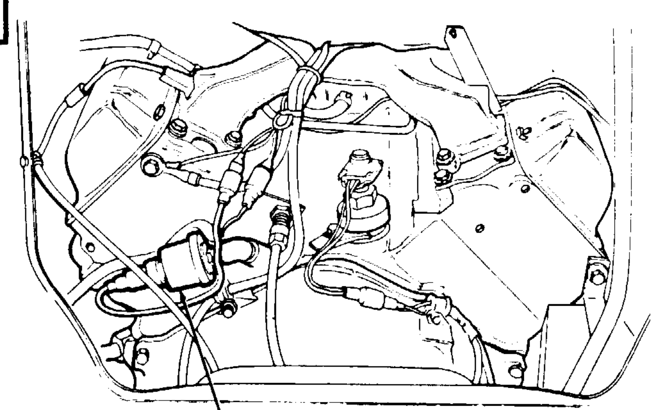
OIL PRESSURE GAUGE

OIL PRESSURE CHART

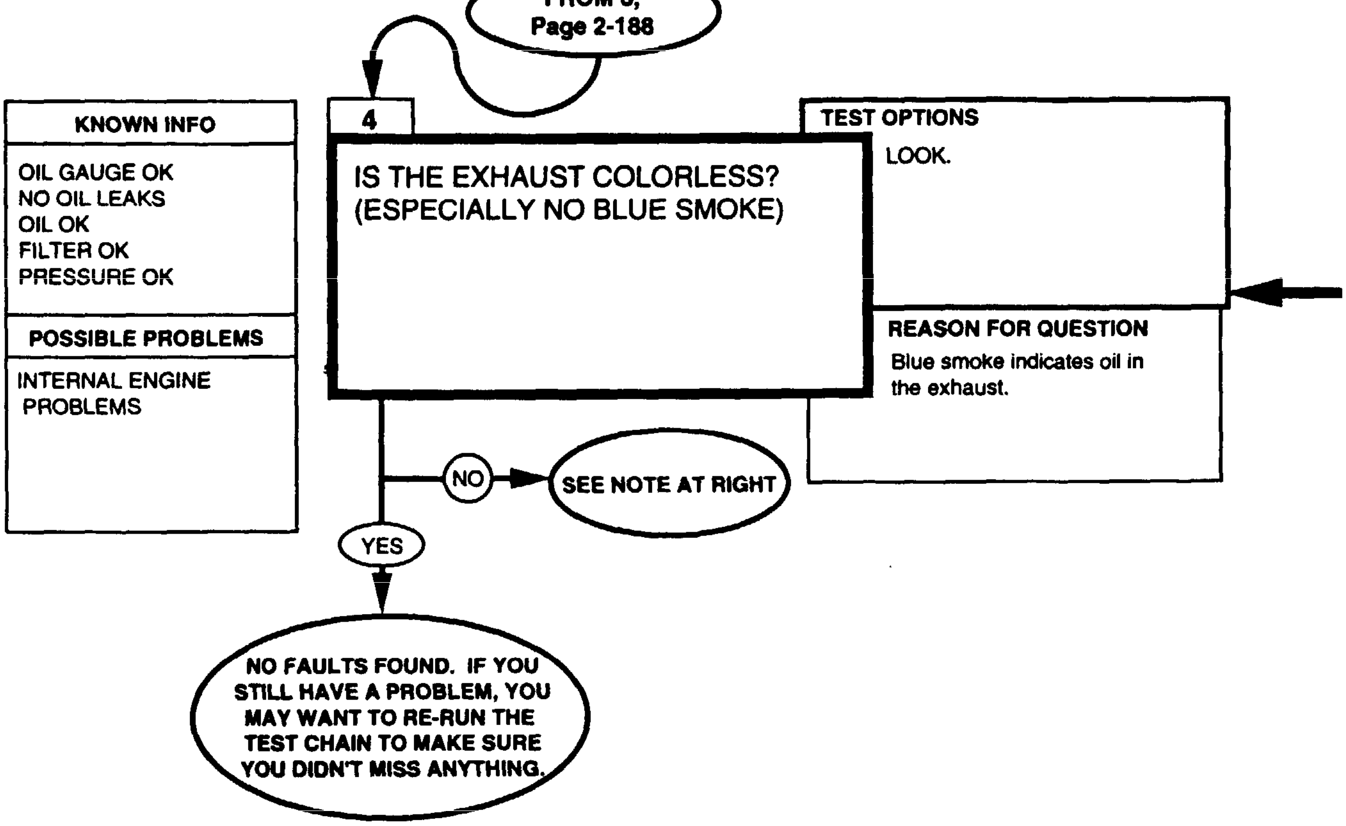
ENGINE RPM	APPROXIMATE OIL PRESSURE
STOP	0 PSI
6.2L IDLE (650 ± 25)	15-20 PSI
6.5L IDLE (725 ± 25)	10-15 PSI
2000	40-50 PSI

Remove sending unit, refer to (para 4-25).

ENGINE RPM INTERLEAVE WITH 0-1000 PSI PRESSURE
1. Connect BLUE Transducer in place of oil pressure sending unit. Dial test 50 (0-1000 psi). Perform offset test. 2. Dial teat 01, interleave with RPM. Dial test 50. 3. Start engine and observe display. VTM will display RPM's, than PSI.



ENGINE LUBRICATION **DIAGNOSTIC FLOWCHART**



NOTE

If the exhaust is not colorless it must be either white, blue or black.
If exhaust color is:

WHITE . . . . .Go to fuel system, Paragraph 2-22. Could be injector timing, DS level fault.

BLUE . . . . .Blue smoke is a sign of oil entering the combustion chambers. It usually enters past the piston rings or intake valve stem seals. This is an internal engine problem that can't be handled at this level of maintenance. You may want to run the Engine Mechanical Tests, Paragraph 2-18 before you notify DS Maintenence.

BLACK. . . . . Intake/exhaust. Para. 2-23

ENGINE LUBRICATION — DIAGNOSTIC FLOWCHART

A
FROM 3, Page 2-188

KNOWN INFO
WRONG OIL PRESSURE

POSSIBLE PROBLEMS
OIL PRESSURE GAUGE
OIL PRESSURE SENSOR
INTERNAL ENGINE PROBLEMS

A1

DID YOU USE THE VEHICLE'S ON-BOARD GAUGE TO MEASURE THE PRESSURE IN QUESTION 3?

TEST OPTIONS
N/A

REASON FOR QUESTION
If you used the STE/ICE-R to measure the pressure, then the engine has an internal fault.

NO → NOTIFY DS MAINTENANCE

YES ↓

KNOWN INFO
WRONG PRESSURE USING VEHICLE GAUGE

POSSIBLE PROBLEMS
GAUGE AND SENDER
ENGINE PROBLEMS

A2

MEASURE THE OIL PRESSURE DIRECTLY. IS IT CORRECT?

TEST OPTIONS
STE/ICE-R TEST 50 AND RPM INTERLEAVED. (Page 2-739)

EXTERNAL GAUGE AND STE/ICE-R TEST 10. (Page 2-734)

REASON FOR QUESTION
Direct verification of the engine's oil pressure will tell you if the problem is in the gage or the engine.

NO → NOTIFY DS MAINTENANCE

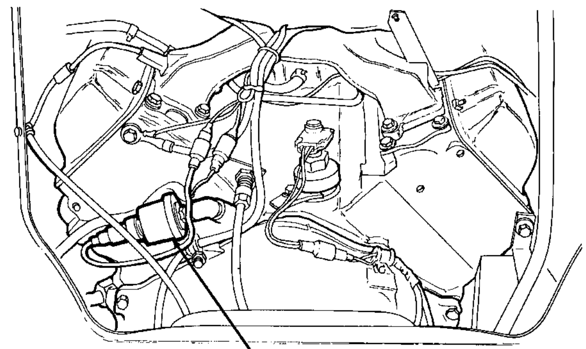
YES ↓

KNOWN INFO
OIL PRESSURE OK

POSSIBLE PROBLEMS
GAUGE
SENDER
WIRING

A3

THE PROBLEM IS IN THE OIL PRESSURE SENDING SYSTEM. GO TO INSTRUMENTS, Page 2-319.



OIL PRESSURE CHART

ENGINE RPM	APPROXIMATE OIL PRESSURE
STOP	0 PSI
6.2L IDLE (650 ± 25)	10-15 PSI
6.5L IDLE (725 ± 25)	10-15 PSI
2000	40-50 PSI

Remove sending unit, refer to (para 4-25).

ENGINE RPM
INTERLEAVE WITH 0-1000 PSI PRESSURE

1. Connect BLUE Transducer in place of oil pressure sending unit. Dial test 50 (0-1000 Psi). Perform offset test.

2. Dial test 01, interleave with RPM. Dial test 50.

3. Start engine and observe display. VTMwill display RPM's, then PSI.

2-27. ALTERNATOR TESTS

These Alternator tests can be run any time you think there may be a problem with the alternator or battery charging or if you were sent here from another system chain.

These tests are NOT for the batteries. These tests are strictly for the alternator, its operation, and its associated wiring. Tests for the batteries are in Battery Circuit, Paragraph 2-29.

A simplified block diagram for the alternator system is given on page 2-195. A detailed functional flow schematic is provided as foldout FO-6 to help you understand the system as you perform the tests.

NOTE

Dual voltage 100, 200, and 400 amp alternators can be installed in a single voltage system. See Table 2-2 for hookup procedures.

After preliminary common tests, the model of alternator must be identified for specific testing to determine if alternator or regulator is defective.

Table 2-2. Adaption of dual voltage alternator on a single voltage system

Dual Voltage Alternator	Single Voltage System
100 Amp	Ground wire afixed to regulator base and 14 volt power stud
200 Amp	Ground wire afixed to regulator base and 14 volt power stud
400 Amp	No ground wire afixed to regulator or 14 volt power stud

60 AMP/100 AMP ALTERNATOR FLOW SCHEMATIC

ENGINE MECHANICAL POWER (DRIVE BELTS/ SERPENTINE BELT)

↓

ALTERNATOR

↓

PROTECTIVE CONTROL BOX/ DISTRIBUTION BOX

↓

BATTERIES

200 AMP/400 AMP ALTERNATOR FLOW SCHEMATIC

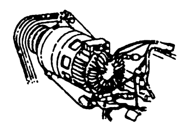
ENGINE MECHANICAL POWER (DRIVE BELTS/ SERPENTINE BELT)

↓

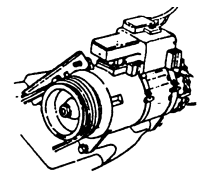
ALTERNATOR

↓

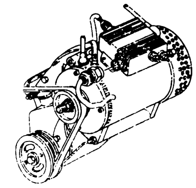
BATTERIES



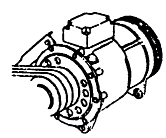
60 AMP PRESTOLITE ALTERNATOR/REGULATOR



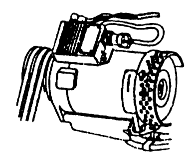
100 AMP PRESTOLITE ALTERNATOR/REGULATOR



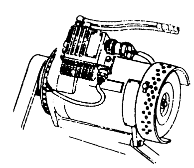
100 AMP DUAL VOLTAGE NIEHOFF ALTERNATOR/REGULATOR



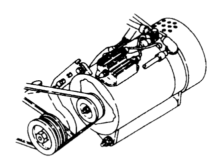
200 AMP PRESTOLITE ALTERNATOR/REGULATOR



200 AMP NIEHOFF ALTERNATOR/REGULATOR (A1)



200 AMP DUAL VOLTAGE NIEHOFF ALTERNATOR/REGULATOR



400 AMP DUAL VOLTAGE NIEHOFF ALTERNATOR/REGULATOR

ALTERNATOR DIAGNOSTIC FLOWCHART

START

1

KNOWN INFO

NOTHING

POSSIBLE PROBLEMS

ALTERNATOR
PROTECTIVE CONTROL BOX/DISTRIBUTION BOX
WIRING
BELTS

ARE ALTERNATOR DRIVEBELTS/ SERPENTINE BELT TIGHT AND IN GOOD CONDITION (NO CRACKS, FRAYS, OR GLAZE)?

TEST OPTIONS

VISUAL INSPECTION, USE BELT TENSION GAUGE/ CHECK TENSIONER POSITION

REASON FOR QUESTION

If belts are loose, worn, or if belt tensioner has fully retracted, the belts will not drive the alternator fast enough to recharge the batteries.

NO → **TIGHTEN OR REPLACE. IF YOU STILL HAVE A PROBLEM, CONTINUE TESTING**

YES ↓

2

KNOWN INFO

BELTS OK

POSSIBLE PROBLEMS

WIRING
ALTERNATOR
PCB/DISTRIBUTION BOX

ARE ALL WIRE CONNECTIONS TO ALTERNATOR CLEAN, TIGHT, AND MAKING GOOD CONNECTION?

TEST OPTIONS

VISUAL INSPECTION

REASON FOR QUESTION

Loose or dirty connections can prevent a good alternator from charging the batteries.

NO → **CLEAN AND TIGHTEN. IF YOU STILL HAVE A PROBLEM, CONTINUE TESTING**

YES ↓

3

KNOWN INFO

BELTS OK
WIRING CONNECTIONS OK

POSSIBLE PROBLEMS

ALTERNATOR
PCB/DISTRIBUTION BOX
WIRING

WITH ROTARY SWITCH IN “RUN” POSITION (ENGINE NOT RUNNING), DO YOU HAVE BATTERY VOLTAGE AT ALTERNATOR OUTPUT TERMINAL ?

TEST OPTIONS

1. STE/ICE-R TESTS 67 AND 89 (INTERLEAVE) (Pages 2-740, 750)
2. MULTIMETER

REASON FOR QUESTION

The alternator must be connected to batteries to be able to recharge the batteries.

NO → **GO TO A, Page 2-202**

YES ↓

GO TO 4 Page 2-198

REFERENCE INFORMATION ALTERNATOR

NOTE

Cracks, glaze, and frays indicate worn belts, which should be replaced (para. 3-81, all except M1123 and "A2" vehicles) (para. 3-83, M1123 and "A2" vehicles). Use a belt tension gauge to determine if the belts need to be tightened, refer to (para 3-82, all except M1123 and "A2" vehicles).

<u>BAD CONNECTIONS ARE THE MOST COMMON PROBLEM !</u>

Sometimes just disconnecting, cleaning, and reconnecting will solve a problem. BE THOROUGH! The time you save may be your own.

Refer to the functional flow schematic and check the following;

1. BATTERY - make sure all connections are clean and tight, including the shunt and power stud.

2. STARTER - check the high current (heavy gauge wire 6A) wire at the starter. Don't just check for voltage; a loose connection will have voltage but can't carry much current.

3. PCB/DISTRIBUTION BOX

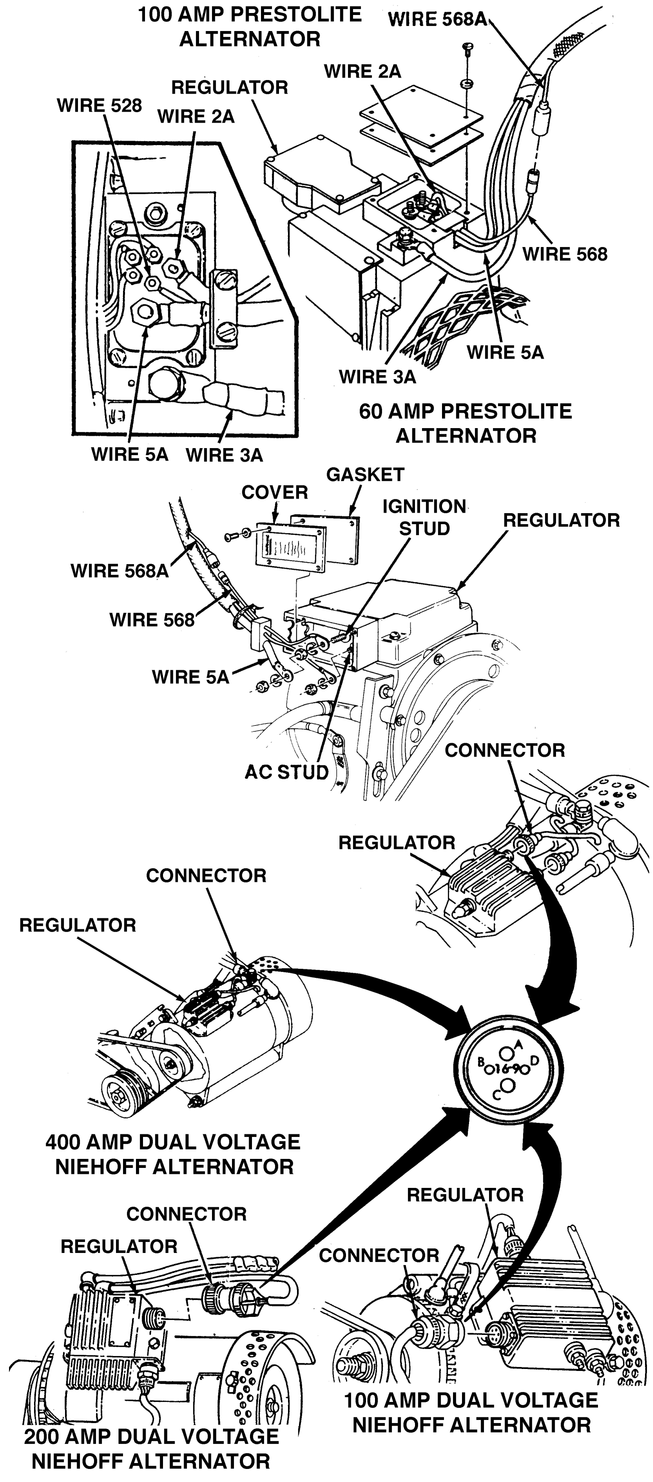
WARNING

Disconnect negative battery cable before disconnecting and reconnecting PCB/distribution box harness.

There is battery voltage at the PCB/distribution box at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

Unscrew BOTH connectors and look for bent or broken pins, pins pushed out of their socket, or dirt and corrosion in the connections.

INTERLEAVE TESTS 67 AND 89 BATTERY VOLTAGE AND DC VOLTAGE
USE CONTROL FUNCTION 06 TO INTERLEAVE TESTS ON THE STE/ICE-R. DIAL 06, PRESS THE TEST BUTTON. WHEN PROMPTED BY THE VTM, DIAL IN TEST 67 AND PRESS THE BUTTON. WHEN PROMPTED AGAIN, DIAL IN TEST 89 AND PRESS THE BUTTON. VTM WILL DISPLAY RESULT FOR TEST 67, THEN 89 THEN 6789, AND THEN REPEAT. SEE TM 9-4910-571-12&P FOR MORE INFORMATION.



ALTERNATOR DIAGNOSTIC FLOWCHART

FROM 3, Page 2-196

KNOWN INFO

BATTERIES OK
BELTS OK
ALTERNATOR CONNECTIONS OK
PCB/DISTRIBUTION BOX OK

POSSIBLE PROBLEMS

ALTERNATOR
ALTERNATOR DRIVE
WIRING

4

START ENGINE. DOES ENGINE IDLE AT CORRECT SPEED
(6.2L 625-675 RPM)?
(6.5L 700-750 RPM)?

TEST OPTIONS

STE/ICE-R TEST 10 (Page 2-734)

REASON FOR QUESTION

If engine idles too low, alternator is not driven fast enough to charge batteries.

NO → ADJUST IDLE RPM SEE NOTE AT RIGHT

YES ↓

KNOWN INFO

BATTERIES OK
BELTS OK
ALTERNATOR CONNECTIONS OK
PCB/DISTRIBUTION BOX OK
ALTERNATOR DRIVE OK

POSSIBLE PROBLEMS

ALTERNATOR
WIRING

5

LOCK THROTTLE AT 1200-1500 RPM.

IS VOLTAGE AT ALTERNATOR OUTPUT TERMINAL 27-29 VOLTS ?

TEST OPTIONS

1. STE/ICE-R TEST 10 (interleave with control function 01 page 2-734) thru 89, page 750
2. MULTIMETER

REASON FOR QUESTION

Alternator voltage must be slightly higher than battery voltage to recharge batteries.

NO → GO TO B, Page 2-204

YES ↓

KNOWN INFO

BATTERIES OK
BELTS OK
ALTERNATOR CONNECTIONS OK
PCB/DISTRIBUTION BOX OK
ALTERNATOR DRIVE OK
ALTERNATOR OUTPUT OK

POSSIBLE PROBLEMS

ALTERNATOR
WIRING

6

IS VOLTAGE AT BATTERY TERMINALS 27-29 VOLTS ?
(SAME AS ALTERNATOR OUTPUT)

TEST OPTIONS

1. STE/ICE-R TEST 67 (Page 2-740)
2. MULTIMETER

REASON FOR QUESTION

If battery voltage is much lower than alternator output, wiring resistance is too high.

NO → REPAIR/REPLACE WIRING SEE NOTE AT RIGHT

YES ↓

GO TO 7, Page 2-200

If the engine doesn't start on its own power, you should check the battery and starter circuits.

NOTES ON IDLE ADJUSTMENT

If idle can be adjusted to within limits, go to step 5.

If idle CANNOT be adjusted to within limits, you may have a problem with the fuel system. You can either continue here or run the fuel system tests and return here.

ENGINE RPM
STE/ICE-R TEST 10

1. Start Test 10, Engine RPM.
2. Crank or start the engine. Displayed reading is RPM. Cranking RPM should be at least 100. Idle RPM should be 625 - 675.

NOTE

A charged battery in good condition is a prerequisite for testing an alternator/regulator system. If battery is suspect, substitute a known good battery in the vehicle.

Output for 60 amp alternator is wire 5A and stud. All other alternators have a large stud on side of housing as output terminal to connect wire 6.

0-45 DC VOLTS
STE/ICE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

NOTES

Check the wiring and the pins at sockets E & F at PCB/distribution box engine connector.

Check the wiring and the pins at sockets D & G at PCB/distribution box body connector.

Check and clean starter solenoid and battery box power stud.

Check and clean battery cables and clamps.

Look for loose, dirty, or broken connections and repair as necessary. If terminal voltage is still low, harness should be replaced. Notify DS maintenance.

BATTERY VOLTAGE
STE/ICE-R TEST 67

1. Start Test 67, battery voltage.
2. Displayed reading is in volts. Batteries should be 23-25.5 volts. Battery voltage will drop when glowplugs turn on.

ALTERNATOR **DIAGNOSTIC FLOWCHART**

FROM 6, Page 2-198

KNOWN INFO

BATTERIES OK
BELTS OK
ALTERNATOR CONNECTIONS OK
PROTECTIVE CONTROL BOX/DISTRIBUTION BOX OK
ALTERNATOR DRIVE OK
ALTERNATOR OUTPUT OK

POSSIBLE PROBLEMS

ALTERNATOR

7

WITH ENGINE RUNNING, MEASURE CURRENT FROM ALTERNATOR WIRE OUTPUT TERMINAL.

IS CURRENT GREATER THAN 30 AMPS?

TEST OPTIONS

STE/ICE-R TEST 80 (Page 2-749)

REASON FOR QUESTION

Alternator must supply enough current to power vehicle loads.

NO: **REPLACE ALTERNATOR RERUN ALTERNATOR TESTS**

YES:

8

IF YOU STILL HAVE A PROBLEM, RERUN THESE TESTS TO MAKE SURE YOU DIDN'T MISS ANYTHING. IF EVERYTHING CHECKS OUT, RUN BATTERY TESTS AND ELECTRICAL TESTS.

NOTE

Wire 5A is output path for 60 amp alternator. All other alternators have large stud on alternator case as output connector for wire 6. Alternator current will go up as you turn on vehicle accessories.

Turn on the lights, wipers, heater, etc. to make sure alternator can supply enough current to power the loads.

To replace 60 and 200 amp alternators, (refer to chapter 4). To replace 100 amp alternator, (refer to chapter 12).
To replace 100, 200, and 400 amp dual voltage alternators, (refer to chapter 4).

BATTERY CURRENT STE/ICE-R TEST 80
1. Start Test 80, battery current. 2. Displayed reading is in amps. The reading will be greater than 30 amps, depending on how many accessories you have on.

ALTERNATOR **DIAGNOSTIC FLOWCHART**

A
FROM 3,
Page 2-196

A1

KNOWN INFO
BATTERY IS NOT CONNECTED TO ALTERNATOR WHEN ROTARY SWITCH IS IN RUN POSITION
POSSIBLE PROBLEMS
PCB/DISTRIBUTION BOX WIRING

IS THE STARTER MOTOR VOLTAGE THE SAME AS BATTERY VOLTAGE?

TEST OPTIONS
1. STE/ICE-R TESTS 67, 68 (Pages 2-740 -741)
2. MULTIMETER

REASON FOR QUESTION
The cable connecting the batteries to the alternator goes to the starter first.

NO → **REPAIR/REPLACE WIRE 6A**

YES ↓

!!

A2

KNOWN INFO
BATTERY IS NOT CONNECTED TO ALTERNATOR WHEN ROTARY SWITCH IS IN RUN POSITION, BATTERIES CONNECTED TO STARTER
POSSIBLE PROBLEMS
PCB/DISTRIBUTION BOX WIRING

DISCONNECT THE BATTERY NEGATIVE CABLE. DISCONNECT ENGINE CONNECTOR AT PCB/DISTRIBUTION BOX. RECONNECT THE BATTERY NEGATIVE CABLE. IS THERE BATTERY VOLTAGE AT SOCKET E OF THE PCB/DISTRIBUTION BOX ENGINE CONNECTOR HARNESS ?

TEST OPTIONS
1. STE/ICE-R TESTS 67, 89 (Pages 2-740, -750)
2. MULTIMETER

REASON FOR QUESTION
This checks the wire from the starter to the PCB/distribution box engine connector.

NO → **REPAIR/REPLACE WIRE 81A**

YES ↓

A3

KNOWN INFO
BATTERY IS NOT CONNECTED TO ALTERNATOR WHEN ROTARY SWITCH IS IN RUN POSITION, BATTERIES CONNECTED TO STARTER
POSSIBLE PROBLEMS
PCB/DISTRIBUTION BOX WIRING

REMOVE THE BATTERY NEGATIVE CABLE. IS THERE CONTINUITY (LESS THAN 20 OHMS RESISTANCE) FROM SOCKET F OF PCB/DISTRIBUTION BOX ENGINE CONNECTOR HARNESS TO WIRE 5A END AT ALTERNATOR?

TEST OPTIONS
1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION
If the box is connected to the alternator, then the relay in the PCB/distribution box is no good.

NO → **SEE NOTE ON RIGHT HAND PAGE**

YES → **REPLACE PCB/DISTRIBUTION BOX**

INTERLEAVE TEST 67 AND 68.
BATTERY VOLTAGE AND DC VOLTAGE

USE CONTROL FUNCTION 06 TO INTERLEAVE TESTS ON THE STE/ICE-R. DIAL 06, PRESS THE TEST BUTTON. WHEN PROMPTED BY THE VTM, DIAL IN TEST 67 AND PRESS THE BUTTON. WHEN PROMPTED AGAIN, DIAL IN TEST 68 AND PRESS THE BUTTON. VTM WILL DISPLAY RESULT FOR TEST 67, THEN 68 THEN 6768, AND THEN REPEAT. SEE TM 9-4910-571-12&P FOR MORE INFORMATION.

WARNING

DISCONNECT NEGATIVE BATTERY CABLE BEFORE DISCONNECTING AND RECONNECTING PROTECTIVE CONTROL BOX/DISTRIBUTION BOX HARNESS.

There is battery voltage at the PCB/distribution box at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

INTERLEAVE TEST 67 AND 89.
BATTERY VOLTAGE AND DC VOLTAGE

USE CONTROL FUNCTION 06 TO INTERLEAVE TESTS ON THE STE/ICE-R. DIAL 06, PRESS THE TEST BUTTON. WHEN PROMPTED BY THE VTM, DIAL IN TEST 67 AND PRESS THE BUTTON. WHEN PROMPTED AGAIN, DIAL IN TEST 89 AND PRESS THE BUTTON. VTM WILL DISPLAY RESULT FOR TEST 67, THEN 89 THEN 6789, AND THEN REPEAT. SEE TM 9-4910-571-12&P FOR MORE INFORMATION.

NOTE

When checking for voltage or continuity in a harness connector (steps A2 and A3), check the wiring at the connector carefully for broken wires. Check to see that the connector pins are not bent, broken, or pushed out of place. Check that the connections are clean and tight. Use the STE/ICE-R in TK mode for this measurement. DO NOT USE THE DCA. Leave the negative battery cable off for the measurement. If there is an open circuit, the STE/ICE-R will measure close to 500 ohms. If you don't have continuity or voltage, and the wires and connections are all ok, then the harness must have a broken wire. In this case you have to replace the wiring harness. Replace harness, notify DS Maintenance.

Replace PCB, refer to (para. 4-5).
Replace distribution box, refer to (para. 4-5.1).

0-4500 OHMS
STE/ICE-R TEST 91

1. Connect RED clip and BLACK clip to the terminations indicated in the question. RED to the first, BLACK to the second.

2. Start Test 91, 0-4500 ohms.

3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays “9.9.9.9”.

ALTERNATOR **DIAGNOSTIC FLOWCHART**

B
FROM 5, Page 2-198

B1

IDENTIFY MODEL ALTERNATOR. TESTING IS DIFFERENT FOR EACH MODEL. IS THIS A 60 AMP PRESTOLITE ALTERNATOR?

TEST OPTIONS

VISUAL

REASON FOR QUESTION

Connections and testing procedures are not the same for different model alternators.

KNOWN INFO

ALTERNATOR OUTPUT VOLTAGE IS NOT CORRECT

POSSIBLE PROBLEMS

ALTERNATOR WIRING

NO → **SEE NOTE ON OPPOSITE PAGE**

YES ↓

B2

STOP ENGINE. DISCONNECT WIRE 568A FROM ALTERNATOR WIRE 568. TURN THE ROTARY SWITCH TO "RUN". MEASURE VOLTAGE AT THE WIRE THAT IS NOT CONNECTED TO THE ALTERNATOR. IS THERE BATTERY VOLTAGE?

TEST OPTIONS

1. STE/ICE-R TEST 89 (Page 2-750)

2. MULTIMETER

REASON FOR QUESTION

Wire 568a and 568 carry ignition current to turn on regulator.

KNOWN INFO

ALTERNATOR OUTPUT VOLTAGE IS NOT CORRECT

POSSIBLE PROBLEMS

ALTERNATOR WIRING

NO → **NOTIFY DS MAINTENANCE TO REPAIR WIRE 568A OR REPLACE HARNESS**

YES ↓

B3

CONNECT WIRE 568A AND 568. TURN ROTARY SWITCH TO “RUN’’. MEASURE VOLTAGE AT ALTERNATOR END OF WIRE 568. IS THERE BATTERY VOLTAGE AT ALTERNATOR END OF WIRE 568?

TEST OPTIONS

1. STE/STE-R TEST 89 (PAGE 2-750)

2. MULTIMETER

REASON FOR QUESTION

Wire 568A and 568 carry ignition current to turn on regulator.

KNOWN INFO

ALTERNATOR OUTPUT VOLTAGE IS NOT CORRECT

POSSIBLE PROBLEMS

ALTERNATOR

NO → **REPLACE WIRE 568**

YES ↓

GO TO B4, Page 2-206

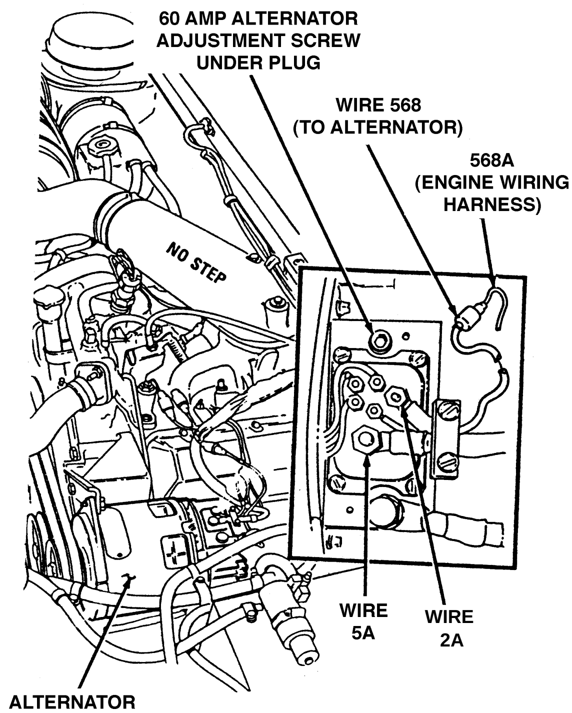
NOTE

For 60 amp Prestolite alternator, continue B.
For 100 amp Prestolite alternator, go to C, page 2-208.
For 200 amp Prestolite alternator, go to D, page 2-212.
For 200 amp single voltage Niehoff alternator, go to E, page 2-218.
For 100 amp single voltage Niehoff alternator, go to F, page 2-222.
For 100 amp dual voltage Niehoff alternator, go to F.1, page 2-224.2.
For 200 amp dual voltage Niehoff alternator, go to G, page 2-224.6.
For 400 amp dual voltage Niehoff alternator, go to H, page 2-224.10.

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

NOTE

Voltage on wire 568 signals regulator to turn on. Without voltage, regulator can't operate. Wire 568A is connected with wire 5A inside engine wire harness. If there is no loose end on wire 568A, wire harness repair is required. Notify DS Maintenance.



ALTERNATOR **DIAGNOSTIC FLOWCHART**

From B3, Page 2-204

KNOWN INFO
ALTERNATOR OUTPUT NOT CORRECT FIELD VOLTAGE OK

POSSIBLE PROBLEMS
ALTERNATOR

B4

RECONNECT WIRE 568. TRY ADJUSTING ALTERNATOR.
IS ALTERNATOR OUTPUT VOLTAGE ADJUSTABLE TO 27-29 VOLTS?

TEST OPTIONS

Adjusting procedure on right hand page using STE/ICE-R tests 10 and 89 (pages 2-734 and 2-750).

REASON FOR QUESTION

The alternator may just need to be adjusted.

NO → REPLACE ALTERNATOR (para 4-2)

YES ↓

B5

AFTER ADJUSTING 60 AMP PRESTOLITE ALTERNATOR, GO TO STEP 6, PAGE 2-198 AND CONTINUE TESTING.

REFERENCE INFORMATION **ALTERNATOR**

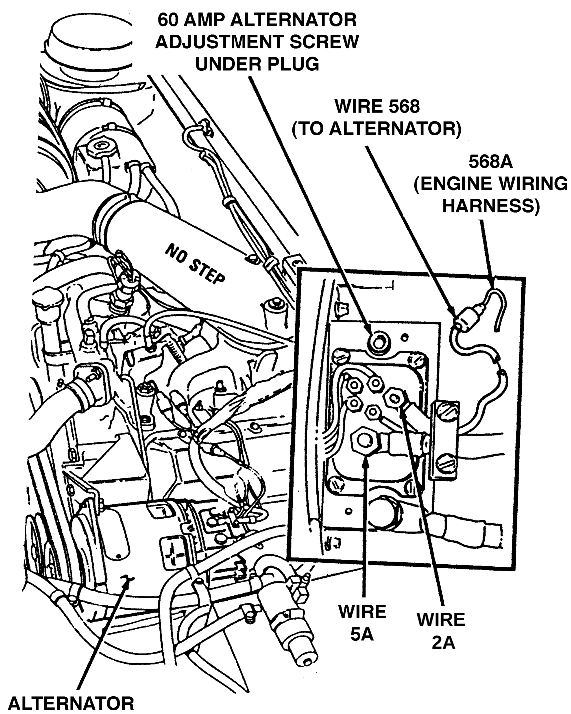
1. Turn engine off.
2. Remove protective cover from alternator wiring.
3. Remove the potting material.
4. Remove hex head plug to expose adjustment screw.
5. Start engine and lock throttle at 1200-1500 RPM by using STE/ICE-R test 10.
6. Connect the Red test lead to wire 5A and the Black lead to engine ground.
7. Monitor alternator output voltage with STE/ICE-R test 89.
8. Use a cross tip screwdriver to adjust the alternator output voltage 28.0 ± 0.5 Volts.
9. Unlock throttle, replace hex head plug, repot the area with silicon caulk, and replace the protective cover.

ENGINE RPM STE/ICE-R TEST 10
1. Start Test 10, Engine RPM. 2. Crank or start the engine. Displayed reading is RPM. Cranking RPM should be approximately 100. Idle RPM should be 625-675.

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

NOTE

Regulator cannot be tested independently from alternator on 60 amp alternator system.



ALTERNATOR **DIAGNOSTIC FLOWCHART**

C
FROM B1,
Page 2-204

C1

IS THIS A 100 AMP PRESTOLITE ALTERNATOR?

TEST OPTIONS
VISUAL

REASON FOR QUESTION
Must know model of alternator to perform proper tests.

NO → SEE NOTE ON OPPOSITE PAGE.

YES ↓

C2

KNOWN INFO
VOLTAGE OUTPUT INCORRECT

POSSIBLE PROBLEMS
WIRING
ALTERNATOR
REGULATOR

STOP ENGINE. DISCONNECT WIRE 568 FROM WIRE 568A. TURN ROTARY SWITCH TO "RUN". MEASURE VOLTAGE AT END OF WIRE 568A. IS THERE BATTERY VOLTAGE IN CONNECTOR AT END OF 568A WIRE?

TEST OPTIONS
1. STE/ICE-R test 89 0-45 volts (page 2-750)
2. Multimeter

REASON FOR QUESTION
Determine if regulator turn on signal is present.

NO → REPLACE WIRE HARNESS. NOTIFY DS

YES ↓

C3

KNOWN INFO
VOLTAGE OUTPUT INCORRECT

POSSIBLE PROBLEMS
WIRING
ALTERNATOR
REGULATOR

TURN ROTARY SWITCH OFF AND RECONNECT WIRES 568 AND 568A.REMOVE REGULATOR COVER AND INSPECT CONNECTION. TURN ROTARY SWITCH ON. MEASURE VOLTAGE AT END OF WIRE 568. IS THERE BATTERY VOLTAGE ON END OF WIRE 568?

TEST OPTIONS
1. STE/ICE-R test 89 0-45 Volts (page 2-750).
2. Multimeter.

REASON FOR QUESTION
Determine if regulator turn on signal is at stud.

NO → REPLACE WIRE 568.

YES ↓

GO TO
C4, Page 2-210

NOTE

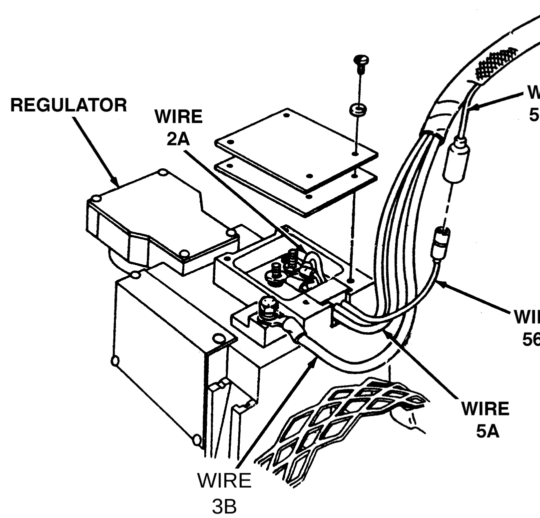
For 60 amp Prestolite alternator, go to B, page 2-204.
For 100 amp Prestolite alternator, continue C.
For 200 amp Prestolite alternator, go to D, page 2-212.
For 200 amp single voltage Niehoff alternator, go to E, page 2-218.
For 100 amp single voltage Niehoff alternator, go to F, page 2-222.
For 100 amp dual voltage Niehoff alternator, go to F.1, page 2-224.2.
For 200 amp dual voltage Niehoff alternator, go to G, page 2-224.6.
For 400 amp dual voltage Niehoff alternator, go to H, page 2-224.10.

NOTE

Voltage on wire 568 signals regulator to turn on. Without voltage, regulator can't operate. Wire 568A is connected with wire 5A inside engine wire harness. If there is no loose end on wire 568A, wire harness repair is required. Notify DS Maintenance.

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

NEWER MODEL REGULATOR



ALTERNATOR **DIAGNOSTIC FLOWCHART**

FROM C3, Page 2-208

KNOWN INFO

VOLTAGE OUTPUT INCORRECT

WIRING OR IGNITION OK

POSSIBLE PROBLEMS

ALTERNATOR
REGULATOR

C4

WAS VOLTAGE READ IN STEP 5, ON PAGE 2-198, LESS THAN 35 VOLTS?

TEST OPTIONS

REASON FOR QUESTION

If voltage exceeded 35 volts, regulator over-voltage protection has failed.

NO → **REPLACE REGULATOR (Para 12-21) or (Para 12-22)**

YES → C5

KNOWN INFO

VOLTAGE OUTPUT INCORRECT

WIRING OR IGNITION OK

POSSIBLE PROBLEMS

ALTERNATOR
REGULATOR

C5

WITH REGULATOR REMOVED FROM ALTERNATOR, PERFORM FULL-FIELD TEST. START ENGINE AND SET SPEED TO 850 RPM. CONNECT A JUMPER WIRE FROM PIN E ON ALTERNATOR TO GROUND. MOMENTARILY WIRE JUMPER FROM PIN D TO BATTERY VOLTAGE. MEASURE VOLTAGE AT ALTERNATOR OUTPUT. DID VOLTAGE RISE TO AT LEAST 75 VOLTS?

TEST OPTIONS

1. STE/ICE-R Tests 10 and 89 (pages 2-734 and 2-750).
2. MULTIMETER

REASON FOR QUESTION

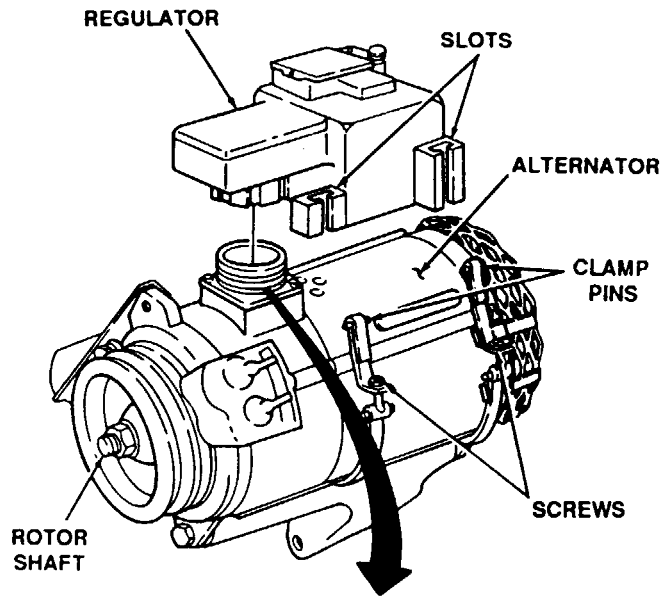
Determine if alternator or regulator is defective.

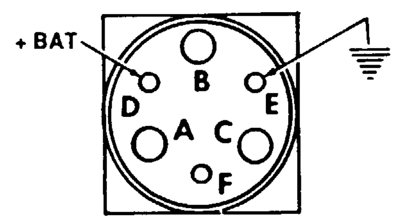
NO → **REPLACE ALTERNATOR (Para 12-23) or (Para 12-24)**

YES → **REPLACE REGULATOR (Para 12-21) or (Para 12-22)**

REFERENCE INFORMATION

ALTERNATOR





CAUTION

Ensure all electrical loads are disconnected or turned off. Higher voltage could damage components in other devices.

1. Disconnect battery ground cable.
2. Loosen screws.
3. Remove clamp pins from slots.
4. Loosen connector nut.
5. Remove regulator from alternator. Secure regulator out of the way.
6. Connect battery ground cable.

NOTE

Jumper wires must be able to handle 15 amp current (14 gauge or larger diameter).

NOTE

Multimeter set to read over 75 vdc.

ENGINE RPM STE/ICE-R TEST 10
1. Start Test 10, Engine RPM. 2. Crank or start the engine. Displayed reading is RPM. Cranking RPM should be approximately 100. Set idle speed to 850 RPM.
0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

ALTERNATOR DIAGNOSTIC FLOWCHART

D
FROM B1,
Page 2-204

D1

IS THIS A 200 AMP PRESTOLITE ALTERNATOR?

TEST OPTIONS

Visual

REASON FOR QUESTION

Must know model of alternator to perform proper tests.

NO → SEE NOTE ON OPPOSITE PAGE.

YES ↓

D2

KNOWN INFO

VOLTAGE OUTPUT INCORRECT

POSSIBLE PROBLEMS

FUSIBLE LINK
WIRING
ALTERNATOR
REGULATOR

STOP ENGINE. DISCONNECT BATTERY GROUND CABLE. REMOVE END OF CABLE/WIRE 6 FROM ALTERNATOR OUTPUT STUD. CHECK FOR BURNED, BROKEN, OR DAMAGED REVERSE POLARITY FUSE. IS FUSE OK?

TEST OPTIONS

Visual

REASON FOR QUESTION

Defective fusible link could cause low or zero output.

NO → REPLACE DAMAGED REVERSE POLARITY FUSE.

YES ↓

D3

KNOWN INFO

VOLTAGE OUTPUT INCORRECT

FUSIBLE LINK OK

POSSIBLE PROBLEMS

WIRING
ALTERNATOR
REGULATOR

REMOVE COVER ON REGULATOR. TURN ROTARY SWITCH TO "RUN". MEASURE VOLTAGE AT IGNITION STUD (WIRE 5A) ON REGULATOR.

IS THERE BATTERY VOLTAGE AT IGNITION STUD (END OF WIRE 5A)?

TEST OPTIONS

STE-ICE-R Test 89
(page 2-750)

REASON FOR QUESTION

Voltage on stud turns regulator on.

NO → NOTIFY DS MAINTENANCE TO REPAIR WIRING HARNESS.

YES ↓

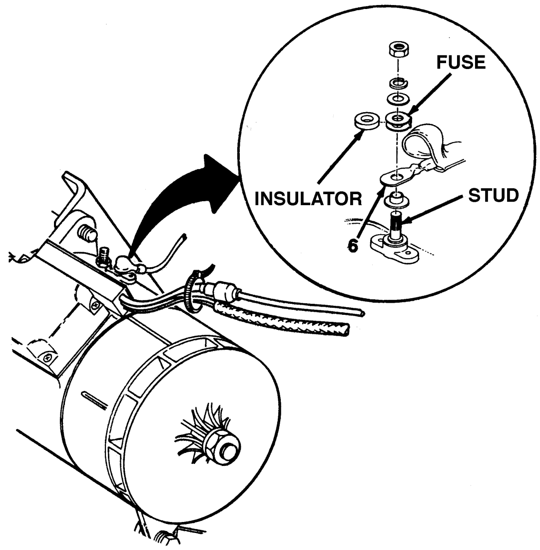
GO TO D4, Page 2-214

REFERENCE INFORMATION

ALTERNATOR

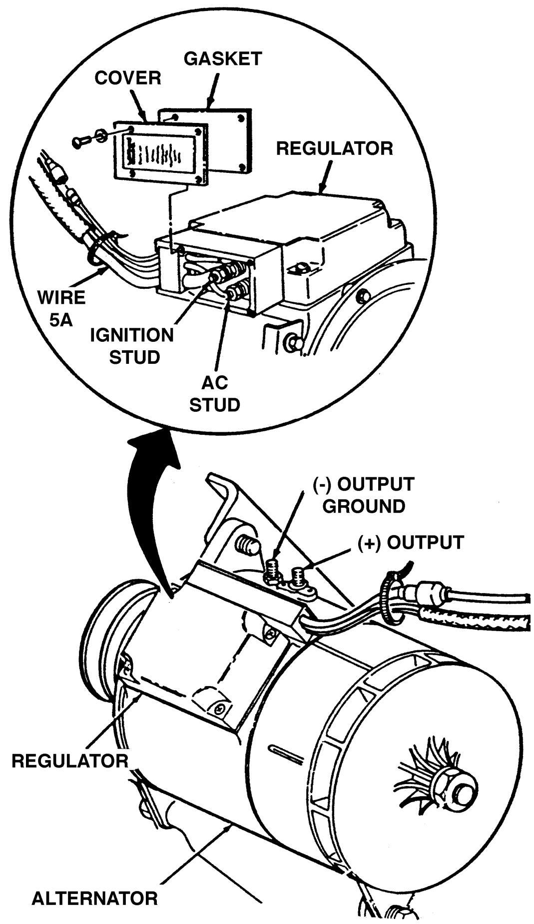
NOTE

For 60 amp Prestolite alternator, go to B, page 2-204.
For 100 amp Prestolite alternator, go to C, page 2-208.
For 200 amp Prestolite alternator, continue D.
For 200 amp single voltage Niehoff alternator, go to E, page 2-218.
For 100 amp single voltage Niehoff alternator, go to F, page 2-222.
For 100 amp dual voltage Niehoff alternator, go to F.1, page 2-224.2.
For 200 amp dual voltage Niehoff alternator, go to G, page 2-224.6.
For 400 amp dual voltage Niehoff alternator, go to H, page 2-224.10.



Replacement of Reverse Polarity Fuse

1. Remove nut, lockwasher, washer, fuse, insulator and cable 6 from output stud.
2. Examine fuse for burns and breaks. Replace fuse and insulator if damaged.
3. Install new fuse and insulator on output stud with washer, lockwasher, and nut. Tighten nut 10-15 lb-in. (14-20 N•m).



1. Disconnect battery ground cable.
2. Remove four screws, lockwashers, gasket, and cover from regulator.
3. Remove potting material as necessary to gain access to studs.

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

ALTERNATOR DIAGNOSTIC FLOWCHART

FROM D3,
Page 2-212

KNOWN INFO

VOLTAGE OUTPUT INCORRECT
FUSIBLE LINK OK

POSSIBLE PROBLEMS

ALTERNATOR
REGULATOR
TEMPERATURE COMPENSATION ERROR

D4

CHECK IF ALTERNATOR HAS BEEN ADJUSTED FOR TEMPERATURE EXTREMES (ARCTIC OR DESERT). IF SO, RESET REGULATOR FOR 28 VOLT OUTPUT. START ENGINE AND CHECK OUTPUT VOLTAGE AT 850 RPM. IS OUTPUT VOLTAGE 27-29 VOLTS?

TEST OPTIONS

STE/ICE-R Tests 10 and 89 (pages 2-734 and 2-750).

REASON FOR QUESTION

Regulator may have wrong temperature compensation setting.

NO → GO TO D5,
Page 2-216

YES → GO TO STEP 6,
Page 2-198

REFERENCE INFORMATION

ALTERNATOR

TEMPERATURE-ENVIRONMENT ADJUSTMENT

1. Disconnect battery ground cable.
2. Remove four screws securing regulator to alternator.
3. Position regulator to allow access to the buss bar link. The buss bar link and voltage setting terminals are located under sealant. It maybe necessary to scrape away some of the sealant to access the buss bar link and terminals.
4. To adjust the voltage setting to 27.2 volts (for hot or desert condition), loosen screw E0 and remove screws E1 and E2. Rotate bus bar link to E2. Reinstall screws E1 and E2 and tighten screw E0.
5. Apply RTV sealant to fully cover buss bar link and voltage setting terminals.
6. Install regulator to alternator with four screws.
7. Connect battery ground cable.
8. Check output voltage, it should read 27.2 volts.

NOTE

To reset alternator output voltage to 28 volts, the buss bar link should be connected between E0 and E1. The terminal connection E0 and E3 provides an output voltage of 28.8 volts (for arctic conditions). When operation in hot weather or arctic conditions cease, the alternator output voltage should be reset to its normal 28.0 volt setting.

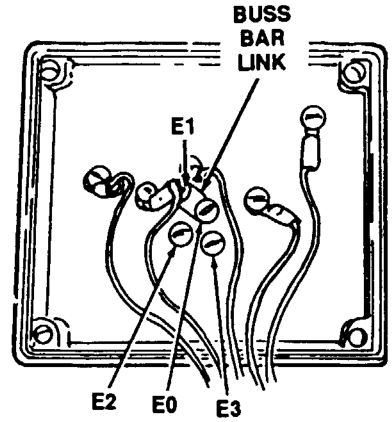
9. Mark the output voltage setting on the alternator and annotate the information in the vehicle log book for future reference.

NOTE

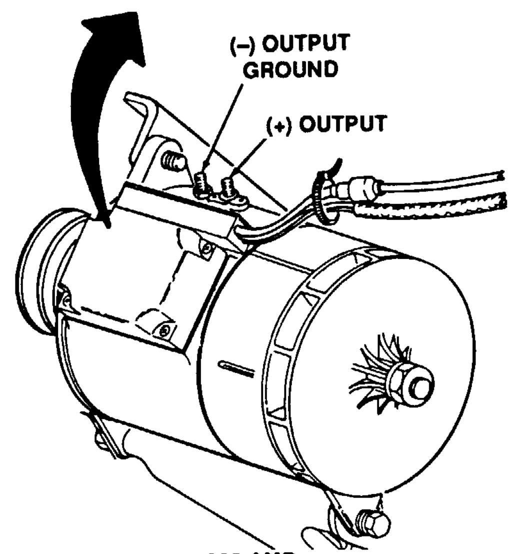
This procedure resets the alternator output approximately 0.8 volts on either side of 28 volts, but will not correct for larger errors.

NOTE

If an overcharge condition exists, wiring to regulator is satisfactory.



BOTTOM OF REGULATOR



200 AMP PRESTOLITE ALTERNATOR

ENGINE RPM STE/ICE-R TEST 10
1. Start test 10, Engine RPM. 2. Crank or start the engine. Displayed reading is RPM. Engine RPM should be 850.

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

ALTERNATOR

DIAGNOSTIC FLOWCHART

FROM D4, Page 2-214

KNOWN INFO
VOLTAGE OUTPUT INCORRECT

POSSIBLE PROBLEMS
ALTERNATOR REGULATOR

D5

REMOVE AND TAG LEADS FROM REGULATOR TERMINALS P,Z,V,Y, AND W. INSULATE ALL LEADS EXCEPT Y AND W. REFER TO PROCEDURE ON NEXT PAGE. RUN FULL FIELD TEST ON ALTERNATOR. IS OUTPUT VOLTAGE 35-40 VOLTS?

TEST OPTIONS
STE-ICE-R Test 89 (page 2-750).

REASON FOR QUESTION
Determine if alternator or regulator is defective.

NO → ALTERNATOR DEFECTIVE, REPLACE, para 4-109.

YES → REGULATOR DEFECTIVE. REPLACE, para 4-114.

REFERENCE INFORMATION

ALTERNATOR

FULL FIELD TEST

1. Disconnect battery ground cable.

NOTE

Tag leads before removal.

2. Remove five screws, lockwashers, and leads from bottom of regulator.
3. Insulate leads from V,P, and Z terminals.
4. Connect 6 volt lantern battery NSN 6135-00-643-1310, (or equivalent that can supply 1.0 amp current at 6 volts) with (+) battery and lead connector to W lead and (-) battery and lead connector to Y lead. Insulate all connections.
5. Monitor voltage across alternator output studs. Meter must be capable of reading 50 volts.

CAUTION

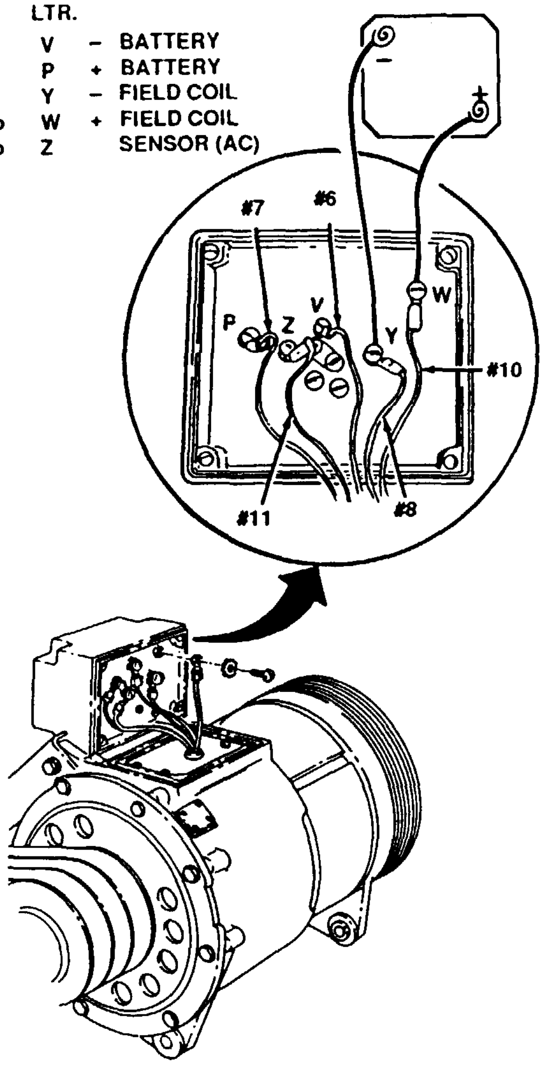
Ensure all vehicle and on board equipment are turned off. Higher voltages could damage components.

6. Connect battery ground cable.
7. Start vehicle and run engine to 900 rpm. Run only long enough to obtain a stable output voltage reading.
8. Stop engine, remove 6 volt battery and leads.

NOTE

If installing alternator, reconnect regulator (para 4-114).

WIRE NO.	TERM. LTR.	FUNCTION
#6 to	V	– BATTERY
#7 to	P	+ BATTERY
#8 to	Y	– FIELD COIL
#10 to	W	+ FIELD COIL
#11 to	Z	SENSOR (AC)



0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

ALTERNATOR DIAGNOSTIC FLOWCHART

E
FROM B1,
Page 2-204

E1

IS THIS A NIEHOFF 200 AMP SINGLE VOLTAGE ALTERNATOR?

TEST OPTIONS
Visual

REASON FOR QUESTION
Must know model of alternator to perform proper tests.

NO → **SEE NOTE ON OPPOSITE PAGE**

YES ↓

E2

KNOWN INFO
VOLTAGE OUTPUT INCORRECT

POSSIBLE PROBLEMS
FUSIBLE LINK
WIRING
ALTERNATOR
REGULATOR

START ENGINE AND ALLOW TO IDLE AT 1200-1500 RPM FOR 2-3 MINUTES.

RECHECK VOLTAGE OUTPUT.

IS ALTERNATOR OUTPUT LESS THAN 26 VOLTS?

TEST OPTIONS
STE/ICE-R Test 10 and 89 (Pages 2-734 and 2-750).

REASON FOR QUESTION
Determine if high or low output voltage.

NO → **IF OUTPUT VOLTAGE IS OVER 30.5 VOLTS, REPLACE REGULATOR, (Para 4-114) or (Para 4-115)**

YES ↓

E3

KNOWN INFO
VOLTAGE OUTPUT INCORRECT

POSSIBLE PROBLEMS
FUSIBLE LINK
WIRING
ALTERNATOR
REGULATOR

STOP ENGINE. CHECK FOR BURNED OR BROKEN REVERSE POLARITY FUSIBLE LINK ON ALTERNATOR OUTPUT STUD. IS FUSIBLE LINK OK?

TEST OPTIONS
Visual

REASON FOR QUESTION
Fusible link connects alternator output stud to wire 6.

NO → **REPLACE FUSIBLE LINK. GO TO STEP 5, Page 2-198**

YES ↓

GO TO E4, Page 2-220

REFERENCE INFORMATION

ALTERNATOR

NOTE

For 60 amp Prestolite alternator, go to B, page 2-204.
For 100 amp Prestolite alternator, go to C, page 2-208.
For 200 amp Prestolite alternator, go to D, page 2-212.
For 200 amp single voltage Niehoff alternator, continue with E.
For 100 amp single voltage Niehoff alternator, go to F, page 2-222.
For 100 amp dual voltage Niehoff alternator, go to F.1, page 2-224.2.
For 200 amp dual voltage Niehoff alternator, go to G, page 2-224.6.
For 400 amp dual voltage Niehoff alternator, go to H, page 2-224.10.

NOTE

The regulator for this model alternator has overvoltage protection. Any output voltage over 30.5 volts is an overvoltage.

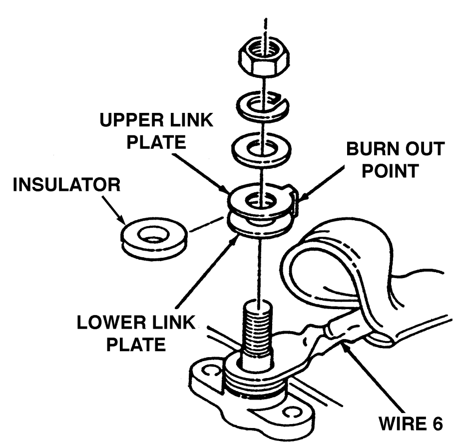
Output voltage of 26-30.5 is acceptable for this alternator.

ENGINE RPM STE/ICE-R TEST 10
1. Start test 10, Engine RPM. 2. Crank or start the engine. Displayed reading is RPM. Engine RPM should be 1200-1500.

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

FUSIBLE LINK REPLACEMENT

1. Disconnect battery ground cable.
2. Remove boot from alternator output terminal.
3. Remove nut, lockwasher, washers, and fusible link from terminal.
4. Inspect fusible link.
5. Replace fusible link if damaged or appears burned.
6. Connect battery ground cable.



ALTERNATOR **DIAGNOSTIC FLOWCHART**

FROM E3, Page 2-218

E4

KNOWN INFO

VOLTAGE OUTPUT INCORRECT
FUSIBLE LINK OK

POSSIBLE PROBLEMS

ALTERNATOR
REGULATOR
WIRING

TURN ROTARY SWITCH TO "RUN" POSITION. CHECK FOR BATTERY VOLTAGE AT RED (ENERGIZE) TERMINAL ON REGULATOR. IS BATTERY VOLTAGE PRESENT?

TEST OPTIONS

STE-ICE-R Test 89 (page 2-750).

REASON FOR QUESTION

As wire 568A is stubbed off, the voltage from wire 5A on red terminal signals regulator to turn on.

NO: **NOTIFY DS MAINTENANCE TO REPAIR OR REPLACE WIRING HARNESS**

YES: go to E5

E5

KNOWN INFO

VOLTAGE OUTPUT INCORRECT
REGULATOR HAS ENERGIZING VOLTAGE
FUSIBLE LINK OK

POSSIBLE PROBLEMS

ALTERNATOR
REGULATOR

DISCONNECT ALTERNATOR-TO-REGULATOR CABLE. START ENGINE AND SET IDLE 1200-1500 RPM. USING 15 AMP CAPACITY JUMPER WIRE, MOMENTARILY CONNECT PIN "A" OF ALTERNATOR CONNECTOR TO ENGINE GROUND. DOES CURRENT AND VOLTAGE RISE DURING CONNECTION TO 180-220 AMPS?

TEST OPTIONS

STE-ICE-R Test 10 and 90 (page 2-734 and 2-751).

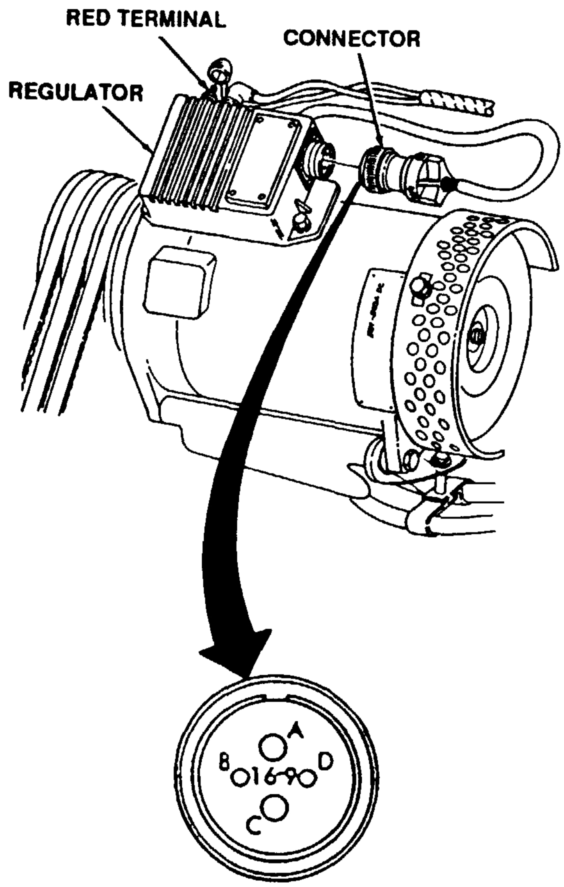
REASON FOR QUESTION

This connection applies full current loading to field coil. Alternator current output should be near maximum.

NO: **REPLACE ALTERNATOR, (Para 4-109). THEN GO TO STEP 5, Page 2-198**

YES: **REPLACE REGULATOR (Para 4-114). THEN GO TO STEP 5, Page 2-198**

REFERENCE INFORMATION **ALTERNATOR**



1. Slide boot back from wire lug to expose red terminal.
2. Make contact at stud.

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

ENGINE RPM STE/ICE-R TEST 10
1. Start Test 10, Engine RPM. 2. Crank or start the engine. Displayed reading is RPM. Set engine to fast idle of 1200-1500 RPM.

0-1500 AMPS DC STE/ICE-R TEST 90
1. Connect probe. 2. Start Test 90, DC amps. 3. Displayed reading is in amps.

ALTERNATOR **DIAGNOSTIC FLOWCHART**

F FROM B1, Page 2-204

F1

IS THIS A NIEHOFF 100 AMP SINGLE VOLTAGE ALTERNATOR?

TEST OPTIONS

Visual

REASON FOR QUESTION

Must know model of alternator to perform proper tests.

NO → **SEE NOTE ON OPPOSITE PAGE**

YES ↓

KNOWN INFO

VOLTAGE OUTPUT INCORRECT

POSSIBLE PROBLEMS

WIRING
ALTERNATOR
REGULATOR

F2

START ENGINE AND ALLOW TO IDLE AT 1200-1500 RPM.

RECHECK VOLTAGE OUTPUT.

IS ALTERNATOR OUTPUT LESS THAN 26 VOLTS?

TEST OPTIONS

1. STE/ICE-R TEST 10 AND 89 (Pages 2-734 and 2-750).

REASON FOR QUESTION

Determine if high or low output voltage.

NO → **IF OUTPUT VOLTAGE IS OVER 30.5 VOLTS, REPLACE REGULATOR (Para 12-22)**

YES ↓

KNOWN INFO

VOLTAGE OUTPUT INCORRECT

POSSIBLE PROBLEMS

WIRING
ALTERNATOR
REGULATOR

F3

STOP ENGINE. DISCONNECT WIRE 568A FROM ALTERNATOR WIRE 568. TURN ROTARY SWITCH TO "RUN". MEASURE VOLTAGE AT THE WIRE THAT IS NOT CONNECTED TO THE ALTERNATOR. IS THERE BATTERY VOLTAGE?

TEST OPTIONS

STE-ICE-R Test 89 (page 2-750)

REASON FOR QUESTION

Wire 568A and wire 568 carry ignition current to turn on regulator.

NO → **NOTIFY DS TO REPAIR OR REPLACE WIRE HARNESS**

YES ↓

GO TO F4, Page 2-224

REFERENCE INFORMATION

ALTERNATOR

NOTE

For 60 amp Prestolite alternator, go to B, page 2-204.
For 100 amp Prestolite alternator, go to C, page 2-208.
For 200 amp Prestolite alternator, go to D, page 2-212.
For 200 amp single voltage Niehoff alternator, go to E, page 2-218.
For 100 amp single voltage Niehoff alternator, continue with F.
For 100 amp dual voltage Niehoff alternator, go to F.1, page 2-224.2.
For 200 amp dual voltage Niehoff alternator, go to G, page 2-224.6.
For 400 amp dual voltage Niehoff alternator, go to H, page 2-224.10.

NOTE

The regulator for this model alternator has overvoltage protection. Any output voltage over 30.5 volts is an overvoltage.

Output voltage of 25-30.5 is acceptable for this alternator.

ENGINE RPM STE/ICE-R TEST 10
1. Start test 10, Engine RPM. 2. Crank or start the engine. Displayed reading is RPM. Engine RPM should be 1200-1500.

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

NOTE

Voltage on wire 568 signals regulator to turn on. Without voltage, regulator can't operate. Wire 568A is connected with wire 5A inside engine wire harness. If there is no loose end on wire 568A, wire harness repair is required.

ALTERNATOR **DIAGNOSTIC FLOWCHART**

FROM F3, Page 2-222

KNOWN INFO

VOLTAGE OUTPUT INCORRECT
REGULATOR HAS ENERGIZING VOLTAGE

POSSIBLE PROBLEMS

ALTERNATOR
REGULATOR
WIRE

F4

CONNECT WIRE 568A AND 568. DISCONNECT WIRE 568 FROM ALTERNATOR. TURN ROTARY SWITCH TO "RUN". MEASURE VOLTAGE AT ALTERNATOR END OF WIRE. IS THERE VOLTAGE AT BATTERY END OF WIRE 568?

TEST OPTIONS

1. STE-ICE-R Test 89 (page 2-750).
2. MULTIMETER

REASON FOR QUESTION

Wire 568A and wire 568 carry ignition current to turn on regulator.

NO → REPLACE WIRE 568

YES ↓

KNOWN INFO

VOLTAGE OUTPUT INCORRECT
REGULATOR HAS ENERGIZING VOLTAGE

POSSIBLE PROBLEMS

ALTERNATOR
REGULATOR

F5

DISCONNECT ALTERNATOR-TO-REGULATOR CABLE. START ENGINE AND SET IDLE 1200-1500 RPM. USING 15 AMP CAPACITY JUMPER WIRE, MOMENTARILY CONNECT PIN A OF ALTERNATOR CONNECTOR TO ENGINE GROUND. DOES CURRENT RISE DURING CONNECTION TO 90-110 AMPS?

TEST OPTIONS

1. STE-ICE-R Test 10 and 90 (pages 2-734 and 2-751).

REASON FOR QUESTION

This connection applies full current loading to field coil. Alternator current output should be near maximum.

NO → REPLACE ALTERNATOR, (para 12-24). THEN GO TO STEP 5, Page 2-198.

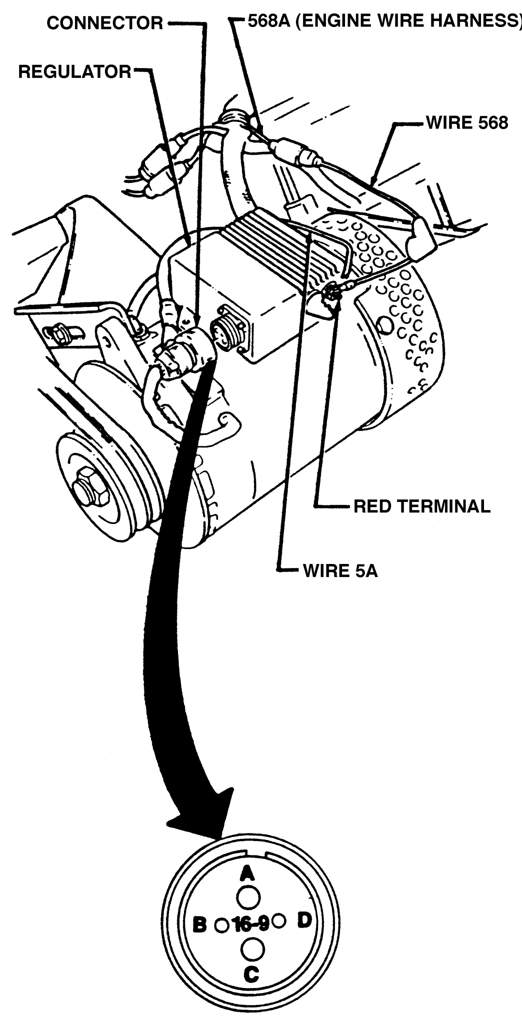
YES → REPLACE REGULATOR (para 12-22). THEN GO TO STEP 5, Page 2-198.

REFERENCE INFORMATION

ALTERNATOR

1. Slide boot back from wire lug to expose red terminal.
2. Make contact at stud.

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.



ENGINE RPM STE/ICE-R TEST 10
1. Start Test 10, Engine RPM. 2. Crank or start the engine. Displayed reading is RPM. Set engine to fast idle of 800-1000 RPM.

0-1500 AMPS DC STE/ICE-R TEST 90
1. Connect probe. 2. Start Test 90, DC amps. 3. Displayed reading is in amps.

ALTERNATOR **DIAGNOSTIC FLOWCHART**

F.1
FROM B1,
Page 2-204

F.1-1

IS THIS A NIEHOFF 100 AMP DUAL VOLTAGE ALTERNATOR?

TEST OPTIONS

Visual

REASON FOR QUESTION

Must know model of alternator to perform proper tests.

NO → **SEE NOTE ON OPPOSITE PAGE**

YES

F.1-2

KNOWN INFO

VOLTAGE OUTPUT INCORRECT

POSSIBLE PROBLEMS

WIRING
ALTERNATOR
REGULATOR

START ENGINE AND ALLOW TO IDLE AT 1200-1500 RPM FOR 2-3 MINUTES.

RECHECK VOLTAGE OUTPUT.

IS ALTERNATOR OUTPUT LESS THAN 26 VOLTS?

TEST OPTIONS

STE/ICE-R TEST 10, (interleave with control function 01 of page 2-734 then 89, page 2-750)

REASON FOR QUESTION

Determine if high or low output voltage.

NO → **IF OUTPUT VOLTAGE IS OVER 30.5 VOLTS, REPLACE REGULATOR (Para 4-5.6)**

YES

F.1-3

KNOWN INFO

VOLTAGE OUTPUT INCORRECT
REGULATOR HAS ENERGIZING VOLTAGE

POSSIBLE PROBLEMS

ALTERNATOR
REGULATOR
WIRING

DISCONNECT ALTERNATOR-TO-REGULATOR CABLE. START ENGINE AND SET IDLE 1200-1500 RPM. USING 15-AMP CAPACITY JUMPER WIRE, MOMENTARILY CONNECT TO ENGINE GROUND. DOES CURRENT AND VOLTAGE RISE DURING CONNECTION?

TEST OPTIONS

STE/ICE -R TEST 10 AND 90 (pages 2-734 and 2-751)

REASON FOR QUESTION

This connection applies full current loading to field coil. Alternator current output should be near maximum.

NO → **REPLACE REGULATOR (Para 4-5.6). THEN GO TO 5, Page 2-198**

YES → **REPLACE REGULATOR (Para 4-5.6). THEN GO TO 5, Page 2-198**

REFERENCE INFORMATION

ALTERNATOR

NOTE

For 60 amp Prestolite alternator, go to B, page 2-204.
For 100 amp Prestolite alternator, go to C, page 2-208.
For 200 amp Prestolite alternator, go to D, page 2-212.
For 200 amp single voltage Niehoff alternator, go to E, page 2-218.
For 100 amp single voltage Niehoff alternator, go to F, page 2-222.
For 100 amp dual voltage Niehoff alternator, continue with F.1.
For 200 amp dual voltage Niehoff alternator, go to G, page 2-224.6.
For 400 amp dual voltage Niehoff alternator, go to H, page 2-224.10.

NOTE

The regulator for this model alternator has overvoltage protection. Any output voltage over 30.5 volts is an overvoltage.

Output voltage of 26-30.5 is acceptable for this alternator.

ENGINE RPM
STE/ICE-R TEST 10

1. Start test 10, Engine RPM.

2. Crank or start the engine. Displayed reading is RPM. Engine RPM should be 1200-1500.

0-1,500 AMPS DC
STE/ICE-R TEST 90

1. Connect probe.

2. Start Test 90, DC amps.

3. Displayed reading is in amps.

NOTE

The regulator for this alternator has overvoltage protection. Any output voltage over 30.5 volts is an overvoltage.

Output voltage of 26-30.5 is acceptable for this alternator.

ALTERNATOR **DIAGNOSTIC FLOWCHART**

FROM F.1-3, Page 2-224.2

F.1-4

KNOWN INFO
VOLTAGE OUTPUT INCORRECT REGULATOR HAS ENERGIZING VOLTAGE
POSSIBLE PROBLEMS
ALTERNATOR REGULATOR WIRING

IDLE ENGINE AT 1200-1500 RPM. DOES VOLTAGE ON 14 VOLT OUTPUT TERMINAL (YELLOW INSULATOR) MEASURE BETWEEN 13.4-14.6 VOLTS?

TEST OPTIONS

MULTIMETER

REASON FOR QUESTION

Determine if high or low output voltage.

NO: **IF OUTPUT VOLTAGE IS NOT CORRECT, REPLACE REGULATOR (Para 4-5.6). RECHECK VOLTAGE. IF VOLTAGE IS STILL NOT CORRECT, REPLACE ALTERNATOR (Para 4-5.2)**

YES: go to F.1-5

F.1-5

KNOWN INFO
VOLTAGE OUTPUT INCORRECT REGULATOR HAS ENERGIZING VOLTAGE
POSSIBLE PROBLEMS
ALTERNATOR REGULATOR WIRING

TURN ROTARY SWITCH TO RUN POSITION. CHECK FOR BATTERY VOLTAGE AT RED (ENERGIZE) TERMINAL ON REGULATOR. IS BATTERY VOLTAGE PRESENT?

TEST OPTIONS

1. STE/ICE-R TEST 10 AND 89 (Page 2-750)
2. MULTIMETER

REASON FOR QUESTION

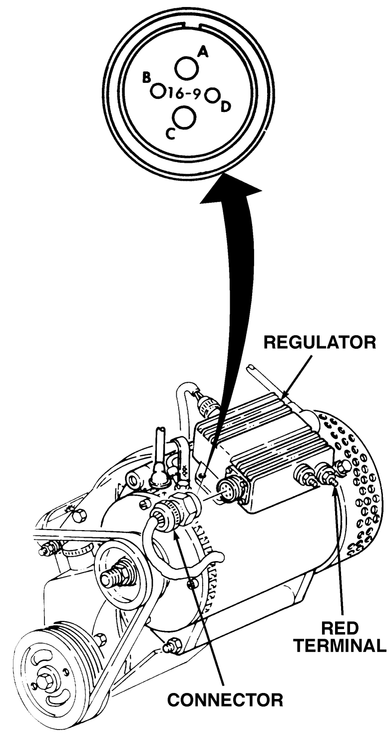
As wire 568A is stubbed off, the voltage from wire 5A on red terminal signals regulator to turn on.

NO: **NOTIFY DS MAINTENANCE TO REPAIR OR REPLACE WIRING HARNESS**

YES: **REPLACE REGULATOR (Para 4-5.6). THEN GO TO 5, Page 2-198**

1. Slide boot back from wire lug to expose red terminal.
2. Make contact at stud.

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC Volts. 3. Displayed reading is in volts.



ALTERNATOR DIAGNOSTIC FLOWCHART

G
FROM B1,
Page 2-204

G1

IS THIS A NIEHOFF 200 AMP DUAL VOLTAGE ALTERNATOR?

TEST OPTIONS

Visual

REASON FOR QUESTION

Must know model of alternator to perform proper tests.

NO → **SEE NOTE ON OPPOSITE PAGE**

YES ↓

G2

KNOWN INFO

VOLTAGE OUTPUT INCORRECT

POSSIBLE PROBLEMS

WIRING
ALTERNATOR
REGULATOR

START ENGINE AND ALLOW TO IDLE AT 1200-1500 RPM FOR 2-3 MINUTES.

RECHECK VOLTAGE OUTPUT.

IS ALTERNATOR OUTPUT LESS THAN 26 VOLTS?

TEST OPTIONS

STE/ICE-R TEST 10,
(interleave with control function 01 of page 2-734 then 89, page 2-750)

REASON FOR QUESTION

Determine if high or low output voltage.

NO → **IF OUTPUT VOLTAGE IS OVER 30.5 VOLTS, REPLACE REGULATOR (Para 4-5.10)**

YES ↓

G3

KNOWN INFO

VOLTAGE OUTPUT INCORRECT
REGULATOR HAS ENERGIZING VOLTAGE

POSSIBLE PROBLEMS

ALTERNATOR
REGULATOR

DISCONNECT ALTERNATOR-TO-REGULATOR CABLE. START ENGINE AND SET IDLE 1200-1500 RPM. USING 15-AMP CAPACITY JUMPER WIRE, MOMENTARILY CONNECT PIN A OF ALTERNATOR CONNECTOR TO ENGINE GROUND. DOES CURRENT AND VOLTAGE RISE DURING CONNECTION?

TEST OPTIONS

STE/ICE-R TEST 10 AND 90
(pages 2-734 and 2-751)

REASON FOR QUESTION

This connection applies full current loading to field coil. Alternator current output should be near maximum.

NO → **REPLACE ALTERNATOR (Para 4-5.7). THEN GO TO 5, Page 2-198**

YES ↓

REPLACE REGULATOR (Para 4-5.10). THEN GO TO 5, Page 2-198

NOTE

For 60 amp Prestolite alternator, go to B, page 2-204.
For 100 amp Prestolite alternator, go to C, page 2-208.
For 200 amp Prestolite alternator, go to D, page 2-212.
For 200 amp single voltage Niehoff alternator, go to E, page 2-218.
For 100 amp single voltage Niehoff alternator, go to F, page 2-222.
For 100 amp dual voltage Niehoff alternator, go to F.1, page 2-224.2.
For 200 amp dual voltage Niehoff alternator, continue with G.
For 400 amp dual voltage Niehoff alternator, go to H, page 2-224.10.

NOTE

The regulator for this model alternator has overvoltage protection. Any output voltage over 30.5 volts is an overvoltage.

Output voltage of 26-30.5 is acceptable for this alternator.

NOTE

The regulator for this alternator has overvoltage protection. Any output voltage over 30.5 volts is an overvoltage.

Output voltage of 26-30.5 is acceptable for this alternator.

ENGINE RPM
STE/ICE-R TEST 10

1. Start test 10, Engine RPM.

2. Crank or start the engine. Displayed reading is RPM. Engine RPM should be 1200-1500.

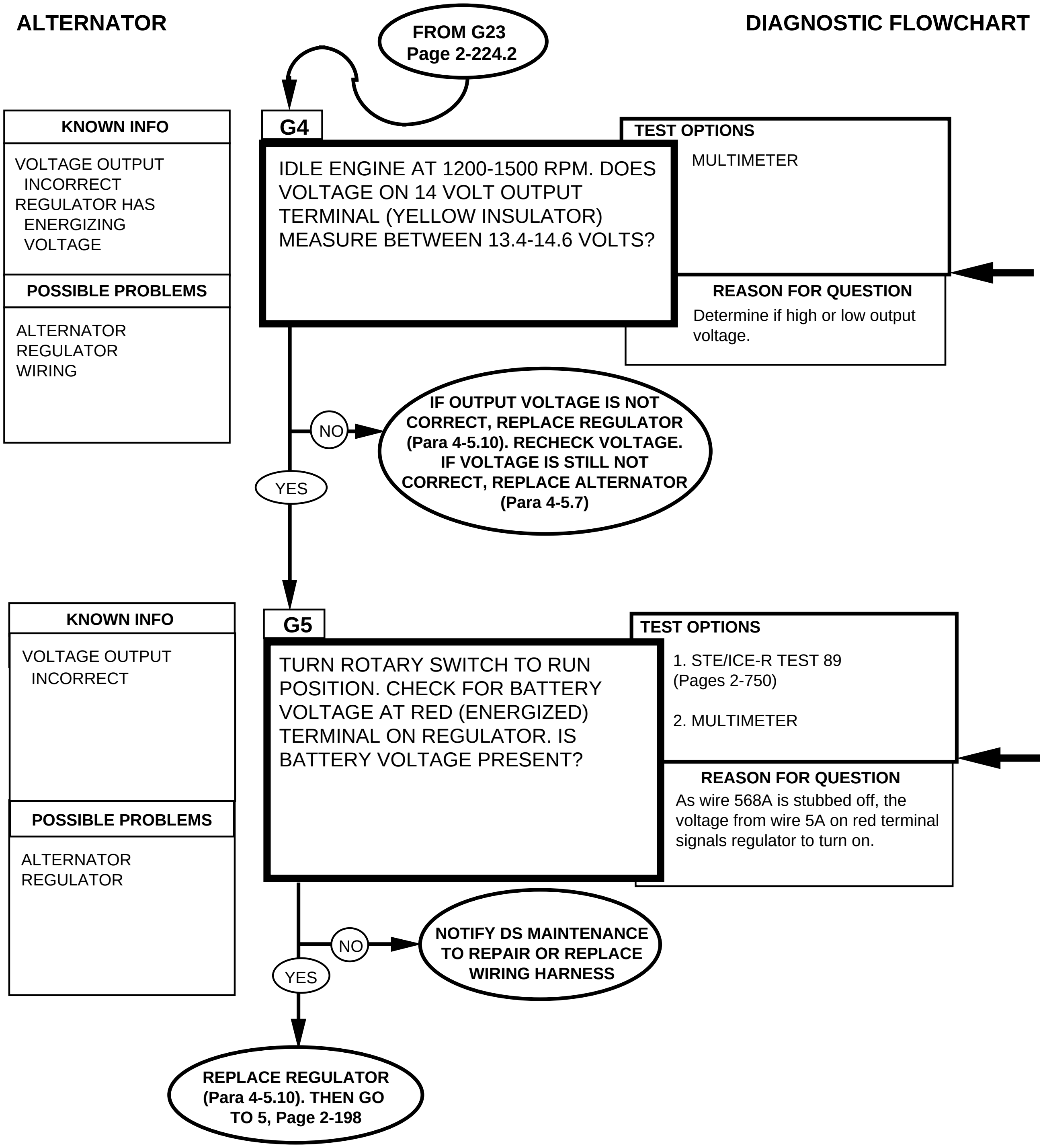
0-45 DC VOLTS
STE/ICE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.

2. Start Test 89, DC Volts.

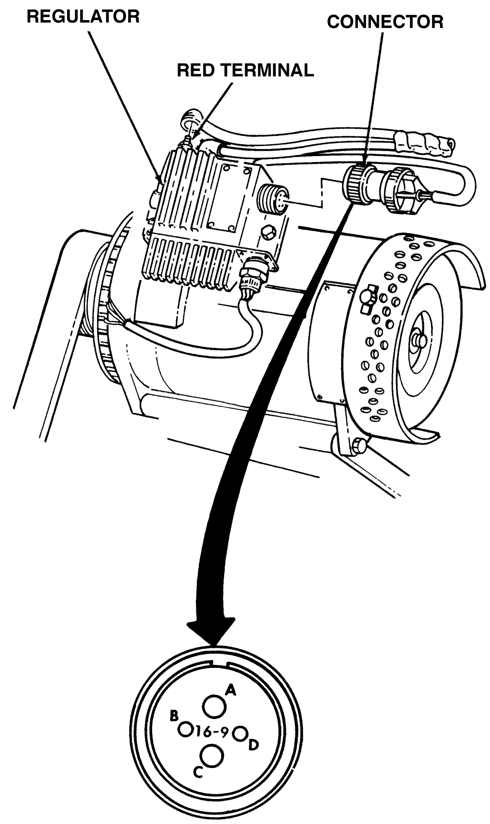
3. Displayed reading is in volts.

ALTERNATOR **DIAGNOSTIC FLOWCHART**



REFERENCE INFORMATION **ALTERNATOR**

1. Slide boot back from wire lug to expose red terminal.
2. Make contact at stud.



0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

ALTERNATOR DIAGNOSTIC FLOWCHART

H
FROM B1,
Page 2-204

H1

IS THIS A NIEHOFF 400 AMP DUAL VOLTAGE ALTERNATOR?

TEST OPTIONS

VISUAL

REASON FOR QUESTION

Must know model of alternator to perform tests.

NO → **SEE NOTE OPPOSITE PAGE**

YES ↓

H2

KNOWN INFO

VOLTAGE OUTPUT INCORRECT

POSSIBLE PROBLEMS

ALTERNATOR
REGULATOR
WIRING

START ENGINE AND ALLOW TO IDLE AT 1200-1500 RPM FOR 2-3 MINUTES. RECHECK VOLTAGE OUTPUT. IS ALTERNATOR OUTPUT LESS THAN 26 VOLTS?

TEST OPTIONS

STE/ICE-R TEST 10
(Interleave with control function 01 of page 2-734 then 89, page 2-750)

REASON FOR QUESTION

Determine if high or low output voltage.

NO → **IF OUTPUT VOLTAGE IS OVER 30.5 VOLTS, REPLACE REGULATOR (Para 4-5.11)**

YES ↓

H3

KNOWN INFO

VOLTAGE OUTPUT INCORRECT
REGULATOR HAS ENERGIZING VOLTAGE

POSSIBLE PROBLEMS

ALTERNATOR
REGULATOR

IDLE ENGINE AT 1200-1500 RPM. DOES VOLTAGE ON 14 VOLT OUTPUT TERMINAL (YELLOW INSULATOR) MEASURE BETWEEN 13.4-14.6 VOLTS?

TEST OPTIONS

MULTIMETER

REASON FOR QUESTION

Determine if high or low output voltage.

NO → **IF OUTPUT VOLTAGE IS NOT CORRECT, REPLACE REGULATOR (Para 4-5.14) RECHECK VOLTAGE. IF VOLTAGE IS STILL NOT CORRECT, REPLACE ALTERNATOR (Para 4-5.12)**

YES ↓

GO TO H4, Page 2-224.12

NOTE

For 60 amp Prestolite alternator, go to B, page 2-204.
For 100 amp Prestolite alternator, go to C, page 2-208.
For 200 amp Prestolite alternator, go to D, page 2-212.
For 200 amp single voltage Niehoff alternator, go to E, page 2-218.
For 100 amp single voltage Niehoff alternator, go to F, page 2-222.
For 100 amp dual voltage Niehoff alternator, go to F.1, page 2-224.2.
For 200 amp dual voltage Niehoff alternator, continue with G.
For 400 amp dual voltage Niehoff alternator, go to H, page 2-224.10.

NOTE

The regulator for this model alternator has overvoltage protection. Any output voltage over 30.5 volts is an overvoltage.

Output voltage of 26-30.5 is acceptable for this alternator.

ENGINE RPM STE/ICE-R TEST 10
1. Start test 10, Engine RPM. 2. Crank or start the engine. Displayed reading is RPM. Engine RPM should be 1200-1500.

NOTE

The regulator for this alternator has overvoltage protection. Any output voltage over 30.5 volts is an overvoltage.

Output voltage of 26-30.5 is acceptable for this alternator.

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC Volts. 3. Displayed reading is in volts.

ALTERNATOR DIAGNOSTIC FLOWCHART

FROM H3, Page 2-224.10

H4

KNOWN INFO

VOLTAGE OUTPUT INCORRECT

POSSIBLE PROBLEMS

ALTERNATOR
REGULATOR
WIRING

TURN ROTARY SWITCH TO RUN POSITION. CHECK FOR BATTERY VOLTAGE AT RED (ENERGIZE) TERMINAL ON REGULATOR. IS BATTERY VOLTAGE PRESENT?

TEST OPTIONS

1. STE/ICE-R TEST 89 (page 2-750)
2. MULTIMETER

REASON FOR QUESTION

As wire 568A is stubbed off, the voltage from wire 5A on red terminal signals regulator to turn on.

NO: NOIFY DS MAINTENANCE TO REPAIR OR REPLACE WIRING HARNESS

YES: Go to H5.

H5

KNOWN INFO

VOLTAGE OUTPUT INCORRECT

REGULATOR HAS ENERGIZING VOLTAGE

POSSIBLE PROBLEMS

ALTERNATOR
REGULATOR

DISCONNECT ALTERNATOR-TO-REGULATOR CABLE. START ENGINE AND SET IDLE 1200-1500 RPM. USING 15-AMP CAPACITY JUMPER WIRE, MOMENTARILY CONNECT TO PIN A OF ALTERNATOR CONNECTOR. DOES CURRENT AND VOLTAGE RISE DURING CONNECTION?

TEST OPTIONS

STE/ICE-R TEST 10 AND 90 (pages 2-734 and 2-751)

REASON FOR QUESTION

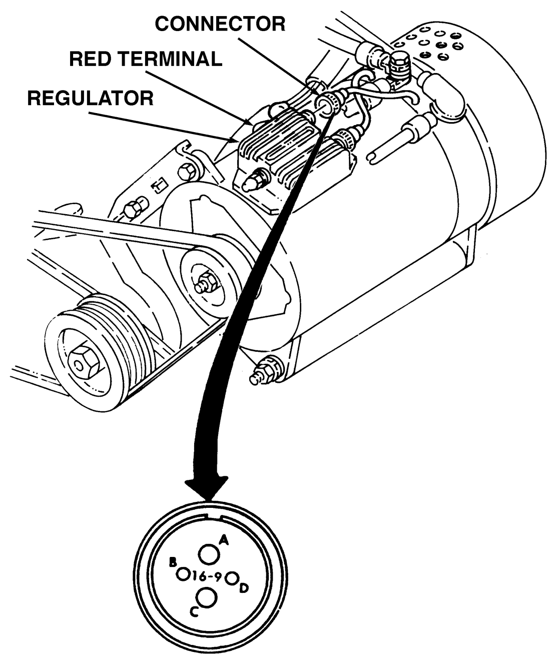
This connection applies full current loading to field coil. Alternator current output should be near maximum.

NO: REPLACE REGULATOR (Para 4-5.11). THEN GO TO 5, Page 2-198

YES: REPLACE REGULATOR (Para 4-5.14). THEN GO TO 5, Page 2-198

REFERENCE INFORMATION **ALTERNATOR**

1. Slide boot back from wire lug to expose red terminal.
2. Make contact at stud.



0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC Volts. 3. Displayed reading is in volts.

ENGINE RPM STE/ICE-R TEST 10
1. Start Test 10, Engine RPM. 2. Crank or start the engine. Displayed reading is RPM. Set engine to fast idle of 1200-1500 RPM.

0-1500 AMPS DC STE/ICE-R TEST 90
1. Connect probe. 2. Start Test 90, DC amps. 3. Displayed reading is in amps.

2-28. PROTECTIVE CONTROL BOX/DISTRIBUTION BOX TESTS

This protective control box /distribution box test can be run any time you think there may be a problem with the protective control box or distribution box, or if you were sent here from another system chain.

NOTE

- To perform PCB/distribution box diagnostics, a PCB test module is needed.
- For fabrication of PCB/distribution box test module, refer to Appendix D, Figs. 96-113, or requesitioned with NSN 6625-01-440-4522.

PROTECTIVE CONTROL BOX/DISTRIBUTION BOX DIAGNOSTIC FLOWCHART

START

1

ENGAGE PARKING BRAKE.
ENSURE ALL VEHICLE GROUNDS AFFECTING PROTECTIVE CONTROL BOX/DISTRIBUTION BOX ARE SECURE.

2

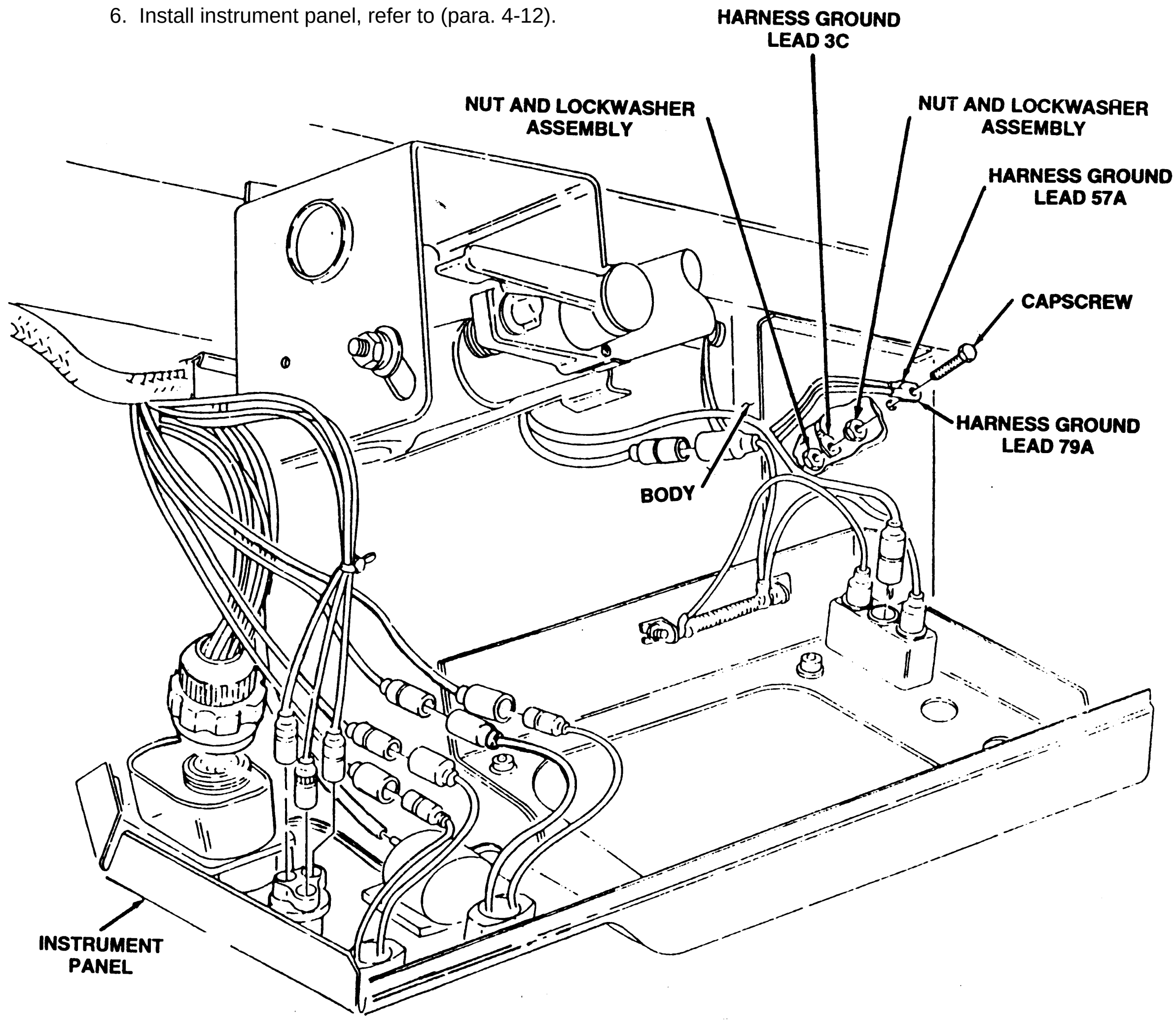
ENSURE ALL ENGINE AND ELECTRICAL ACCESSORY SWITCHES ARE IN THE "OFF" POSITION.

3

PLACE TRANSMISSION AND TRANSFER CASE SHIFT LEVERS IN NEUTRAL DRIVE POSITION.

GO TO 4,
Page 2-230

1. Remove instrument panel, refer to (para. 4-12).
2. Remove nut and lockwasher assembly and engine harness ground lead 3C from body. Remove nut and lockwasher assembly , capscrew, and harness ground leads 57A and 79A from body. Discard nut and lockwasher assemblies.
3. Inspect and clean wires and connection points.
4. Apply antiseize compound to harness ground leads 57A and 79A and install on body with capscrew and nut and lockwasher assembly. Apply antiseize compound to engine harness ground lead 3C and install on body with nut and lockwasher assembly.
5. Cover leads 3C, 57A, and 79A with RTV.
6. Install instrument panel, refer to (para. 4-12).



PROTECTIVE CONTROL BOX/DISTRIBUTION BOX

DIAGNOSTIC FLOWCHART

FROM 3, Page 2-228

4

DISCONNECT BATTERY GROUND CABLE.

5

DISCONNECT THE BODY AND ENGINE WIRING HARNESS CANNON PLUGS FROM PROTECTIVE CONTROL BOX/DISTRIBUTION BOX.
NOTE: THE DISTRIBUTION BOX HAS AN ADDITIONAL GLOWPLUG HARNESS.

6

CONNECT DIAGNOSTIC TEST MODULE HARNESS RECEPTACLE AND CONNECTORS TO BODY AND ENGINE WIRING HARNESS CANNON PLUGS.

GO TO 7, Page 2-232

WARNING

Disconnect negative battery cable before disconnecting and reconnecting protective control box/distribution box harness. Failure to do so may result in injury to personnel or damage to equipment.

PROTECTIVE CONTROL BOX/DISTRIBUTION BOX — DIAGNOSTIC FLOWCHART

FROM 6, Page 2-230

KNOWN INFO

NOTHING

POSSIBLE PROBLEMS

- BATTERIES BAD
- LEAD 57B BAD GROUND
- PARKING BRAKE SWITCH BAD
- BODY HARNESS WIRES BAD
- GLOWPLUG CONTROLLER BAD
- ALTERNATOR BAD
- HARNESS WIRE 2A BAD
- IGNITION SWITCH BAD
- HARNESS WIRE 29A BAD
- HARNESS WIRE 29C BAD
- PROTECTIVE CONTROL BOX/ DISTRIBUTION BOX BAD

7 CONNECT BATTERY GROUND CABLE WITH IGNITION SWITCH IN THE “OFF” POSITION. ARE ANY LEDS “ON”? (REFER TO TABLE AT RIGHT)

TEST OPTIONS

1. TRY IT
2. VISUAL

REASON FOR QUESTION

If no LEDs are ON, that would indicate malfunctioning batteries.

NO → GO TO 1, Page 2-252

YES ↓

KNOWN INFO

BATTERIES OK

POSSIBLE PROBLEMS

- LEAD 57B BAD GROUND
- PARKING BRAKE SWITCH BAD
- BODY HARNESS WIRES BAD
- ALTERNATOR BAD
- HARNESS WIRE 2A BAD
- IGNITION SWITCH BAD
- HARNESS WIRE 29A BAD
- HARNESS WIRE 29C BAD
- PROTECTIVE CONTROL BOX/ DISTRIBUTION BOX BAD

8 ARE LEDS 3 AND 4 “ON”?

TEST OPTIONS

VISUAL

REASON FOR QUESTION

If these LEDs are not ON, that would indicate protective control box (PCB)/distribution box malfunctions.

!!

NO → REPLACE PROTECTIVE CONTROL BOX/DISTRIBUTION BOX

YES ↓

KNOWN INFO

BATTERIES OK

POSSIBLE PROBLEMS

- LEAD 57B BAD GROUND
- PARKING BRAKE SWITCH BAD
- BODY HARNESS WIRES BAD
- ALTERNATOR BAD
- HARNESS WIRE 2A BAD
- IGNITION SWITCH BAD
- HARNESS WIRE 29A BAD
- HARNESS WIRE 29C BAD
- PROTECTIVE CONTROL BOX/ DISTRIBUTION BOX BAD

9 IS LED 7 “ON”?

TEST OPTIONS

VISUAL

REASON FOR QUESTION

If this LED is not ON, that would indicate a bad connection to ground.

NO → REPAIR/PROPERLY GROUND BODY HARNESS WIRE 57B

YES → GO TO 10, Page 2-234

REFERENCE INFORMATION

PROTECTIVE CONTROL BOX/DISTRIBUTION BOX

NOTE

This analyzer requires all glow plugs be serviceable and the batteries fully charged in order to operate properly. Prior to performing diagnostic checks ensure these two items are checked. If either of these two items are found to be faulty, repair/replace prior to beginning checks. Failure to do so will cause the analyzer to give false readings, therefore causing the needless replacement of serviceable components.

WARNING

Disconnect negative battery cable before disconnecting and reconnecting protective control box/distribution box harness. Failure to do so may result in injury to personnel or damage to equipment.

Replace protective control box, refer to (para. 4-5).
Replace distribution box, refer to (para. 4-5.1).

Repair lead connectors, refer to (para. 4-85).
Repair lead, refer to (para. 4-85).

IGNITION SWITCH POSITION	DIAGNOSTIC CHECKS (GO TASKS) (For vehicles with protective control box/distribution box)
OFF	**LED's 1, 3, 4, 6, 7, "ON"; Remaining LED's "OFF" If all LED's are "OFF", battery power is not available. If LED 3 or 4 is "OFF", replace the PCB/distribution box. If LED 7 is "OFF", body harness wire 57B is not grounded.**
RUN - (PCB)	**LED's 1,2,3,4,5,6,7,8,11,13 "ON". LED 13 "OFF" after a few seconds (glow plug warm up time).**
(ENGINE NOT RUNNING-PCB)	**LED 13 "OFF if engine is at operating temperature. LED 11 cycling "ON" and "OFF" (glow plug controller operatlon) LED's 9, 10, 12 "OFF". Release parking brake lever. LED 6 "OFF". Engage parking brake lever. LED 6 "ON". If all LED's are "OFF", no battery power is available. If LED 3 or 4 is "OFF", replace the PCB. If LED 7 is "OFF", harness wire 57B is not grounded If LED 2 is "OFF", and all glow plugs are serviceable, replace the PCB. If LED 5 is "OFF", replace the PCB is LED 13 is "ON". If LED's 5 and 13 are "OFF", the ignition switch is defective and/or harness wires 29A and 29C are defective. If LED 13 is "OFF" aud LED 5 is "ON" and the engine is not at operating temperature from a previous run, replace the PCB. The PCB is operational if the engine is at operating temperature from a previous run. If LED 6 is "OFF" and the parking brake lever is engaged the parking brake switch is defective or the wires in the body harness are defective If LED 8 is "OFF", replace the PCB. If LED 11 is "OFF", check the glow plug controller. If the glow plug controller is functioning properly, replace the PCB.**
RUN - (Distribution Box)	**LED's 1, 2, 3, 4, 5, 6, 7, 8,13 "ON"; remaining LED's "OFF" LED 13 "OFF" after a few seconds (glow plug warm up time).**
(ENGINE NOT RUNNING-Distribution Box)	**LED 13 "OFF" if engine is at operating temperature. LED 6 "OFF if parking brake lever is released. LED 6 "ON" if parking brake lever is engaged If LED 2, 3, 4, or 8 is "OFF", replace distribution box. If LED 7 is "OFF", body harness wire 57B is not grounded If LED 5 is "OFF", replace distribution box if LED 13 is "ON". If LED's 5 and 13 are "OFF", the ignition switch and/or harness wires 29A and 29C are defective. If LED 13 is "OFF" and LED 5 is "ON", and engine is not at operating temperature from a previous run, replace distribution box. Distribution box is operation if engine is at operating temperature from a previous run. If LED 6 is "OFF"and the parking brake lever is engaged the parking brake switch and/or the wires in the body harness are defective.**
START (ENGINE CRANKING-PCB)	**LED 10 momentarily "ON" and then remains "OFF" (starter motor frequency lockout). If LED 11 and 13 remain "ON" or engine does not crank; check battery voltage; charge is low. If LED 10 does not momentarily come "ON" and then stays "OFF", replace PCB.**
START (ENGINE CRANKING-Distribution Box)	**LED 10 momentarily "ON". If LED 13 is "ON or engine does not crank; check battery voltage; charge is low. If LED 10 does not momentarily come "ON" and then stays "OFF", and ignition switch is operating properly, replace distribution box.**
RUN (ENGINE RUNNING-PCB)	**LED's 1,2,3,4,5,6,7,8,9,12 "ON" LED 11 cycling "ON" and "OFF" (glow plug controller operation): "OFF" time interval increases as engine warms up. LED 11 "OFF" (when engine is at operating temperature). LED 11 may remain "OFF" (when engine is at operating temperature from prevlous run). LED 13 "OFF" Release parking brake lever. LED 6 "OFF". Engage parking brake lever. LED 6 "ON". If LED 2, 3, 4, 5, or 8 is "OFF" and all glow plugs are serviceable replace the PCB. If LED 7 is "OFF", the body harness wire 57B is not grounded. If LED 9 is "OFF" and LED 12 is "ON", replace the PCB. If LED's 9 and 12 are "OFF", there is no alternator output (alternating current tap) available and/or the engine harness wire 2A is defective. If LED 11 is "OFF" and the engine is not at operating temperature, check the glow plug controller. If the glow plug controller is functioning properly, replace the PCB.**
RUN (ENGINE RUNNING-Distribution Box)	**LED's 1, 2, 3, 4, 5, 6, 7, 8, 12 "ON", remaining LED's "OFF" LED 6 "OFF" if parking brake lever is released. LED 6 "ON" if parking brake lever is released If LED's 2, 3, 4, 5 or 8 is "OFF" replace distribution box. If LED 7 is "OFF", body harness wire 57B is not grounded If LED 12 is "OFF", there is no alternator output (alternating current tap) available and/or engine harness wire 2A is defective.**

PROTECTIVE CONTROL BOX/DISTRIBUTION BOX

DIAGNOSTIC FLOWCHART

KNOWN INFO

BATTERIES OK
LEAD 57B GROUND OK

POSSIBLE PROBLEMS

PARKING BRAKE SWITCH BAD
BODY HARNESS WIRES BAD
GLOWPLUG CONTROLLER BAD
ALTERNATOR BAD
HARNESS WIRE 2A BAD
IGNITION SWITCH BAD
HARNESS WIRE 29A BAD
HARNESS WIRE 29C BAD
PROTECTIVE CONTROL BOX/ DISTRIBUTION BOX BAD

FROM 9, Page 2-232

10

WITH THE IGNITION SWITCH IN "RUN" (ENGINE NOT RUNNING) POSITION, ARE ANY LEDs "ON"? (REFER TO TABLE AT RIGHT)

TEST OPTIONS

1.TRY IT

2.VISUAL

REASON FOR QUESTION

If no LEDs are ON, that would indicate malfunctioning batteries.

NO → **GO TO 1, Page 2-252**

YES ↓

KNOWN INFO

BATTERIES OK
LEAD 57B GROUND OK

POSSIBLE PROBLEMS

PARKING BRAKE SWITCH BAD
BODY HARNESS WIRES BAD
GLOWPLUG CONTROLLER BAD
ALTERNATOR BAD
HARNESS WIRE 2A BAD
IGNITION SWITCH BAD
HARNESS WIRE 29A BAD
HARNESS WIRE 29C BAD
PROTECTIVE CONTROL BOX/ DISTRIBUTION BOX BAD

11

IS LED 7 "ON"?

TEST OPTIONS

VISUAL

REASON FOR QUESTION

If these LEDs are not ON that would indicate a bad connection to ground.

NO → **REPAIR GROUND BODY HARNESS WIRE 57B**

YES ↓

KNOWN INFO

BATTERIES OK
LEAD 57B GROUND OK

POSSIBLE PROBLEMS

PARKING BRAKE SWITCH BAD
BODY HARNESS WIRES BAD
GLOWPLUG CONTROLLER BAD
ALTERNATOR BAD
HARNESS WIRE 2A BAD
IGNITION SWITCH BAD
HARNESS WIRE 29A BAD
HARNESS WIRE 29C BAD
PROTECTIVE CONTROL BOX/ DISTRIBUTION BOX BAD

12

ARE LEDs 2, 3, AND 4 "ON"?

TEST OPTIONS

VISUAL

REASON FOR QUESTION

If those LEDs are not ON, that would indicate a protective control box (PCB)/distribution box malfunction.

NO → **REPLACE PROTECTIVE CONTROL BOX/DISTRIBUTION BOX**

YES ↓

GO TO 13, Page 2-236

REFERENCE INFORMATION

NOTE

This analyzer requires all glow plugs be serviceable and the batteries fully charged in order to operate properly. Prior to performing diagnostic checks ensure these two items are checked. If either of these two items are found to be faulty, repair/replace prior to beginning checks. Failure to do so will cause the analyzer to give false readings, therefore causing the needless replacement of serviceable components.

Repair lead connectors, refer to (para. 4-85).
Repair lead, refer to (para. 4-85).

WARNING

Disconnect negative battery cable before disconnecting and reconnecting protective control box/distribution box harness. Failure to do so may result in injury to personnel or damage to equipment.

Replace protective control box, refer to (para. 4-5).
Replace distribution box, refer to (para. 4-5.1).

PROTECTIVE CONTROL BOX/DISTRIBUTION BOX

	DIAGNOSTIC CHECKS (GO TASKS) (For Vehicles with protective control box/distribution box)
OFF	LED's 1, 3, 4, 6, 7, "ON"; Remaining LED's "OFF" If all LED's are "OFF", battery power is not available. If LED 3 or 4 is "OFF", replace the PCB/distribution box. If LED 7 is "OFF", body harness wire 57B is not grounded.
RUN - (PCB)	LED's 1,2,3,4,5,6,7,8,11,13 "ON". LED 13 "OFF" after a few seconds (glow plug warm up time).
(ENGINE NOT RUNNING-PCB)	LED 13 "OFF if engine is at operating temperature. LED 11 cycling "ON" and "OFF" (glow plug controller operation) LED's 9, 10, 12 "OFF". Release parking brake lever. LED 6 "OFF". Engage parking brake lever. LED 6 "ON". If all LED's are "OFF", no battery power is available. If LED 3 or 4 is "OFF", replace the PCB. If LED 7 is "OFF", harness wire 57B is not grounded If LED 2 is "OFF", and all glow plugs are serviceable, replace the PCB. If LED 5 is "OFF", replace the PCB is LED 13 is "ON". If LED's 5 and 13 are "OFF", the ignition switch is defective and/or harness wires 29A and 29C are defective. If LED 13 is "OFF" aud LED 5 is "ON" and the engine is not at operating temperature from a previous run, replace the PCB. The PCB is operational if the engine is at operating temperature from a previous run. If LED 6 is "OFF" and the parking brake lever is engaged the parking brake switch is defective or the wires in the body harness are defective If LED 8 is "OFF", replace the PCB. If LED 11 is "OFF", check the glow plug controller. If the glow plug controller is functioning properly, replace the PCB.
RUN - (Distribution Box)	LED's 1, 2, 3, 4, 5, 6, 7, 8,13 "ON"; remaining LED's "OFF" LED 13 "OFF" after a few seconds (glow plug warm up time).
(ENGINE NOT RUNNING-Distribution Box)	LED 13 "OFF" if engine is at operating temperature. LED 6 "OFF if parking brake lever is released. LED 6 "ON" if parking brake lever is engaged If LED 2, 3, 4, or 8 is "OFF", replace distribution box. If LED 7 is "OFF", body harness wire 57B is not grounded If LED 5 is "OFF", replace distribution box if LED 13 is "ON". If LED's 5 and 13 are "OFF", the ignition switch and/or harness wires 29A and 29C are defective. If LED 13 is "OFF" and LED 5 is "ON", and engine is not at operating temperature from a previous run, replace distribution box. Distribution box is operation if engine is at operating temperature from a previous run. If LED 6 is "OFF"and the parking brake lever is engaged the parking brake switch and/or the wires in the body harness are defective.
START (ENGINE CRANKING-PCB)	LED 10 momentarily "ON" and then remains "OFF" (starter motor frequency lockout). If LED 11 and 13 remain "ON" or engine does not crank; check battery voltage; charge is low. If LED 10 does not momentarily come "ON" and then stays "OFF", replace PCB.
START (ENGINE CRANKING-Distribution Box)	LED 10 momentarily "ON". If LED 13 is "ON or engine does not crank; check battery voltage; charge is low. If LED 10 does not momentarily come "ON" and then stays "OFF", and ignition switch is operating properly, replace distribution box.
RUN (ENGINE RUNNING-PCB)	LED's 1,2,3,4,5,6,7,8,9,12 "ON" LED 11 cycling "ON" and "OFF" (glow plug controller operation): "OFF" time interval increases as engine warms up. LED 11 "OFF" (when engine is at operating temperature). LED 11 may remain "OFF" (when engine is at operating temperature from prevlous run). LED 13 "OFF" Release parking brake lever. LED 6 "OFF". Engage parking brake lever. LED 6 "ON". If LED 2, 3, 4, 5, or 8 is "OFF" and all glow plugs are serviceable replace the PCB. If LED 7 is "OFF", the body harness wire 57B is not grounded. If LED 9 is "OFF" and LED 12 is "ON", replace the PCB. If LED's 9 and 12 are "OFF", there is no alternator output (alternating current tap) available and/or the engine harness wire 2A is defective. If LED 11 is "OFF" and the engine is not at operating temperature, check the glow plug controller. If the glow plug controller is functioning properly, replace the PCB.
RUN (ENGINE RUNNING-Distribution Box)	LED's 1, 2, 3, 4, 5, 6, 7, 8, 12 "ON", remaining LED's "OFF" LED 6 "OFF" if parking brake lever is released. LED 6 "ON" if parking brake lever is released If LED's 2, 3, 4, 5 or 8 is "OFF" replace distribution box. If LED 7 is "OFF", body harness wire 57B is not grounded If LED 12 is "OFF", there is no alternator output (alternating current tap) available and/or engine harness wire 2A is defective.

PROTECTIVE CONTROL BOX/DISTRIBUTION BOX

DIAGNOSTIC FLOWCHART

FROM 12
Page 2-234

KNOWN INFO

BATTERIES OK
LEAD 57B GROUND OK

POSSIBLE PROBLEMS

PARKING BRAKE SWITCH BAD
BODY HARNESS WIRES BAD
GLOWPLUG CONTROLLER BAD
ALTERNATOR BAD
HARNESS WIRE 2A BAD
IGNITION SWITCH BAD
HARNESS WIRE 29A BAD
HARNESS WIRE 29C BAD
PROTECTIVE CONTROL BOX/ DISTRIBUTION BOX BAD

13

DID LED 13 COME "ON" WITH PCB? IF ENGINE IS AT OPERATING TEMPERATURE, LED 13 WILL NOT COME ON. WITH DISTRIBUTION BOX, LIGHT WILL COME ON WHEN ENGINE IS AT OPERATING TEMPERATURE.

TEST OPTIONS

1.TRY IT

2.VISUAL

REASON FOR QUESTION

If this LED is not ON, that would indicate either malfunctioning ignition switch, damaged harness wires 29A and 29C, or malfunctioning protective control box (PCB)/distribution box.

NO → GO TO A1, Page 2-248

YES ↓

KNOWN INFO

BATTERIES OK
LEAD 57B GROUND OK
IGNITION SWITCH OK
HARNESS WIRE 29A OK
HARNESS WIRE 29C OK

POSSIBLE PROBLEMS

PARKING BRAKE SWITCH BAD
BODY HARNESS WIRES BAD
GLOWPLUG CONTROLLER BAD
ALTERNATOR BAD
HARNESS WIRE 2A BAD
PROTECTIVE CONTROL BOX/ DISTRIBUTION BOX BAD

14

IS LED 5 "ON"?

TEST OPTIONS

VISUAL

REASON FOR QUESTION

If this LED is not ON, that would indicate protective control box (PCB)/distribution box malfunctions.

!!

NO → REPLACE PROTECTIVE CONTROL BOX/DISTRIBUTION BOX

YES ↓

KNOWN INFO

BATTERIES OK
LEAD 57B GROUND OK
IGNITION SWITCH OK
HARNESS WIRE 29A OK
HARNESS WIRE 29C OK

POSSIBLE PROBLEMS

PARKING BRAKE SWITCH BAD
BODY HARNESS WIRES BAD
GLOWPLUG CONTROLLER BAD
ALTERNATOR BAD
HARNESS WIRE 2A BAD
PROTECTIVE CONTROL BOX/ DISTRIBUTION BOX BAD

15

IS LED 6 "ON"?

TEST OPTIONS

VISUAL

REASON FOR QUESTION

If this LED is not ON, that would indicate a parking brake switch or brake warning light malfunction, or damage to body harness wires.

NO → REPLACE PARKING BRAKE SWITCH AND/ OR REPAIR WIRES IN BODY HARNESS

YES ↓

GO TO 16, Page 2-238

WARNING

Disconnect negative battery cable before disconnecting and reconnecting protective control box/distribution box harness. Failure to do so may result in injury to personnel or damage to equipment.

Replace protective control box, refer to (para. 4-5).

Replace distribution box, refer to (para. 4-5.1).

Repair lead connectors, refer to (para. 4-85).

Repair leads, refer to (para. 4-85).

PROTECTIVE CONTROL BOX/DISTRIBUTION BOX DIAGNOSTIC FLOWCHART

FROM 15, Page 2-236

KNOWN INFO

BATTERIES OK
LEAD 57B GROUND OK
IGNITION SWITCH OK
HARNESS WIRE 29A OK
HARNESS WIRE 29C OK
PARKING BRAKE SWITCH OK
BODY HARNESS WIRES OK

POSSIBLE PROBLEMS

GLOWPLUG CONTROLLER BAD
ALTERNATOR BAD
HARNESS WIRE 2A BAD
PROTECTIVE CONTROL BOX/ DISTRIBUTION BOX BAD

16

IS LED 8 “ON”?
FOR DISTRIBUTION BOX, IF YES, GO TO 18.

TEST OPTIONS

1.TRY IT
2.VISUAL

REASON FOR QUESTION

If this LED is not ON, that would indicate a protective control box/distribution box malfunction.

!!

NO → REPLACE PROTECTIVE CONTROL BOX/DISTRIBUTION BOX

YES ↓

KNOWN INFO

BATTERIES OK
LEAD 57B GROUND OK
IGNITION SWITCH OK
HARNESS WIRE 29A OK
HARNESS WIRE 29C OK
PARKING BRAKE SWITCH OK
BODY HARNESS WIRES OK

POSSIBLE PROBLEMS

GLOWPLUG CONTROLLER BAD
ALTERNATOR BAD
HARNESS WIRE 2A BAD
PROTECTIVE CONTROL BOX/ DISTRIBUTION BOX BAD

17

IS LED 11 “ON”?
DURING GLOW PLUG CYCLING, LED 11 MAY FLICKER.
NOTE: LED 11 IS NOT USED WITH THE DISTRIBUTION BOX

TEST OPTIONS

VISUAL

REASON FOR QUESTION

If this LED is not ON, that would indicate a glowplugs controller malfunction.

NO → GO TO D1, Page 2-314

YES ↓

KNOWN INFO

BATTERIES OK
LEAD 57B GROUND OK
IGNITION SWITCH OK
HARNESS WIRE 29A OK
HARNESS WIRE 29C OK
PARKING BRAKE SWITCH OK
BODY HARNESS WIRES OK
GLOWPLUG CONTROLLER OK

POSSIBLE PROBLEMS

ALTERNATOR BAD
HARNESS WIRE 2A BAD
PROTECTIVE CONTROL BOX/ DISTRIBUTION BOX BAD

18

WITH THE IGNITION SWITCH IN THE “START” (ENGINE CRANKING) POSITION, DO LEDs 11 AND 13 GO “OUT”, AND DOES ENGINE CRANK?
NOTE: LED 11 DOES NOT FUNCTION WITH DISTRIBUTION BOX.

TEST OPTIONS

1.TRY IT
2.VISUAL

REASON FOR QUESTION

If these LEDs do not go ON, that would indicate malfunctioning batteries.

NO → CHECK BATTERY VOLTAGE AND CHARGE IF NEEDED

YES ↓

GO TO 19, Page 2-240

WARNING

Disconnect negative battery cable before disconnecting and reconnecting protective control box or distribution box harness. Failure to do so may result in injury to personnel or damage to equipment.

Replace protective control box, refer to (para. 4-5).
Replace distribution box, refer to (para. 4-5.1).

Replace glowplug controller. refer to (para. 4-29).

Service/repair batteries. refer to (para. 4-79).

PROTECTIVE CONTROL BOX/DISTRIBUTION BOX

DIAGNOSTIC FLOWCHART

FROM 18,
Page 2-238

KNOWN INFO

BATTERIES OK
LEAD 57B GROUND OK
IGNITION SWITCH OK
HARNESS WIRE 29A OK
HARNESS WIRE 29C OK
PARKING BRAKE SWITCH OK
BODY HARNESS WIRES OK

POSSIBLE PROBLEMS

ALTERNATOR BAD
HARNESS WIRE 2A BAD
PROTECTIVE CONTROL BOX/ DISTRIBUTION BOX BAD

19

DOES LED 10 MOMENTARILY COME “ON” THEN STAY “OFF”?

TEST OPTIONS

VISUAL

REASON FOR QUESTION

If this LED is not momentarily ON, that would indicate a protective control box (PCB)/distribution box malfunction.

!!

NO → **REPLACE PROTECTIVE CONTROL BOX/DISTRIBUTION BOX**

YES ↓

KNOWN INFO

BATTERIES OK
LEAD 57B GROUND OK
IGNITION SWITCH OK
HARNESS WIRE 29A OK
HARNESS WIRE 29C OK
PARKING BRAKE SWITCH OK
BODY HARNESS WIRES OK

POSSIBLE PROBLEMS

ALTERNATOR BAD
HARNESS WIRE 2A BAD
PROTECTIVE CONTROL BOX/ DISTRIBUTION BOX BAD

20

WITH THE IGNITION SWITCH IN THE “RUN” (ENGINE RUNNING) POSITION, ARE LEDs 2,3,4,5, AND 8 “ON”?

TEST OPTIONS

1.TRY IT

2.VISUAL

REASON FOR QUESTION

If these LEDs are not ON, that would indicate a protective control box (PCB)/distribution box malfunction.

!!

NO → **REPLACE PROTECTIVE CONTROL BOX/DISTRIBUTION BOX**

YES ↓

KNOWN INFO

BATTERIES OK
IGNITION SWITCH OK
HARNESS WIRE 29A OK
HARNESS WIRE 29C OK
PARKING BRAKE SWITCH OK
BODY HARNESS WIRES OK

POSSIBLE PROBLEMS

ALTERNATOR BAD
LEAD 57B GROUND BAD
HARNESS WIRE 2A BAD
PROTECTIVE CONTROL BOX/ DISTRIBUTION BOX BAD

21

IS LED 7 “ON”?

TEST OPTIONS

VISUAL

REASON FOR QUESTION

If this LED is not ON, that would indicate a bad connection to ground.

NO → **REPAIR GROUND BODY HARNESS WIRE 57B**

YES ↓

GO TO 22, Page 2-242

WARNING

Disconnect negative battery cable before disconnecting and reconnecting protective control box or distribution box harness. Failure to do so may result in injury to personnel or damage to equipment.

Replace protective control box, refer to (para. 4-5).
Replace distribution box, refer to (para. 4-5.1).

WARNING

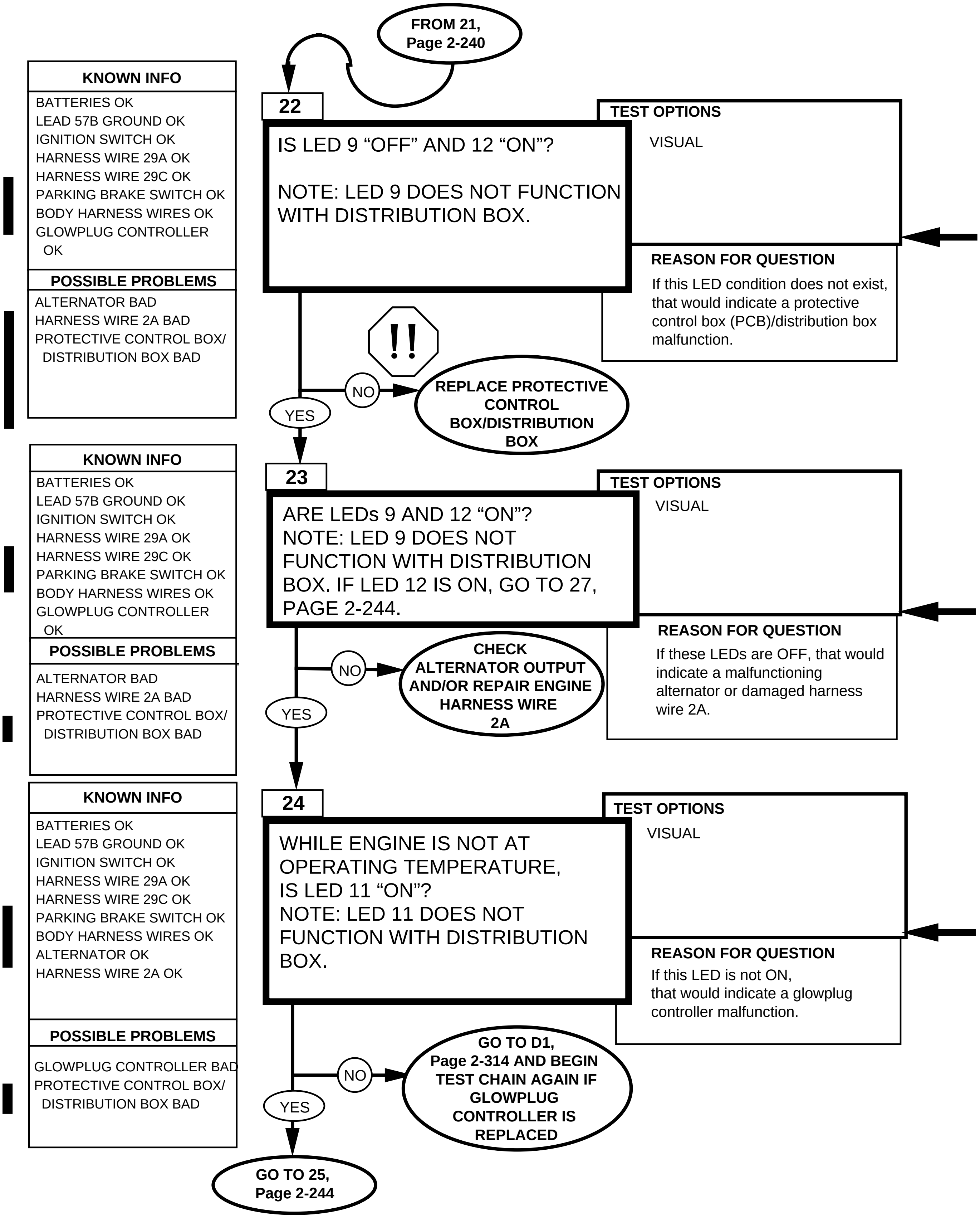
Disconnect negative battery cable before disconnecting and reconnecting protective control box or distribution box harness. Failure to do so may result in injury to personnel or damage to equipment.

Replace protective control box, refer to (para. 4-5).
Replace distribution box, refer to (para. 4-5.1).

Repair lead connectors, refer to (para. 4-85).

Repair leads, refer to (para. 4-85).

PROTECTIVE CONTROL BOX/DISTRIBUTION BOX — DIAGNOSTIC FLOWCHART



WARNING

Disconnect negative battery cable before disconnecting and reconnecting protective control box or distribution box harness. Failure to do so may result in injury to personnel or damage to equipment.

Replace protective control box, refer to (para. 4-5).
Replace distribution box, refer to (para. 4-5.1).

Repair lead connectors, refer to (para. 4-85).
Repair leads, refer to (para. 4-85).

Repair glowplug controller, refer to (para. 4-29).

PROTECTIVE CONTROL BOX/DISTRIBUTION BOX — DIAGNOSTIC FLOWCHART

FROM 24, Page 2-242

KNOWN INFO

BATTERIES OK
LEAD 57B GROUND OK
IGNITION SWITCH OK
HARNESS WIRE 29A OK
HARNESS WIRE 29C OK
PARKING BRAKE SWITCH OK
BODY HARNESS WIRES OK
GLOWPLUG CONTROLLER OK
ALTERNATOR OK
HARNESS WIRE 2A OK

POSSIBLE PROBLEMS

PROTECTIVE CONTROL BOX BAD

25

IS LED 11 CYCLING “ON” AND “OFF”?
NOTE:
LED 11 DOES NOT FUNCTION WITH DISTRIBUTION BOX.

TEST OPTIONS

VISUAL

REASON FOR QUESTION

If LED is not cycling ON and OFF, that would indicate a protective control box (PCB) malfunction.

NO → **REPLACE PROTECTIVE CONTROL BOX**

!!

YES ↓

KNOWN INFO

BATTERIES OK
LEAD 57B GROUND OK
IGNITION SWITCH OK
HARNESS WIRE 29A OK
HARNESS WIRE 29C OK
PARKING BRAKE SWITCH OK
BODY HARNESS WIRES OK
ALTERNATOR OK
HARNESS WIRE 2A OK
PROTECTIVE CONTROL BOX OK

POSSIBLE PROBLEMS

GLOWPLUG CONTROLLER BAD

26

AT ENGINE OPERATING TEMPERATURE, DOES LED 11 STOP CYCLING “ON” AND “OFF”?
NOTE: LED 11 DOES NOT FUNCTION WITH DISTRIBUTION BOX.

TEST OPTIONS

VISUAL

REASON FOR QUESTION

If LED does not stop cycling ON and OFF, that would indicate a glowplugs controller malfunction.

NO → **GO TO D1, Page 2-314 AND BEGIN TEST CHAIN AGAIN IF GLOW PLUG CONTROLLER IS REPLACED**

YES ↓

27

NO PROTECTIVE CONTROL BOX OR DISTRIBUTION BOX FAULT FOUND.

GO TO 28, Page 2-246

WARNING

Disconnect negative battery cable before disconnecting and reconnecting protective control box/distribution box harness. Failure to do so may result in injury to personnel or damage to equipment.

Replace protective control box, refer to (para. 4-5).

PROTECTIVE CONTROL BOX/DISTRIBUTION BOX

DIAGNOSTIC FLOWCHART

FROM 27,
Page 2-244

28

DISCONNECT BATTERY GROUND CABLE.

29

DISCONNECT BODY AND ENGINE WIRING HARNESS CANNON PLUGS FROM DIAGNOSTIC TEST MODULE.

DISCONNECT CONNECTORS FROM PROTECTIVE CONTROL BOX/DISTRIBUTION BOX.

30

CONNECT BODY AND ENGINE WIRING HARNESS CANNON PLUGS TO PROTECTIVE CONTROL BOX/DISTRIBUTION BOX.

CONNECT BATTERY GROUND CABLE.

REFERENCE INFORMATION

PROTECTIVE CONTROL BOX/DISTRIBUTION BOX

WARNING

Disconnect negative battery cable before disconnecting and reconnecting protective control box or distribution box harness. Failure to do so may result in injury to personnel or damage to equipment.

PROTECTIVE CONTROL BOX/DISTRIBUTION BOX DIAGNOSTIC FLOWCHART

A
FROM 13,
Page 2-236

31

IF LED 5 IS "ON," REPLACE PROTECTIVE CONTROL BOX/DISTRIBUTION BOX, OR REPAIR/REPLACE IGNITION SWITCH AND/OR HARNESS WIRES 29A AND 29C.

Replace protective control box, refer to (para. 4-5).
Replace distribution box, refer to (para. 4-5.1).
Repair/replace rotary switch, refer to (para. 4-7).
Repair/replace leads 29A and 29C, refer to (para. 4-85).

2-29. BATTERY CIRCUIT TEST

These Battery Circuit tests maybe run any time you think you have a battery problem of if you were sent here by another test chain. Just follow the path, answering the questions. Additional information and notes are given on the facing page when necessary.

The fold-out page shows the location of the major components of the Battery Circuit in case you are not familiar with them. Fold-out page FO-7 may be left open for reference while testing.

BATTERY CIRCUIT — DIAGNOSTIC FLOWCHART

START

1

KNOWN INFO

NOTHING

POSSIBLE PROBLEMS

BATTERIES
CABLES
ALTERNATOR CIRCUIT
CABLE CONNECTIONS

ARE ALL BATTERY CONNECTIONS CLEAN AND TIGHT ?

TEST OPTIONS

VISUAL

REASON FOR QUESTION

A loose or dirty connection can make good batteries look bad and may not allow current to flow.

NO → CLEAN AND TIGHTEN ALL CONNECTIONS

YES ↓

2

KNOWN INFO

CONNECTIONS OK

POSSIBLE PROBLEMS

BATTERIES
CABLES
ALTERNATOR CIRCUIT

ARE THE BATTERIES FILLED TO THE PROPER LEVEL ?

TEST OPTIONS

VISUAL

REASON FOR QUESTION

Batteries need water for the electrolyte solution. Batteries don't work right if the electrolyte level is low.

NO → ADD WATER TO PROPER LEVEL

YES ↓

3

KNOWN INFO

CONNECTIONS OK
WATER LEVEL OK

POSSIBLE PROBLEMS

BATTERIES
CABLES
ALTERNATOR CIRCUIT

IS BATTERY VOLTAGE 23.5 - 25.5 VOLTS ?

TEST OPTIONS

1. STE/ICE-R TEST 67 (Page 2-740)
2. MULTIMETER

REASON FOR QUESTION

If the battery voltage is not correct, you may have bad batteries or a problem in the alternator circuit.

NO → GO TO A, Page 2-256

YES → GO TO 4, Page 2-254

BAD CONNECTIONS ARE THE MOST COMMON PROBLEM !

Sometimes, just disconnecting, cleaning and reconnecting will solve a problem. BE THOROUGH ! The time you save may be your own.

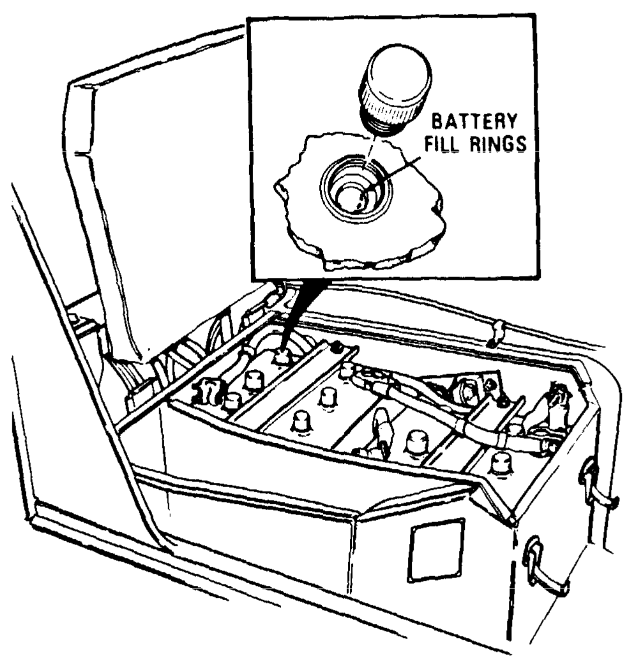
Refer to the functional flow schematic and check the following;

1. BATTERY - make sure all connections are clean and tight. This includes the interconnect cables, clamps, shunt, power stud and the slave connector. Also check wires 6A and 7A under vehicle where they enter shunt.

2. STARTER - check the high current (heavy gauge) wire at the starter. Don't just check for voltage; a loose connection will have voltage but can't carry much current.

There is a ring inside the battery fill plugs. The water level should be at the ring.

BATTERY VOLTAGE STE/ICE-R TEST 67
1. Start Test 67, battery voltage. 2. Displayed reading is in volts. Batteries should be 23-25.5 volts. Batteries voltage will drop when glowplugs turn on.



BATTERY CIRCUIT

DIAGNOSTIC FLOWCHART

FROM 3, Page 2-252

4

KNOWN INFO

CONNECTIONS OK
WATER LEVEL OK
BATTERY VOLTAGE OK
ALTERNATOR CIRCUIT OK

POSSIBLE PROBLEMS

BATTERIES
CABLES

IS BATTERY PAIR RESISTANCE LESS THAN 25 MILLIOHMS AND BATTERY RESISTANCE CHANGE LESS THAN 50 MILLIOHMS/SECOND?

TEST OPTIONS

STE/ICE-R TESTS 73, 75
(Page 2-746, 748)

REASON FOR QUESTION

If either resistance reading is too high, the batteries are probably weak and may not produce enough power.

NO → GO TO B, Page 2-258

YES ↓

5

KNOWN INFO

BATTERIES OK
ALTERNATOR CIRCUIT OK

POSSIBLE PROBLEMS

CABLES

IS THE STARTER NEGATIVE CABLE VOLTAGE DROP LESS THAN 0.25 VOLTS ?

TEST OPTIONS

1. STE/ICE-R TEST 69
   (Page 2-742)
2. MULTIMETER

REASON FOR QUESTION

A large voltage drop indicates high resistance. High resistance means less current flow.

NO → REPAIR/ REPLACE WIRE 7A

YES ↓

6

KNOWN INFO

BATTERIES OK
NEGATIVE CABLE OK
ALTERNATOR CIRCUIT OK

POSSIBLE PROBLEMS

CABLES

IS THE VOLTAGE DROP FROM THE POWER STUD TO THE STARTER LESS THAN 0.25 VOLTS ? TEST POINT IS THE POWER STUD, GROUND IS THE STARTER TERMINAL.

TEST OPTIONS

1. STE/ICE-R TEST 89
   (Page 2-750)
2. MULTIMETER

REASON FOR QUESTION

A large voltage drop indicates high resistance. High resistance means less current flow.

NO → REPAIR/ REPLACE WIRE 6A

YES ↓

NO FAULTS FOUND IN BATTERY CIRCUIT

These tests check the strength of the batteries during engine cranking. If you don't have STE/ICE-R, skip this step, but remember that you haven't tested the batteries under load.

BATTERY INTERNAL RESISTANCE
STE/ICE-R TEST 73

1. Disconnect wire 54A at injection pump to prevent stating.

2. Disconnect glowplug controller and fan solenoid.

3. Start Test 73, battery internal resistance.

4. Waif for the GO massage. Crank the engine.

5. Result is displayed in milliohms. Battery resistance should be 25 milliohms max.

BATTERY RESISTANCE CHANGE
STE/ICE-R TEST 75

1. Disconnect wire 54A at injection pump to prevent starting.

2. Disconnect glowplug controller and fan solenoid.

3. Start Test 75, battery resistance change.

4. Wait for the GO message. Crank the engine.

5. Result is displayed in milliohms/second. Battery resistance change should be 50 milliohms/second max.

STARTER NEG. CABLE VOLTAGE DROP
STE/ICE-R TEST 69

1. Start Test 69, starter negative cable voltage drop.

2. Displayed reading is in volts. The cable voltage drop should be less than 0.25 volts maximum.

0-45 DC VOLTS
STE/ICE-R TEST 69

1. Connect RED dip to the indicated test point, BLACK clip to negative or ground.

2. Start Test 89, DC Volts.

3. Displayed reading is in volts.

BATTERY CIRCUIT DIAGNOSTIC FLOWCHART

A
FROM 3,
Page 2-252

KNOWN INFO

BATTERY VOLTAGE IS NOT CORRECT

POSSIBLE PROBLEMS

BATTERY OR BATTERIES
CABLES
ALTERNATOR

A1

DOES EACH BATTERY MEASURE 11-13 VOLTS?

TEST OPTIONS

1. STE/ICE-R TEST 89 (Page 2-750)
2. MULTIMETER

REASON FOR QUESTION

A good battery has 12 volts at 70° F (22° C).

NO → RECHARGE OR REPLACE BATTERY

YES ↓

KNOWN INFO

BATTERIES OK

POSSIBLE PROBLEMS

CABLES

A2

CHECK THE VOLTAGE DROP ACROSS EACH CABLE IN THE BATTERY BOX (SEE NOTE AT RIGHT). ARE ALL VOLTAGE DROPS LESS THAN 0.25 VOLTS MAX?

TEST OPTIONS

1. STE/ICE-R TEST 89 (Page 2-750)
2. MULTIMETER

REASON FOR QUESTION

Everything else checks out OK. These cables are the only thing in the battery circuit we haven't tested.

NO → REPAIR/ REPLACE BAD CABLE OR CABLES

YES ↓

KNOWN INFO

BATTERY VOLTAGE NOT CORRECT

POSSIBLE PROBLEMS

BATTERIES
ALTERNATOR

A3

YOUR BATTERIES ARE OVER-CHARGED OR DISCHARGED. RUN THE ALTERNATOR TESTS. IF NO FAULTS ARE FOUND, REPLACE THE DEFECTIVE BATTERY OR BATTERIES.

REFERENCE INFORMATION

BATTERY CIRCUIT

Measure from the positive poet to the negative poet of each battery.

For battery replacement instructions, refer to (para. 4-79).

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

NOTE

Check these cables:

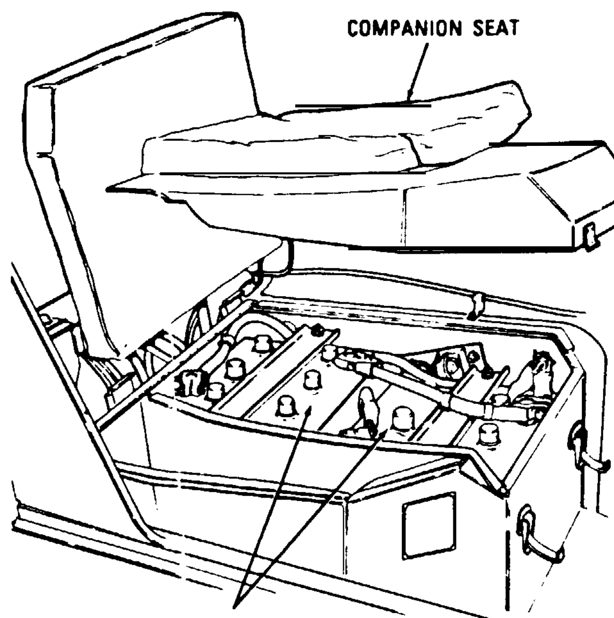
WIRE 68, connecting the batteries together. Test point is the postive terminal of one of the batteries.

WIRE 49A, connecting the batteries to the power stud. Test point is the power stud.

Wire connecting the battery to the shunt. Test point is the shunt.

Wire connecting shunt to ground stud. Test point is the shunt.

For repair or replacement of cables, refer to (para. 4-73).



If you use STE/ICE-R test 67 in Step 3 on page 2-252, you may have a faulty DCA. Try running the tests using STE/ICE-R test 89 with the W2 cable.

Sea paragraph 4-79. (Also check each battery's specific gravity in accordance with TM 9-6140-200-14.)

Replace battery refer to (para. 4-79).

B FROM 4, Page 2-254

B1

KNOWN INFO
BATTERY RESISTANCE NO GOOD

POSSIBLE PROBLEMS
BATTERIES CABLES

IS EACH BATTERY RESISTANCE LESS THAN 25 MILLIOHMS AND EACH BATTERY RESISTANCE CHANGE LESS THAN 50 MILLIOHMS/SECOND ?

TEST OPTIONS

REARRANGE BATTERY BOX TO TEST ONE BATTERY.

RUN STE/ICE-R TESTS 73,75. (Page 2-746, 748).

REASON FOR QUESTION

If either resistance reading is too high, the batteries are probably weak and may not produce enough power.

NO → REPLACE DEFECTIVE BATTERY

YES ↓

B2

KNOWN INFO
BATTERIES OK

POSSIBLE PROBLEMS
CABLES

CHECK THE VOLTAGE DROP ACROSS ALL CABLES IN THE BATTERY BOX (SEE NOTE AT RIGHT) AND THE POSITIVE AND NEGATIVE CABLES TO THE STARTER. ARE ALL VOLTAGE DROPS LESS THAN 0.25 VOLTS?

TEST OPTIONS

1. STE/ICE-R TEST 89 (Page 2-750)
2. STE/ICE-R TEST 74 (STARTER CKT RESISTANCE) OR TEST 69 (NEGATIVE CABLE DROP) OR TEST 68 (STARTER MOTOR VOLTAGE) (Page 2-750, 747, 742, 741)
3. MULTIMETER

REASON FOR QUESTION

Everything else has checked OK. These cables are the only thing in the battery circuit we haven't tested.

NO → REPAIR/ REPLACE BAD CABLE OR CABLES

YES ↓

B3

NO FAULTS FOUND.
(IF YOU USED TESTS 73 & 75 IN STEP 4, P. 2-254, YOU MAY HAVE A PROBLEM WITH THE DCA. CHECK THE DCA CONNECTIONS AND TRY RUNNING STEP 4 USING TESTS 77 & 79.) SEE NOTE TO RIGHT.

REFERENCE INFORMATION

BATTERY CIRCUIT

Replace batteries, refer to (para 4-79).

BATTERY INTERNAL RESISTANCE STE/ICE-R TEST 73
1. Disconnect wire 54A at injection pump to prevent starting.
2. Disconnect glowplug controller and fan solenoid (to keep waveform clean).
3. Start Test 73, battery internal resistance.
4. Wait for the GO message. Crank the engine.
5. Result is displayed in milliohms. Battery resistance should be 25 milliohms max.

NOTE

Check these cables
- WIRE 68, correcting the batteries together. Test point is the positive terminal of one of the batteries.
- WIRE 49A, connecting the battery to the power stud. Test point is the power stud.
- Wire connecting the battery to the shunt. Test point is the negative terminal of the battery.
- Wire connecting shunt to ground stud. Test point is the shunt.

Replace batteries, refer to (para 4-79).

BATTERY RESISTANCE CHANGE STE/ICE-R TEST 75
1. Disconnect wire 54A at injection pump to prevent starting.
2. Disconnect glowplug controller and fan solenoid (to keep waveform dean).
3. Start Test 75, battery resistance change.
4. Wait for the GO message. Crank the engine.
5. Result is displayed in milliohms/second. Battery resistance change should be 50 milliohms/second max.

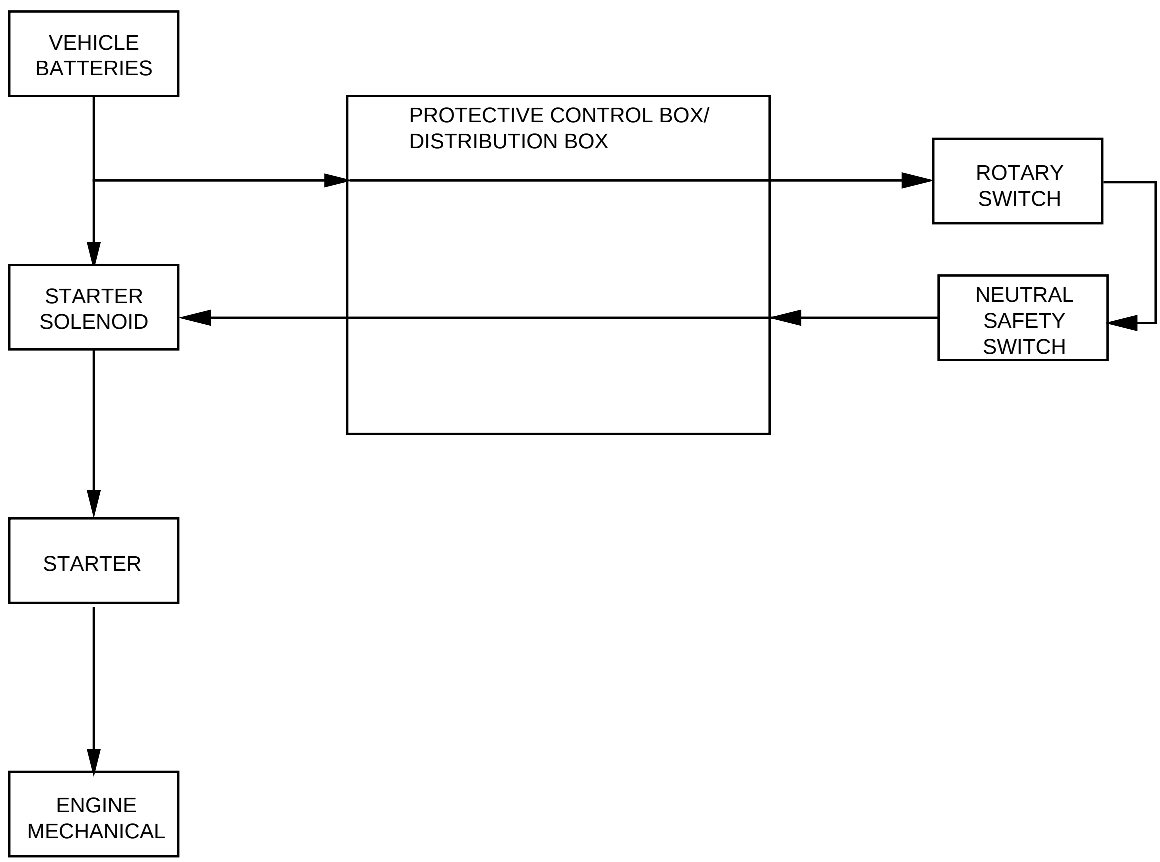
NOTE

Tests 77 and 79 are TK tests that do the same thing that DCA tests 73 and 75 do. See TM 9-4910-571-12&P for instructions on how to run these tests.

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK dip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

2-30. STARTER CIRCUIT TESTS

STARTER CIRCUIT WITHOUT STARTER LOCKOUT



GENERAL DESCRIPTION

The Starter Circuit consists of the batteries, starter solenoid, starter motor, rotary switch, neutral safety switch, protective control box/distribution box, and related electrical wiring. The relationship of these parts is shown in the block diagram above, and a simplified functional flow schematic is provided on the foldout FO-8.

The starter solenoid and starter motor are enclosed in housings to protect them from dirt, icing conditions, and other road hazards.

When the rotary switch is turned to “START,” the starter solenoid is energized. The solenoid contacts close, sending battery power to the starter motor. The battery power causes the starter motor pinion gear to engage the engine flywheel ring gear and the engine cranks. When the engine starts, the rotary switch should be released, allowing it to return to the “RUN” position. This deenergizes the starter solenoid which, in turn, disengages the starter motor from the engine.

Solenoid current flows from the rotary switch through the neutral safety switch and protective control box/distribution box to the solenoid.

STARTER CIRCUIT **DIAGNOSTIC FLOWCHART**

START

!!

1

KNOWN INFO

ENGINE WON'T CRANK OR CRANKS SLOWLY

POSSIBLE PROBLEMS

WIRING
BATTERIES
STARTER
SOLENOID
ROTORY SWITCH
ENGINE LOCKED
PCB/DISTRIBUTION BOX

CHECK ALL CABLES AND CONNECTIONS (BATTERY, STARTER, SOLENOID, ROTARY SWITCH, PCB/DISTRIBUTION BOX). REPAIR, CLEAN, OR REPLACE AS REQUIRED.

TEST OPTIONS

VISUAL INSPECTION

REASON FOR QUESTION

Bad connections are a very common problem.

NO → **REPAIR OR REPLACE CABLES, CONNECTORS**

YES ↓

2

KNOWN INFO

CABLES & CONNECTORS APPEAR OK

POSSIBLE PROBLEMS

WIRING
BATTERIES
STARTER/SOLENOID
ROTARY SWITCH
ENGINE LOCK
PCB/DISTRIBUTION BOX

CHECK BATTERY VOLTAGE WHILE TRYING TO CRANK THE ENGINE. IS THE BATTERY VOLTAGE AT LEAST 18 VOLTS?

TEST OPTIONS

1. STE/ICE-R TEST 67 (Page 2-740)
2. MULTIMETER
3. VOLTS GAUGE

REASON FOR QUESTION

If the engine cranks you know the engine is not locked and the rotary switch is OK.

NO → **GO TO BATTERY CIRCUIT, Page 2-252**

YES ↓

GO TO 3, Page 2-264

REFERENCE INFORMATION

STARTER CIRCUIT

BAD CONNECTIONS ARE THE MOST COMMON PROBLEM !

Sometimes, just disconnecting, cleaning and reconnecting will solve a problem. BE THOROUGH! The time you save may be your own.
Refer to the functional flow schematic and check the following:

1. BATTERY - make sure all connections are clean and tight, including the shunt and power stud.

2. STARTER - check the high current (heavy gauge wire 6A) wire at the starter. Don't just check for voltage; a loose connection will have voltage but can't carry much current.

WARNING

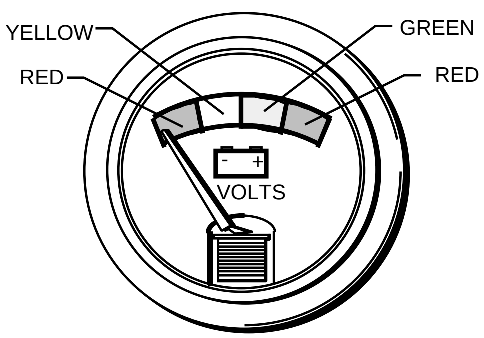
Disconnect negative battery cable before disconnecting and reconnecting protective control box/distribution box harness.

There is battery voltage at the PCB/distribution box at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel. 2

3. PROTECTIVE CONTROL BOX/ DISTRIBUTION BOX - Unscrew BOTH connectors and look for bent or broken pins, pins pushed out of their socket, or dirt and corrosion in the connections.

4. ROTARY SWITCH - Check the wires at the switch. Don't just look. Feel the connections to make sure they're snug. Many problems can be solved by seeing with your fingers, not just your eyes.

A cold engine should crank at least 100 RPM.
A warm engine should crank at least 180 RPM.



VOLTS GAUGE

BATTERY VOLTAGE STE/ICE-R TEST 67
1. Start Test 67, battery voltage. 2. Displayed reading is in volts. Batteries should be 23-25.5 volts. Batteries voltage will drop when glowplugs turn on.

BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.

STARTER CIRCUIT **DIAGNOSTIC FLOWCHART**

FROM 2, Page 2-262

KNOWN INFO

CABLES & CONNECTORS APPEAR OK

POSSIBLE PROBLEMS

BATTERIES
STARTER/SOLENOID
ROTARY SWITCH
ENGINE LOCK
PCB/DISTRIBUTION BOX

3

DOES THE ENGINE CRANK AT LEAST 200 RPM?

TEST OPTIONS

1. LISTEN
2. STE/ICE-R TEST 10 (Page 2-734)

REASON FOR QUESTION

If the engine cranks you know the engine is not locked and the rotary switch is OK.

NO → **GO TO A, Page 2-268; H Page 2-296**

YES ↓

KNOWN INFO

ROTARY SWITCH OK
ENGINE NOT LOCKED
PCB/DISTRIBUTION BOX OK

POSSIBLE PROBLEMS

STARTER
STARTER SHIMS
FLY WHEEL
BATTERIES

4

DOES THE STARTER CRANK THE ENGINE WITHOUT ANY GRINDING, SQUEAKING, OR UNUSUAL NOISE?

TEST OPTIONS

LISTEN

REASON FOR QUESTION

This is a check for mechanical problems such as improperly shimmed starter, damaged flywheel, or burnt starter.

NO → **GO TO B, Page 2-272**

YES ↓

GO TO 5, Page 2-266

ENGINE RPM
STE/ICE-R TEST 10

1. Start Test 10, Engine RPM.

2. Crank or start the engine. Displayed reading is RPM. Cranking RPM should be approximately 200. Idle RPM should be 625-675 (6.2L and 6.5L).

STARTER CIRCUIT **DIAGNOSTIC FLOWCHART**

FROM 4, Page 2-264

5

DOES THE STARTER STOP CRANKING WHEN THE ROTARY SWITCH IS RETURNED TO THE "RUN" OR "STOP" POSITIONS?

KNOWN INFO

CRANKS OK

POSSIBLE PROBLEMS

ROTARY SWITCH
STARTER
PCB/DISTRIBUTION BOX

TEST OPTIONS

LISTEN

REASON FOR QUESTION

The starter solenoid could be stuck or, more likely there may be a short to the solenoid.

NO → **GO TO C, Page 2-276**

YES ↓

6

IS THE AVERAGE STARTER CURRENT BETWEEN 200 & 300 AMPS?

KNOWN INFO

ROTARY SWITCH OK
ENGINE NOT LOCKED
PCB/DISTRIBUTION BOX OK

POSSIBLE PROBLEMS

BATTERIES
STARTER/SOLENOID

TEST OPTIONS

1. STE/ICE-R TEST 71 (Page 2-744)
2. MULTIMETER

REASON FOR QUESTION

This will tell if the starter is OK and if the batteries have enough power to crank the engine.

NO → **GO TO D, Page 2-282**

YES ↓

7

IS THE BATTERY VOLTAGE AT LEAST 18.5 VOLTS WHILE CRANKING?

KNOWN INFO

ROTARY SWITCH OK
ENGINE NOT LOCKED
STARTER OK

POSSIBLE PROBLEMS

BATTERIES

TEST OPTIONS

1. STE/ICE-R TEST 67 (Page 2-740)
2. MULTIMETER

REASON FOR QUESTION

A good cranking voltage, combined with a good starter current shows that the batteries are OK.

NO → **GO TO BATTERY TESTS, Page 2-252**

YES ↓

NO FAULTS FOUND

REFERENCE INFORMATION

STARTER CIRCUIT

STARTER AVERAGE CURRENT STE/ICE-R TEST 71

1. Start Test 71, starter average current.
2. Displayed reading is in amps. The starter should draw at least 200 amps with a peak of over 400 amps.

BATTERY CURRENT MULTIMETER

1. Set the voltmeter to a DC volts scale of about 1 volt.
2. Connect the BLACK lead to the battery side of the current shunt and the RED lead to the other end of the current shunt.
3. Current shunt voltage is proportional to battery current, 100 millivolts. 1000 amps. To get current, multiply millivolts x 10.

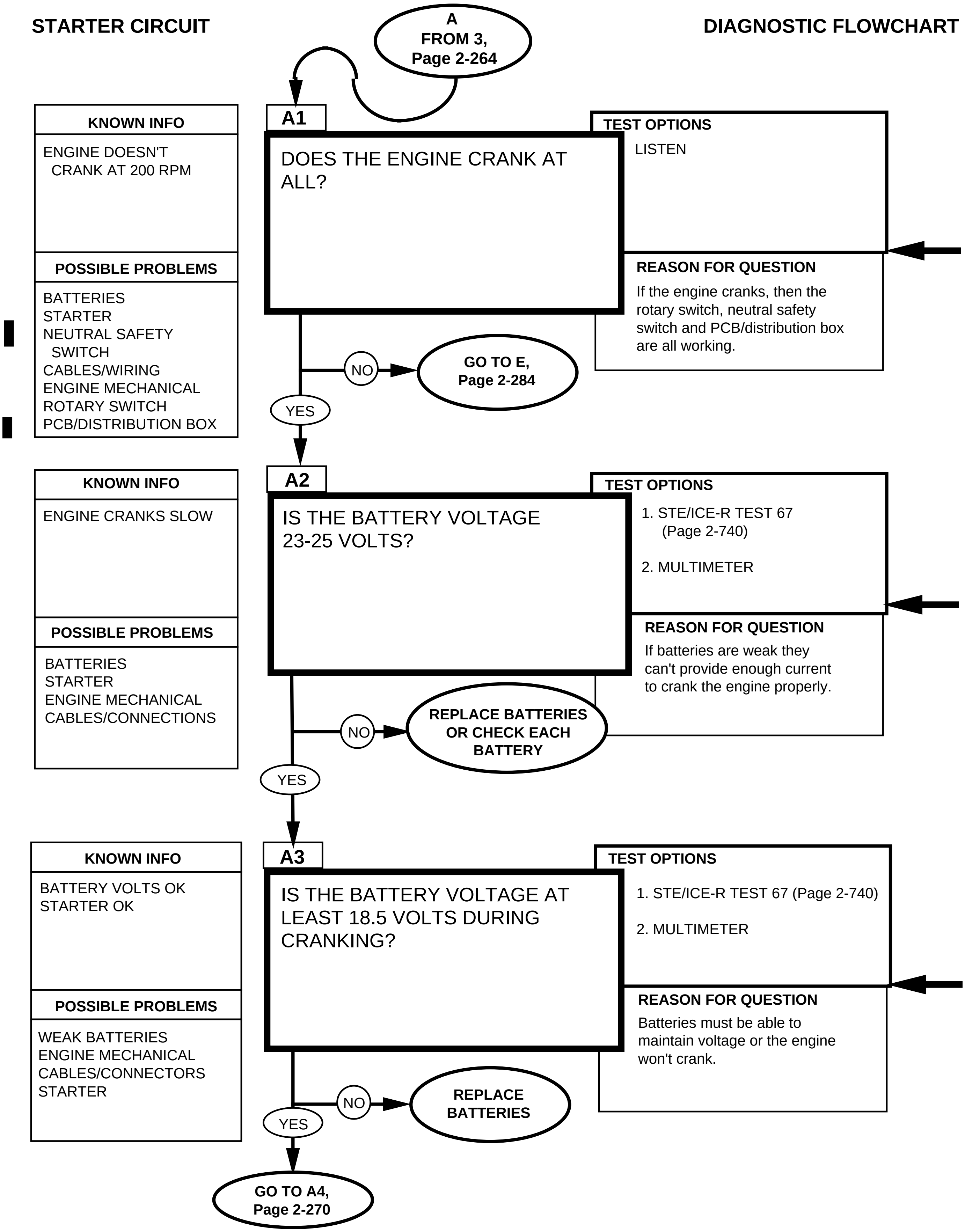
BATTERY VOLTAGE STE/ICE-R TEST 67

1. Start Test 67, battery voltage.
2. Displayed reading is in volts. Batteries should be 23-25.5 volts. Batteries voltage will drop when glowplugs turn on.

BATTERY VOLTAGE MULTIMETER

1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to reed the correct scale.

STARTER CIRCUIT DIAGNOSTIC FLOWCHART



REFERENCE INFORMATION

STARTER CIRCUIT

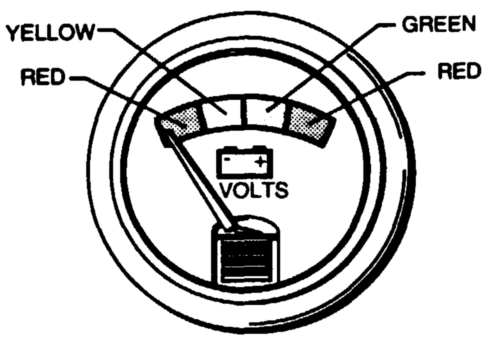
BATTERY VOLTAGE STE/ICE-R TEST 67
1. Start Test 67, battery voltage. 2. Displayed reading is in volts. Batteries should be 23-25.5 volts. Batteries voltage will drop when glowplugs turn on.

VOLTAGE MULTIMETER
1. Set the voltmeter to a DC vollts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.

Connect red to
positive = power stud

Connect black to
negative = battery side of current shunt

Replace batteries, refer to (para 4-79).



VOLTS GAUGE

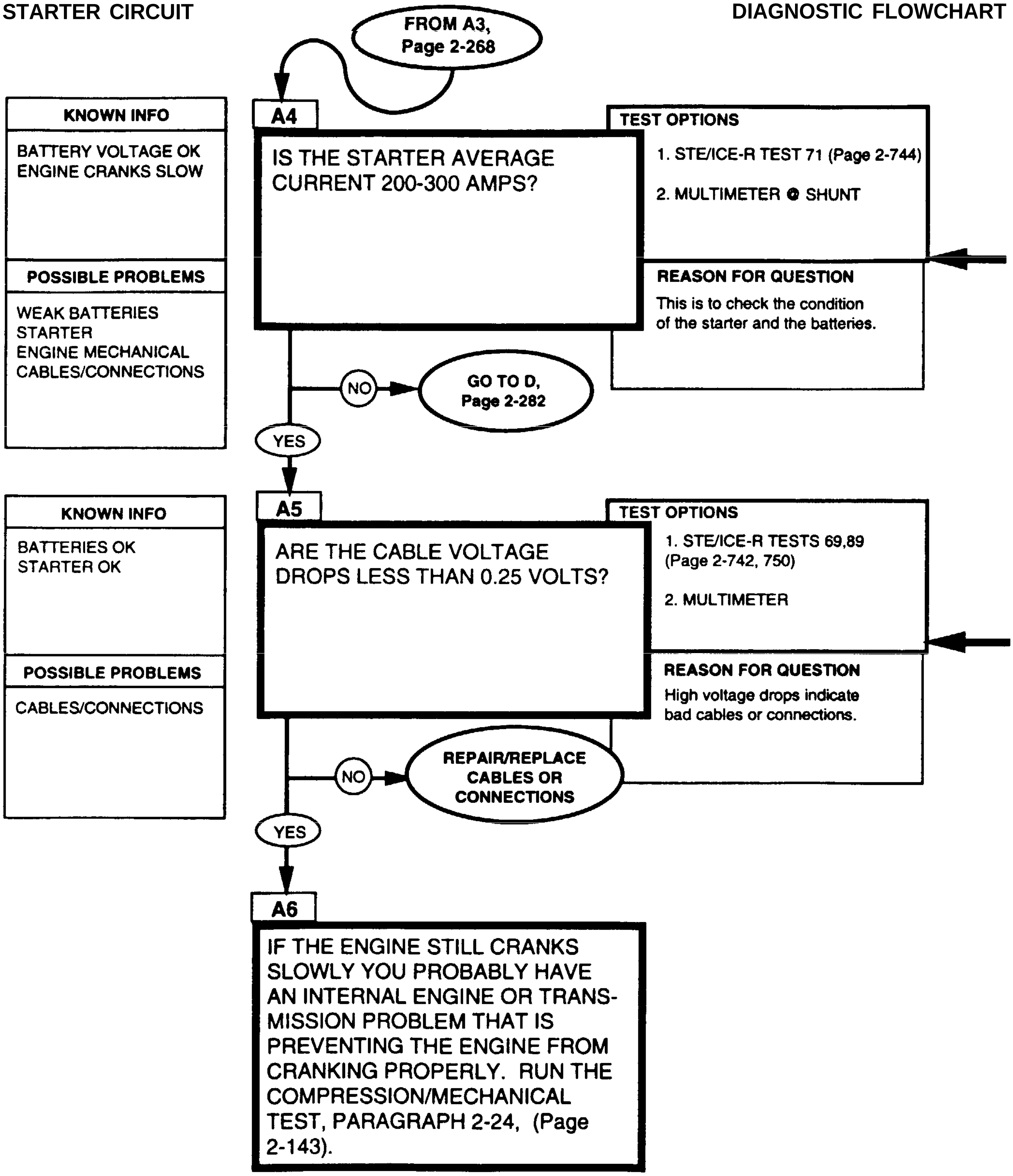
Connect red to
positive = power stud

Connect black to
negative = battery side of current shunt

Replace batteries, refer to (para 4-79).

STARTER CIRCUIT

DIAGNOSTIC FLOWCHART



STARTER AVERAGE CURRENT
STE/ICE-R TEST 71

1. Start Test 71, starter average current.

2. Displayed reading is in amps. The starter should draw at least 200 amps with a peak of over 400 amps.

STARTER NEG. CABLE VOLTAGE DROP
STE/ICE-R TEST 69

1. Start Test 69, starter negative cable voltage drop.

2. Displayed reading is in volts. The cable voltage drop should be less than 0.25 volts max.

Check these cables;

Starter negative cable - STE/ICE-R test 69

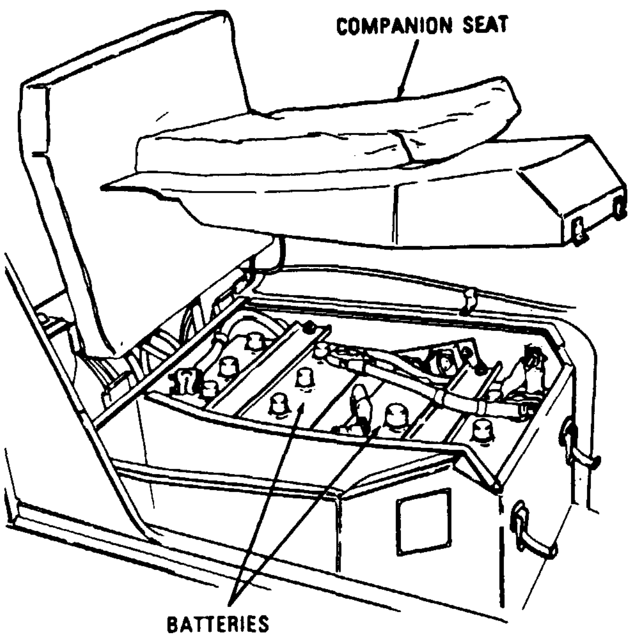
Wire 68, connecting the batteries together. Test point is the positive battery post.

Wire 49A, connecting battery to power stud. Test point is the power stud.

Wire connecting battery to shunt (50A). Test point is the positive battery post.

Power stud to starter motor (6A). Test point is the power stud.

Replace or repair cables, refer to (para 4-73).



0-45 DC VOLTS
STE/ICE-R TEST 89

1. connect RED clip to the indicated test point, BLACK clip to negative or ground.

2. Start Test 89, DC Volts.

3. Displayed reading is in volts.

BATTERY CURRENT
MULTIMETER

1. Set the voltmeter to a DC volts scale of about 1 volt.

2. Connect the BLACK lead to the battery side of the current shunt and the RED lead to the other end of the current shunt.

3. Current shunt voltage is proportional to battery current, 100 millivolts = 1000 amps. To get current, multiply millivolts x 10.

VOLTAGE
MULTIMETER

1. Set the voltmeter to a DC volts scale of at least 40 volts.

2. Connect the RED lead to positive and the BLACK lead to negative.

3. Be sure to read the correct scale.

STARTER CIRCUIT **DIAGNOSTIC FLOWCHART**

B FROM 4, Page 2-264

B1

KNOWN INFO

BATTERIES OK
PCB/DISTRIBUTION BOX OK
NEUTRAL SAFETY SWITCH
ROTARY SWITCH

POSSIBLE PROBLEMS

STARTER
FLYWHEEL
WIRING

REMOVE STARTER AND INSPECT FOR DEFECTS. IS IT OK? (FOLLOW THE "YES" PATH IF THERE ARE NO VISIBLE DEFECTS.)

TEST OPTIONS

VISUAL

REASON FOR QUESTION

If defects are visible, starter is faulty.

NO → **REPLACE STARTER**

YES ↓

B2

KNOWN INFO

BATTERIES OK
STARTER NOT VISIBLY DEFECTIVE

POSSIBLE PROBLEMS

STARTER
FLYWHEEL
WIRING

INSPECT FLYWHEEL FOR MISSING OR DEFECTIVE TEETH. (FOLLOW THE "YES" PATH IF THERE ARE NO VISIBLE DEFECTS)

TEST OPTIONS

VISUAL

REASON FOR QUESTION

Bad or missing teeth on flywheel can cause engine to crank improperly or not at all.

NO → **NOTIFY DS LEVEL MAINTENANCE**

YES ↓

B3

KNOWN INFO

BATTERIES OK
FLYWHEEL OK
STARTER NOT VISIBLY DEFECTIVE

POSSIBLE PROBLEMS

STARTER

PUT STARTER BACK ON ENGINE. BE VERY CAREFUL TO SHIM THE STARTER PROPERLY.

TEST OPTIONS

N/A

REASON FOR QUESTION

The starter may have been improperly installed with the wrong shims and/or bolts.

GO TO B4, Page 2-274

Remove Starter motor.
Check the pinion and gear for missing or broken teeth, unusual wear, bent pieces, etc.
Check the pinion by fuming it on the screw shaft.
Check the armature by prying the pinion with a screwdriver. The armature should turn freely.

Replace starter, refer to (para 4-8).

Disconnect the fuel solenoid, wire 54A, to prevent accidental starting. Rotate the engine with a breaker bar and socket on the crankshaft pulley to inspect the engine flywheel for missing or defective teeth.

Replace starter, refer to (para 4-8).

STARTER CIRCUIT DIAGNOSTIC FLOWCHART

KNOWN INFO

BATTERIES OK
WIRING OK
STARTER NOT VISIBLY DEFECTIVE

POSSIBLE PROBLEMS

STARTER
ENGINE

FROM B3, Page 2-272

B4

DOES STARTER ENGAGE AND DISENGAGE PROPERLY?

TEST OPTIONS

VISUAL (LISTEN)

REASON FOR QUESTION

If starter still does not engage and disengage properly, it must be defective.

NO → REPLACE STARTER

YES ↓

B5

RETURN TO STARTER CIRCUIT, RUN STEP 4, Page 2-264.

Replace starter, refer to (para 4-8).

STARTER CIRCUIT **DIAGNOSTIC FLOWCHART**

C
FROM 5,
Page 2-266

KNOWN INFO

ENGINE WON'T STOP CRANKING

POSSIBLE PROBLEMS

ROTARY SWITCH
PCB/DISTRIBUTION BOX
WIRING
STARTER

C1

DISCONNECT NEGATIVE BATTERY CABLE TO STOP CRANKING.

REASON FOR QUESTION

No matter what's wrong, the starter can't crank without battery power.

KNOWN INFO

ENGINE WON'T STOP CRANKING

POSSIBLE PROBLEMS

ROTARY SWITCH
PCB/DISTRIBUTION BOX
WIRING
STARTER

C2

DISCONNECT WIRES AT ROTARY SWITCH. WITH SWITCH IN “OFF” POSITION, DO YOU GET:
OPEN CIRCUIT FROM B TO S?
OPEN CIRCUIT FROM B TO R?
OPEN CIRCUIT FROM R TO S?

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION

A good switch exhibits these open circuits in the “OFF” position.

NO → **REPLACE SWITCH**

YES ↓

KNOWN INFO

ENGINE WON'T STOP CRANKING

POSSIBLE PROBLEMS

ROTARY SWITCH
PCB/DISTRIBUTION BOX
WIRING
STARTER

C3

WITH ROTARY SWITCH IN “RUN” POSITION, DO YOU GET:
OPEN CIRCUIT FROM B TO S?
OPEN CIRCUIT FROM R TO S?
SHORT CIRCUIT FROM B TO R?

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION

A good switch has these opens and shorts.

NO → **REPLACE SWITCH**

YES ↓

GO TO C4, Page 2-278

0-4500 OHMS
STE/ICE-R TEST 91

1. Connect RED clip and BLACK clip to the indicated test points in the question. RED to the first, BLACK to the second.

2. Start Test 91, 0-4500 ohms.

3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

Don't forget that your vehicle batteries are disconnected, so you can't run the STE/ICE-R from the DCA, you have to use the power cable and connect directly to the batteries.

When the resistance is too high for STE/ICE-R to measure, as in the case of an open circuit, STE/ICE-R displays "9.9.9.9."

Replace rotary switch, refer to (pare 4-7).

CONTINUITY (RESISTANCE)
MULTIMETER

1. Set the voltmeter to an ohms scale of about 1000 ohms.

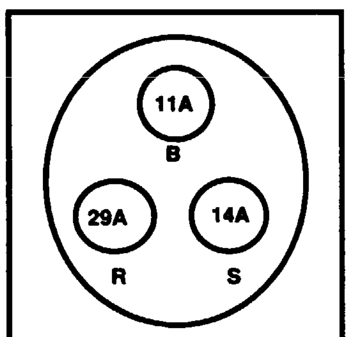
2. Connect the RED and BLACK leads to the connections stated in the question.

3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

Don't forget that your vehicle batteries are disconnected, so you can't run the STE/ICE-R from the DCA, you have to use the power cable and connect directly to the batteries.

When the resistance is too high for STE/ICE-R to measure, es in the case of an open circuit, STE/ICE-R displays "9.9.9.9."

Replace rotary switch, refer to (para 4-7).



REAR OF ROTARY SWITCH

STARTER CIRCUIT DIAGNOSTIC FLOWCHART

FROM C3, Page 2-276

C4

KNOWN INFO

ROTARY SWITCH OK

POSSIBLE PROBLEMS

PCB/DISTRIBUTION BOX WIRING
STARTER

RECONNECT ROTARY SWITCH. TURN SWITCH TO "STOP." CHECK FOR OPEN CIRCUIT IN THE PCB BODY CONNECTOR HARNESS BETWEEN THE FOLLOWING SOCKETS; G-A, G-B, A-B, F-A, AND F-B.
ARE THEY ALL OPEN CIRCUITS ?

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION

Continuity between any of these pins indicates a short between the wires in body harness

NO → **REPAIR APPROPRIATE WIRE OR REPLACE HARNESS**

YES ↓

C5

KNOWN INFO

ROTARY SWITCH OK
BODY HARNESS OK

POSSIBLE PROBLEMS

PCB/DISTRIBUTION BOX WIRING
STARTER

RECONNECT BODY CONNECTOR. DISCONNECT ENGINE CONNECTOR. DISCONNECT WIRE 74A AT STARTER. IS THERE AN OPEN CIRCUIT FROM SOCKET E TO SOCKET I ENGINE CONNECTOR HARNESS?

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION

Continuity between these pins indicates a short in the engine harness.

NO → **REPAIR WIRES OR REPLACE HARNESS**

YES ↓

C6

KNOWN INFO

ROTARY SWITCH OK
BODY HARNESS OK

POSSIBLE PROBLEMS

PCB/DISTRIBUTION BOX WIRING
STARTER

IS THERE AN OPEN CIRCUIT FROM SOCKET E OF PCB/DISTRIBUTION BOX ENGINE CONNECTOR HARNESS TO ENGINE GROUND?

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION

Continuity indicates shorted connector in the starter solenoid.

NO → **REPLACE STARTER**

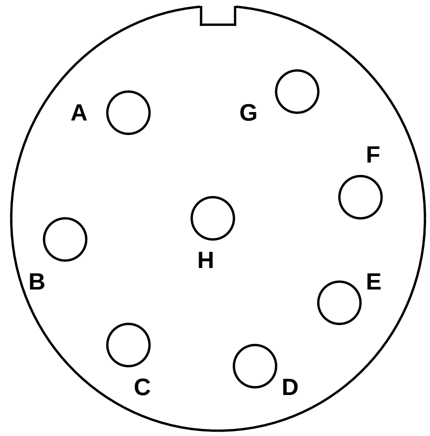
YES ↓

GO TO C7, Page 2-280

Don't forget that your vehicle batteries are disconnected, so you can't run the STE/ICE-R from the DCA, you have to use the power cable and connect directly to the batteries.

When the resistance is too high for STE/ICE-R to measure, as in the case of an open circuit, STE/ICE-R displays "9.9.9.9."

Repair wiring or replace harness, refer to (para. 4-85).



PCB/DISTRIBUTION BOX BODY CONNECTOR

Check the wires at the connectors for shorts. If there are no visible shorts, you have to replace the harness.

Repair wiring or replace harness, refer to (para. 4-85).

0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated test points in the question. RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms. 2. Connect the RED and BLACK leads to the connections stated in the question. 3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

Replace starter, refer to (para. 4-8).

STARTER CIRCUIT **DIAGNOSTIC FLOWCHART**

FROM C6, Page 2-278

C7

KNOWN INFO
ENGINE HARNESS OK
POSSIBLE PROBLEMS
PCB/DISTRIBUTION BOX BATTERY

RECONNECT WIRE 74A TO STARTER. IS BATTERY VOLTAGE LESS THAN 20 VOLTS ?

TEST OPTIONS

1. STE/ICE-R TEST 67 (Page 2-740)
2. MULTIMETER

REASON FOR QUESTION

Low battery voltage may, under the proper conditions, cause the starter solenoid to remain energized.

NO → **REPLACE PCB/DISTRIBUTION BOX**

YES ↓

C8

KNOWN INFO
ENGINE HARNESS OK
POSSIBLE PROBLEMS
PCB/DISTRIBUTION BOX BATTERY

DISCONNECT BATTERY NEGATIVE CABLE. RECONNECT ENGINE CONNECTOR. REPLACE BATTERY NEGATIVE CABLE. REPLACE BATTERIES. TRY CRANKING ENGINE. IF IT WON'T STOP CRANKING, REPLACE PCB/DISTRIBUTION BOX. RE-RUN STARTER CIRCUIT TEST CHAIN (STEP 1, Page 2-262).

Replace PCB, refer to (para. 4-5).
Replace distribution box (para. 4-5.1).

BATTERY VOLTAGE
MULTIMETER

1. Set the voltmeter to a DC volts scale of at least 40 volts.

2. Connect the RED lead to positive and the BLACK lead to negative.

3. Be sure to read the correct scale.

Replace batteries, refer to (para. 4-79).
Replace distribution box (para. 4-5.1).

BATTERY VOLTAGE
STE/ICE-R TEST 67

1. Start Test 67, battery voltage.

2. Displayed reading is in volts. Batteries should be 23-25.5 volts. Batteries voltage will drop when glowplugs turn on.

STARTER CIRCUIT DIAGNOSTIC FLOWCHART

D
FROM 6, Page 2-266
OR A4, Page 2-270

D1

KNOWN INFO
CURRENT DRAW TOO HIGH OR LOW.

POSSIBLE PROBLEMS
BATTERIES
STARTER
CABLES

IS BATTERY VOLTAGE 23-25.5 VOLTS?

TEST OPTIONS
1. STE/ICE-R TEST 67 (Page 2-740)
2. MULTIMETER

REASON FOR QUESTION
Low voltage may indicate low battery capacity.

NO → RECHARGE OR REPLACE BATTERIES

YES ↓

D2

KNOWN INFO
BATTERY VOLTAGE OK

POSSIBLE PROBLEMS
BATTERIES
STARTER
CABLES

IS BATTERY INTERNAL RESISTANCE LESS THAN 25 MILLIOHMS AND BATTERY RESISTANCE CHANGE LESS THAN 50 MILLIOHMS/SECOND ?

TEST OPTIONS
STE/ICE-R TESTS 73,75 (Page 2-746, 748)

REASON FOR QUESTION
Battery resistance and resistance change is an indication of the ability of the battery to supply current.

NO → REPLACE BATTERIES

YES ↓

D3

KNOWN INFO
BATTERIES OK

POSSIBLE PROBLEMS
STARTER
CABLES

ARE THE POSITIVE AND NEGATIVE CABLE DROPS 0.25 VOLTS EACH?

TEST OPTIONS
1. STE/ICE-R TESTS 69,89 (Page 2-742, 750)
2. MULTIMETER

REASON FOR QUESTION
High cable resistance may limit current flow.

NO → REPLACE CABLE

YES → REPLACE STARTER

Replace batteries, refer to (para 4-79).

**BATTERY VOLTAGE
STE/ICE-R TEST 67**

1. Start Test 67, battery voltage.

2. Displayed reading is in volts. Batteries should be 23-25.5 volts. Batteries voltage will drop when glowplugs turn on.

Replace batteries, refer to (para 4-79).

**BATTERY INTERNAL Resistance
STE/ICE-R TEST 73**

1. Disconnect wire 54A at injection pump to prevent starting.

2. Disconnect glowplug controller and fan solenoid (to keep waveform clean).

3. Start Test 73, battery internal resistance.

4. Wait for the GO massage. Crank the engine.

5. Result is displayed in milliohms. Battery resistance should be 25 milliohms max.

Replace cables or starter, refer to (para 4-77 or 4-8).

**STARTER NEG. CABLE VOLTAGE DROP
STE/ICE-R TEST 69**

1. Start Test 69, starter negative cable voltage drop.

2. Displayed reading is in volts. The cable voltage drop should be less than 0.25 volts max.

**BATTERY VOLTAGE
MULTIMETER**

1. Set the voltmeter to a DC volts scale of at least 40 volts.

2. Connect the RED lead to positive and the BLACK lead to negative.

3. Be sure to read the correct scale.

**BATTERY RESISTANCE CHANGE
STE/ICE-R TEST 75**

1. Disconnect wire 54A at injection pump to prevent starting.

2. Disconnect glowplug controller and fan solenoid (to keep waveform clean).

3. Start Test 75, battery resistance change.

4. Wait for the GO message. Crank the engine.

5. Result is displayed in milliiohms/second. Battery resistence change should be 50 milliohms/second max.

**0-45 DC VOLTS
STE/ICE-R TEST 89**

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.

2. Start Test 89, DC volts.

3. Displayed reading is in volts.

**VOLTAGE
MULTIMETER**

l. Set the voltrneter to a DC volta scale of at least 40 volts.

2. Connect the RED lead to positive and the BLACK lead to negative.

3. Be sure to read the correct scale.

STARTER CIRCUIT DIAGNOSTIC FLOWCHART

E
FROM A1,
Page 2-268

E1

KNOWN INFO

ENGINE WON'T CRANK

POSSIBLE PROBLEMS

BATTERY
STARTER
PCB/DISTRIBUTION BOX
ROTARY SWITCH
NEUTRAL SAFETY SWITCH
WIRING/CABLES
LOCKED ENGINE

IS BATTERY VOLTAGE AT LEAST 20 VOLTS?

TEST OPTIONS

1. STE/ICE-R TEST 67 (Page 2-740)
2. MULTIMETER

REASON FOR QUESTION

Low battery voltage can prevent cranking.

NO → **REPLACE BATTERIES**

YES ↓

E2

KNOWN INFO

BATTERY SHOULD AT LEAST CRANK ENGINE SLOWLY.

POSSIBLE PROBLEMS

STARTER
PCB/DISTRIBUTION BOX
ROTARY SWITCH
NEUTRAL SAFETY SWITCH
WIRING/CABLES
LOCKED ENGINE

DO YOU HAVE BATTERY VOLTAGE AT STARTER MOTOR (WIRE 6A)?

TEST OPTIONS

1. STE/ICE-R TEST 68 (Page 2-741)
2. MULTIMETER

REASON FOR QUESTION

Must have voltage available at starter to crank.

NO → **GO TO F, Page 2-288**

YES ↓

E3

KNOWN INFO

VOLTAGE AVAILABLE AT STARTER

POSSIBLE PROBLEMS

BATTERY
STARTER
PCB/DISTRIBUTION BOX
ROTARY SWITCH
NEUTRAL SAFETY SWITCH
WIRING/CABLES
LOCKED ENGINE

WITH ROTARY SWITCH IN “START” POSITION, DO YOU HAVE BATTERY VOLTAGE AT SOLENOID SWITCH TERMINAL (74A)?

TEST OPTIONS

1. STE/ICE-R TEST 70 (Page 2-743)
2. MULTIMETER

REASON FOR QUESTION

Must have voltage at switch terminal to energize solenoid.

NO → **GO TO G, Page 2-290**

YES → **GO TO E4, Page 2-286**

REFERENCE INFORMATION

STARTER CIRCUIT

BATTERY VOLTAGE
STE/ICE-R TEST 67

1. Start Test 67, battery voltage.

2. Displayed reading is in volts. Batteries should be 23-25.5 volts. Batteries voltage will drop when glowplugs turn on.

Replace batteries, refer to (para 4-79).

BATTERY VOLTAGE
MULTIMETER

1. Set the voltmeter to a DC volts scale at least 40 volts.

2. Connect the RED lead to positive and the BLACK lead to negative.

3. Be sure to read the correct scale.

STARTER MOTOR VOLTAGE
STE/ICE-R TEST 68

1. Start Test 68, starter motor voltage.

2. Displayed reading is in volts. Starter motor voltage should be the same as battery voltage, 23-25.5 volts. During cranking the starter motor voltage should beat least 18 volts.

STARTER SOLENOID VOLTAGE
STE/ICE-R TEST 70

1. Start Test 70, starter solenoid voltage.

2. Displayed reading is in volts. Starter solenoid voltage should be the same as battery voltage, 23-25.5 volts. During cranking the starter solenoid voltage should be at least 18 volts.

STARTER CIRCUIT

DIAGNOSTIC FLOWCHART

FROM E3,
Page 2-284

KNOWN INFO
ENGINE FREE
POSSIBLE PROBLEMS
STARTER

E4

REPLACE STARTER.

REFERENCE INFORMATION

STARTER CIRCUIT

Replace starter, refer to (para 4-8)

STARTER CIRCUIT **DIAGNOSTIC FLOWCHART**

F
FROM E2,
Page 2-284

KNOWN INFO

BATTERY VOLTAGE NOT AVAILABLE AT SOLENOID STUD.

POSSIBLE PROBLEMS

CABLES, CONNECTIONS

F1

CLEAN AND TIGHTEN BATTERY TERMINALS AND CLAMPS.

REASON FOR QUESTION

Dirty battery connections can prevent current flow.

KNOWN INFO

BATTERY CONNECTIONS OK

POSSIBLE PROBLEMS

CABLE

F2

IS THE STARTER POSITIVE CABLE (WIRE 6A) VOLTAGE DROP LESS THAN 0.25 VOLTS ?

TEST OPTIONS

1. STE/ICE-R TEST 89 (Page 2-750)
2. MULTIMETER

REASON FOR QUESTION

High voltage drop indicates high resistance in the cable.

NO → REPLACE CABLE

YES ↓

F3

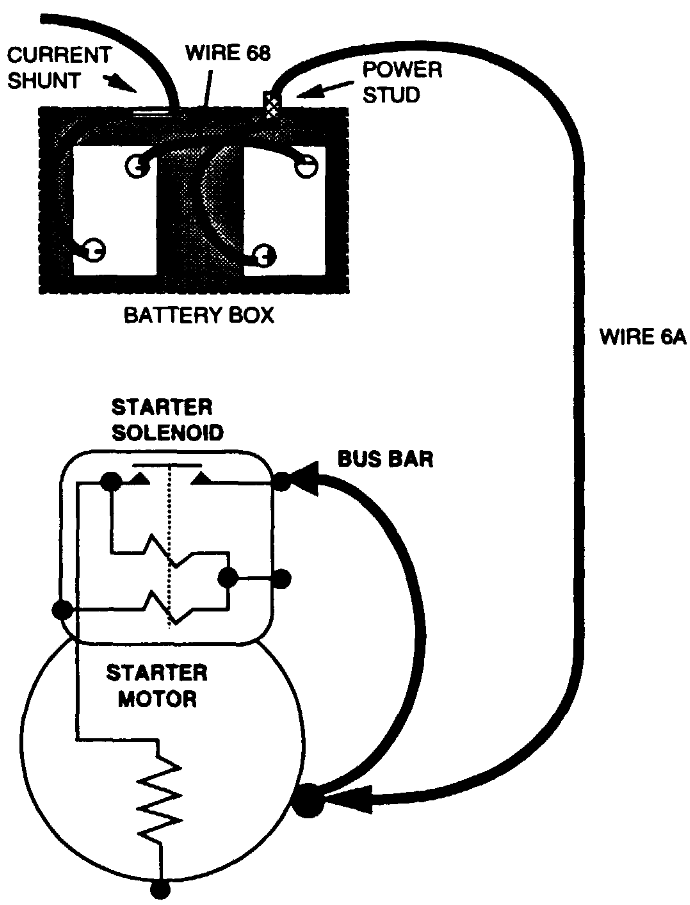
NO FAULTS FOUND. RUN BATTERY TESTS (Page 2-251).

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

Replace cable, refer to (para 4-77).

Put the red lead on the power stud, and the black on the terminal of the starter in order to measure the voltage along wire 6A.



STARTER CIRCUIT — DIAGNOSTIC FLOWCHART

G
FROM E3,
Page 2-284

G1

KNOWN INFO

NO SOLENOID CONTROL VOLTAGE

POSSIBLE PROBLEMS

PCB/DISTRIBUTION BOX WIRING
ROTARY SWITCH
NEUTRAL SAFETY SWITCH

DISCONNECT WIRE 14A AT THE NEUTRAL SAFETY SWITCH. TURN ROTARY SWITCH TO START. IS THERE BATTERY VOLTAGE AT WIRE 14A (THE NEUTRAL SAFETY SWITCH END)?

TEST OPTIONS

1. STE/ICE-R TEST 89 (Page 2-750)
2. MULTIMETER

REASON FOR QUESTION

Current flows to neutral safety switch before reaching solenoid.

NO → GO TO I, Page 2-298

YES ↓

G2

KNOWN INFO

VOLTAGE AVAILABLE
ROTARY SWITCH OK

POSSIBLE PROBLEMS

NEUTRAL SAFETY SWITCH
PCB/DISTRIBUTION BOX WIRING

DISCONNECT WIRE 14B AT NEUTRAL SAFETY SWITCH. IS THERE CONTINUITY ACROSS NEUTRAL SAFETY SWITCH? (WIRE 14 TO WIRE 14)

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION

If there is no continuity, then current will not flow through switch.

NO → REPLACE NEUTRAL SAFETY SWITCH

YES ↓

!!

G3

KNOWN INFO

NEUTRAL SAFETY SWITCH OK

POSSIBLE PROBLEMS

PCB/DISTRIBUTION BOX WIRING

DISCONNECT BODY CONNECTOR FROM PROTECTIVE CONTROL BOX/DISTRIBUTION BOX. IS THERE CONTINUITY FROM WIRE 14B AT NEUTRAL SAFETY SWITCH TO BODY CONNECTOR HARNESS SOCKET "A"?

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION

An open wire here could have prevented current flow between PCB/distribution box and neutral switch.

NO → REPAIR 14B OR REPLACE HARNESS

YES ↓

GO TO G4, Page 2-292

REFERENCE INFORMATION

STARTER CIRCUIT

The connections for the neutral safety switch can be reached by removing the engine cover. The connections are near the gear shift lever.

Replace rotary switch, refer to (para. 4-7).

WARNING

Disconnect negative battery cable before disconnecting and reconnecting protective control box/distribution box harness.

There is battery voltage at the PCB/distribution box at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

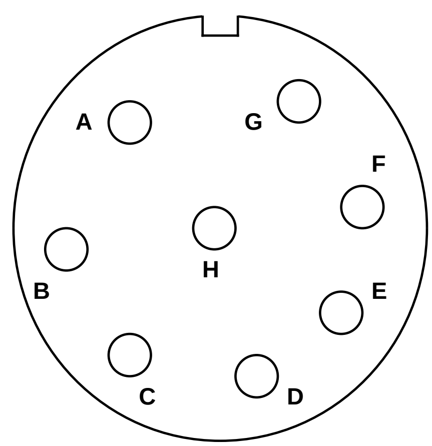
Repair wiring or replace switch, refer to (para. 4-7).

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.

CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms. 2. Connect the RED and BLACK leads to the connections stated in the question. 3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the terminations indicated in the question. RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays “9.9.9.9.”



PCB/DISTRIBUTION BOX BODY CONNECTOR

STARTER CIRCUIT **DIAGNOSTIC FLOWCHART**

FROM G3, Page 2-290

!!

G4

KNOWN INFO

NEUTRAL SAFETY SWITCH OK

POSSIBLE PROBLEMS

ROTARY SWITCH
PCB/DISTRIBUTION BOX
WIRING

DISCONNECT WIRE 29A FROM ROTARY SWITCH. IS THERE CONTINUITY FROM WIRE 29A AT ROTARY SWITCH TO SOCKET “B” OF PCB/DISTRIBUTION BOX BODY CONNECTOR HARNESS ?

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION

If this wire doesn't carry battery voltage to the PCB/distribution box, the PCB/distribution box will not send battery voltage to the starter solenoid.

NO → **REPAIR WIRE 29A OR 29C OR REPLACE HARNESS**

YES ↓

G5

KNOWN INFO

NEUTRAL SAFETY SWITCH OK

POSSIBLE PROBLEMS

ROTARY SWITCH
PCB/DISTRIBUTION BOX
WIRING

RECONNECT PCB/DISTRIBUTION BOX BODY CONNECTOR HARNESS.
DO YOU HAVE BATTERY VOLTAGE AT THE “R” TERMINAL OF THE ROTARY SWITCH WITH THE SWITCH IN “RUN” AND IN “START”?

TEST OPTIONS

1. STE/ICE-R TEST 89 (Page 2-750)
2. MULTIMETER

REASON FOR QUESTION

If there isn't battery voltage at the RUN terminal in both the RUN and START positions, the vehicle won't start.

NO → **REPLACE ROTARY SWITCH**

YES ↓

GO TO G6, Page 2-294

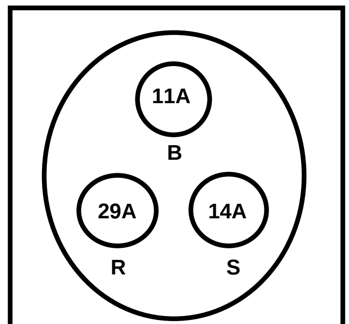
WARNING

Disconnect negative battery cable before disconnecting and reconnecting protective control box/distribution box harness.

There is battery voltage at the PCB/distribution box at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

Check the wires and connections at both ends for broken wires or any kind of bad connection. Repair whatever you can. If the wires and connections seem OK, you have to replace the harness.

Repair wiring or replace harness, refer to (para. 4-85).



REAR OF ROTARY SWITCH

Replace rotary switch, refer to (para. 4-7).

0-4500 OHMS
STE/ICE-R TEST 91

1. Connect RED clip and BLACK clip to the terminations indicated in the question. RED to the first, BLACK to the second.

2. Start Test 91, 0-4500 ohms.

3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays “9.9.9.9.”

0-45 DC VOLTS
STE/ICE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.

2. Start Test 89, DC volts.

3. Displayed reading is in volts.

CONTINUITY (RESISTANCE)
MULTIMETER

1. Set the voltmeter to an ohms scale of about 1000 ohms.

2. Connect the RED and BLACK leads to the connections stated in the question.

3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

VOLTAGE
MULTIMETER

1. Set the voltmeter to a DC volts scale of at least 40 volts.

2. Connect the RED lead to positive and the BLACK lead to negative.

3. Be sure to read the correct scale.

STARTER CIRCUIT DIAGNOSTIC FLOWCHART

FROM G5, Page 2-292

!!

KNOWN INFO

POWER AVAILABLE TO PCB/DISTRIBUTION BOX

POSSIBLE PROBLEMS

PCB/DISTRIBUTION BOX WIRING

G6

DISCONNECT BATTERY NEGATIVE CABLE. RECONNECT NEUTRAL SAFETY SWITCH. DISCONNECT ENGINE CONNECTOR FROM PCB/DISTRIBUTION BOX. IS THERE CONTINUITY FROM ENGINE CONNECTOR HARNESS SOCKET “I” TO THE STARTER SOLENOID WIRE 74A?

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION

If there is continuity there, you know all the wiring is good and the problem is in the PCB/distribution box.

NO → **REPAIR 74A OR REPLACE HARNESS**

YES ↓

KNOWN INFO

WIRING OK

POSSIBLE PROBLEMS

PCB/DISTRIBUTION BOX

G7

REPLACE PCB/DISTRIBUTION BOX. IF YOU STILL HAVE A PROBLEM, RE-RUN THE TEST CHAIN (Page 2-261).

WARNING

Disconnect negative battery cable before disconnecting and reconnecting protective control box/distribution box harness.

There is battery voltage at the PCB/distribution box at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

Replace PCB, refer to (para. 4-5).
Replace distribution box, refer to (para. 4-5.1).

0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the terminals indicated in the question. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE-R displays “9.9.9.9.”

CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms. 2. Connect the RED and BLACK leads to the connections stated in the question. 3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

STARTER CIRCUIT **DIAGNOSTIC FLOWCHART**

H
FROM 3,
Page 2-264

H1

REMOVE GLOWPLUGS AND TRY TURNING ENGINE WITH A BREAKER BAR. DOES IT TURN?

KNOWN INFO
CAN'T TURN ENGINE MANUALLY
POSSIBLE PROBLEMS
INTERNAL MECHANICAL PROBLEM HYDRAULIC LOCK

REASON FOR QUESTION
If the engine is hydrostatically locked then removing the glowplugs will allow the fuel to flow out of the locked cylinder and the engine should turn.

NO → NOTIFY DS MAINTENANCE

YES ↓

H2

DOES THE ENGINE TURN SMOOTHLY AND WITHOUT ANY UNUSUAL NOISES?

KNOWN INFO
HYDRAULIC LOCK REMOVED
POSSIBLE PROBLEMS
INTERNAL MECHANICAL PROBLEM

REASON FOR QUESTION
Excessive noise and jerky rotation may indicate binding or broken internal engine components.

NO → NOTIFY DS MAINTENANCE

YES ↓

H3

REINSTALL GLOWPLUGS AND RE-RUN STARTER SYSTEM TESTS (GO TO PAGE 2-261). IF ENGINE LOCKS AGAIN NOTIFY DS MAINTENANCE.

KNOWN INFO
ENGINE CAN ROTATE SMOOTHLY
POSSIBLE PROBLEMS

WARNING

Disconnect wire 54A to prevent accidental starting. Failure to do so may result in serious injury or death.

STARTER CIRCUIT **DIAGNOSTIC FLOWCHART**

I
FROM G1,
Page 2-290

I1

KNOWN INFO

NO VOLTAGE AVAILABLE AT NEUTRAL SAFETY SWITCH.

POSSIBLE PROBLEMS

ROTARY SWITCH
PCB/DISTRIBUTION BOX
WIRING

DISCONNECT WIRE 11A AT ROTARY SWITCH. IS THERE BATTERY VOLTAGE AT WIRE 11A ?

TEST OPTIONS

1. STE/ICE-R TEST 89 (Page 2-750)
2. MULTIMETER

REASON FOR QUESTION

Power must be available to rotary switch.

NO → **GO TO J, Page 2-300**

YES ↓

I2

KNOWN INFO

BATTERY VOLTAGE AVAILABLE TO ROTARY SWITCH.

POSSIBLE PROBLEMS

ROTARY SWITCH
PCB/DISTRIBUTION BOX
WIRING

DISCONNECT WIRE 14A AT ROTARY SWITCH . WITH THE ROTARY SWITCH TURNED TO START, IS THERE CONTINUITY BETWEEN THE “B” STUD AND THE “S” STUD ?

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION

Continuity here indicates rotary switch is OK.

NO → **REPLACE ROTARY SWITCH. RECONNECT 14A AT NEUTRAL SAFETY SWITCH**

YES ↓

I3

KNOWN INFO

ROTARY SWITCH OK

POSSIBLE PROBLEMS

WIRING

REPAIR WIRE 14A OR REPLACE HARNESS.

REFERENCE INFORMATION

STARTER CIRCUIT

VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.

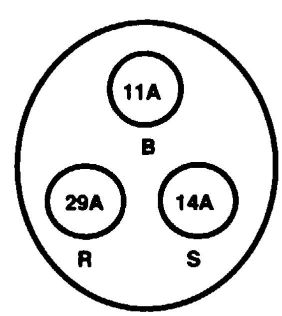
CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms. 2. Connect the RED and BLACK leads to the connections stated in the question. 3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

Replace rotary switch, refer to (para 4-7).

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the terminations indicated in the question. RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

Repair wiring or replace harness, refer to (para 4-85).



REAR OF ROTARY SWITCH

STARTER CIRCUIT DIAGNOSTIC FLOWCHART

J
FROM I1,
Page 2-298

!!

J1

KNOWN INFO

NO VOLTAGE AT ROTARY SWITCH

POSSIBLE PROBLEMS

PCB/DISTRIBUTION BOX WIRING

DISCONNECT BATTERY NEGATIVE CABLE. DISCONNECT BODY CONNECTOR FROM PCB/DISTRIBUTION BOX. IS THERE CONTINUITY FROM SOCKET G OF BODY CONNECTOR HARNESS TO WIRE 11A AT ROTARY SWITCH ?

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION

If this wire is open, no power can get to the rotary switch.

NO → **REPAIR WIRE 11A OR REPLACE HARNESS**

YES ↓

!!

J2

KNOWN INFO

NO VOLTAGE AT ROTARY SWITCH
WIRING TO ROTARY SWITCH OK

POSSIBLE PROBLEMS

PCB/DISTRIBUTION BOX WIRING

RECONNECT WIRE 11A AT ROTARY SWITCH. DISCONNECT ENGINE CONNECTOR OF PCB/DISTRIBUTION BOX. RECONNECT BATTERY NEGATIVE CABLE. IS THERE BATTERY VOLTAGE AT SOCKET E OF CONNECTOR HARNESS?

TEST OPTIONS

1. STE/ICE-R TEST 89 (Page 2-750)
2. MULTIMETER

REASON FOR QUESTION

This wire provides power from the batteries directly to the PCB/distribution box. If there is power here, then this wire is OK and the PCB/distribution box must be bad.

NO → **REPAIR WIRE 81A OR REPLACE HARNESS**

YES ↓

!!

J3

KNOWN INFO

WIRING OK

POSSIBLE PROBLEMS

PCB/DISTRIBUTION BOX

REPLACE PROTECTIVE CONTROL BOX/DISTRIBUTION BOX.

REFERENCE INFORMATION

STARTER CIRCUIT

WARNING

Disconnect negative battery cable before disconnecting and reconnecting PCB/ distribution box harness.

There is battery voltage at the PCB/distribution box at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

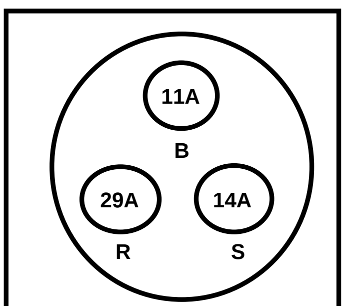
Replace harness or repair wiring, refer to (para. 4-85).

WARNING

Disconnect negative battery cable before disconnecting and reconnecting PCB/distribution box harness.

There is battery voltage at the PCB/distribution box at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

Replace harness or repair wiring, refer to (para. 4-85).



REAR OF ROTARY SWITCH

WARNING

Disconnect negative battery cable before disconnecting and reconnecting PCB/distribution box harness.

There is battery voltage at the PCB/distribution box at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

Replace PCB, refer to (para. 4-5).

Replace distribution box, refer to (para. 4-5.1)

VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.

CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms. 2. Connect the RED and BLACK leads to the connections stated in the question. 3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in the question. RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays '9.9.9.9.'

2-31. GLOWPLUGS CIRCUIT TESTS (PROTECTIVE CONTROL BOX)

These tests of the Glowplugs Circuit can be run anytime you think there may be a problem with the glowplugs, or if you were sent here from another test.

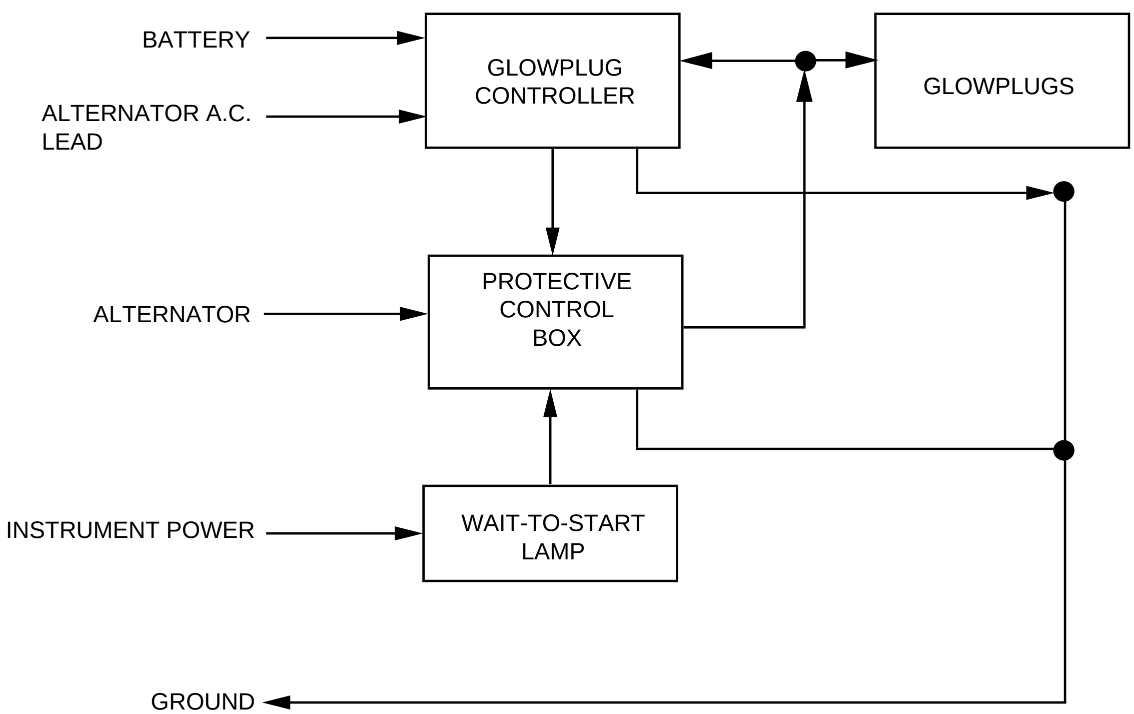
If you were sent from another test, be sure to mark where you came from so you will be able to return.

If you are running this test because the engine is hard to start when cold, remember that there is also a cold start advance circuit (part of the fuel system) which is not checked here.

For any starting problem, we recommend running the “STARTABILITY” test chain just to be sure you don't miss anything.

At the bottom of this page is a simplified block diagram which shows how the different parts of the glowplug circuit depend on each other and on other engine circuits.

Refer to fold-out page FO-9 and leave it open for reference while preforming these tests. The fold-out diagram is arranged to allow you to follow the diagnostic logic and understand what you are testing, when and why.



GLOWPLUGS CIRCUIT SIMPLIFIED BLOCK DIAGRAM FOR PROTECTIVE CONTROL BOX

GLOWPLUGS — DIAGNOSTIC FLOWCHART

START

KNOWN INFO
NOTHING

POSSIBLE PROBLEMS
GLOWPLUGS
GLOWPLUG CONTROLLER
PCB
CABLES

1
TO RUN THE GLOWPLUG CIRCUIT TESTS, THE BATTERIES MUST BE IN A GOOD STATE OF CHARGE. IF YOU AREN'T SURE, RUN THE BATTERY CIRCUIT TESTS. IF YOU ARE HERE BECAUSE THE "WAIT-TO-START" LAMP DOESN'T WORK PROPERLY, SEE THE NOTE ON THE RIGHT-HAND PAGE.

TEST OPTIONS
BATTERY TESTS
(Page 2-251)

REASON FOR QUESTION
The glowplugs and their control circuits require battery power to work.

KNOWN INFO
BATTERIES OK

POSSIBLE PROBLEMS
GLOWPLUGS
GLOWPLUG CONTROLLER
PCB
CABLES

2
CHECK ALL THE GLOWPLUG CIRCUIT CONNECTIONS (GLOW-PLUGS, GLOWPLUG CONTROLLER, PROTECTIVE CONTROL BOX). ARE ALL THE CONNECTIONS CLEAN AND TIGHT?

TEST OPTIONS
VISUAL INSPECTION

REASON FOR QUESTION
Loose or dirty connections can hinder current flow or cause mixups in the control signals.

NO → REPAIR AS NECESSARY

YES ↓

KNOWN INFO
BATTERIES OK
CABLES/CONNECTIONS SEEM OK

POSSIBLE PROBLEMS
GLOWPLUGS
GLOWPLUG CONTROLLER
PCB
CABLES

3
TURN THE ROTARY SWITCH TO "RUN". DO THE GLOWPLUGS DRAW 75-125 AMPS? (SEE NOTE ON RIGHT HAND PAGE).

TEST OPTIONS
1. STE/ICE-R TEST 80
(Page 2-749)
2. MULTIMETER

REASON FOR QUESTION
If the current is OK, then the glowplugs and protective control box are OK.

NO → GO TO A, Page 2-308

YES → GO TO 4, Page 2-306

REFERENCE INFORMATION

GLOWPLUGS

If the engine cranks ok (or starts), then the batteries are good enough for testing the glowplugs. If the engine starts, shut it off.

You can use STE/ICE Test 10 to measure cranking speed. The engine should crank at least 100 RPM in cold weather and at least 180 RPM in warm weather.

WARNING

Disconnect negative battery cable before disconnecting and reconnecting protective control box harness.

There is battery voltage at the PCS at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

BAD CONNECTIONS ARE THE MOST COMMON **PROBLEM!**

Sometimes, just disconnecting, cleaning and reconnecting will solve a problem. BE THOROUGH ! The time you save may be your own. Refer to the functional flow schematic and check the following

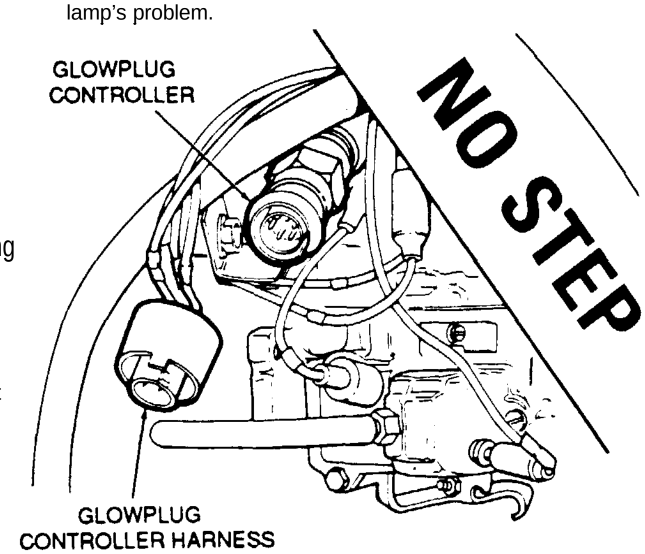
1. BATTERY - make sure all connections are dean and tight, including the shunt and power stud.
2. PROTECTIVE CONTROL BOX - unscrew BOTH connectors and look for bent or broken pins, pins pushed out of their socket, or dirt and corrosion in the connections.
3. GLOWPLUG CONTROLLER - pop the controller connector off (squeeze the sides) and check the pins in both the controller and the connector. Look for bent, broken or pushed out pins, dirt or corrosion. Check for broken wires at the connector. Take note that pin 2 of the glowplugs controller connector has no pin in it.
4. GLOWPLUGS - Check that all the glowplug wires are snug. Don't just look with your eyes. Many problems are solved by looking with your fingers to be sure a connection is snug.

NORMAL GLOWPLUG OPERATION

The glowplugs first come ON when the engine temperature is below 120 °F (49°C) and the rotary switch is turned to "RUN". They stay ON for up to 9 seconds and then go OFF. They will stay OFF for about 7-15 seconds then come ON again for about 1 second.

NOTE

The WAIT-TO-START lamp is NOT diagnosed in this section. If the lamp does not work property, the glowplug circuit may be affecting its operation. Run these tests to check out the glowplug circuit. If the lamp still does not work properly, go to the INSTRUMENTS section for a full diagnosis of the lamp's problem.



BATTERY CURRENT MULTIMETER

1. Set the voltmeter to a DC volts scale of about 1 volt.
2. Connect the BLACK lead to the battery side of the current shunt and the RED lead to the other end of the current shunt.
3. Currant shunt voltage is proportional to battery current, 100 millivolts = 1000 amps. To get current, multiply millivolts x 10.

BATTERY CURRENT STE/ICE-R TEST 80

1. Start Test 80, battery currant.
2. Displayed reading is in amps. The reading will be greater then 30 amps, depending on how many accessories you have on.

NOTE

To check for glowplug current draw, start STE/ICE-R Test 80, battery current. Turn off all accessories (lights, heater, wipers etc). STE/ICE-R should immediately measure at least 74 amps. Take note, however, that if all your glowplugs are working, the current draw should be close to or more than 100 amps, especially if it's cold. If it's near freezing and the glowplugs only draw 75-80 amps, you probably have a few bad glowplugs.

GLOWPLUGS **DIAGNOSTIC FLOWCHART**

FROM 3, Page 2-304

KNOWN INFO
BATTERIES OK PCB OK GLOWPLUGS OK
POSSIBLE PROBLEMS
GLOWPLUG CONTROLLER CABLES

4

DO THE GLOWPLUGS CYCLE PROPERLY? (SEE THE NORMAL GLOWPLUG OPERATION DESCRIPTION ON THE RIGHT HAND PAGE.)

TEST OPTIONS

1. STE/ICE-R TEST 80 (Page 2-749)
2. MULTIMETER

REASON FOR QUESTION

If the glowplugs cycle, the glowplug controller is working. Since current draw is OK, the only thing left to check is the cycling.

NO → GO TO B, Page 2-310

YES ↓

5

NO GLOWPLUGS FAULT FOUND.

NORMAL GLOWPLUG OPERATION

The glowplugs first come ON when the engine temperature is below 120 °F (49 °C) and the rotary switch is turned to RUN. They stay ON for up to 9 seconds and then go OFF. They will stay OFF for about 7-15 seconds then come ON again for about 1 second, than go OFF again. If you don't start the engine, the glowplugs should keep cycling like this, due to the glowplug cycle timer in the glowplugs controller. It you start the engine, they will cycle until the engine is warm, due to the afterglow cycle timer in the glowplug controller. When the engine gets up to 120 °F (49 °C), the glowplugs should stop cycling completely.

ENGINE NOT RUNNING
ROTARY SWITCH IN RUN.

If the glowplugs are cycling property, you should hear a click from the protective control box (PCB) when the glowplugs turn on and when they turn off. This is the glowplug cycle timer, a thermal circuit breaker. A good way to check for cycling is STE/ICE-R test 80, battery current. When the glowplugs turn on, STE/ICE-R will measure 74-125 amps. When the glowplugs turn off, the STE/ICE-R will measure 3-8 amps.

ENGINE RUNNING.
ROTARY SWITCH IN RUN

If the glowplugs are cycling properly, you can hear a click from the protective control box (PCB) when the glowplugs turn on and when they turn off (you may have to duck your head under the dash). This is the afterglow cycle timer, a thermal circuit breaker. A good way to check for cycling is STE/ICE-R test 80, battery current. When the glowplugs turn on, STE/ICE-R will measure 74-125 amps. When the glowplugs turn off, STE/ICE-R will measure 3-8 amps. As the engine gets warmer, the glowplugs turn on leas frequently and for baa time.

NOTE

If you don't have a STE/ICE-R or a multimeter for measuring current, you can watch the vehicle volts gauge for indication of glowplug operation. The glowplugs drew so much current that the volts gage should jump about half-an-inch to the left when the glowplugs come on. Before starting the engine, you should hear the glowplug power relay click open and closed as the glowplugs cycle. (You can hear the relay after the engine has started by leaning your head under the dash near the protective control box.) This method won't tell you if all the glowplugs are working property, but it at least shows that the glowplugs are trying to work and that the glowplug power relay is working.

EXPECTED GLOWPLUG CURRENT

ROTARY SWITCH IN RUN POSITION;

GLOWPLUGS ON : 74 - 125 AMPS 74 is only for weak batteries. You should get at least 100 amps when glowplugs are working properly.

GLOWPLUGS OFF : AT or NEAR ZERO With the rotary switch in the RUN position, other parts of the vehicle are drawing current. You might measure up to 8 amps.

BATTERY CURRENT
STE/ICE-R TEST 80

1. Start Test 80, battery current.

2. Displayed reading is in amps. The reading will be greater then 30 amps, depending on how many accessories you have on.

BATTERY CURRENT
MULTIMETER

1. Set the voltmeter to a DC volts scale of about 1 volt.

2. Connect the BLACK lead to the battery side of the current shunt and the RED lead to the other end of the current shunt.

3. Current shunt voltage is proportional to battery current, 100 millivolts = 1000 amps. To get current, multiply millivolts x 10.

GLOWPLUGS

DIAGNOSTIC FLOWCHART

A
FROM 3,
Page 2-304

A1

KNOWN INFO

GLOWPLUGS DO NOT DRAW ENOUGH CURRENT

POSSIBLE PROBLEMS

GLOWPLUGS
GLOWPLUG CONTROLLER
CABLES

TURN THE ROTARY SWITCH TO "RUN". DO THE GLOWPLUGS DRAW AT LEAST 15 AMPS?

TEST OPTIONS

1. STE/ICE-R TEST 80 (Page 2-749)
2. MULTIMETER

REASON FOR QUESTION

A working glowplug draws 12-15 amps. If at least one glowplug is working, the protective control box is OK.

NO GO TO C, Page 2-312

YES

A2

KNOWN INFO

GLOWPLUGS DRAW SOME BUT NOT ENOUGH CURRENT.
PCB OK

POSSIBLE PROBLEMS

GLOWPLUGS
GLOWPLUG CONTROLLER
CABLES

DO THE GLOWPLUGS CYCLE PROPERLY?

TEST OPTIONS

1. STE/ICE-R TEST 80 (Page 2-749)
2. MULTIMETER

REASON FOR QUESTION

If the glowplugs cycle properly, the glowplug controller is OK.

NO GO TO B, Page 2-310

YES

!!

A3

KNOWN INFO

GLOWPLUGS DRAW SOME BUT NOT ENOUGH CURRENT
PCB OK
GLOWPLUG CONTROLLER OK

POSSIBLE PROBLEMS

GLOWPLUGS
CABLES

CHECK THE GLOWPLUGS AND WIRES USING THE PROCEDURE ON THE RIGHT-HAND PAGE. REPAIR OR REPLACE PARTS AS REQUIRED. RE-RUN THE MAIN TEST CHAIN.

TEST OPTIONS

SEE THE PROCEDURE ON THE RIGHT HAND PAGE AND USE:

1. STE/ICE-R TEST #91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION

Since the glowplugs draw some current and cycle properly, the only reason they wouldn't draw enough current is that the glow-plugs themselves are bad or the wires are no good.

REFERENCE INFORMATION

Dead glowplugs draw virtually no current, but other parts of the vehicle are drawing some current, up to 8 amps. If any glowplugs are drawing any current, then the protective control box is probably OK.

For a good description of how glowplugs cycle and how to check for proper cycling, refer to page 2-307.

WARNING

Disconnect negative battery cable before disconnecting and reconnecting protective control box harness.

There is battery voltage at the PCB at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

If most or all of the glowplugs are bad, you may also have a problem with the protective control box or the glowplug controller which caused them to go bed (usually they burn out from being on too long or not turning off at all). After replacing the bad glowplugs, rerun the glowplugs test chain paying special attention to the glowplugs cycling, especially that they turn OFF when they should.

Replace glowplugs, wires, or harness, refer to (para 3-38).

GLOWPLUGS

BATTERY CURRENT STE/ICE-R TEST 80
1. Start Test 80, battery current. 2. Displayed reading is in amps. The reading will be greater then 30 amps, depending on how many accessories you have on.

BATTERY CURRENT MULTIMETER
1. Set the voltmeter to a DC volts scale of about 1 volt. 2. Connect the BLACK lead to the battery side of the current shunt and the RED lead to the other end of the current shunt. 3. Current shunt voltage is proportional to battery current, 100 millivolts = 1000 amps. To get current, multiply millivolts x 10.

CHECKING GLOWPLUGS & THEIR WIRES

1. Disconnect ALL the glowplugs.
2. Disconnect the negative battery cable. Disconnect the PCB connector harness from the PCB. Reconnect the negative battery cable. Measure the resistance between pin Din the engine connector harness of the protective control box and ground. There should NOT be continuity (resistance reading off-the-scale). If there is continuity, repair or replace the harness.
3. Repeat the following for each glowplug
   a. Reconnect the wiring harness to the glowplug while you repeat the resistance measurement described in step 2. When you reconnect the wire to the glowplug, the resistance should drop to between 1 and 2 ohms (glowplugs are typically 1.6 ohms).

   b. If step a passed;
   disconnect the glowplug again, making sure the resistance goes off-scale again. Repeat step a for the next glowplug.

   c. If step a failed;
   then either the glowplug or its wire is no good. Take the wire off the glowplug again and measure the resistance from the glowplug to the engine block. If the resistance is 1-2 ohms, then the cable is no good, otherwise replace the glowplug and check the cable for continuity, just to be sure.
4. Reconnect the PCB and all wires.

GLOWPLUGS

DIAGNOSTIC FLOWCHART

B
FROM 4,
Page 2-306 or
A2, Page 2-308

B1

KNOWN INFO
GLOWPLUG CURRENT OK NOT CYCLING PROPERLY

POSSIBLE PROBLEMS
PCB

TURN ROTARY SWITCH TO "STOP". DISCONNECT GLOW-PLUG CONTROLLER. TURN ROTARY SWITCH TO "RUN". DO GLOW PLUGS STILL DRAW CURRENT?

TEST OPTIONS

1. STE/ICE-R TEST 80 (Page 2-749)
2. MULTIMETER

REASON FOR QUESTION

If the glowplug controller is shorted, the glowplug power relay in the protective control box will always be closed.

NO → GO TO E, Page 2-316

YES ↓

B2

KNOWN INFO
GLOWPLUG CURRENT OK GLOWPLUGS NOT CYCLING GLOWPLUGS DRAW CURRENT WITH CONTROLLER DISCONNECTED.

POSSIBLE PROBLEMS
WIRING SHORT PCB (GLOWPLUG POWER RELAY)

MEASURE VOLTAGE AT SOCKET 6 OF GLOWPLUG CONTROLLER CONNECTOR HARNESS. IS THERE BATTERY VOLTAGE AT THIS SOCKET?

TEST OPTIONS

1. STE/ICE-R TEST 89 (Page 2-750)
2. MULTIMETER

REASON FOR QUESTION

If there is a short in the harness, this wire will have battery voltage.

NO → REPLACE PCB

YES ↓

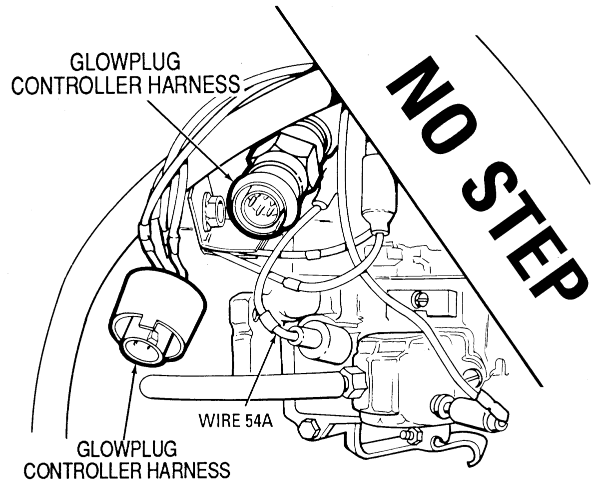
B3

SHORT IN ENGINE CONNECTOR HARNESS. REPAIR OR REPLACE HARNESS.

NOTE

Ensure that alternator "AC" tap is functioning correctly by measuring DC volts at wire 2A. Reading should be between 9-16 Vdc. If this votage is not present, glowplug system will never stop cycling.

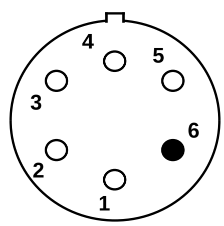
Refer to the functional flow schematic. If the glowplug controller is shorted (continuity from pin 6 to pin 3), the glowplug power relay will always be energized and the glowplugs will always be drawing current.



BATTERY CURRENT STE/ICE-R TEST 80
1. Start Test 80, battery current. 2. Displayed reading is in amps. The reading will be greater than 30 amps, depending on how many accessories you have on.

BATTERY CURRENT MULTIMETER
1. Set the voltmeter to a DC volts scale of about 1 volt. 2. Connect the BLACK lead to the battery side of the current shunt and the RED lead to the other end of the current shunt. 3. Current shunt voltage is proportional to battery current, 100 millivolts = 1000 amps. To get current, multiply millivolts x 10.

Since the glowplugs draw current without the glowplug controller connected, there must be a short in the harness or a stuck relay in the protective control box (PCB). If there were a short in the harness directly to the glowplugs, the glowplugs would have burned out long ago and you wouldn't be here. The only other short in the harness that would make the glowplugs turn on without the glowplug controller installed would show up as battery voltage at pin 6 of the controller's connector.



Glowplug Controller Harness Schematic

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

Replace PCB, refer to (para. 4-5).

Check the end of the harness at the protective control box, glowplugs, etc. for shorts. Repair whatever you can. If you don't see anything wrong, the short must be in the main body of the harness, which means that you have to replace the harness.

!!

WARNING

Disconnect negative battery cable before disconnecting and reconnecting protective control box.

There is battery voltage at the PCB at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

For repair or replacement of wiring, refer to (para. 4-85).

VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.

GLOWPLUGS

DIAGNOSTIC FLOWCHART

C
FROM A1,
Page 2-308

C1

TURN ROTARY SWITCH TO "STOP". IS THERE LESS THAN 0.5 VOLTS AT GLOWPLUG WIRES?

KNOWN INFO

GLOWPLUGS DON'T DRAW ANY CURRENT

POSSIBLE PROBLEMS

GLOWPLUG CONTROLLER
WIRING (OPEN CIRCUIT)
8 BAD GLOWPLUGS
PCB

TEST OPTIONS

1. STE/ICE-R TEST 89 (Page 2-750)
2. MULTIMETER

REASON FOR QUESTION

There should not be voltage at glowplugs with switch off.

NO → SHORT IN HARNESS

YES ↓

C2

TURN THE ROTARY SWITCH TO "RUN". IS THERE LESS THAN 0.5 VOLTS AT THE GLOWPLUG WIRES?

KNOWN INFO

NO SHORTS
GLOWPLUGS DRAW ZERO AMPS

POSSIBLE PROBLEMS

GLOWPLUG CONTROLLER
BAD GLOWPLUGS
PCB

TEST OPTIONS

1. STE/ICE-R TEST 89 (Page 2-750)
2. MULTIMETER

REASON FOR QUESTION

To see if power is getting to glowplugs.

NO → REPLACE GLOWPLUGS

YES ↓

C3

!!

TURN ROTARY SWITCH TO "STOP". MAKE SURE GLOWPLUG CONTROLLER IS CONNECTED. IS THERE CONTINUITY FROM SOCKET 'A' TO SOCKET 'B' OF PCB ENGINE CONNECTOR HARNESS ?

KNOWN INFO

NO SHORTS
GLOWPLUGS DRAW NO CURRENT
NO VOLTAGE AT GLOWPLUGS

POSSIBLE PROBLEMS

OPEN IN PCB
OPEN IN GLOWPLUG CONTROLLER
OPEN IN WIRING

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION

Continuity indicates the harness and controller are ok.
Non-continuity indicates an open in the harness or controller.

NO → GO TO D, Page 2-314

YES ↓

REPLACE PCB

Replace harness. Notify DS Maintenance.

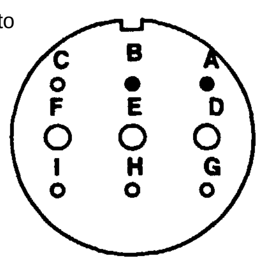
Replace glowplugs, refer to (para 3-38).

WARNING

Disconnect negative battery cable before disconnecting and reconnecting protective control box harness.

There is battery voltage at the PCB at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

Replace PCB, refer to (para 4-5).



Engine Connector with pins 'A' & 'B' highlighted.

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.

0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated test points in the question. RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms. 2. Connect the RED and BLACK leads to the connections stated in the question. 3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

GLOWPLUGS — DIAGNOSTIC FLOWCHART

D
FROM C3,
Page 2-312; 17, Page 2-238;
24, Page 2-242; 26, Page 2-244;

D1

KNOWN INFO

OPEN CIRCUIT IN GLOW-PLUG CONTROLLER OR WIRING

POSSIBLE PROBLEMS

WIRING
GLOWPLUG CONTROLLER

IS THERE CONTINUITY BETWEEN PCB ENGINE CONNECTOR HARNESS SOCKET "B" AND GLOWPLUG CONTROLLER HARNESS CONNECTOR SOCKET "3"?

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION

This checks the return wire from the glowplug controller to the protective control box.

NO → **REPAIR/REPLACE WIRE 459B**

YES ↓

D2

KNOWN INFO

OPEN CIRCUIT IN GLOW-PLUG CONTROLLER OR WIRING

POSSIBLE PROBLEMS

WIRING
GLOWPLUG CONTROLLER

IS THERE CONTINUITY BETWEEN PCB ENGINE CONNECTOR HARNESS SOCKET "A" AND GLOWPLUG CONTROLLER HARNESS CONNECTOR SOCKET "6" ?

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION

This checks the main power wire from the protective control box to the glowplug controller.

NO → **REPLACE WIRE 543 &/OR 569B**

YES ↓

D3

REPLACE GLOWPLUG CONTROLLER. DOES THE ENGINE START EASILY WHEN COLD?

REASON FOR TESTS

You verified that the wiring is OK so the controller must be bad.

NO → **GO TO C, Page 2-110**

YES ↓

NO FAULTS

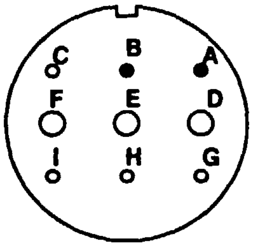
REFERENCE INFORMATION

GLOWPLUGS

WARNING

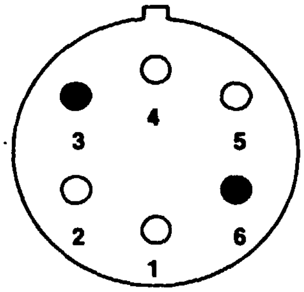
Disconnect negative battery cable before disconnecting and reconnecting protective control box harness.

There is battery voltage at the PCB at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.



Engine Connector Harness with sockets "A" & "B" highlighted.

0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated test points in the question. RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays '9.9.9.9.'



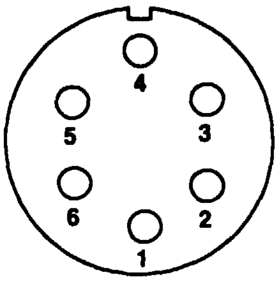
Glowplug Controller Harness with sockets 3 & 6 highlighted

CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms. 2. Connect the RED and BLACK leads to the connections stated in the question. 3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

NOTE

You will not be able to check the solid-state controller using the pin-to-pin resistance check. The solid-state controller is identified by a green finish and a larger case.

Replace glowplug controller, refer to (para 4-29).

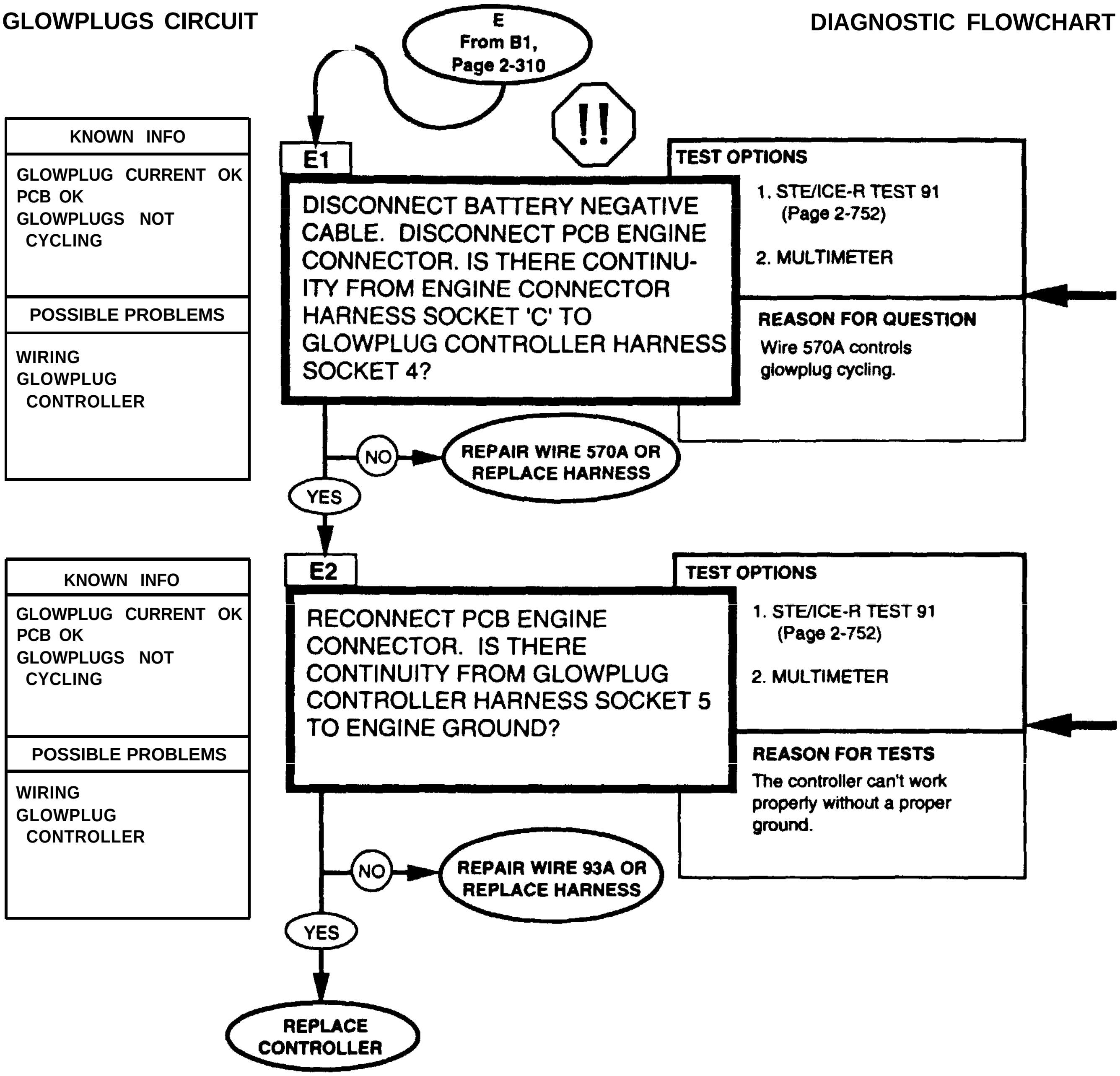


Glowplug Controller

PIN-TO-PIN		RESISTANCE
1	5	130 Ω ± Ω
2	3	0.40 Ω TO 0.75 Ω
4	5	27 Ω ± 3 Ω
2	6	.45 Ω MAXIMUM

GLOWPLUGS CIRCUIT

DIAGNOSTIC FLOWCHART



REFERENCE INFORMATION

GLOWPLUGS CIRCUIT

WARNING

Disconnect negative battery cable before disconnecting and reconnecting protective control box harness.

There is battery voltage at the PCB at all times. Failure to disconnect battery cable will result m damage to equipment or injury to personnel.

Repair wiring or replace harness, refer to (pare 4-34).

0-4500 OHMS
STE/ICE-R TEST 91

1. Connect RED clip and BLACK clip to the indicated test points in the question. RED to the first, BLACK to the second.

2. Start Test 91,0-4500 ohms.

3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

Repair wiring or replace harness, refer to (para 4-85).

Replace glowplug controller, refer to (para 4-29).

CONTINUITY (RESISTANCE)
Multimeter

1. Set the voltmeter to an ohms scale of about 1000 ohms.

2. Connect the RED and BLACK leads to the connections stated in the question.

3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

2-31.1. GLOWPLUGS CIRCUIT TESTS (DISTRIBUTION BOX)

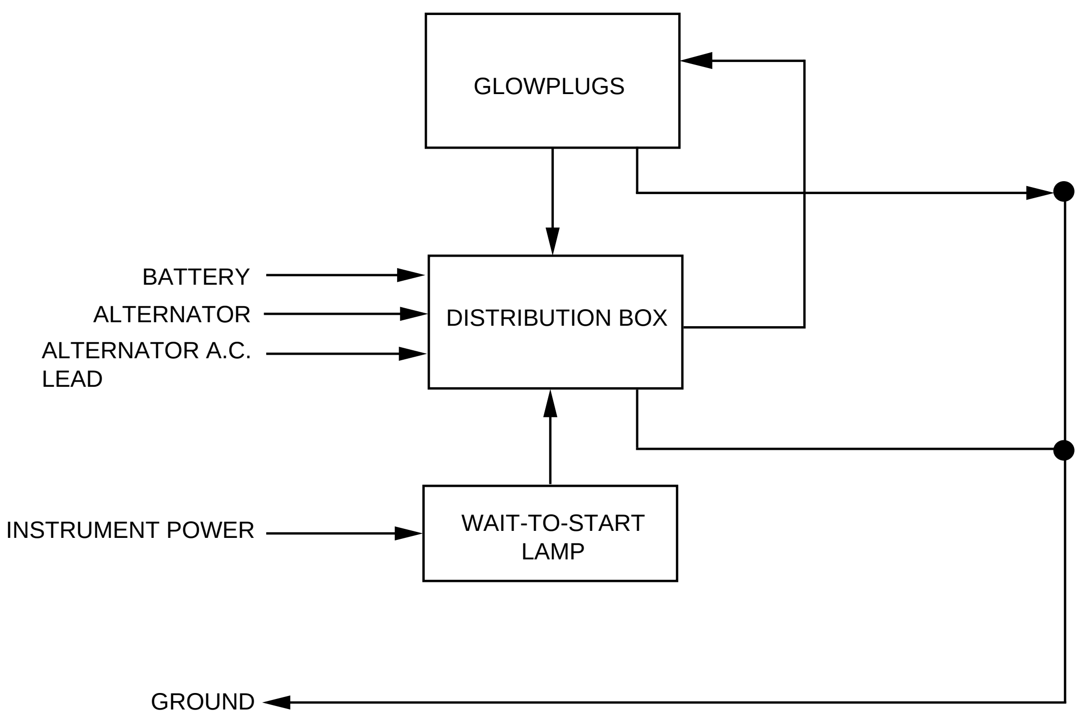
These tests of the Glowplugs Circuit can be run anytime you think there may be a problem with the glowplugs, or if you were sent here from another test.

If you were sent from another test, be sure to mark where you came from so you will be able to return.

If you are running this test because the engine is hard to start when cold, remember that there is also a cold start advance circuit (part of the fuel system) which is not checked here.

For any starting problem, we recommend running the “STARTABILITY” test chain just to be sure you don't miss anything.

At the bottom of this page is a simplified block diagram which shows how the different parts of the glowplug circuit depend on each other and on other engine circuits.



GLOWPLUGS CIRCUIT SIMPLIFIED BLOCK DIAGRAM FOR DISTRIBUTION BOX

GLOWPLUGS

DIAGNOSTIC FLOWCHART

START

1

TO RUN THE GLOWPLUG CIRCUIT TESTS, THE BATTERIES MUST BE IN A GOOD STATE OF CHARGE. IF YOU AREN'T SURE, RUN THE BATTERY CIRCUIT TESTS. IF YOU ARE HERE BECAUSE THE "WAIT-TO-START" LAMP DOESN'T WORK PROPERLY, SEE THE NOTE ON THE RIGHT-HAND PAGE.

KNOWN INFO

NOTHING

POSSIBLE PROBLEMS

GLOWPLUGS
DISTRIBUTION BOX
CABLES

TEST OPTIONS

BATTERY TESTS
(Page 2-251)

REASON FOR QUESTION

The glowplugs and their control circuits require battery power to work.

2

!!

CHECK ALL THE GLOWPLUG CIRCUIT CONNECTIONS (GLOW-PLUGS, GLOWPLUG HARNESS CONNECTIONS). ARE ALL THE CONNECTIONS CLEAN AND TIGHT?

KNOWN INFO

BATTERIES OK

POSSIBLE PROBLEMS

GLOWPLUGS
DISTRIBUTION BOX
CABLES

TEST OPTIONS

VISUAL INSPECTION

REASON FOR QUESTION

Loose or dirty connections can hinder current flow or cause mixups in the control signals.

NO → **REPAIR AS NECESSARY**

YES ↓

3

MEASURE THE RESISTANCE FROM PINS A THROUGH H OF GLOWPLUG HARNESS AND GROUND. IS THE READING 2 TO 3 OHMS?

KNOWN INFO

BATTERIES OK
CABLES/CONNECTIONS SEEM OK

POSSIBLE PROBLEMS

GLOWPLUGS
DISTRIBUTION BOX
CABLES

TEST OPTIONS

1. STE/ICE-R TEST 80
(Page 2-749)
2. MULTIMETER

REASON FOR QUESTION

If the resistance is OK, then the glowplugs and harness are OK.

NO → **GO TO A, Page 2-318.6**

YES → **GO TO 4, Page 2-318.4**

REFERENCE INFORMATION

GLOWPLUGS

If the engine cranks ok (or starts), then the batteries are good enough for testing the glowplugs. If the engine starts, shut it off.

You can use STE/ICE Test 10 to measure cranking speed. The engine should crank at least 100 RPM in cold weather and at least 180 RPM in warm weather.

WARNING

Disconnect negative battery cable before disconnecting and reconnecting distribution box harness.

There is battery voltage at the distribution box at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

BAD CONNECTIONS ARE THE MOST COMMON PROBLEM !

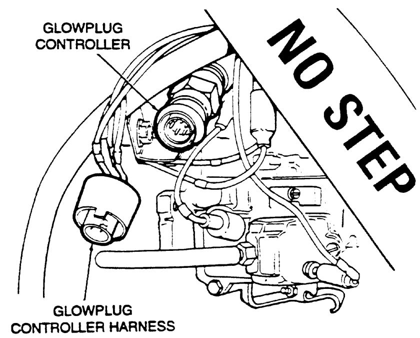
Sometimes, just disconnecting, cleaning and reconnecting will solve a problem. BE THOROUGH ! The time you save may be your own. Refer to the functional flow schematic and check the following;
1. BATTERY - make sure all connections are clean and tight, including the shunt and power stud.
2. DISTRIBUTION BOX - unscrew the three connectors and look for bent or broken pins, pins pushed out of their socket, or dirt and corrosion in the connections.
3. GLOWPLUGS - Check that all the glowplug wires are snug. Don't just look with your eyes. Many problems are solved by looking with your fingers to be sure a connection is snug.

NORMAL GLOWPLUG OPERATION

The glowplugs are heated quickly for 5 to 20 seconds. This cycle is active while the "Wait-to-Start" light is on. The length of "on" time is dependent on battery voltage, the weaker the batteries the longer the "on" time. This cycle will only repeat if the run start switch has been off for more than 2 1/2 minutes. After the initial 5 to 20 seconds preglow, the system goes to afterglow. Afterglow provides lower voltage to the glowplugs to keep them at operating temperature for approximately 60 seconds.

NOTE

The "WAIT-TO-START" lamp is NOT diagnosed in this section. If the lamp does not work properly, the glowplug circuit may be affecting its operation. Run these tests to check out the glowplug circuit. If the lamp still does not work properly, go to the INSTRUMENTS section for a full diagnosis of the lamp's problem.



BATTERY CURRENT MULTIMETER

1. Set the voltmeter to a DC volts scale of about 1 volt.

2. Connect the BLACK lead to the battery side of the current shunt and the RED lead to the other end of the current shunt.

3. Current shunt voltage is proportional to battery current, 100 millivolts = 1000 amps. To get current, multiply millivolts x 10.

BATTERY CURRENT STE/ICE-R TEST 80

1. Start Test 80, battery current.

2. Displayed reading is in amps. The reading will be greater than 30 amps, depending on how many accessories you have on.

NOTE

To check for glowplug current draw, start STE/ICE-R Test 80, battery current. Turn off all accessories (lights, heater, wipers etc). STE/ICE-R should immediately measure at least 74 amps. Take note, however, that if all your glowplugs are working, the current draw should be close to or more than 100 amps, especially if it's cold. If it's near freezing and the glowplugs only draw 75-80 amps, you probably have a few bad glowplugs.

GLOWPLUGS

DIAGNOSTIC FLOWCHART

FROM 3, Page 2-318.2

KNOWN INFO

BATTERIES OK
GLOWPLUGS OK
DISTRIBUTION BOX OK

POSSIBLE PROBLEMS

CABLES
GLOWPLUG CONTROL CIRCUIT

4

DO THE GLOWPLUGS CYCLE PROPERLY? (SEE THE NORMAL GLOWPLUG OPERATION DESCRIPTION ON THE RIGHT HAND PAGE.)

TEST OPTIONS

1. STE/ICE-R TEST 80 (Page 2-749)
2. MULTIMETER

REASON FOR QUESTION

If the glowplugs cycle, the glowplug controller is working. Since current draw is OK, the only thing left to check is the cycling.

NO → **GO TO B, Page 2-318.8**

YES →

5

NO GLOWPLUGS FAULT FOUND.

NORMAL GLOWPLUG OPERATION

The glowplugs first come ON when the engine temperature is below 120 °F (49 °C) and the rotary switch is turned to RUN. They stay ON for up to 9 seconds and then go OFF. They will stay OFF for about 7-15 seconds then come ON again for about 1 second, then go OFF again. If you don't start the engine, the glowplugs should keep cycling like this, due to the glowplug cycle timer in the glowplugs controller. If you start the engine, they will cycle until the engine is warm, due to the afterglow cycle timer in the glowplug controller. When the engine gets up to 120 °F (49 °C), the glowplugs should stop cycling completely.

EXPECTED GLOWPLUG CURRENT

ROTARY SWITCH IN RUN POSITION;

GLOWPLUGS ON : 74 - 125 AMPS 74 is only for weak batteries. You should get at least 100 amps when glowplugs are working properly.

GLOWPLUGS OFF : AT or NEAR ZERO With the rotary switch in the RUN position, other parts of the vehicle are drawing current. You might measure up to 8 amps.

ENGINE NOT RUNNING,
ROTARY SWITCH IN RUN.

If the glowplugs are cycling properly, you should hear a click from the distribution box when the glowplugs turn on and when they turn off. This is the glowplug cycle timer, a thermal circuit breaker. A good way to check for cycling is STE/ICE-R test 80, battery current. When the glowplugs turn on, STE/ICE-R will measure 74-125 amps. When the glowplugs turn off, the STE/ICE-R will measure 3-8 amps.

BATTERY CURRENT
STE/ICE-R TEST 80

1. Start Test 80, battery current.

2. Displayed reading is in amps. The reading will be greater then 30 amps, depending on how many accessories you have on.

ENGINE RUNNING,
ROTARY SWITCH IN RUN

If the glowplugs are cycling properly, you can hear a click from the distribution box when the glowplugs turn on and when they turn off (you may have to duck your head under the dash). This is the afterglow cycle timer, a thermal circuit breaker. A good way to check for cycling is STE/ICE-R test 80, battery current. When the glowplugs turn on, STE/ICE-R will measure 74-125 amps. When the glowplugs turn off, STE/ICE-R will measure 3-8 amps. As the engine gets warmer, the glowplugs turn on less frequently and for less time.

BATTERY CURRENT
MULTIMETER

1. Set the voltmeter to a DC volts scale of about 1 volt.

2. Connect the BLACK lead to the battery side of the current shunt and the RED lead to the other end of the current shunt.

3. Current shunt voltage is proportional to battery current, 100 millivolts = 1000 amps. To get current, multiply millivolts x 10.

NOTE

If you don't have a STE/ICE-R or a multimeter for measuring current, you can watch the vehicle volts gauge for indication of glowplug operation. The glowplugs draw so much current that the volts gage should jump about half-an-inch to the left when the glowplugs come on. Before starting the engine, you should hear the glowplug power relay click open and closed as the glowplugs cycle. (You can hear the relay after the engine has started by leaning your head under the dash near the distribution box.) This method won't tell you if all the glowplugs are working properly, but it at least shows that the glowplugs are trying to work and that the glowplug power relay is working.

GLOWPLUGS — DIAGNOSTIC FLOWCHART

A
FROM 3,
Page 2-318.2

A1

KNOWN INFO

GLOWPLUGS DO NOT DRAW ENOUGH CURRENT

POSSIBLE PROBLEMS

GLOWPLUGS
GLOWPLUG CONTROLLER
CABLES

TURN THE ROTARY SWITCH TO "RUN". DO THE GLOWPLUGS DRAW AT LEAST 15 AMPS?

TEST OPTIONS

1. STE/ICE-R TEST 80 (Page 2-749)
2. MULTIMETER

REASON FOR QUESTION

A working glowplug draws 12-15 amps. If at least one glowplug is working, the distribution box is OK.

NO — GO TO C, Page 2-318.10

YES

A2

KNOWN INFO

GLOWPLUGS DRAW SOME BUT NOT ENOUGH CURRENT
DISTRIBUTION BOX OK

POSSIBLE PROBLEMS

GLOWPLUGS
GLOWPLUG CONTROLLER
CABLES

DO THE GLOWPLUGS CYCLE PROPERLY?

TEST OPTIONS

1. STE/ICE-R TEST 80 (Page 2-749)
2. MULTIMETER

REASON FOR QUESTION

If the glowplugs cycle properly, the glowplug controller is OK.

NO — GO TO B, Page 2-318.8

YES

!!

A3

KNOWN INFO

GLOWPLUGS DRAW SOME BUT NOT ENOUGH CURRENT
DISTRIBUTION BOX OK
GLOWPLUG CONTROLLER OK

POSSIBLE PROBLEMS

GLOWPLUGS
CABLES

CHECK THE GLOWPLUGS AND WIRES USING THE PROCEDURE ON THE RIGHT-HAND PAGE. REPAIR OR REPLACE PARTS AS REQUIRED. RERUN THE MAIN TEST CHAIN.

TEST OPTIONS

SEE THE PROCEDURE ON THE RIGHT HAND PAGE AND USE:

1. STE/ICE-R TEST #91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION

Since the glowplugs draw some current and cycle properly, the only reason they wouldn't draw enough current is that the glowplugs themselves are bad or the wires are no good.

REFERENCE INFORMATION

Dead glowplugs draw virtually no current, but other parts of the vehicle are drawing some current, up to 8 amps. If any glowplugs are drawing any current, then the distribution box and glowplug circuit is probably OK.

For a good description of how glowplugs cycle and how to check for proper cycling, refer to page 2-307.

WARNING

Disconnect negative battery cable before disconnecting and reconnecting distribution box harness.

There is battery voltage at the distribution box at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

If most or all of the glowplugs are bad, you may also have a problem with the distribution box or the glowplug controller which caused them to go bad (usually they burn out from being on too long or not turning off at all). After replacing the bad glowplugs, rerun the glowplugs test chain paying special attention to the glowplugs cycling, especially that they turn OFF when they should.

Replace glowplugs, wires, or harness, refer to (para. 3-38).

GLOWPLUGS

BATTERY CURRENT
STE/ICE-R TEST 80

1. Start Test 80, battery current.

2. Displayed reading is in amps. The reading will be greater then 30 amps, depending on how many accessories you have on.

BATTERY CURRENT
MULTIMETER

1. Set the voltmeter to a DC volts scale of about 1 volt.

2. Connect the BLACK lead to the battery side of the current shunt and the RED lead to the other end of the current shunt.

3. Current shunt voltage is proportional to battery current, 100 millivolts = 1000 amps. To get current, multiply millivolts x 10.

CHECKING GLOWPLUGS & THEIR WIRES

1. Disconnect ALL the glowplugs.

2. Disconnect the negative battery cable. Disconnect the distribution box connector harness from the distribution box. Reconnect the negative battery cable. Measure the resistance between pin D in the engine connector harness of the distribution box and ground. There should NOT be continuity (resistance reading off-the-scale). If there is continuity, repair or replace the harness.

3. Repeat the following for each glowplug:
   a. Reconnect the wiring harness to the glowplug while you repeat the resistance measurement described in step 2. When you reconnect the wire to the glowplug, the resistance should drop to between 1 and 2 ohms (glowplugs are typically 1.6 ohms).

   b. If step a passed;
   disconnect the glowplug again, making sure the resistance goes off-scale again. Repeat step a for the next glowplug.

   c. If step a failed;
   then either the glowplug or its wire is no good. Take the wire off the glowplug again and measure the resistance from the glowplug to the engine block. If the resistance is 1 - 2 ohms, then the cable is no good, otherwise replace the glowplug and check the cable for continuity, just to be sure.

4. Reconnect the distribution box and all wires.

GLOWPLUGS

DIAGNOSTIC FLOWCHART

B
FROM 4,
Page 2-318.4 or
A2, Page 2-318.6

KNOWN INFO

GLOWPLUG CURRENT OK
NOT CYCLING PROPERLY

POSSIBLE PROBLEMS

DISTRIBUTION BOX

B1

TURN ROTARY SWITCH TO “STOP”. DISCONNECT DISTRIBUTION BOX. TURN ROTARY SWITCH TO “RUN”. DO GLOW PLUGS STILL DRAW CURRENT?

TEST OPTIONS

1. STE/ICE-R TEST 80 (Page 2-749)
2. MULTIMETER

REASON FOR QUESTION

If the distribution box is shorted, the glowplug power relay in the distribution box will always be closed.

NO → **GO TO E, Page 2-318.14**

YES ↓

KNOWN INFO

GLOWPLUG CURRENT OK
GLOWPLUGS NOT CYCLING
GLOWPLUGS DRAW CURRENT WITH DISTRIBUTION BOX DISCONNECTED.

POSSIBLE PROBLEMS

WIRING SHORT
DISTRIBUTION BOX (GLOWPLUG POWER RELAY)

B2

MEASURE VOLTAGE AT SOCKET 6 OF GLOWPLUG CONTROLLER CONNECTOR HARNESS. IS THERE BATTERY VOLTAGE AT THIS SOCKET?

TEST OPTIONS

1. STE/ICE-R TEST 89 (Page 2-750)
2. MULTIMETER

REASON FOR QUESTION

If there is a short in the harness, this wire will have battery voltage.

!!

NO → **REPLACE DISTRIBUTION BOX**

YES ↓

!!

B3

SHORT IN ENGINE CONNECTOR HARNESS. REPAIR OR REPLACE HARNESS.

REFERENCE INFORMATION

GLOWPLUGS

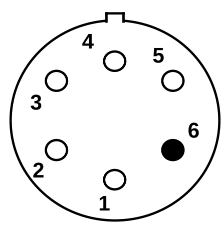
NOTE

Ensure that alternator "AC" tap is functioning correctly by measuring DC volts at wire 2A. Reading should be between 9-16 Vdc. If this voltage is not present, glowplug system will never stop cycling.

Refer to the functional flow schematic. If the distribution box is shorted (continuity from pin 6 to pin 3), the glowplug power relay will always be energized and the glowplugs will always be drawing current.

BATTERY CURRENT STE/ICE-R TEST 80
1. Start Test 80, battery current. 2. Displayed reading is in amps. The reading will be greater then 30 amps, depending on how many accessories you have on.

Since the glowplugs draw current without the distribution box connected, there must be a short in the harness or a stuck relay in the distribution box. If there were a short in the harness directly to the glowplugs, the glowplugs would have burned out long ago and you wouldn't be here. The only other short in the harness that would make the glowplugs turn on without the distribution box installed would show up as battery voltage at pin 6 of the controller's connector.



Glowplug Controller Harness Schematic

Replace distribution box, refer to (para. 4-5.1).

Check the end of the harness at the distribution box, glowplugs, etc. for shorts. Repair whatever you can. If you don't see anything wrong, the short must be in the main body of the harness, which means that you have to replace the harness.

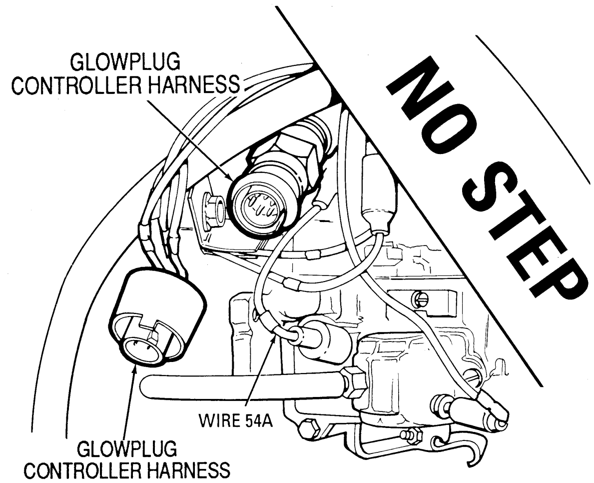
!!

WARNING

Disconnect negative battery cable before disconnecting and reconnecting distribution box harness.

There is battery voltage at the distribution box at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

For repair or replacement of wiring, refer to (para. 4-85).



BATTERY CURRENT MULTIMETER
1. Set the voltmeter to a DC volts scale of about 1 volt. 2. Connect the BLACK lead to the battery side of the current shunt and the RED lead to the other end of the current shunt. 3. Current shunt voltage is proportional to battery current, 100 millivolts = 1000 amps. To get current, multiply millivolts x 10.

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.

GLOWPLUGS — DIAGNOSTIC FLOWCHART

C
FROM A1,
Page 2-318.6

C1

KNOWN INFO

GLOWPLUGS DON'T DRAW ANY CURRENT

POSSIBLE PROBLEMS

GLOWPLUG CONTROLLER
WIRING (OPEN CIRCUIT)
BAD GLOWPLUGS
DISTRIBUTION BOX

TURN ROTARY SWITCH TO "STOP". IS THERE LESS THAN 0.5 VOLTS AT GLOWPLUG WIRES?

TEST OPTIONS

1. STE/ICE-R TEST 89 (Page 2-750)
2. MULTIMETER

REASON FOR QUESTION

There should not be voltage at glowplugs with switch off.

NO → **SHORT IN HARNESS**

YES → C2

C2

KNOWN INFO

NO SHORTS
GLOWPLUGS DRAW ZERO AMPS

POSSIBLE PROBLEMS

GLOWPLUG CONTROLLER
BAD GLOWPLUGS
DISTRIBUTION BOX

TURN THE ROTARY SWITCH TO "RUN". IS THERE LESS THAN 0.5 VOLTS AT THE GLOWPLUG WIRES?

TEST OPTIONS

1. STE/ICE-R TEST 89 (Page 2-750)
2. MULTIMETER

REASON FOR QUESTION

To see if power is getting to glowplugs.

NO → **REPLACE GLOWPLUGS**

YES → C3

!!

C3

KNOWN INFO

NO SHORTS
GLOWPLUGS DRAW NO CURRENT
NO VOLTAGE AT GLOWPLUGS

POSSIBLE PROBLEMS

OPEN IN DISTRIBUTION BOX
OPEN IN WIRING

TURN ROTARY SWITCH TO "STOP". MAKE SURE GLOWPLUG CONTROLLER IS CONNECTED. IS THERE CONTINUITY FROM SOCKET 'A' TO SOCKET 'B' OF DISTRIBUTION BOX ENGINE CONNECTOR HARNESS ?

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION

Continuity indicates the harness and controller are ok. Non-continuiity indicates an open in the harness or distribution box.

NO → **GO TO D, Page 2-318.12**

YES → **REPLACE DISTRIBUTION BOX**

Replace harness. Notify DS Maintenance.

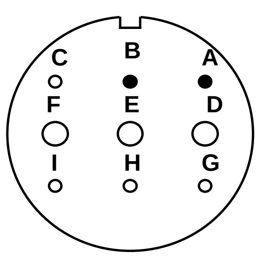
Replace glowplugs, refer to (para. 3-38).

WARNING

Disconnect negative battery cable before disconnecting and reconnecting distribution box harness.

There is battery voltage at the distribution box at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

Replace distribution box, refer to (para. 4-5.1).



Engine Connector with pins 'A' & 'B' highlighted.

0-45 DC VOLTS
STE/ICE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.

2. Start Test 89, DC volts.

3. Displayed reading is in volts.

VOLTAGE
MULTIMETER

1. Set the voltmeter to a DC volts scale of at least 40 volts.

2. Connect the RED lead to positive and the BLACK lead to negative.

3. Be sure to read the correct scale.

0-4500 OHMS
STE/ICE-R TEST 91

1. Connect RED clip and BLACK clip to the indicated test points in the question. RED to the first, BLACK to the second.

2. Start Test 91, 0-4500 ohms.

3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays “9.9.9.9.”

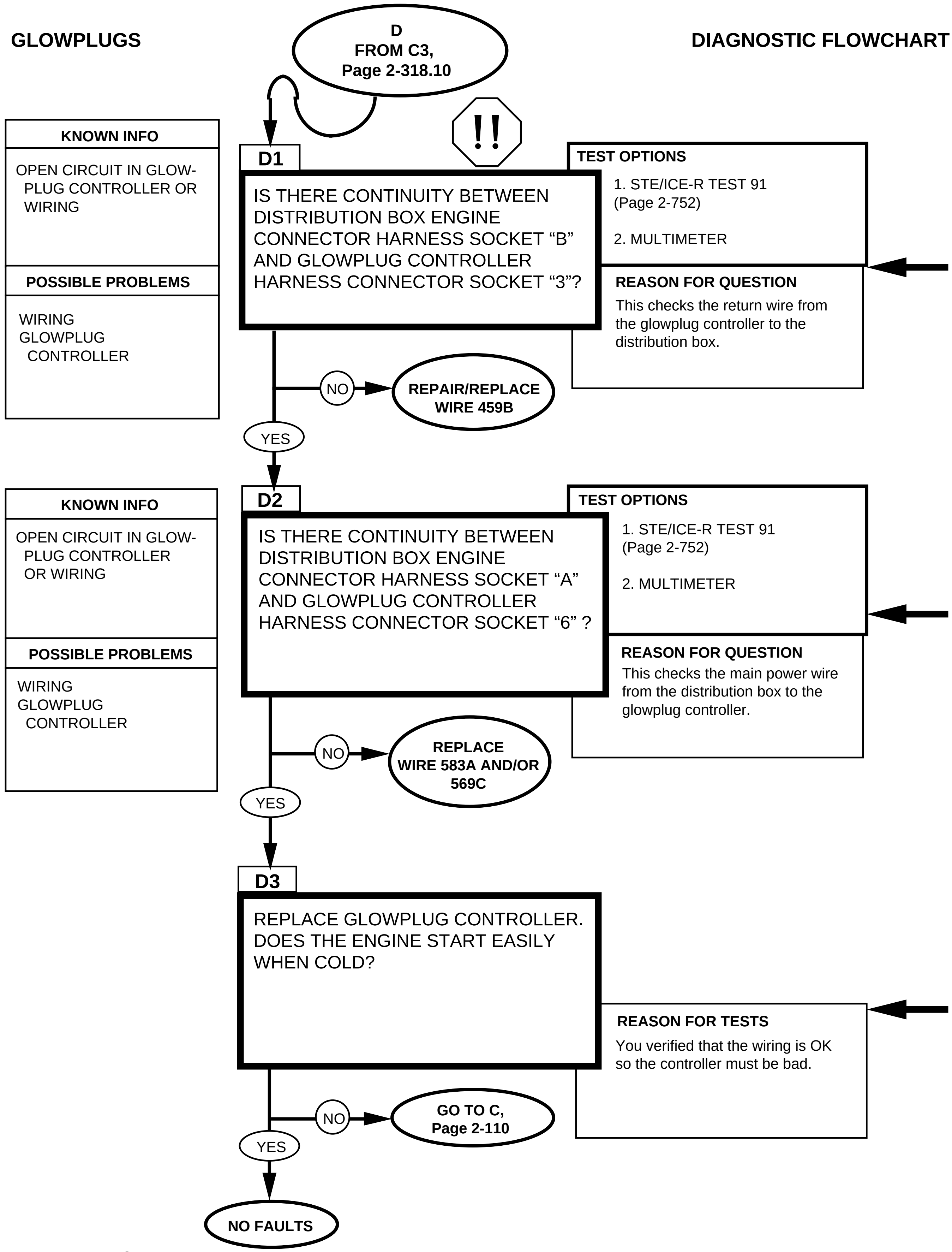
CONTINUITY (RESISTANCE)
MULTIMETER

1. Set the voltmeter to an ohms scale of about 1000 ohms.

2. Connect the RED and BLACK leads to the connections stated in the question.

3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

GLOWPLUGS DIAGNOSTIC FLOWCHART



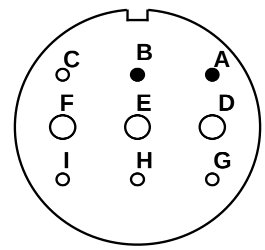
REFERENCE INFORMATION

GLOWPLUGS

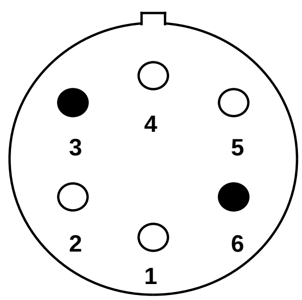
WARNING

Disconnect negative battery cable before disconnecting and reconnecting distribution box harness.

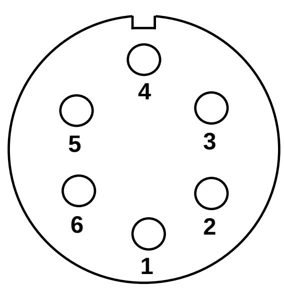
There is battery voltage at the distribution box at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.



Engine Connector Harness with sockets “A” & “B” highlighted.



Glowplug Controller Harness with sockets 3 & 6 highlighted



Glowplug Controller

0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated test points in the question. RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays '9.9.9.9.'

CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms. 2. Connect the RED and BLACK leads to the connections stated in the question. 3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

GLOWPLUGS CIRCUIT

DIAGNOSTIC FLOWCHART

E
From B1,
Page 2-318.8

!!

KNOWN INFO

GLOWPLUG CURRENT OK
DISTRIBUTION BOX OK
GLOWPLUGS NOT CYCLING

POSSIBLE PROBLEMS

WIRING
GLOWPLUG CONTROLLER

E1

DISCONNECT BATTERY NEGATIVE CABLE. DISCONNECT DISTRIBUTION BOX ENGINE CONNECTOR. IS THERE CONTINUITY FROM ENGINE CONNECTOR HARNESS SOCKET 'C' TO GLOWPLUG CONTROLLER HARNESS SOCKET 4?

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION

Wire 570A controls glowplug cycling.

NO → **REPAIR WIRE 570A OR REPLACE HARNESS**

YES ↓

KNOWN INFO

GLOWPLUG CURRENT OK
DISTRIBUTION BOX OK
GLOWPLUGS NOT CYCLING

POSSIBLE PROBLEMS

WIRING
GLOWPLUG CONTROLLER

E2

RECONNECT DISTRIBUTION BOX ENGINE CONNECTOR. IS THERE CONTINUITY FROM GLOWPLUG CONTROLLER HARNESS SOCKET 5 TO ENGINE GROUND?

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

REASON FOR TESTS

The controller can't work properly without a proper ground.

NO → **REPAIR WIRE 93A OR REPLACE HARNESS**

YES ↓

REPLACE CONTROLLER

REFERENCE INFORMATION **GLOWPLUGS CIRCUIT**

WARNING

Disconnect negative battery cable before disconnecting and reconnecting distribution box harness.

There is battery voltage at the distribution box at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

Repair wiring or replace harness, refer to (para. 4-84).

0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated test points in the question. RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

Repair wiring or replace harness, refer to (para. 4-85).

Replace glowplug controller, refer to (para. 4-29).

CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms. 2. Connect the RED and BLACK leads to the connections stated in the question. 3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

2-32. INSTRUMENT TESTS

These Instrument Tests can be run any time you think there is a problem with the instruments or if you were sent here from another test.

If you get an unusual gauge reading it is a good idea to check out the system that the gauge monitors to be sure that it is a gauge problem and not a real problem in the engine or electrical system.

Refer to fold-out page FO-10 and leave fold-out open for reference during testing. Diagrams of the individual gauge circuits will be found on the page that deals with that circuit.

INSTRUMENTS CIRCUIT

DIAGNOSTIC FLOWCHART

START

KNOWN INFO

ONE OR MORE GAUGES AND WARNING LAMPS DON'T WORK

POSSIBLE PROBLEMS

MASTER POWER
INSTRUMENTS
WIRING
SENDING UNITS

1

WITH THE ROTARY SWITCH IN THE ENGINE "STOP" POSITION, ARE ALL THE GAUGES IN THE "OFF" POSITION AND WARNING LAMPS OFF?

TEST OPTIONS

VISUAL

REASON FOR QUESTION

If any of the gauges or lamps are functioning then the electrical system is partially powered in the OFF position.

NO → GO TO A, Page 2-328

YES ↓

KNOWN INFO

NO POWER TO THE GAUGES WITH THE ROTARY SWITCH IN THE "OFF" POSITION

POSSIBLE PROBLEMS

MASTER POWER
INSTRUMENTS
WIRING
SENDING UNITS

2

TURN THE ROTARY SWITCH "OFF". DISCONNECT THE GLOWPLUG CONTROLLER. WITH THE ROTARY SWITCH IN THE "RUN" POSITION, DO ANY OF THE GAUGES AND WARNING LAMPS FUNCTION?

TEST OPTIONS

VISUAL

REASON FOR QUESTION

If any of the devices work then the master power circuit works.

NO → GO TO B, Page 2-330

YES ↓

KNOWN INFO

POWER AVAILABLE TO GAUGES AND WARNING LAMPS

POSSIBLE PROBLEMS

INSTRUMENTS
WIRING
SENDING UNITS

3

TURN THE ROTARY SWITCH OFF. RECONNECT THE GLOWPLUG CONTROLLER. TURN THE ROTARY SWITCH "ON". DOES THE WAIT-TO-START LAMP COME ON AT ANY TIME? [ENGINE TEMPERATURE MUST BE BELOW 120 °F (49°C).]

TEST OPTIONS

VISUAL

REASON FOR QUESTION

If the wait-to-start light comes on at any time then the circuit is being powered.

NO → GO TO C, Page 2-332

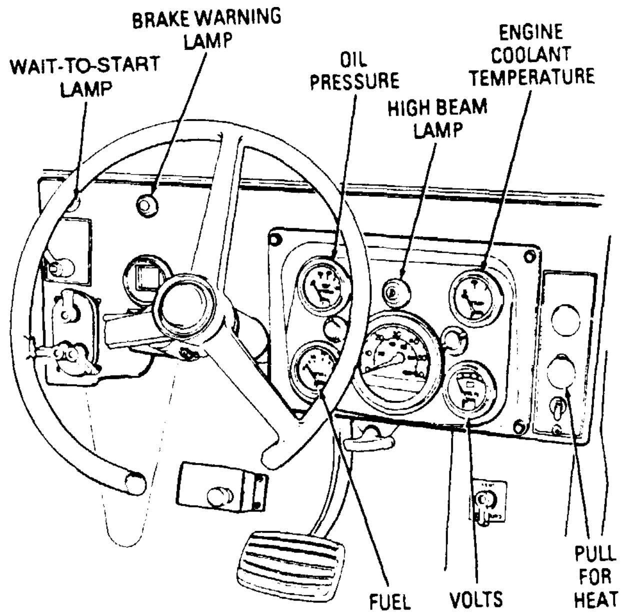
YES ↓

GO TO 4, Page 2-322

REFERENCE INFORMATION **INSTRUMENTS CIRCUIT**

None of the following instruments and accessories should work when the rotary switch is in the STOP position:

Volts gauge
Wait-to-start lamp
Temperature gauge
oil pressure gauge
Fuel gauge
Windshield wiper/washer
Brake warning lamp



If any of the instruments and accessories work when the rotary switch is in the RUN position, then power is available and the circuit breaker is OK.

NOTE

The wait-to-start lamp is not an accurate indication of glowplug operation. Make sure the glowplugs are operating property BEFORE you check out the light. Go to the Glowplug Tests, page 2-303. Return here if the light still doesn't operate property.

The wait-t-start lamp should come on when the engine is below 120°F (49° C) and the rotary switch is first turned to the RUN position.

INSTRUMENTS CIRCUIT — DIAGNOSTIC FLOWCHART

FROM 3, Page 2-320

KNOWN INFO
WAIT-TO-START LAMP OK

POSSIBLE PROBLEMS
INSTRUMENTS
WIRING
SENDING UNITS

4
DOES THE BRAKE WARNING LAMP OPERATE PROPERLY?

TEST OPTIONS
VISUAL

REASON FOR QUESTION
If the brake warning lamp comes on at any time then the circuit is being powered.

NO → SEE NOTE AT RIGHT

YES ↓

KNOWN INFO
BRAKE LAMP OK

POSSIBLE PROBLEMS
INSTRUMENTS
WIRING
SENDING UNITS

5
DOES THE VOLT GAUGE WORK?

TEST OPTIONS
VISUAL

REASON FOR QUESTION
If the volts gauge works then the power to the instruments is OK.

NO → GO TO E, Page 2-346

YES ↓

KNOWN INFO
VOLT GAUGE OK

POSSIBLE PROBLEMS
INSTRUMENTS
WIRING
SENDING UNITS

6
TURN ROTARY SWITCH TO "OFF" POSITON. DISCONNECT THE GLOW PLUG CONTROLLER. WITH THE ROTARY SWITCH IN THE "RUN" POSITION DOES THE WINDSHIELD WIPER WORK? TURN ROTARY SWITCH TO "OFF" POSITION. RECONNECT THE GLOWPLUG CONTROLLER.

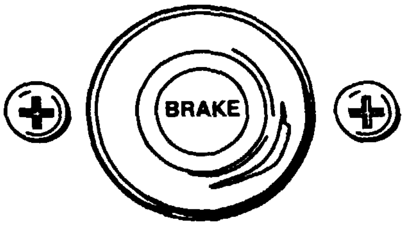
TEST OPTIONS
VISUAL

REASON FOR QUESTION
If the windshield wiper works then the power to the wiper is OK.

NO → GO TO F, Page 2-348

YES → GO TO 7, Page 2-324

The brake warning lamp should come on when the engine is cranking, when the parking brake is set, or When there is a failure in the brake system. If brake warning lamp stays on, go to 1, page 2-342. If the warning lamp does not come on, go to D, page 2-338.

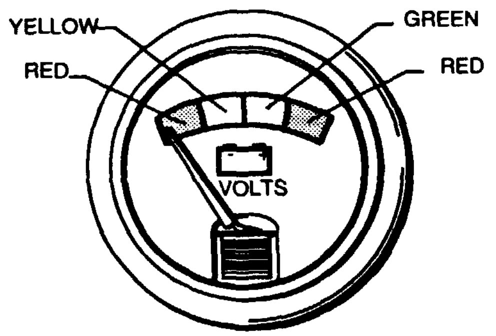


BRAKE WARNING LAMP

The volt gauge may be checked by running STE/ICE-R Test 67 with the engine running. The position in the center of the green area of the volt gauge marked GEN is approximately 26 volts.

The volt gauge is a gatvanometer type gauge. It is conceivable that the coil in the gauge may have a broken wire that only opens when the gauge is heated up. If you are having an intermittent gauge problem, leave the vehicle running for awhile and watch the gauge.

If the charging system is ok, but the gauge is reading full scale one way or the other, then you may have this type of problem.



VOLT GAUGE

Rotary switch has to be in the RUN position for the windshield wiper or washer to operate.

INSTRUMENTS CIRCUIT

DIAGNOSTIC FLOWCHART

FROM 6, Page 2-322

KNOWN INFO

WINDSHIELD WIPERS OK

POSSIBLE PROBLEMS

FUEL GAUGE
OIL PRESSURE GAUGE
TEMPERATURE GAUGE
WIRING
SENDING UNITS

7

WITH THE IGNITION SWITCH IN THE RUN POSITION, DOES THE FUEL GAUGE WORK PROPERLY.

TEST OPTIONS

VISUAL

REASON FOR QUESTION

If the fuel gauge works, then the power to the gauge is OK

NO → GO TO G, Page 2-352

YES ↓

KNOWN INFO

FUEL GAUGE OK

POSSIBLE PROBLEMS

FUEL GAUGE
OIL PRESSURE GAUGE
TEMPERATURE GAUGE
WIRING
SENDING UNITS

8

DOES THE ENGINE OIL PRESSURE GAUGE WORK WITH THE ENGINE RUNNING?

TEST OPTIONS

VISUAL

REASON FOR QUESTION

If the oil pressure gauge works, then the power to the gauge is OK

NO → GO TO H, Page 2-356

YES ↓

KNOWN INFO

OIL PRESSURE GAUGE OK

POSSIBLE PROBLEMS

TEMPERATURE GAUGE
WIRING
SENDING UNITS

9

DOES THE ENGINE TEMPERATURE GAUGE WORK WITH THE ENGINE WARM?

TEST OPTIONS

VISUAL

REASON FOR QUESTION

If the temp gauge works, then the power to the gauge is OK

NO → GO TO I, Page 2-360

YES → GO TO 10, Page 2-326

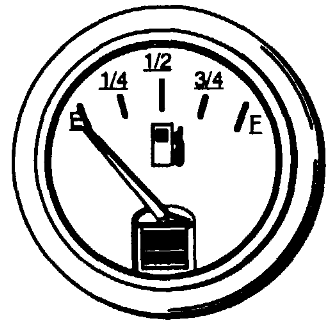
REFERENCE INFORMATION

INSTRUMENTS CIRCUIT

NOTE

These gauges are galvanometer type gauges. It is conceivable that the coil in the gauge may have a broken wire that only opens when the gauge is warmed up. If you are having an intermittent gauge problem, leave the vehicle running for a while and watch the gauge. If the system the gauge monitors is OK, but the gauge is reading full scale one way or the other, then you may have this type of problem.

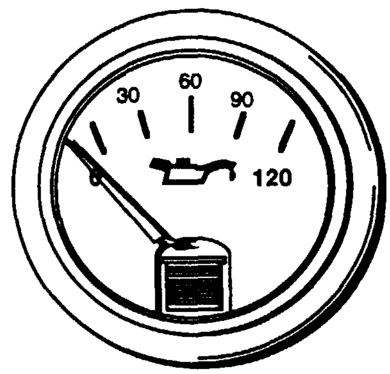
Fill the fuel tank if necessary to obtain a reading greater than empty.



FUEL GAUGE

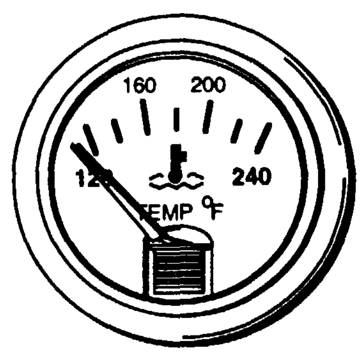
With the engine running, the oil pressure should be approximately 10 PSI at idle, 40-45 PSI at 2000 RPM, and it should be 0 when stopped.

Make sure shift lever is in neutral before running this test.



OIL PRESSURE GAUGE

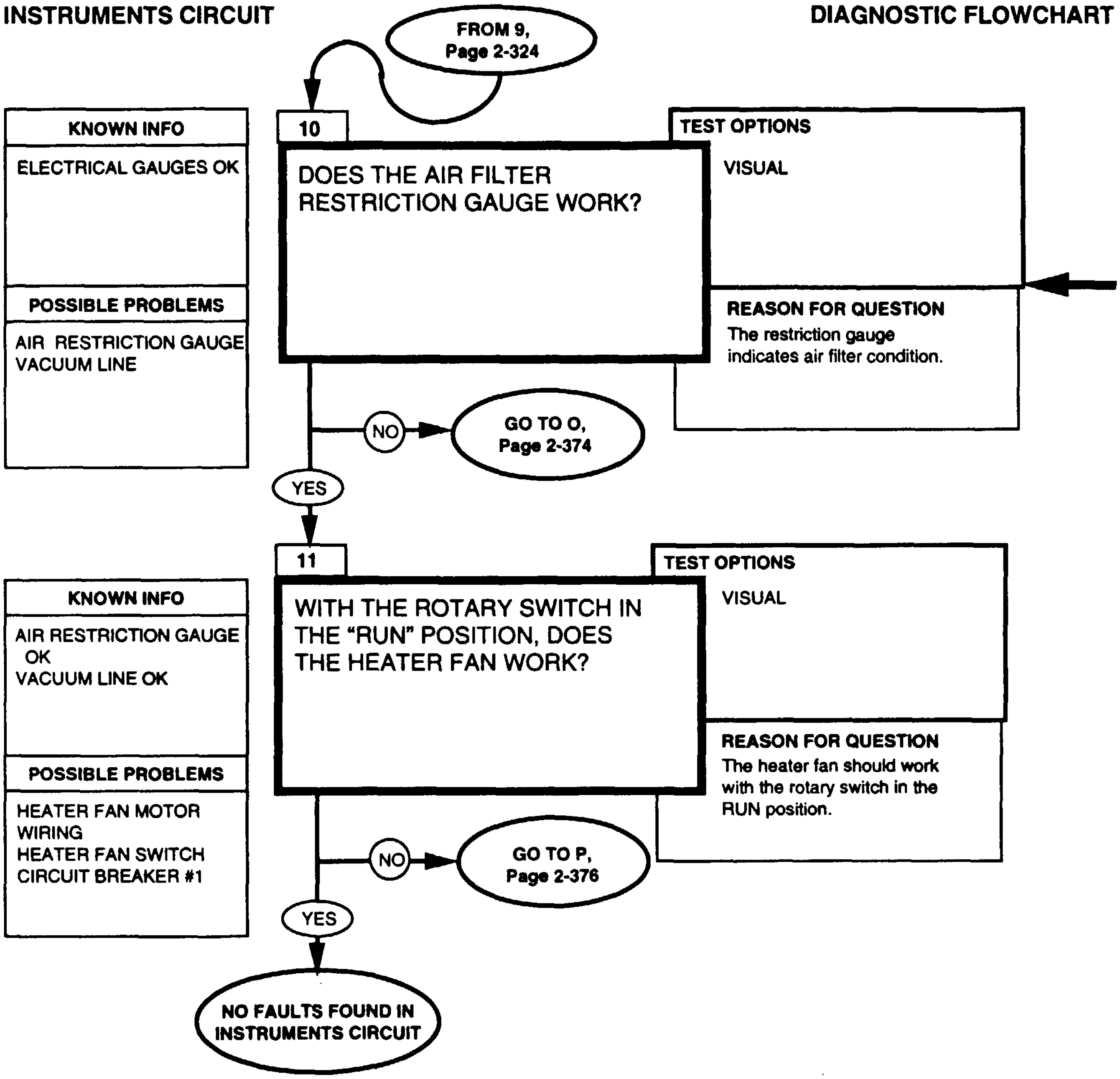
With the engine cold the gauge should read off scale to the left and when warm the reading should be 190°- 230°F (88° - 110° C).



TEMPERATURE GAUGE

INSTRUMENTS CIRCUIT

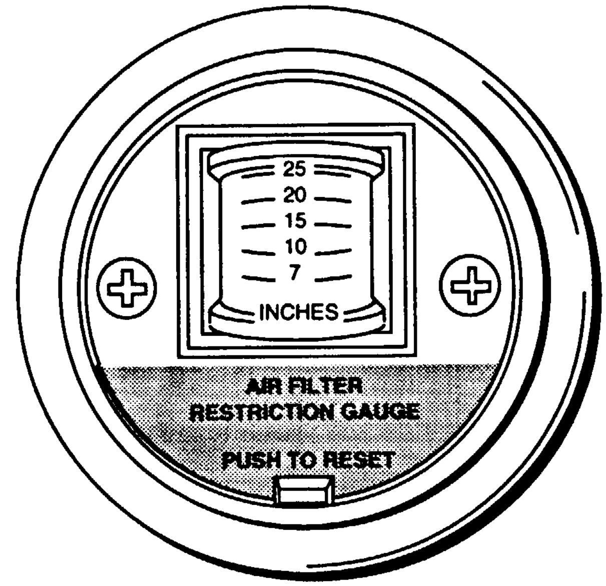
DIAGNOSTIC FLOWCHART

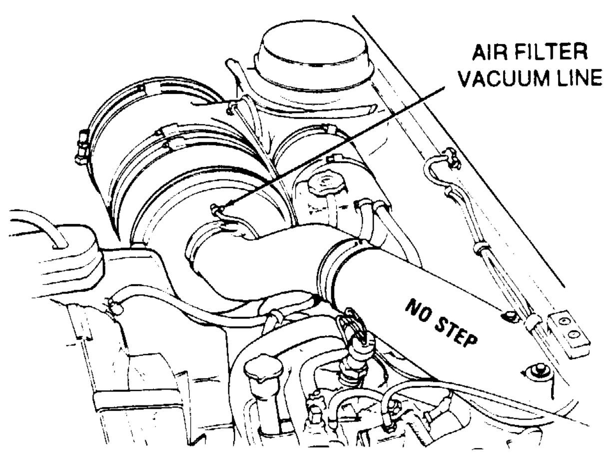


REFERENCE INFORMATION

INSTRUMENTS CIRCUIT

When vacuum is applied to the line at the air filter, the gauge should read yellow and hold the reading until it is released by pressing the reset button on the gauge.





INSTRUMENTS CIRCUIT **DIAGNOSTIC FLOWCHART**

A
FROM 1,
Page 2-320

KNOWN INFO

SOME GAUGES AND LAMPS HAVE POWER WHEN THEY SHOULDN'T

POSSIBLE PROBLEMS

ROTARY SWITCH
WIRING

A1

DISCONNECT WIRE 29B FROM CIRCUIT BREAKER 2. WITH THE ROTARY SWITCH IN THE "OFF" POSITION DO YOU HAVE 0 VOLTAGE AT W29B?

TEST OPTIONS

1. STE/ICE-R TEST 89 (Page 2-750)
2. MULTIMETER

REASON FOR QUESTION

Voltage here indicates a short circuit to power.

NO → GO TO J, Page 2-364

YES ↓

KNOWN INFO

ROTARY SWITCH OK

POSSIBLE PROBLEMS

WIRING

A2

DISCONNECT WIRE 29D FROM CIRCUIT BREAKER "2". WITH THE ROTARY SWITCH IN THE "OFF" POSITION, DO YOU HAVE 0 VOLTAGE AT W29D?

TEST OPTIONS

1. STE/ICE-R TEST 89 (Page 2-750)
2. MULTIMETER

REASON FOR QUESTION

Voltage here indicates a short circuit to power.

NO → REPAIR SHORT 29D or 27F,G,H,L,K or 567A or REPLACE HARNESS

YES ↓

KNOWN INFO

NO SHORTS TO POWER

POSSIBLE PROBLEMS

WIRING

A3

CHECK CONTINUITY FROM ALL GAUGE GROUND TERMINALS TO ENGINE GROUND (WIRES 58E-H). DO YOU HAVE CONTINUITY?

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION

A good ground circuit is necessary for proper gauge operation.

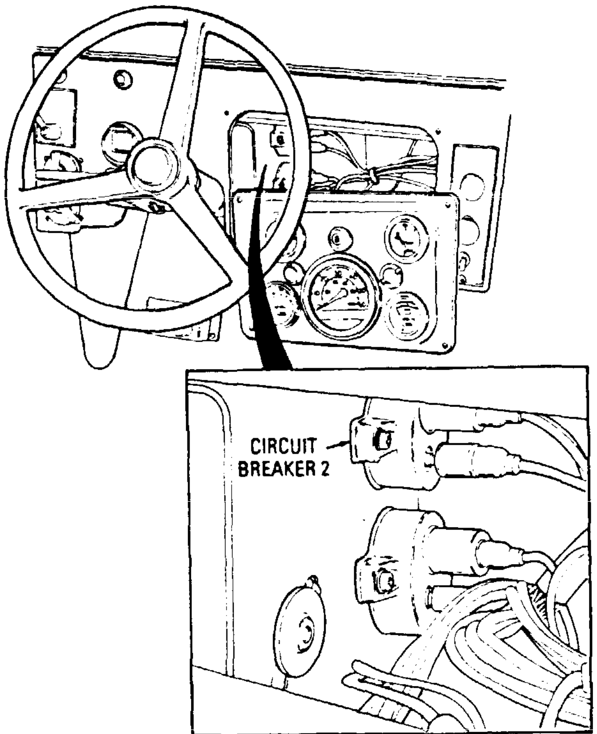
NO → REPAIR 58E-H or REPLACE HARNESS

YES ↓

SEE NOTE AT RIGHT

REFERENCE INFORMATION **INSTRUMENTS CIRCUIT**

The easiest way to reach the circuit breaker and gauge wiring is to remove the gauge panel screws and pull the panel out far enough to work with the wiring.



Replace harness/or repair wiring, refer to (para 4-85).

Connect the Black test lead to a good engine ground and connect the Red test lead to each gauge ground terminal (the uninsulated screw) one at a time and note each reading.

NOTE

You have checked all the wiring that is common to all the gauges and warning lamps. Reconnect wires and return to step 2 of the go-chain, page 2-320, and continue testing.

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.

0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in the question. RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms. 2. Connect the RED and BLACK leads to the connections stated in the question. 3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

INSTRUMENTS CIRCUIT

DIAGNOSTIC FLOWCHART

B
FROM 2,
Page 2-320

B1

KNOWN INFO

ENGINE STARTS AND RUNS SO THERE IS POWER TO THE ROTARY SWITCH

POSSIBLE PROBLEMS

CIRCUIT BREAKER 2
GAUGES
LAMPS
SENDING UNITS
WIRING

DISCONNECT WIRE 29B FROM CIRCUIT BREAKER 2. WITH ROTARY SWITCH IN THE "RUN" POSITION, DO YOU HAVE BATTERY VOLTAGE AT WIRE 29B?

TEST OPTIONS

1. STE/ICE-R TEST 89 (Page 2-750)
2. MULTIMETER

REASON FOR QUESTION

Voltage here indicates that the wiring to the circuit breaker is OK.

NO → REPAIR 29B or REPLACE HARNESS.

YES ↓

B2

KNOWN INFO

POWER AVAILABLE TO CIRCUIT BREAKER

POSSIBLE PROBLEMS

CIRCUIT BREAKER 2
GAUGES
LAMPS
SENDING UNITS
WIRING

RECONNECT WIRE 29B. DIS-CONNECT WIRE 29D FROM CIRCUIT BREAKER 2. WITH ROTARY SWITCH IN THE "RUN" POSITION, DO YOU HAVE BATTERY VOLTAGE AT CIRCUIT BREAKER "2"?

TEST OPTIONS

1. STE/ICE-R TEST 89 (Page 2-750)
2. MULTIMETER

REASON FOR QUESTION

If you have voltage here then the circuit breaker is OK.

NO → REPLACE CIRCUIT BREAKER 2

YES ↓

B3

KNOWN INFO

CIRCUIT BREAKER 2 OK

POSSIBLE PROBLEMS

GAUGES
LAMPS
SENDING UNITS
WIRING

RECONNECT WIRE 29D AT CIRCUIT BREAKER 2. WITH ROTARY SWITCH IN THE "RUN" POSITON, CHECK FOR BATTERY VOLTAGE AT THE GAUGE WIRES 27G, 27H, 27J AND 567A. DO YOU HAVE BATTERY VOLTAGE AT ANY OF THESE WIRES?

TEST OPTIONS

1. STE/ICE-R TEST 89 (Page 2-750)
2. MULTIMETER

REASON FOR QUESTION

If you have voltage here then any faults will be in the individual gauge circuits.

NO → REPAIR 29D or 27P or REPLACE HARNESS

YES ↓

SEE NOTE AT RIGHT

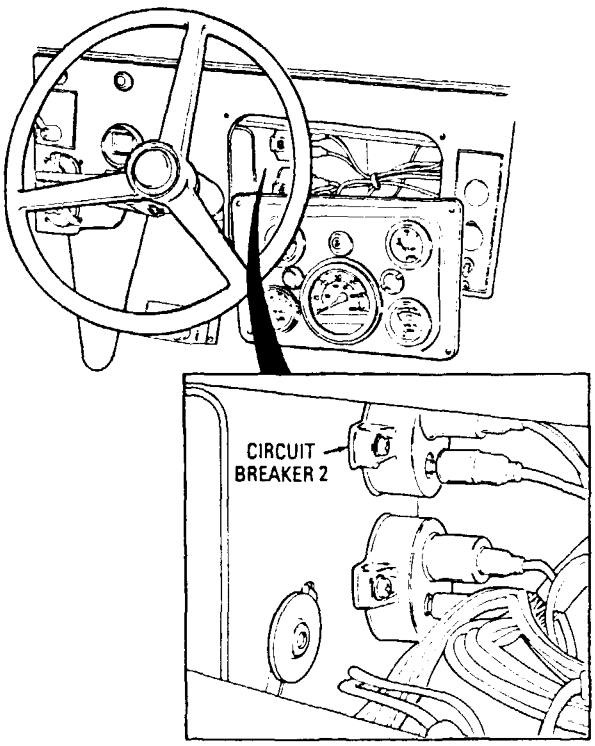
The easiest way to reach the circuit breaker and gauge wiring is to remove the gauge panel screws and pull the panel out far enough to work with the wiring.

Replace harness/or repair wiring, refer to (para 4-85).

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

Replace circuit breaker, refer to (para 4-9).



Replace harness/or repair wiring, refer to (para 4-85).

NOTE

You have checked all the common power wiring to all the gauges and warning lamps. Reconnect wires and return to step 3 of the go-chain, page 2-320, and continue testing.

INSTRUMENTS CIRCUIT — DIAGNOSTIC FLOWCHART

C
FROM 3,
Page 2-320

C1

DISCONNECT WIRE 27F AT THE WAIT-TO-START LAMP. WITH THE ROTARY SWITCH IN THE “RUN” POSITION, DO YOU HAVE BATTERY VOLTAGE AT WIRE 27F?

KNOWN INFO

POWER AVAILABLE TO GAUGES
WAIT-TO-START LAMP DOESN'T COME ON

POSSIBLE PROBLEMS

WAIT-TO-START LAMP
PCB/DISTRIBUTION BOX
GLOWPLUG CONTROLLER
WIRING
NOTE: NO GLOWPLUG CONTROLLER WITH DISTRIBUTION BOX

TEST OPTIONS

1. STE/ICE-R TEST 89 (Page 2-750)
2. MULTIMETER

REASON FOR QUESTION

You know power is available at the wire junction. Now you need to know if it is reaching the gauge.

NO → **REPAIR 27F or REPLACE HARNESS**

YES ↓

!!

C2

DISCONNECT PCB/DISTRIBUTION BOX ENGINE CONNECTOR, BODY CONNECTOR & WIRE 571A AT THE WAIT-TO-START LAMP. DO YOU HAVE CONTINUITY BETWEEN WIRE 571A & SOCKET E ON THE BODY CONNECTOR HARNESS?

KNOWN INFO

POWER AVAILABLE TO LAMP

POSSIBLE PROBLEMS

WAIT-TO-START LAMP
PCB/DISTRIBUTION BOX
GLOWPLUG CONTROLLER
WIRING

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION

The ground circuit for the lamp goes through this wire and the PCB/distribution box.

NO → **REPAIR 571A or REPLACE HARNESS**

YES ↓

C3

CONNECT RED LEAD OF STE/ICE-R OR MULTIMETER TO LEAD WIRE 27 OF THE WAIT-TO-START LAMP AND CONNECT THE BLACK LEAD TO WIRE 571 LEAD OF THE LAMP. DOES THE LAMP GLOW DIMLY?

KNOWN INFO

LAMP HAS GROUND

POSSIBLE PROBLEMS

WAIT-TO-START LAMP
PCB/DISTRIBUTION BOX
GLOWPLUG CONTROLLER
WIRING

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER (RESISTANCE)

REASON FOR QUESTION

You need to make sure the lamp can light.

NO → **REPLACE WAIT-TO -START LAMP**

YES ↓

PCB, GO TO C4, Page 2-334

DISTRIBUTION BOX, GO TO C7, Page 2-336

REFERENCE INFORMATION

WARNING

Disconnect negative battery cable before disconnecting and reconnecting protective control box/distribution box harness.

There is battery voltage at the PCB/distribution box at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

1. Set the voltmeter to a DC volts scale of at least 40 volts.

2. Connect the RED lead to positive and the BLACK lead to negative.

3. Be sure to read the correct scale.

0-4500 OHMS
STE/ICE-R TEST 91

1. Connect RED clip and BLACK clip to the terminations indicated in the question. RED to the first, BLACK to the second.

2. Start Test 91, 0-4500 ohms.

3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

It is important to connect the leads as indicated because you are checking continuity across a diode. The lamp will glow dimly because you are supplying a small amount of power thru STE/ICE-R. You may have to shade the lamp with your hand to see if it glows.

NOTE

A multimeter may not supply enough power to light the lamp. In this case look for a much greater resistance when measuring with the leads connected in one direction than when they are connected in reverse.

Replace harness or lamp, refer to (para. 4-17).

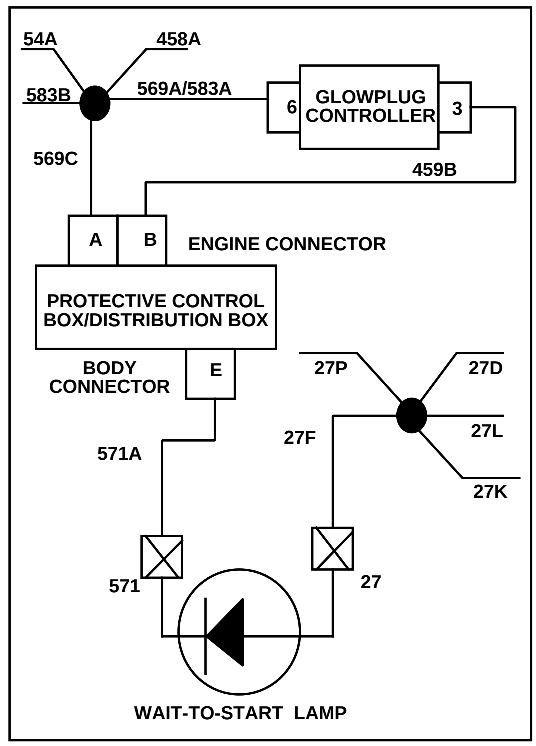
INSTRUMENTS CIRCUIT

0-45 DC VOLTS
STE/ICE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.

2. Start Test 89, DC volts.

3. Displayed reading is in volts.



CONTINUITY (RESISTANCE)
MULTIMETER

1. Set the voltmeter to an ohms scale of about 1000 ohms.

2. Connect the RED and BLACK leads to the connections stated in the question.

3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

INSTRUMENTS CIRCUIT **DIAGNOSTIC FLOWCHART**

FROM C3, Page 2-332

C4

KNOWN INFO

LAMP OK

POSSIBLE PROBLEMS

PCB/DISTRIBUTION BOX
GLOWPLUG CONTROLLER
WIRING

NOTE: FOR DISTRIBUTION BOX SKIP STEPS C4, C5, AND C6. DISCONNECT GLOWPLUG CONTROLLER. DO YOU HAVE CONTINUITY BETWEEN SOCKET "6" IN THE CONTROLLER HARNESS & SOCKET A IN THE ENGINE CONNECTOR HARNESS?

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION

This wire provides power to the controller.

NO → **REPAIR 569A, 569C or REPLACE HARNESS**

YES ↓

C5

KNOWN INFO

LAMP OK

POSSIBLE PROBLEMS

PCB/DISTRIBUTION BOX
GLOWPLUG CONTROLLER
WIRING

DO YOU HAVE CONTINUITY BETWEEN SOCKET "3" IN THE CONTROLLER HARNESS & SOCKET "B" IN THE ENGINE CONNECTOR HARNESS?

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION

This wire returns power for the lamp.

NO → **REPAIR 459B or REPLACE HARNESS**

YES ↓

C6

KNOWN INFO

WIRING TO & FROM CONTROLLER OK

POSSIBLE PROBLEMS

PCB/DISTRIBUTION BOX
GLOWPLUG CONTROLLER

RECONNECT GLOWPLUG CONTROLLER. DO YOU HAVE CONTINUITY BETWEEN SOCKET "A" & SOCKET "B" IN THE ENGINE CONNECTOR HARNESS?

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION

If you don't have continuity here then you know that the controller is bad.

NO → **REPLACE GLOWPLUG CONTROLLER**

YES ↓

GO TO C7, Page 2-336

REFERENCE INFORMATION

WARNING

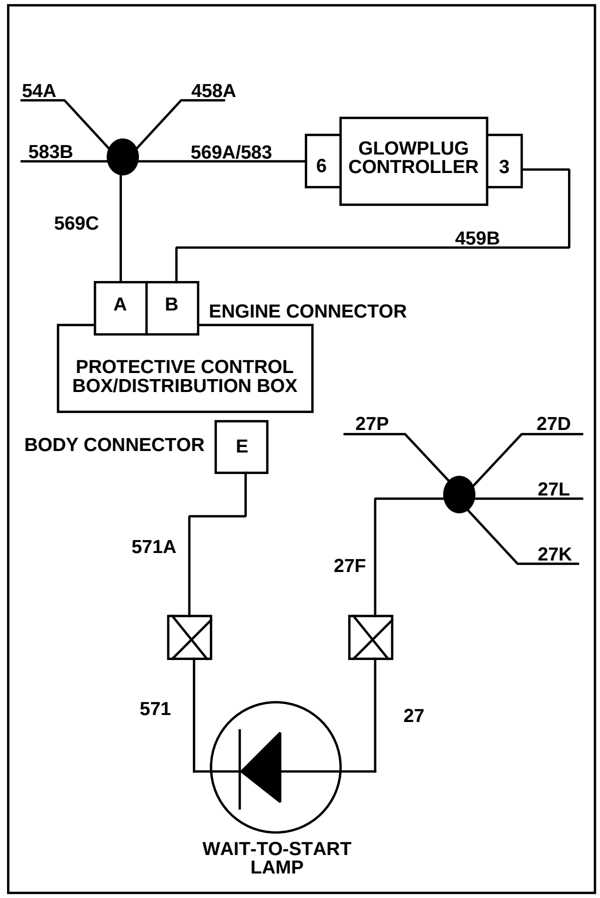
Disconnect negative battery cable before disconnecting and reconnecting protective control box/distribution box harness.

There is battery voltage at the PCB/distribution box at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the terminations indicated in the question. RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

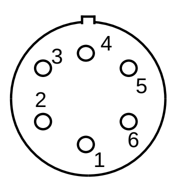
CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms. 2. Connect the RED and BLACK leads to the connections stated in the question. 3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

INSTRUMENTS CIRCUIT

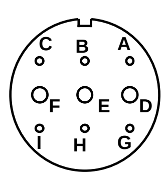


Engine temperature must be below 120°F (49°C) in order to make this test, otherwise normal operation of the glowplug controller will cause the circuit to be open.

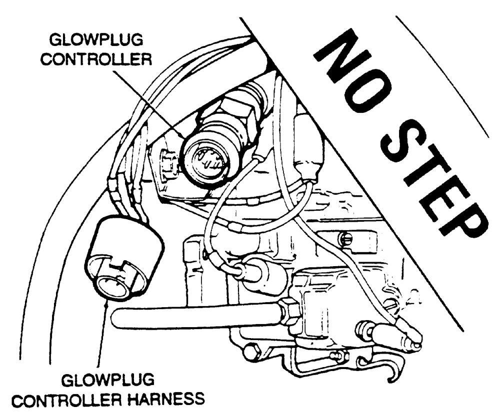
Replace harness and glowplug controller, refer to (para. 4-29).



GLOWPLUG CONTROLLER HARNESS



PCB ENGINE CONNECTOR



INSTRUMENTS CIRCUIT **DIAGNOSTIC FLOWCHART**

FROM C6, Page 2-334

KNOWN INFO

GLOWPLUG CONTROLLER OK

POSSIBLE PROBLEMS

PCB/DISTRIBUTION BOX

C7

RECONNECT ALL WIRING (RECONNECT ENGINE CONNECTOR LAST) AND RECHECK WAIT-TO-START LAMP OPERATION. WITH THE ROTARY SWITCH IN THE "RUN" POSITION, DOES THE WAIT-TO-START LAMP COME ON ?

NO → **REPLACE PCB/DISTRIBUTION BOX**

YES → **NO FAULTS**

TEST OPTIONS

CONNECT THE WIRES

REASON FOR QUESTION

You may have fixed a loose or dirty connection without knowing it.

REFERENCE INFORMATION **INSTRUMENTS CIRCUIT**

WARNING

Disconnect negative battery cable before disconnecting and reconnecting protective control box/distribution box harness.

There is battery voltage at the PCB/distribution box at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

Engine temperature must be below 120°F (49° C) or the lamp may not come on.

Replace PCB, refer to (para. 4-5).
Replace distribution box (para. 4-5.1).

INSTRUMENTS CIRCUIT — DIAGNOSTIC FLOWCHART

D
FROM 4,
Page 2-322

D1

KNOWN INFO

BRAKE LAMP DOESN'T COME ON

POWER AVAILABLE TO THE GAUGES

POSSIBLE PROBLEMS

PARKING BRAKE SWITCH
BRAKE LAMP
WIRING

DISCONNECT WIRE 27L AT THE BRAKE WARNING LAMP.

WITH THE ROTARY SWITCH IN THE "RUN" POSITION, DO YOU HAVE BATTERY VOLTAGE AT WIRE 27L?

TEST OPTIONS

1. STE/ICE-R TEST 89 (Page 2-750)
2. MULTIMETER

REASON FOR QUESTION

This wire provides power for the lamp.

NO → REPAIR 27L or REPLACE HARNESS

YES ↓

D2

KNOWN INFO

POWER AVAILABLE TO THE LAMP

POSSIBLE PROBLEMS

PARKING BRAKE SWITCH
BRAKE LAMP
WIRING

DISCONNECT WIRE 67D AT BRAKE LAMP. CONNECT RED LEAD OF STE/ICE-R OR MULTIMETER TO WIRE 67. CONNECT THE BLACK LEAD TO WIRE 27.

DOES THE LAMP GLOW DIMLY?

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER (RESISTANCE)

REASON FOR QUESTION

You need to know that the lamp will light.

NO → REPLACE BRAKE WARNING LAMP

YES ↓

D3

KNOWN INFO

BRAKE LAMP OK

POSSIBLE PROBLEMS

PARKING BRAKE SWITCH
WIRING

DISCONNECT WIRE 67C AT PARKING BRAKE SWITCH.

DO YOU HAVE CONTINUITY BETWEEN WIRE 67C AT THE SWITCH & WIRE 67D AT THE LAMP?

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

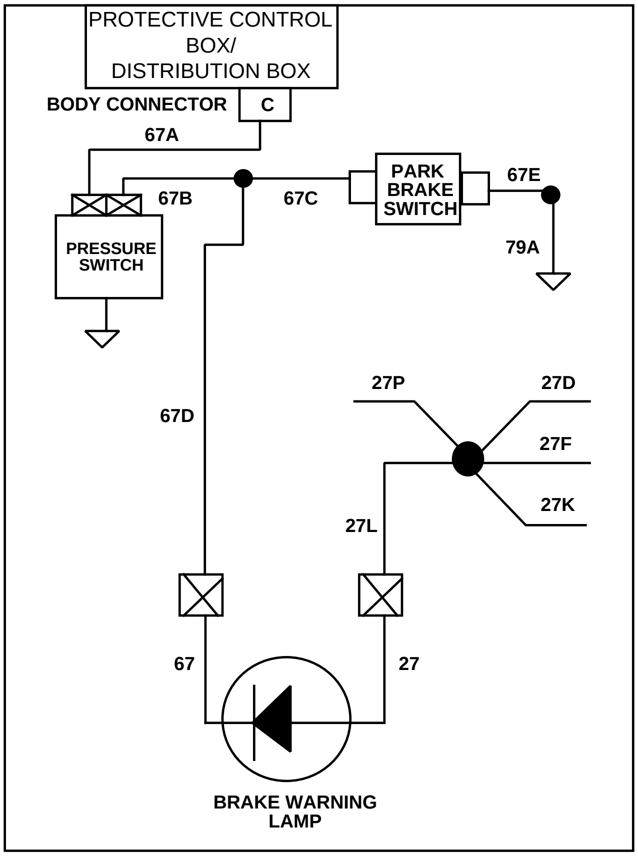
REASON FOR QUESTION

If either of these wires are open, the lamp circuit will not be grounded.

NO → REPAIR 67C,D, or REPLACE HARNESS

YES ↓

GO TO D4,
Page 2-340



0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.

0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in the question. RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

It is important to connect the leads as indicated because you are checking continuity across a diode. The lamp will glow dimly because you are supplying a small amount of power thru STE/ICE-R. You may have to shade the lamp with your hand to see if it glows.

NOTE

A multimeter may not supply enough power to light the lamp. In this case look for a much greater resistance when measuring with the leads connected in one direction than when they are connected in reverse.

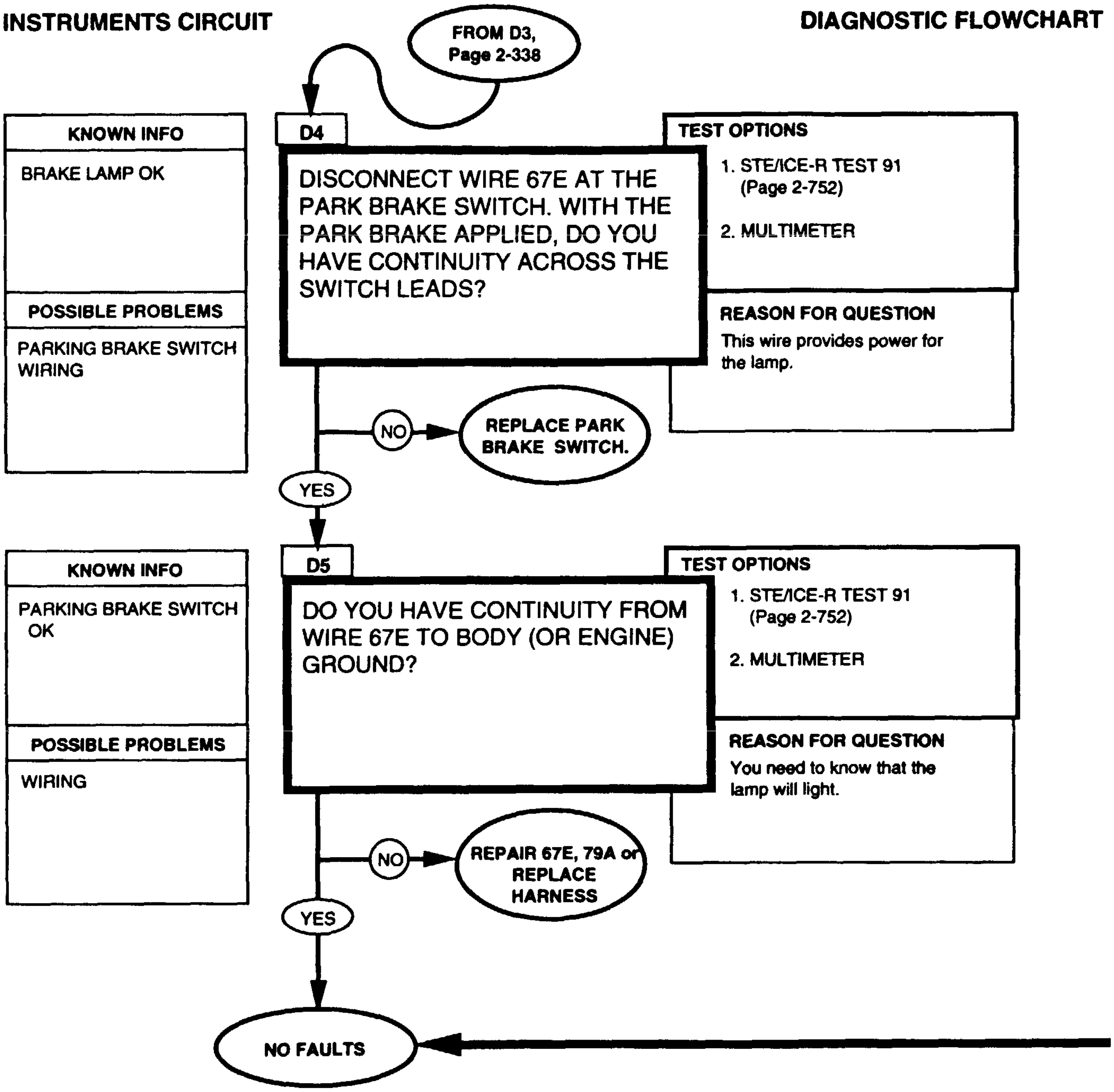
CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms. 2. Connect the RED and BLACK leads to the connections stated in the question. 3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

Replace harness/or repair wiring, refer to (para. 4-85).

Replace brake warning lamp, refer to (para. 4-17).

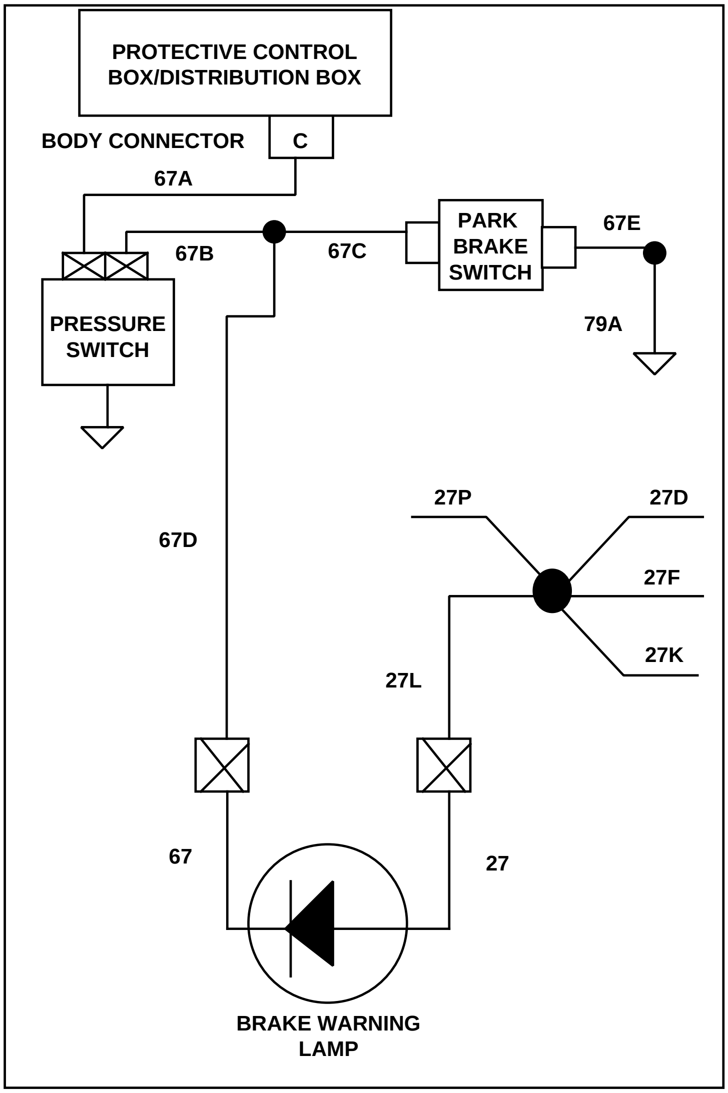
INSTRUMENTS CIRCUIT

DIAGNOSTIC FLOWCHART



REFERENCE INFORMATION

INSTRUMENTS CIRCUIT



0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the terminations indicated in the question. RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays '9.9.9.9.'

CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms. 2. Connect the RED and BLACK leads to the connections stated in the question. 3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

Reconnect all wiring. Connect the glowplug controller last.

Replace parking brake switch. Refer to (para. 4-19).

Replace harness/or repair wiring. Refer to (para. 4-85).

INSTRUMENTS CIRCUIT DIAGNOSTIC FLOWCHART

START

1

KNOWN INFO

BRAKE WARNING LIGHT WON'T GO OFF

POSSIBLE PROBLEMS

WIRING
PARKING BRAKE SWITCH
PCB/DISTRIBUTION BOX
BRAKE WARNING PRESSURE SWITCH

BLEED BRAKE SYSTEM. DOES THE LIGHT STAY "ON"?

TEST OPTIONS

NONE

REASON FOR QUESTION

If the lamp stays on, it could be that the hydraulic brake system has a fault and might require bleeding.

NO → **END OF TEST**

YES ↓

2

KNOWN INFO

BRAKE WARNING LIGHT WON'T GO OFF

POSSIBLE PROBLEMS

WIRING
PARKING BRAKE SWITCH
PCB/DISTRIBUTION BOX
BRAKE WARNING PRESSURE SWITCH

DISCONNECT WIRE 67A AND 67B FROM BRAKE WARNING PRESSURE SWITCH, WIRE 67C FROM PARKING BRAKE SWITCH. DISCONNECT THE PCB/DISTRIBUTION BOX BODY HARNESS CONNECTOR. CONNECT A JUMPER WIRE BETWEEN WIRES 67A AND 67B. DOES THE LIGHT GO "OUT"?

TEST OPTIONS

1. STE/ICE-R TEST 89 (Page 2-750)
2. MULTIMETER

REASON FOR QUESTION

If the lamp stays on with the PCB/distribution box, valve switch and park brake switch disconnected, the problem is in the wiring.

NO → **REPAIR OR REPLACE WIRING HARNESS**

YES ↓

3

KNOWN INFO

WIRING OK

POSSIBLE PROBLEMS

BRAKE WARNING PRESSURE SWITCH
PCB/DISTRIBUTION BOX
PARKING BRAKE SWITCH

CONNECT PCB/DISTRIBUTION BOX BODY HARNESS. DOES THE LIGHT STAY "OFF"?

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER (RESISTANCE)

REASON FOR QUESTION

When the protective control box/distribution box is connected, the light should not come on. If it does, the PCB/distribution box is faulty.

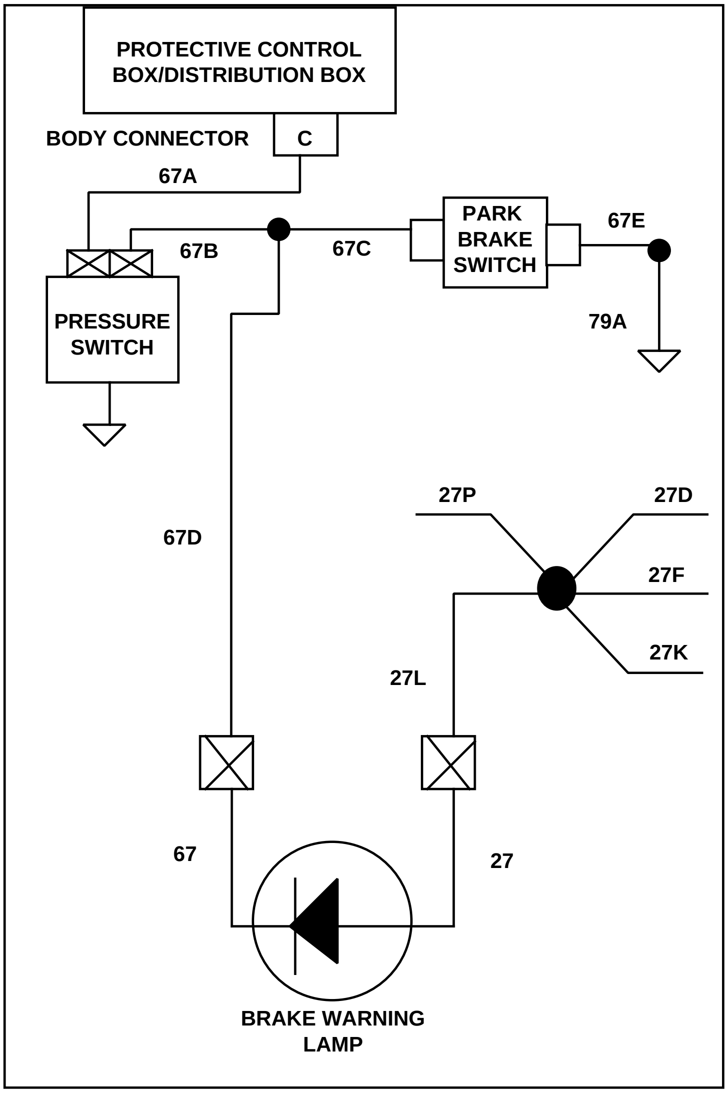
NO → **REPLACE PCB/DISTRIBUTION BOX**

YES ↓

GO TO 4, Page 2-344

REFERENCE INFORMATION

INSTRUMENTS CIRCUIT



0-45 OHMS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to the negative. 3. Be sure to read the correct scale.

0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the terminations indicated in the question. RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays '9.9.9.9.'

Bleed brake system. Refer to (para. 7-10).

Replace parking brake switch. Refer to (para. 4-19).

Replace harness/or repair wiring. Refer to (para. 4-85).

Replace PCB. Refer to (para. 4-5).

Replace distribution box (para. 4-5.1).

CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms. 2. Connect the RED and BLACK leads to the connections stated in the question. 3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

INSTRUMENTS CIRCUIT — DIAGNOSTIC FLOWCHART

FROM 3, Page 2-342

4

KNOWN INFO

WIRING OK
PCB/DISTRIBUTION BOX OK
BRAKE WARNING VALVE SWITCH OK

POSSIBLE PROBLEMS

PARKING BRAKE SWITCH

CONNECT PARKING BRAKE SWITCH. MAKE SURE THE PARKING BRAKE IS DISENGAGED. DOES THE LIGHT STAY OFF?

TEST OPTIONS

VISUAL

REASON FOR QUESTION

The light will only come on when the parking brake switch is connected. If the parking brake switch has a problem.

NO → **REPLACE PARKING BRAKE SWITCH**

YES → 5

5

KNOWN INFO

PCB/DISTRIBUTION BOX OK
WIRING OK

POSSIBLE PROBLEMS

BRAKE WARNING PRESSURE SWITCH
PARKING BRAKE SWITCH

REMOVE JUMPER WIRE. CONNECT BRAKE WARNING PRESSURE SWITCH. DOES LIGHT STAY OFF?

TEST OPTIONS

1. STE/ICE-R TEST 91 (PAGE 2-752)
2. MULTIMETER

REASON FOR QUESTION

If the light comes on when brake warning pressure switch is connected, the brake warning pressure switch is the problem.

NO → **REPLACE PROPORTIONING VALVE**

YES → **END OF TEST**

REFERENCE INFORMATION

INSTRUMENTS CIRCUIT

Replace parking brake switch, refer to (para. 4-19).

When the brake warning pressure switch is defective, the proportioning valve must be replaced. Refer to (para. 7-18).

0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the terminations indicated in the question. RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms. 2. Connect the RED and BLACK leads to the connections stated in the question. 3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

INSTRUMENTS CIRCUIT **DIAGNOSTIC FLOWCHART**

E
FROM 5,
Page 2-322

KNOWN INFO

POWER AVAILABLE TO GAUGES
VOLT GAUGE DOESN'T WORK

POSSIBLE PROBLEMS

VOLT GAUGE
WIRING

E1

DISCONNECT WIRE 567A AT THE VOLT GAUGE. WITH THE ROTARY SWITCH IN THE "RUN" POSITION, DO YOU HAVE BATTERY VOLTAGE AT WIRE 567A?

TEST OPTIONS

1. STE/ICE-R TEST 89 (Page 2-750)
2. MULTIMETER

REASON FOR QUESTION

The gauge reads voltage on this wire.

NO → REPAIR 567A or REPLACE HARNESS

YES ↓

KNOWN INFO

POWER AVAILABLE AT VOLT GAUGE

POSSIBLE PROBLEMS

VOLT GAUGE
WIRING

E2

IS THERE CONTINUITY BETWEEN WIRE 58F AND ENGINE (OR BODY) GROUND?

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION

This wire is the ground reference for the gauge.

NO → REPAIR 58F,D,B,A or REPLACE HARNESS

YES ↓

REPLACE VOLT GAUGE. RERUN INSTRUMENT TESTS TO VERIFY NO OTHER FAULTS.

REFERENCE INFORMATION **INSTRUMENTS CIRCUIT**

Replace harness/or repair wiring, refer to (para 4-85).

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.

Replace harness/or repair wiring, refer to (para 4-85).

0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in the question. RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

Be sure the charging system is functioning properly before replacing the gauge. Run the alternator tests, page 2-196, if you're not sure.

Replace volt gauge, refer to (para 4-13).

CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms. 2. Connect the RED and BLACK leads to the connections stated in the question. 3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

INSTRUMENTS CIRCUITS **DIAGNOSTIC FLOWCHART**

F
FROM 6,
Page 2-322

KNOWN INFO

POWER AVAILABLE TO GAUGES
WINDSHIELD WIPERS DON'T WORK

POSSIBLE PROBLEMS

WIPER MOTOR WIRING

F1

DISCONNECT WIRE 27 AT WIPER MOTOR CONNECTOR. WITH ROTARY SWITCH IN THE "RUN" POSITION, DO YOU HAVE BATTERY VOLTAGE AT THE MOTOR CONNECTOR?

TEST OPTIONS

1. STE/ICE-R TEST 89 (page 2-750)
2. MULTIMETER

REASON FOR QUESTION

This wire provides power to the wipers.

NO → GO TO M, Page 2-370

YES ↓

KNOWN INFO

POWER TO WIPER MOTOR

POSSIBLE PROBLEMS

WIPER MOTOR WIRING

F2

DO YOU HAVE CONTINUITY FROM WIRE 57 AT THE CONNECTOR-TO-BODY (OR ENGINE) GROUND?

TEST OPTIONS

1. STE/ICE-R TEST 91 (page 2-752)
2. MULTIMETER

REASON FOR QUESTION

This wire provides ground for the wipers.

NO → GO TO N, Page 2-372

YES ↓

REPLACE WIPER MOTOR SF5578716 OR GO TO Page 2-350 FOR WIPER MOTOR P/N 12342501

REFERENCE INFORMATION

INSTRUMENTS CIRCUIT

Replace wiper motor SF5578716. Refer to (para. 10-71.)

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.

0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in the question. RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE-R displays "9.9.9.9."

CONTNUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms. 2. Connect the RED and BLACK leads to the connections stated in the question. 3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

INSTRUMENTS CIRCUIT **DIAGNOSTIC FLOWCHART**

F
FROM 2,
Page 2-348

KNOWN INFO

POWER TO WIPER MOTOR

POSSIBLE PROBLEMS

WIPER MOTOR WIRING

F3

DISCONNECT SWITCH WIRING FROM MOTOR ASSEMBLY. WITH SWITCH IN THE "OFF" POSITION, DO YOU HAVE CONTINUITY FROM INPUT CONNECTOR (BATTERY) AND SOCKET 4. YOU SHOULD ALSO HAVE CONTINUITY BETWEEN PIN 2 AND SOCKET 3.

TEST OPTIONS

MULTIMETER

REASON FOR QUESTION

This will determine if the switch is defective.

NO → **REPLACE WIPER SWITCH**

YES ↓

KNOWN INFO

POWER TO WIPER MOTOR

POSSIBLE PROBLEMS

WIPER MOTOR WIRING

F4

WITH SWITCH IN THE "LOW SPEED" POSITION, DO YOU HAVE CONTINUITY FROM INPUT CONNECTOR (BATTERY) TO PIN 2? WITH THE SWITCH IN THE "HIGH SPEED" POSITION, CONTINUITY SHOULD EXIST BETWEEN INPUT CONNECTOR (BATTERY) AND PIN 1.

TEST OPTIONS

MULTIMETER

REASON FOR QUESTION

This will determine if the switch is defective.

NO → **REPLACE WIPER SWITCH**

YES ↓

F5

WITH SWITCH DEPRESSED FOR THE "PUSH-TO-WASH" OPERATION, CONTINUITY SHOULD EXIST BETWEEN THE INPUT CONNECTOR (BATTERY) AND WASH TERMINAL.

NO → **REPLACE WIPER SWITCH**

YES ↓

REPLACE WIPER MOTOR

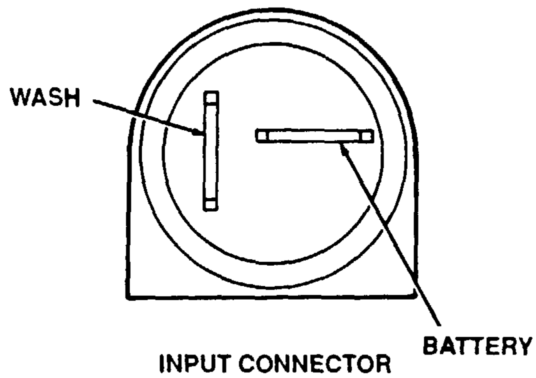
REFERENCE INFORMATION

INSTRUMENTS CIRCUITS

Replace wiper switch, refer to (para. 10-72.)

CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms. 2. Connect the RED and BLACK leads to the connections stated in the question. 3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

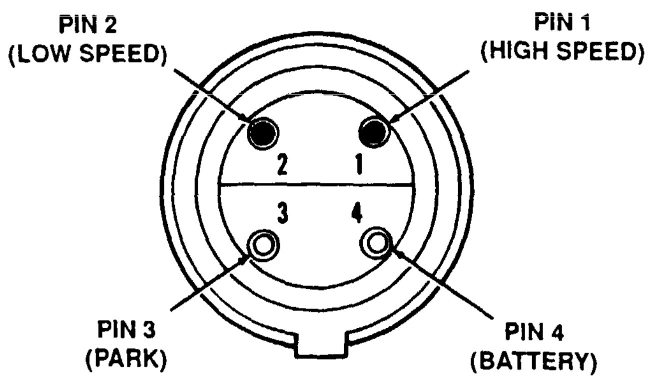
Replace wiper switch, refer to (para. 10-72.)



INPUT CONNECTOR

Replace wiper switch, refer to (para. 10-72.)

Replace wiper motor, refer to (para. 10-72.)



MOTOR CONNECTOR

INSTRUMENTS CIRCUIT

DIAGNOSTIC FLOWCHART

G
FROM 7,
Page 2-324

G1

KNOWN INFO

FUEL GAUGE DOESN'T WORK

POSSIBLE PROBLEMS

GAUGE
WIRING
SENDING UNIT

DISCONNECT WIRE 27J FROM FUEL GAUGE. WITH THE ROTARY SWITCH IN THE "RUN" POSITION, DO YOU HAVE BATTERY VOLTAGE AT WIRE 27J?

TEST OPTIONS

1. STE/ICE-R TESTS 89 (PAGE 2-750)
2. MULTIMETER

REASON FOR QUESTION

This wire provides power for the gauge.

NO → REPAIR 27J or REPLACE HARNESS

YES ↓

G2

KNOWN INFO

POWER AVAILABLE TO THE GAUGE

POSSIBLE PROBLEMS

GAUGE
WIRING
SENDING UNIT

IS THERE CONTINUITY BETWEEN WIRE 58H AT THE FUEL GAUGE AND GROUND?

TEST OPTIONS

1. STE/ICE-R TESTS 91 (PAGE 2-752)
2. MULTIMETER

REASON FOR QUESTION

If there is continuity then the ground is OK.

NO → REPAIR 58H or REPLACE HARNESS

YES ↓

G3

KNOWN INFO

GAUGE GROUND OK

POSSIBLE PROBLEMS

GAUGE
WIRING
SENDING UNIT

RECONNECT WIRE 27J & DISCONNECT WIRE 28A AT THE GAUGE. IS THE RESISTANCE BETWEEN WIRE 28A AT FUEL GAUGE AND CHASSIS GROUND WITHIN 0 TO 35 OHMS?

TEST OPTIONS

1. STE/ICE-R TESTS 91 (PAGE 2-752)
2. MULTIMETER

REASON FOR QUESTION

If the resistance is OK then the sense line is OK.

NO → GO TO L, Page 2-366

YES ↓

GO TO G4, Page 2-354

REFERENCE INFORMATION

INSTRUMENTS CIRCUIT

Replace harness/or repair wiring, refer to (para 4-85).

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.

Replace harness/or repair wiring, refer to (para 4-85).

0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in the question. RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms. 2. Connect the RED and BLACK leads to the connections stated in the question. 3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

INSTRUMENTS CIRCUIT **DIAGNOSTIC FLOWCHART**

FROM G3, Page 2-352

G4

KNOWN INFO
GAUGE HAS POWER & GROUND SENDER OK WIRING OK
POSSIBLE PROBLEMS
GAUGE

WITH THE ROTARY SWITCH IN THE "RUN" POSITION, SHORT THE SOCKET FOR WIRE 28A TO GROUND. DOES THE FUEL GAUGE READ AT OR BELOW EMPTY?

TEST OPTIONS

TRY IT

REASON FOR QUESTION

Gauge should read at or below empty.

NO → **REPLACE FUEL GAUGE**

YES ↓

G5

KNOWN INFO
GAUGE HAS POWER & GROUND SENDER OK WIRING OK
POSSIBLE PROBLEMS
GAUGE

WITH THE ROTARY SWITCH IN THE "ON" POSITION AND WIRE 28A OPEN, DOES THE FUEL GAUGE READ OFF SCALE TO ABOVE FULL?

TEST OPTIONS

TRY IT

REASON FOR QUESTION

Gauge should read off-scale.

NO → **REPLACE FUEL GAUGE**

YES ↓

NO FAULTS

Replace fuel gauge,refer to (para 4-13).

Replace fuel gauge, refer to (para 4-13).

INSTRUMENTS CIRCUIT | **DIAGNOSTIC FLOWCHART**

H
FROM 8,
Page 2-324

KNOWN INFO

POWER AVAILABLE TO THE GAUGES
OIL PRESSURE GAUGE DOESN'T WORK.

POSSIBLE PROBLEMS

GAUGE
SENDING UNIT
WIRING

H1

DISCONNECT WIRE 27H AT THE OIL PRESSURE GAUGE. WITH THE ROTARY SWITCH IN THE "RUN" POSITION, DO YOU HAVE BATTERY VOLTAGE AT WIRE 27H?

TEST OPTIONS

1. STE/ICE-R TEST 89 (PAGE 2-750)
2. MULTIMETER

REASON FOR QUESTION

This is the power wire for the gauge.

NO → **REPAIR 27H or REPLACE HARNESS**

YES ↓

KNOWN INFO

OIL PRESSURE GAUGE HAS POWER.

POSSIBLE PROBLEMS

GAUGE
SENDING UNIT
WIRING

H2

WITH THE ROTARY SWITCH IN THE "OFF" POSITION, DO YOU HAVE CONTINUITY BETWEEN WIRE 58G AT THE GAUGE AND ENGINE (OR BODY) GROUND?

TEST OPTIONS

1. STE/ICE-R TEST 91 (PAGE 2-752)
2. MULTIMETER

REASON FOR QUESTION

This is the ground wire for the gauge.

NO → **REPAIR 58G or REPLACE HARNESS**

YES ↓

KNOWN INFO

GAUGE GROUND OK

POSSIBLE PROBLEMS

OIL PRESSURE GAUGE
SENDING UNIT
WIRING

H3

DISCONNECT WIRE 36A AT THE GAUGE AND AT THE OIL PRESSURE SENDING UNIT. DO YOU HAVE CONTINUITY THRU WIRE 36A? RECONNECT WIRE 36A AFTER MAKING THE MEASUREMENT.

TEST OPTIONS

1. STE/ICE-R TEST 91 (PAGE 2-752)
2. MULTIMETER

REASON FOR QUESTION

If this wire is open then the gauge will always read offscale to the left.

NO → **REPAIR 36A or REPLACE HARNESS**

YES ↓

GO TO H4,
Page 2-358

REFERENCE INFORMATION

INSTRUMENTS CIRCUIT

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

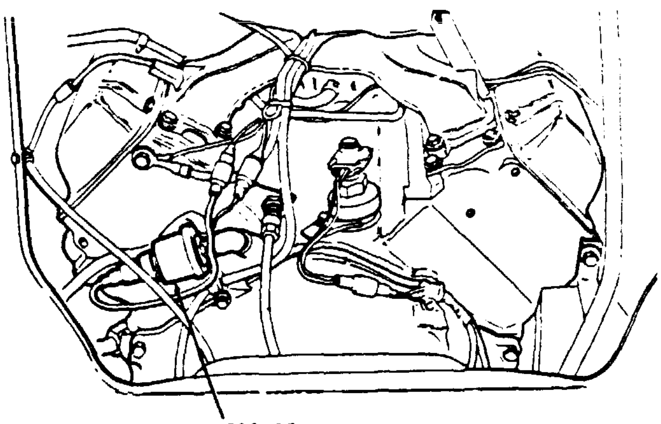
Replace harness/or repair wiring, refer to (para 4-85).

BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.

0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in the question. RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms. 2. Connect the RED and BLACK leads to the connections stated in the question. 3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

Replace harness/or repair wiring, refer to (para 4-85).



Replace harness/or repair wiring, refer to (para 4-85).

INSTRUMENTS CIRCUIT **DIAGNOSTIC FLOWCHART**

FROM H3, Page 2-356

KNOWN INFO

WIRING OK

POSSIBLE PROBLEMS

GAUGE
SENDING UNIT

H4

RECONNECT WIRE 27H AT THE OIL PRESSURE GAUGE. DISCONNECT WIRE 36A AT THE OIL PRESSURE SENDING UNIT. WITH THE ROTARY SWITCH IN THE "RUN" POSITION, DOES THE GAUGE READ OFF SCALE ABOVE 120 psi?

TEST OPTIONS

TRY IT

REASON FOR QUESTION

This will determine if the gauge can respond to an input signal.

NO → REPLACE OIL PRESSURE GAUGE

YES ↓

KNOWN INFO

WIRING OK

POSSIBLE PROBLEMS

GAUGE
SENDING UNIT

H5

WITH THE ROTARY SWITCH IN THE "RUN" POSITION SHORT WIRE 36A TO ENGINE GROUND AT THE OIL PRESSURE SENDING UNIT. DOES THE GAUGE READ AT OR BELOW ZERO?

TEST OPTIONS

TRY IT

REASON FOR QUESTION

This will determine if the gauge can respond to an input signal.

NO → REPLACE OIL PRESSURE GAUGE

YES ↓

REPLACE OIL PRESSURE SENDING UNIT

Make sure wire 36A is not connected to the sending unit and is not touching anything metal that could cause the wire to be grounded.

Replace oil pressure gauge, refer to (para 4-13).

Wire 36A must be connected at the gauge. Short the wire at the sending unit to ground.

Replace oil pressure gauge, refer to (para 4-13).

Replace oil pressure sending unit, refer to (para 4-25).

INSTRUMENTS CIRCUIT — DIAGNOSTIC FLOWCHART

I
FROM 9,
Page 2-324

I1

KNOWN INFO

POWER AVAILABLE TO THE GAUGES
TEMPERATURE GAUGE DOESN'T WORK.

POSSIBLE PROBLEMS

GAUGE
SENDING UNIT
WIRING

DISCONNECT WIRE 27G AT THE TEMPERATURE GAUGE. WITH THE ROTARY SWITCH IN THE "RUN" POSITION, DO YOU HAVE BATTERY VOLTAGE AT WIRE 27G?

TEST OPTIONS

1. STE/ICE-R TEST 89 (PAGE 2-750)
2. MULTIMETER

REASON FOR QUESTION

This is the power wire for the gauge.

NO → REPAIR 27G or REPLACE HARNESS

YES ↓

I2

KNOWN INFO

TEMPERATURE GAUGE HAS POWER.

POSSIBLE PROBLEMS

GAUGE
SENDING UNIT
WIRING

WITH THE ROTARY SWITCH IN THE "OFF" POSITION, DO YOU HAVE CONTINUITY BETWEEN WIRE 58E AT THE GAUGE AND ENGINE (OR BODY) GROUND?

TEST OPTIONS

1. STE/ICE-R TEST 91 (PAGE 2-752)
2. MULTIMETER

REASON FOR QUESTION

This is the ground wire for the gauge.

NO → REPAIR 58E or REPLACE HARNESS

YES ↓

I3

KNOWN INFO

GAUGE GROUND OK

POSSIBLE PROBLEMS

TEMPERATURE GAUGE
SENDING UNIT
WIRING

DISCONNECT WIRE 33A AT THE GAUGE AND AT THE WIRE 33B AT THE TEMPERATURE SENDING UNIT. DO YOU HAVE CONTINUITY FROM WIRE 33A TO WIRE 33B?

TEST OPTIONS

1. STE/ICE-R TEST 91 (PAGE 2-752)
2. MULTIMETER

REASON FOR QUESTION

If either of these wires are open then the gauge will always read off scale to the left.

NO → REPAIR 33A, 33B or REPLACE HARNESS

YES ↓

GO TO I4, Page 2-362

REFERENCE INFORMATION

INSTRUMENTS CIRCUIT

Replace harness/or repair wiring, refer to (para 4-85).

Replace harness/or repair wiring, refer to (para 4-85).

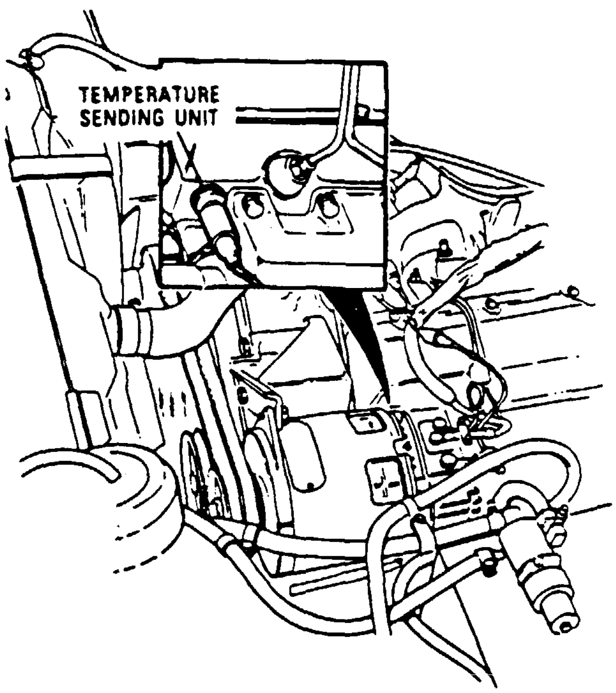
0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in the question. RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

Replace harness/or repair wiring, refer to (para 4-85).

BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).



INSTRUMENTS CIRCUIT | **DIAGNOSTIC FLOWCHART**

FROM I3, Page 2-360

KNOWN INFO

WIRING OK

POSSIBLE PROBLEMS

GAUGE
SENDING UNIT

I4

RECONNECT WIRES 27G AND 33A AT THE TEMPERATURE GAUGE. WITH THE ROTARY SWITCH IN THE "RUN" POSITION, DOES THE GAUGE READ OFF SCALE BELOW 120°F (49 °C)?

TEST OPTIONS

TRY IT

REASON FOR QUESTION

This will determine if the gauge can respond to an input signal.

NO → REPLACE TEMPERATURE GAUGE

YES ↓

KNOWN INFO

WIRING OK

POSSIBLE PROBLEMS

GAUGE
SENDING UNIT

I5

WITH THE ROTARY SWITCH IN THE "RUN" POSITION, SHORT WIRE 33B TO ENGINE GROUND. DOES THE GAUGE READ OFF SCALE ABOVE 240°F (116° C)?

TEST OPTIONS

TRY IT

REASON FOR QUESTION

This will determine if the gauge can respond to an input signal.

NO → REPLACE TEMPERATURE GAUGE

YES ↓

REPLACE TEMPERATURE SENDING UNIT

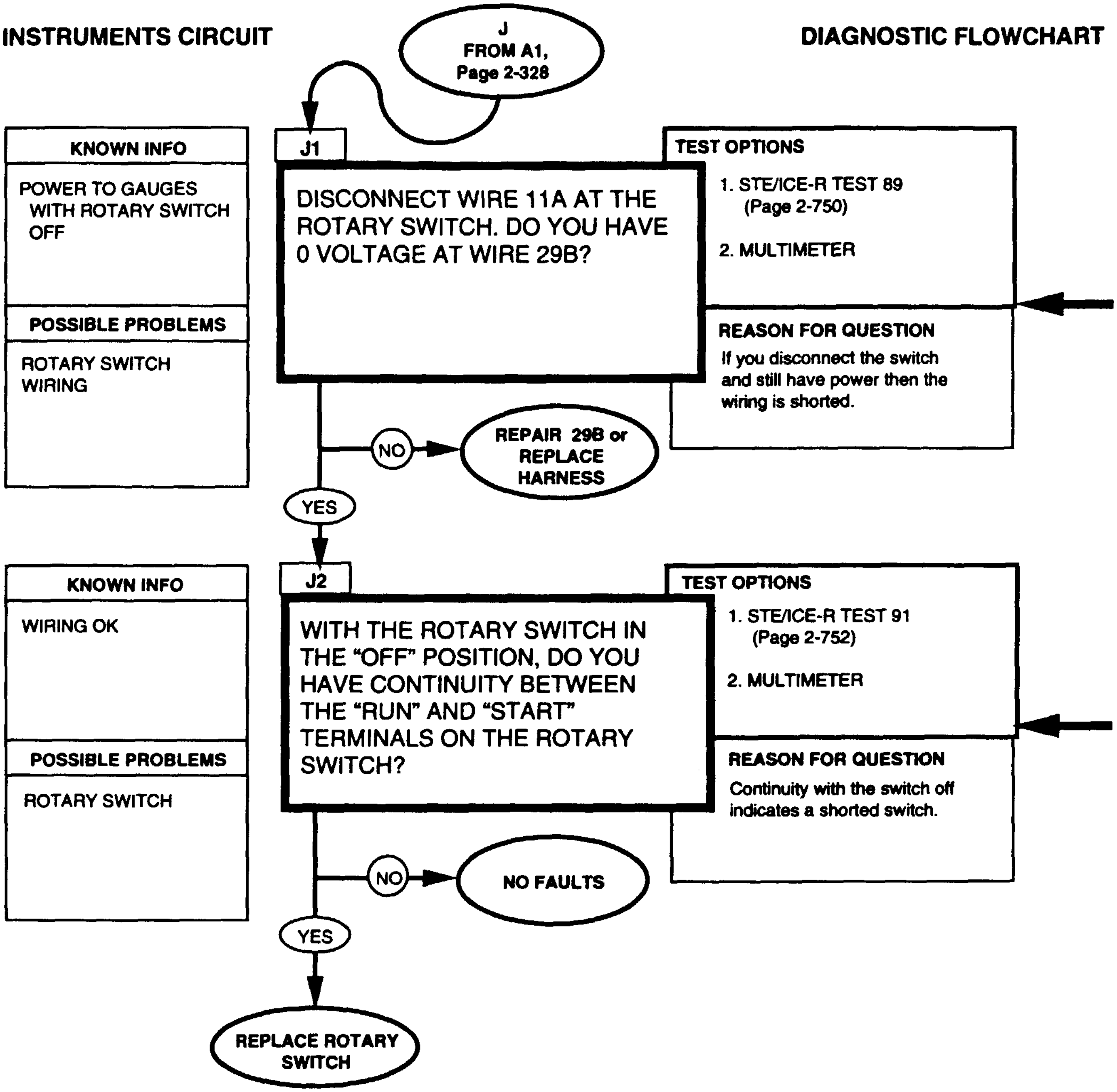
Make sure wire 33B is not connected to the sending unit and is not touching anything metal that could cause the wire to be grounded.

Replace temperature gauge, refer to (para 4-13).

Replace temperature gauge, refer to (para 4-13).

Replace temperature sending unit, refer to (para 4-24).

INSTRUMENTS CIRCUIT **DIAGNOSTIC FLOWCHART**

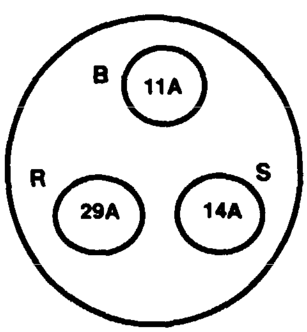


REFERENCE INFORMATION

INSTRUMENTS CIRCUIT

Replace harness/or repair wiring, refer to (para 4-85).

Replace rotary switch, refer to (para 4-7).



REAR OF ROTARY SWITCH

0-45 DC VOLTS
STE/ICE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.

2. Start Test 89, DC volts.

3. Displayed reading is in volts.

BATTERY VOLTAGE
MULTIMETER

1. Set the voltmeter to a DC volts scale of at least 40 volts.

2. Connect the RED lead to positive and the BLACK lead to negative.

3. Be sure to read the correct scale.

0-4500 OHMS
STE/ICE-R TEST 91

1. Connect RED clip and BLACK clip to the indicated terminals in the question. RED to the first, BLACK to the second.

2. Start Test 91, 0-4500 ohms.

3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

CONTINUITY (RESISTANCE)
MULTIMETER

1. Set the voltmeter to an ohms scale of about 1000 ohms.

2. Connect the RED and BLACK leads to the connections stated in the question.

3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

INSTRUMENTS CIRCUIT — DIAGNOSTIC FLOWCHART

L
FROM G3,
Page 2-352

L1

DISCONNECT WIRE 28A AT THE FUEL SENDING UNIT HARNESS. IS THERE CONTINUITY BETWEEN THE ENDS OF WIRE 28A AT THE FUEL GAUGE AND AT THE FUEL SENDING UNIT HARNESS?

KNOWN INFO
WINDSHIELD WIPERS OK

POSSIBLE PROBLEMS
FUEL GAUGE OIL PRESSURE GAUGE TEMPERATURE GAUGE

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION

If the wire is OK then the sense line from the sending unit to the gauge is OK.

NO → REPAIR 28A

YES ↓

L2

IS THERE CONTINUITY BETWEEN WIRE 58C AT THE FUEL SENDING UNIT HARNESS AND BODY (OR ENGINE) GROUND?

KNOWN INFO
WINDSHIELD WIPERS OK

POSSIBLE PROBLEMS
FUEL GAUGE OIL PRESSURE GAUGE TEMPERATURE GAUGE

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION

If the wire is OK then the sending unit ground is OK.

NO → REPAIR WIRE 58C

YES ↓

L3

CHECK RESISTANCE ACROSS WIRE 28B & WIRE 58J AT THE FUEL SENDING UNIT HARNESS. IS THE RESISTANCE LESS THAN 50 OHMS?

KNOWN INFO
WINDSHIELD WIPERS OK

POSSIBLE PROBLEMS
FUEL GAUGE OIL PRESSURE GAUGE TEMPERATURE GAUGE

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION

If the fuel sending unit is OK then it could have been bad connections.

NO → GO TO L4, Page 2-368

YES ↓

NO FAULTS

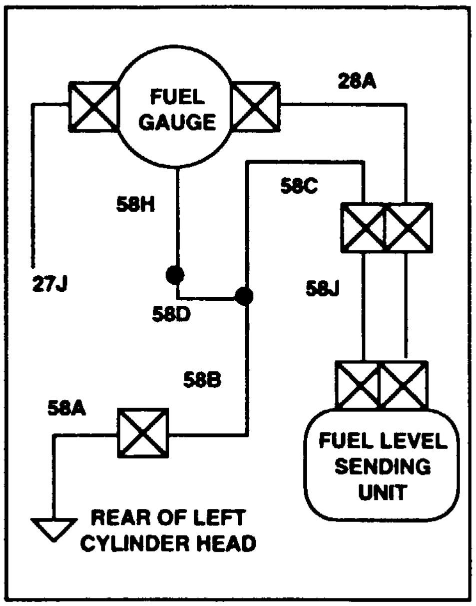
REFERENCE INFORMATION

INSTRUMENTS CIRCUIT

0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in the question. RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

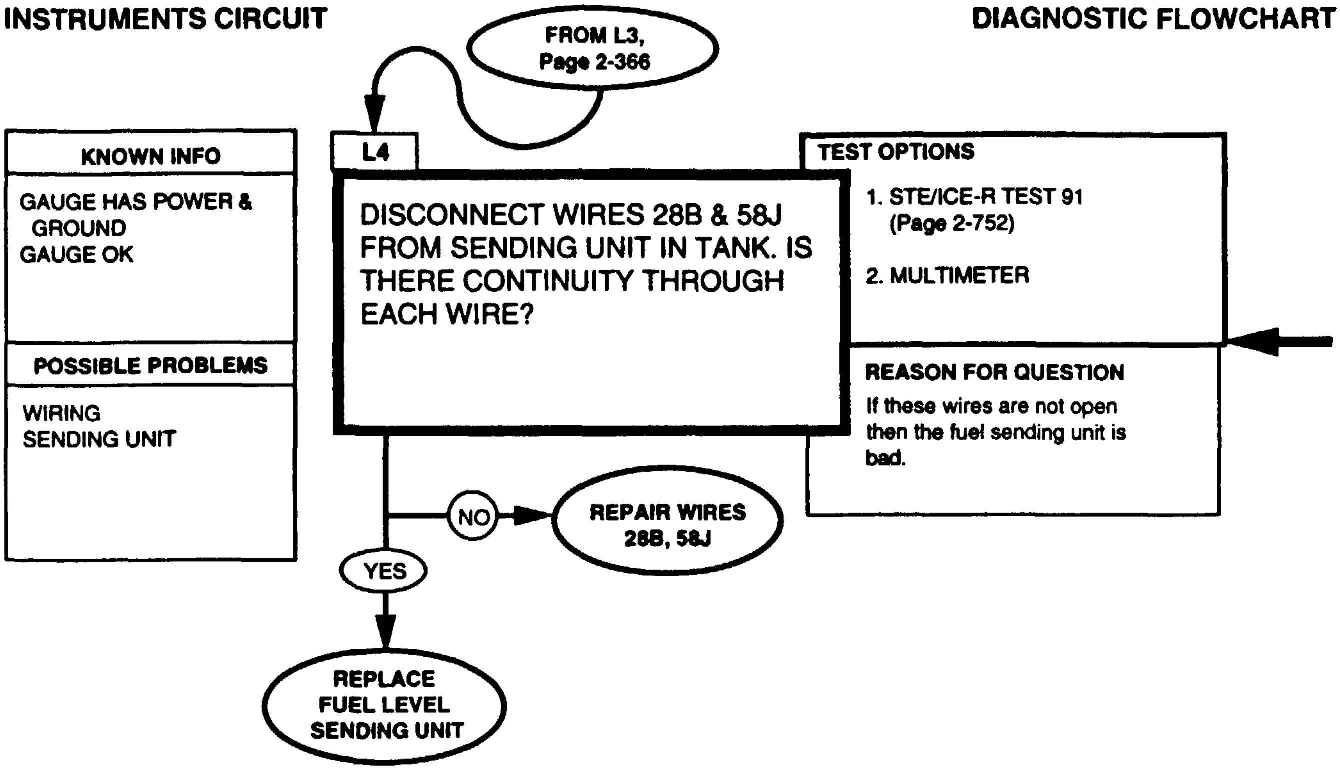
CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms. 2. Connect the RED and BLACK leads to the connections stated in the question. 3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

The connector is located above the driveshaft toward the rear of the vehicle.



GAUGE READING	OHMS
FULL	35
HALF	16
EMPTY	0

INSTRUMENTS CIRCUIT DIAGNOSTIC FLOWCHART

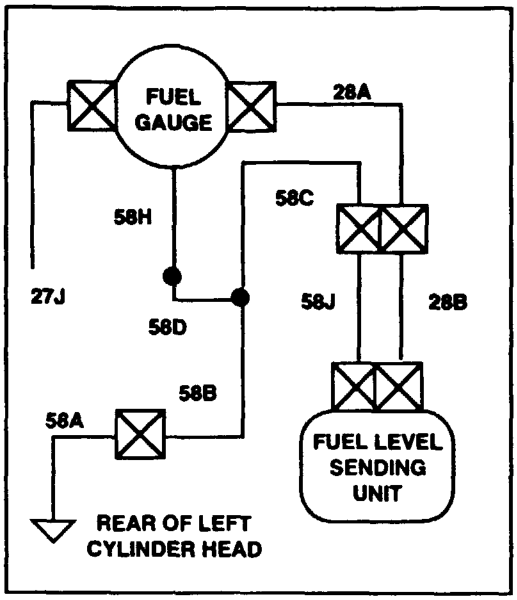


REFERENCE INFORMATION

INSTRUMENTS CIRCUIT

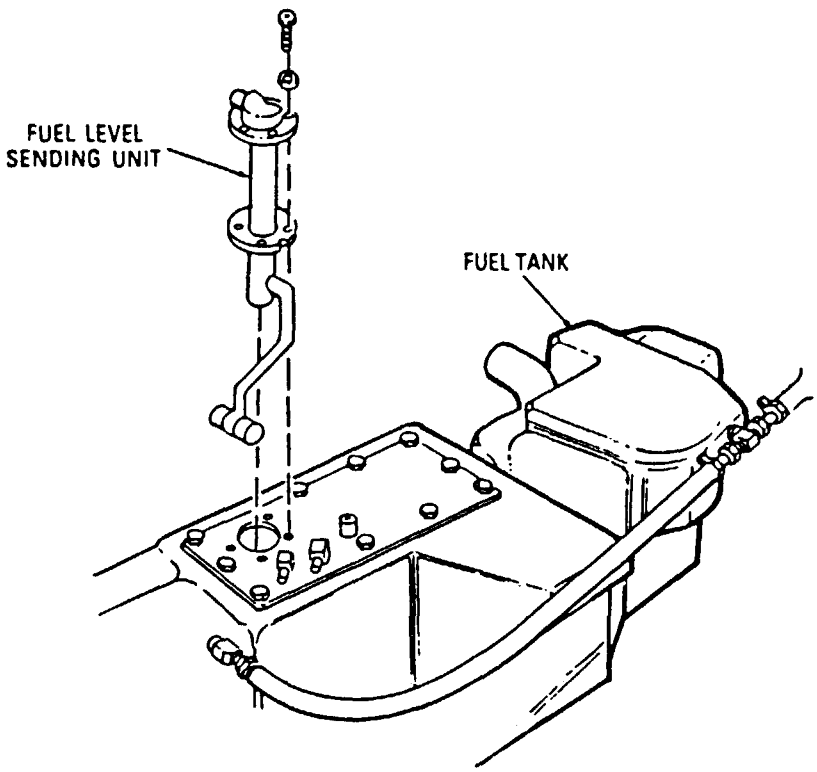
In order to reach these wires and the sending unit you have to remove the fuel tank. You may want to recheck the previous steps to be sure you didn't miss anything before you proceed with this step.

Replace fuel level sending unit and repair wiring, refer to (para 4-28 and 4-85).



0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in the question. RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).



INSTRUMENTS CIRCUIT — DIAGNOSTIC FLOWCHART

M
FROM F1,
Page 2-348

M1

KNOWN INFO

POWER AVAILABLE TO GAUGES
NO POWER AT WIPER MOTOR

POSSIBLE PROBLEMS

WIRING

REMOVE CLEVIS PINS AND TILT WINDSHIELD FORWARD. WITH ROTARY SWITCH IN THE "RUN" POSITION, IS THERE BATTERY VOLTAGE AT CONTACT P ON THE BODY?

TEST OPTIONS

1. STE/ICE-R TEST 89 (Page 2-750)
2. MULTIMETER

REASON FOR QUESTION

These contacts provide power and ground connections to the wiper motor.

NO → **REPAIR 27K or REPLACE HARNESS**

YES → M2

M2

KNOWN INFO

POWER TO CONTACT

POSSIBLE PROBLEMS

WIRING

DO YOU HAVE CONTINUITY FROM CONTACT P ON THE WINDSHIELD FRAME TO WIRE 27 AT THE CONNECTOR?

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION

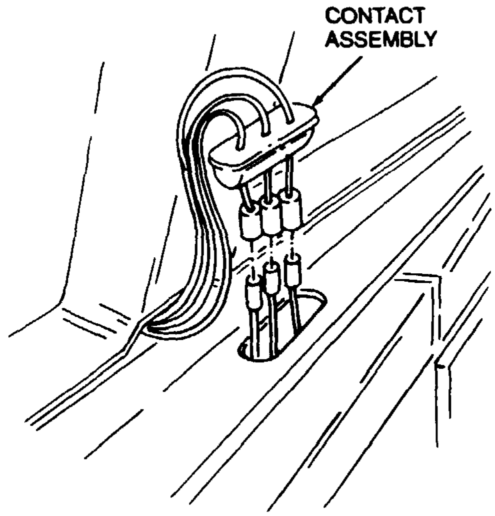
These contacts provide power and ground connections to the wiper motor.

NO → **REPAIR 27 or REPLACE HARNESS**

YES → **NO FAULT**

REFERENCE INFORMATION

INSTRUMENTS CIRCUIT

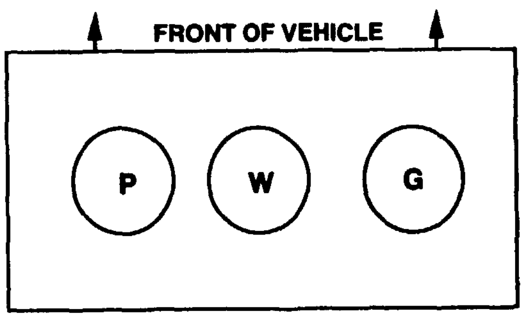


Make sure these contacts are clean otherwise the wiper motor may not have power or ground.

If you experience intermittent problems with the wiper motor on your vehicle, inspect the terminals and the rubber grommet of the contact assembly. If the terminals are dirty or corroded, clean or replace as required. If the grommet shows signs of damage or deformity, replace the contact assembly (TM 9-2320-280-24P).

Replace harness or repair wiring, refer to (para 4-85).

Replace harness/or repair wiring, refer to (para 4-85).



WINDSHIELD CONNECTOR
AS VIEWED FROM ABOVE

0-45 DC VOLTS
STE/ICE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.

2. Start Test 89, DC volts.

3. Displayed reading is in volts.

BATTERY VOLTAGE
MULTIMETER

1. Set the voltmeter to a DC volts scale of at least 40 volts.

2. Connect the RED lead to positive and the BLACK lead to negative.

3. Be sure to read the correct scale.

CONTINUITY (RESISTANCE)
MULTIMETER

1. Set the voltmeter to an ohms scale of about 1000 ohms.

2. Connect the RED and BLACK leads to the connections stated in the question.

3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

0-4500 OHMS
STE/ICE-R TEST 91

1. Connect RED clip and BLACK clip to the indicated terminals in the question. RED to the first, BLACK to the second.

2. Start Test 91, 0-4500 ohms.

3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

INSTRUMENTS CIRCUIT **DIAGNOSTIC FLOWCHART**

N
FROM F2,
Page 2-348

N1

KNOWN INFO

NO WIPER MOTOR GROUND

POSSIBLE PROBLEMS

WIRING

REMOVE CLEVIS PINS AND TILT WINDSHIELD FORWARD. DO YOU HAVE CONTINUITY FROM CONTACT G ON THE BODY TO BODY (OR ENGINE) GROUND?

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION

These contacts provide power and ground connections to the wiper motor.

NO → **REPAIR 57F or REPLACE HARNESS**

YES ↓

N2

KNOWN INFO

GROUND AT CONTACT

POSSIBLE PROBLEMS

WIRING

DO YOU HAVE CONTINUITY FROM CONTACT G ON THE WINDSHIELD FRAME TO WIRE 57 AT THE CONNECTOR?

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION

These contacts provide power and ground connections to the wiper motor.

NO → **REPAIR 57 or REPLACE HARNESS**

YES ↓

NO FAULT

REFERENCE INFORMATION

INSTRUMENTS CIRCUIT

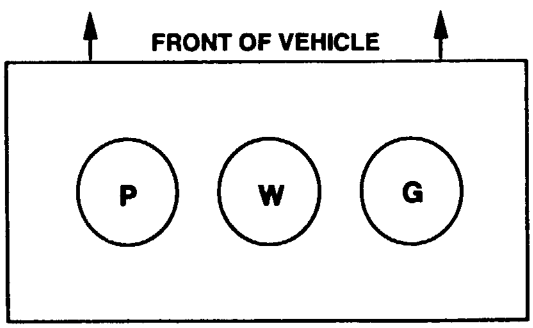
Make sure these contacts are clean otherwise the wiper motor may not have power or ground.

Replace harness/or repair wiring, refer to (para 4-85).

0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in the question. RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

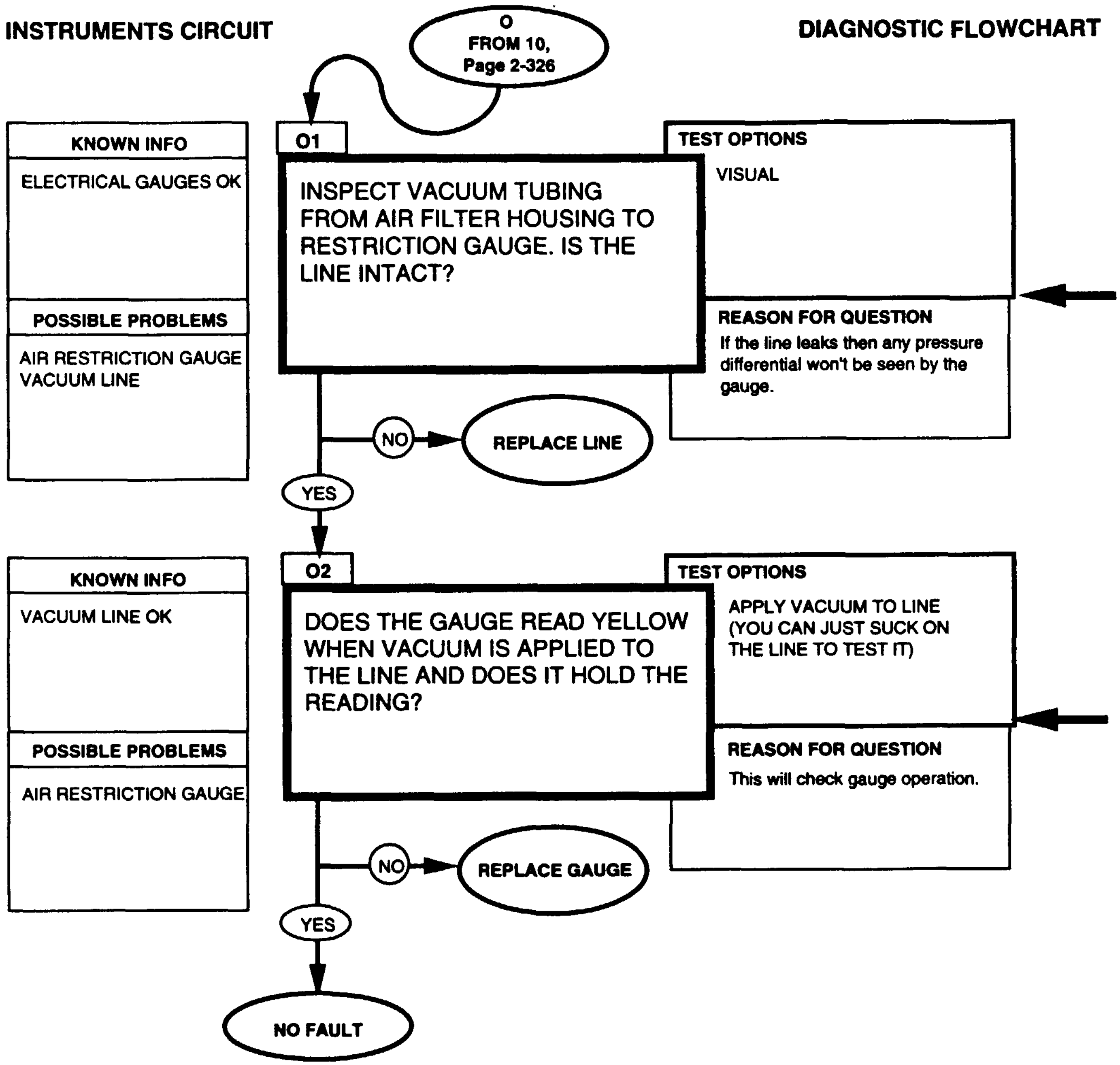
Replace harness/or repair wiring, refer to (para 4-85).

CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms. 2. Connect the RED and BLACK leads to the connections stated in the question. 3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).



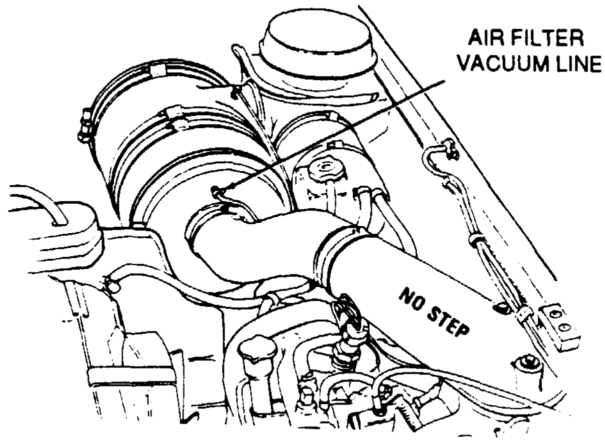
WINDSHIELD CONNECTOR
AS VIEWED FROM ABOVE

INSTRUMENTS CIRCUIT DIAGNOSTIC FLOWCHART



You can provide enough vacuum to operate the gauge by sucking on the line.

Replace vacuum line, refer to (para 3-19).



Replace gauge, refer to (para 3-17).

INSTRUMENTS CIRCUIT

DIAGNOSTIC FLOWCHART

P
FROM 11,
Page 2-326

KNOWN INFO

AIR FILTER RESTRICTION GAUGE OK
VACUUM TUBE OK

POSSIBLE PROBLEMS

WIRING
SWITCH
MOTOR
CIRCUIT BREAKER #1
PCB

P1

REMOVE WIRE 27C FROM CIRCUIT BREAKER #1. WITH THE ROTARY SWITCH IN THE "RUN" POSITION, IS THERE BATTERY VOLTAGE AT WIRE 27C AT CIRCUIT BREAKER #1?

TEST OPTIONS

1. STE/ICE-R TEST 89 (Page 2-750)
2. MULTIMETER

REASON FOR QUESTION

Voltage here indicates that wiring to the circuit breaker is OK.

NO → GO TO Q, Page 2-380

YES ↓

KNOWN INFO

WIRE 27C OK

POSSIBLE PROBLEMS

WIRING
SWITCH
MOTOR
CIRCUIT BREAKER #1
PCB

P2

RECONNECT WIRE 27C. REMOVE WIRE 27D FROM THE HEATER FAN SWITCH. WITH THE ROTARY SWITCH IN THE "RUN" POSITION, IS THERE BATTERY VOLTAGE AT WIRE 27D?

TEST OPTIONS

1. STE/ICE-R TEST 89 (Page 2-750)
2. MULTIMETER

REASON FOR QUESTION

If you have voltage here, then the circuit breaker and wiring to the switch is OK.

NO → GO TO R, Page 2-382

YES ↓

KNOWN INFO

WIRE 27C OK
WIRE 27D OK
CIRCUIT BREAKER #1 OK

POSSIBLE PROBLEMS

WIRING
SWITCH
MOTOR
PCB

P3

RECONNECT WIRE 27D. REMOVE WIRE 400D FROM THE HEATER FAN MOTOR. WITH THE ROTARY SWITCH IN THE "RUN" POSITION AND THE HEATER FAN SWITCH ON HIGH, IS THERE BATTERY VOLTAGE AT WIRE 400D?

TEST OPTIONS

1. STE/ICE-R TEST 89 (Page 2-750)
2. MULTIMETER

REASON FOR QUESTION

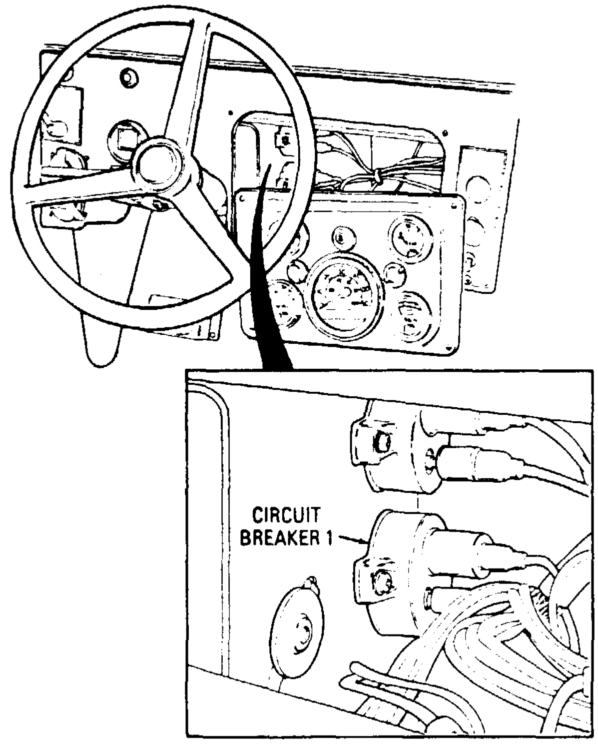
Voltage here indicates that wiring to the heater fan motor is OK.

NO → GO TO S, Page 2-384

YES ↓

GO TO P4, Page 2-378

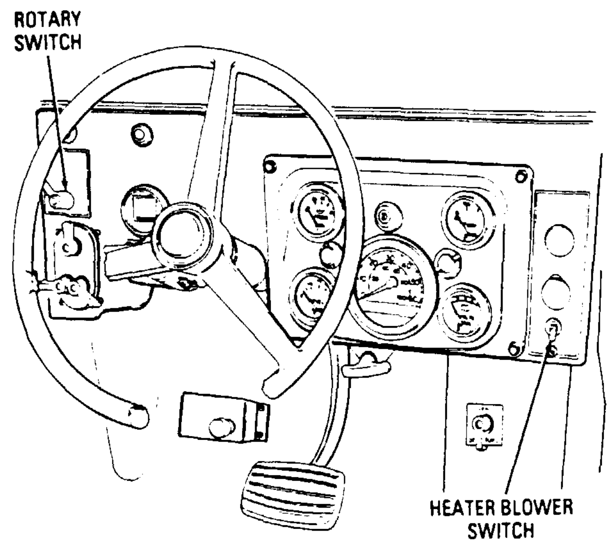
The easiest way to reach the circuit breaker is to remove the gauge panel screws and pull the panel out far enough to work with the wiring.



0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.

The heater motor is located directly in front of the passenger seat under the dashboard, connected to the heating ducts.



INSTRUMENTS CIRCUIT DIAGNOSTIC FLOWCHART

FROM P3, Page 2-316

KNOWN INFO

WIRE 27C OK
WIRE 27D OK
CIRCUIT BREAKER #1 OK
WIRE 400D OK
SWITCH OK

POSSIBLE PROBLEMS

WIRING
MOTOR
PCB

P4

IS THERE CONTINUITY FROM WIRE 57E AT THE HEATER FAN MOTOR TO BODY GROUND?

TEST OPTIONS

1. STE/ICE-R TEST 91 (PAGE 2-752)
2. MULTIMETER

REASON FOR QUESTION

This wire provides the motor's connection to ground.

NO → GO TO T, Page 2-386

YES ↓

P5

IF THE PROBLEM CONTINUES, REPLACE THE HEATER MOTOR. RETURN TO THE INSTRUMENTS TEST CHAIN, PAGE 2-319.

REFERENCE INFORMATION

INSTRUMENTS CIRCUIT

0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in the question. RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Lees then 5 ohms is continuity. It the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms. 2. Connect the RED and BLACK leads to the connections stated in the question. 3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

INSTRUCTIONS CIRCUIT DIAGNOSTIC FLOWCHART

Q
FROM P1,
Page 2-376

KNOWN INFO

NONE

POSSIBLE PROBLEMS

WIRE 27C
PCB BODY
CONNECTOR

Q1

REPAIR/REPLACE WIRE 27C. WITH THE ROTARY SWITCH IN THE "RUN" POSITION, DO YOU HAVE BATTERY VOLTAGE AT WIRE 27C AT CIRCUIT BREAKER #1?

TEST OPTIONS

1. STE/ICE-R TEST 89 (Page 2-750)
2. MULTIMETER

REASON FOR QUESTION

Voltage here indicates that the wiring was bad, and the problem was solved.

NO → REPAIR/REPLACE BODY CONNECTOR HARNESS

YES ↓

Q2

RETURN TO P2, PAGE 2-376.

REFERENCE INFORMATION

INSTRUMENTS CIRCUIT

0-45 DC VOLTS
STE/ICE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

Replace harness/or repair wiring, refer to (para 4-85).

BATTERY VOLTAGE
MULTIMETER

1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

INSTRUMENTS CIRCUIT

DIAGNOSTIC FLOWCHART

R
FROM P2,
Page 2-376

KNOWN INFO

WIRE 27C OK

POSSIBLE PROBLEMS

WIRE 27D
CIRCUIT BREAKER #1

R1

IS THERE CONTINUITY FROM WIRE 27D AT THE HEATER FAN SWITCH TO WIRE 27D AT CIRCUIT BREAKER #1?

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION

Continuity indicates that the wire is OK, and the circuit breaker must be the problem.

NO: REPAIR/REPLACE WIRE27D. RETURN TO P3, Page 2-376

YES:

R3

REPLACE CIRCUIT BREAKER #1. RETURN TO P3, PAGE 2-376.

Replace harness or repair wiring, refer to (para 4-85).

0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated test points in the question. RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms. 2. Connect the RED and BLACK leads to the connections stated in the question. 3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

INSTRUMENTS CIRCUIT

DIAGNOSTIC FLOWCHART

S
FROM P3,
Page 2-376

KNOWN INFO

WIRE 27C OK
WIRE 27D OK
CIRCUIT BREAKER #1 OK

POSSIBLE PROBLEMS

WIRE 400D
SWITCH

S1

IS THERE CONTINUITY FROM WIRE 400D AT THE HEATER MOTOR TO WIRE 400D AT THE HEATER FAN SWITCH?

TEST OPTIONS

1. STE/ICE-R TEST 91
   (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION

Continuity indicates that the wiring is OK, and the switch must be the problem.

NO: REPAIR/REPLACE WIRE 400D. RETURN TO P4, Page 2-378

YES:

S2

REPLACE THE HEATER FAN SWITCH. RECONNECT ALL WIRES. RETURN TO P4, PAGE 2-378.

REFERENCE INFORMATION

INSTRUMENTS CIRCUIT

Repair wire or replace harness, refer to (para 4-85).

0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated test points in the question. RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms. 2. Connect the RED and BLACK leads to the connections stated in the question. 3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

INSTRUMENTS CIRCUIT

DIAGNOSTIC FLOWCHART

T
FROM P4,
Page 2-378

KNOWN INFO

WIRE 27C OK
WIRE 27D OK
CIRCUIT BREAKER #1 OK
WIRE 400D OK
SWITCH OK

POSSIBLE PROBLEMS

WIRE 57E
PCB BODY CONNECTOR

T1

DISCONNECT THE PCB BODY CONNECTOR. IS THERE CONTINUITY FROM WIRE 57E AT THE HEATER MOTOR TO SOCKET D OF THE PCB BODY CONNECTOR HARNESS?

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

REASON FOR QUESTION

If there is continuity, the wiring is OK, and the PCB must be the problem.

NO → REPAIR 57E OR REPLACE HARNESS. RETURN TO P5, Page 2-378

YES ↓

T2

REPLACE THE PCB. RETURN TO P5, PAGE 2-378.

WARNING

Disconnect negative battery cable before disconnecting and reconnecting protective control box harness.

There is battery voltage at the PCB at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

Replace harness or repair wiring, refer to (para 4-85).

0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in the question. RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

WARNING

Disconnect negative battery cable before disconnecting and reconnecting protective control box harness.

There is battery voltage at the PCB at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

Replace the PCB, refer to (para 4-5).

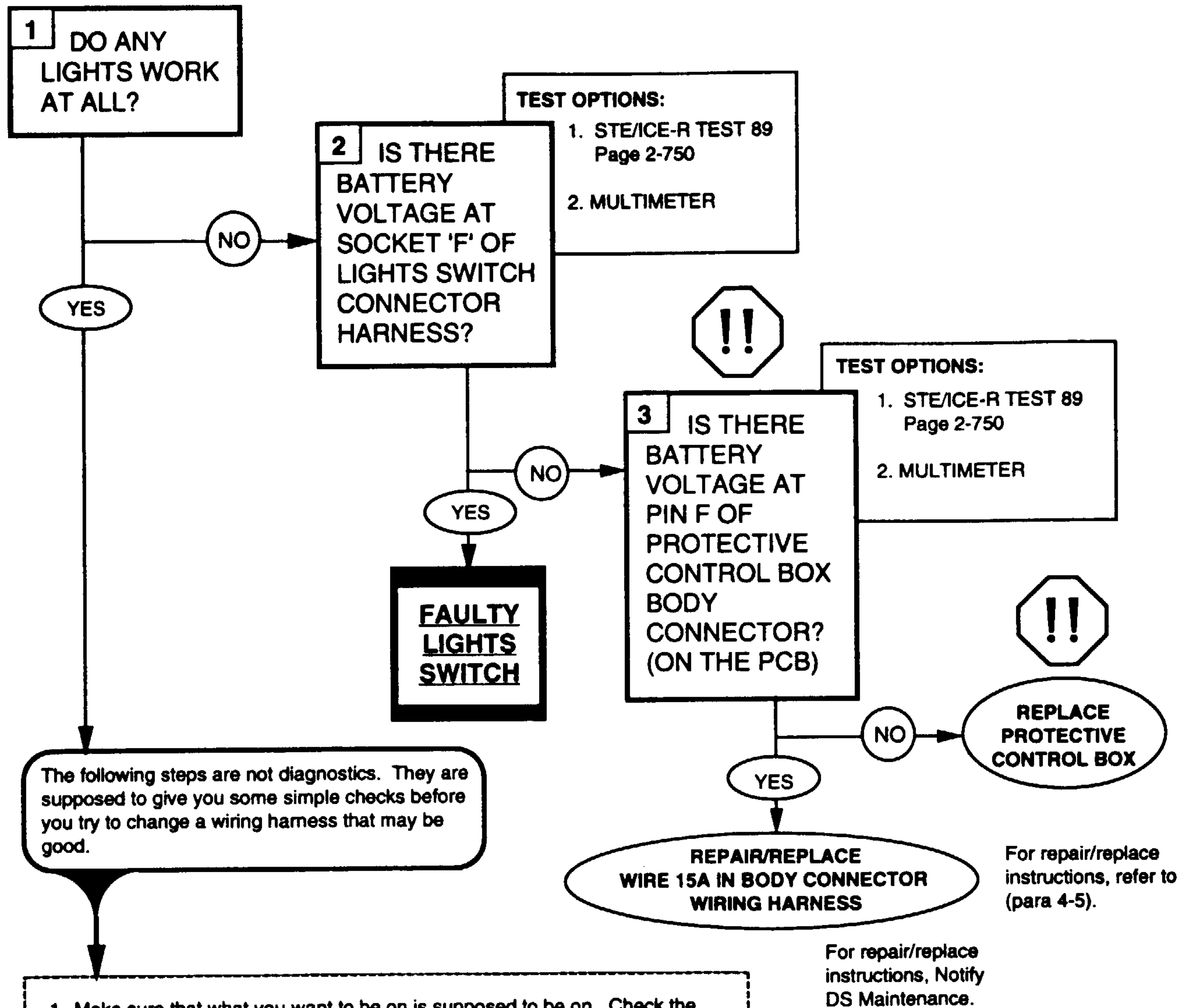
CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms. 2. Connect the RED and BLACK leads to the connections stated in the question. 3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

2-33. LIGHT TESTS

The Lights paragraph has almost no flow chart to guide you through a problem. This is because there aren't very many problems that can occur. The most common problems are burned-out bulbs and loose or corroded connections. Aside from bulbs and wiring, the only components are the PCB and the lights switch. If either of these is found to be faulty, you just replace the bad unit. On the following pages you will find diagrams of the major portions of the Lights Circuit. These are designed to help you isolate a problem without wasting too much time.

LIGHTS

DIAGNOSTIC FLOWCHART



1. Make sure that what you want to be on is supposed to be on. Check the switches (lights, high-low beam, etc).
2. Check the socket and connection(s) for corrosion, cracks or loose parts. Repair or replace any damaged components.
3. Try replacing the bulb that doesn't work with a bulb that you know works.
4. If the connections look good and a known good bulb doesn't work, you have to start checking voltage and continuity.
   a) Check for battery voltage (STE/ICE-R TEST 89, P2-750) at the light socket, there may be a fault in the wiring harness.
   b) Check for continuity to ground (STE/ICE-R TEST 91, P2-752) from the light socket, there may be a missing connection to ground.
   c) Go to the wiring diagram(s) for more help.

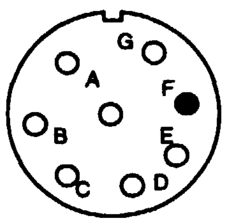
WARNING

DISCONNECT NEGATIVE BATTERY CABLE BEFORE DISCONNECTING AND RECONNECTING PROTECTIVE CONTROL BOX HARNESS.

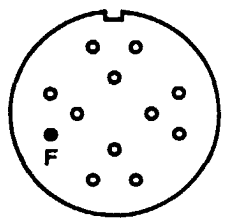
There is battery voltage at the PCB at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in the question. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

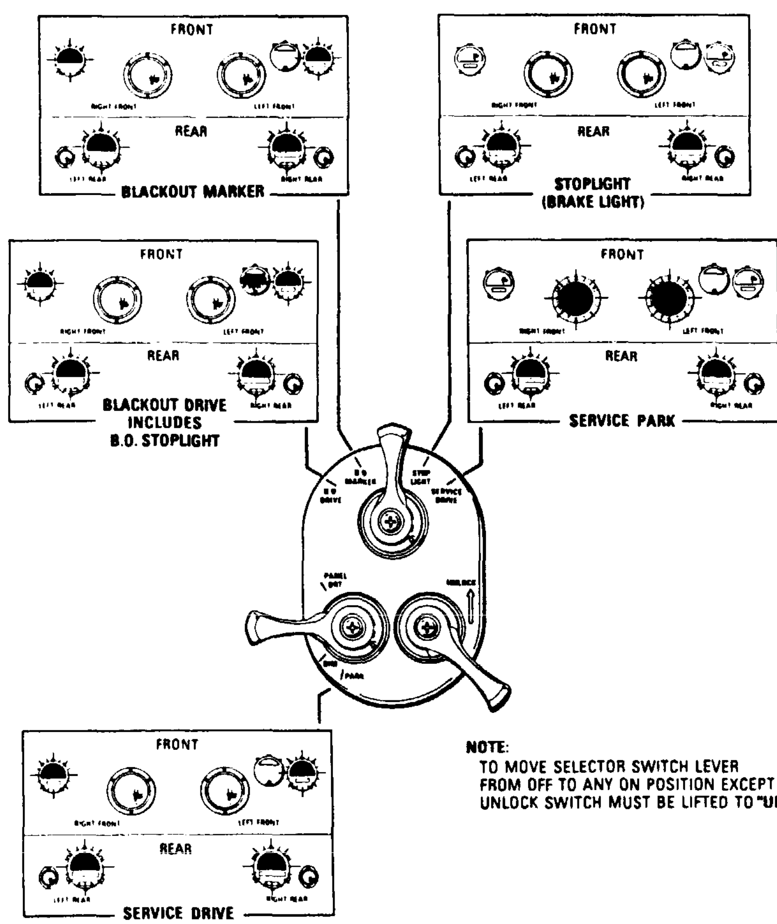
0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to positive, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.



PCB BODY CONNECTOR

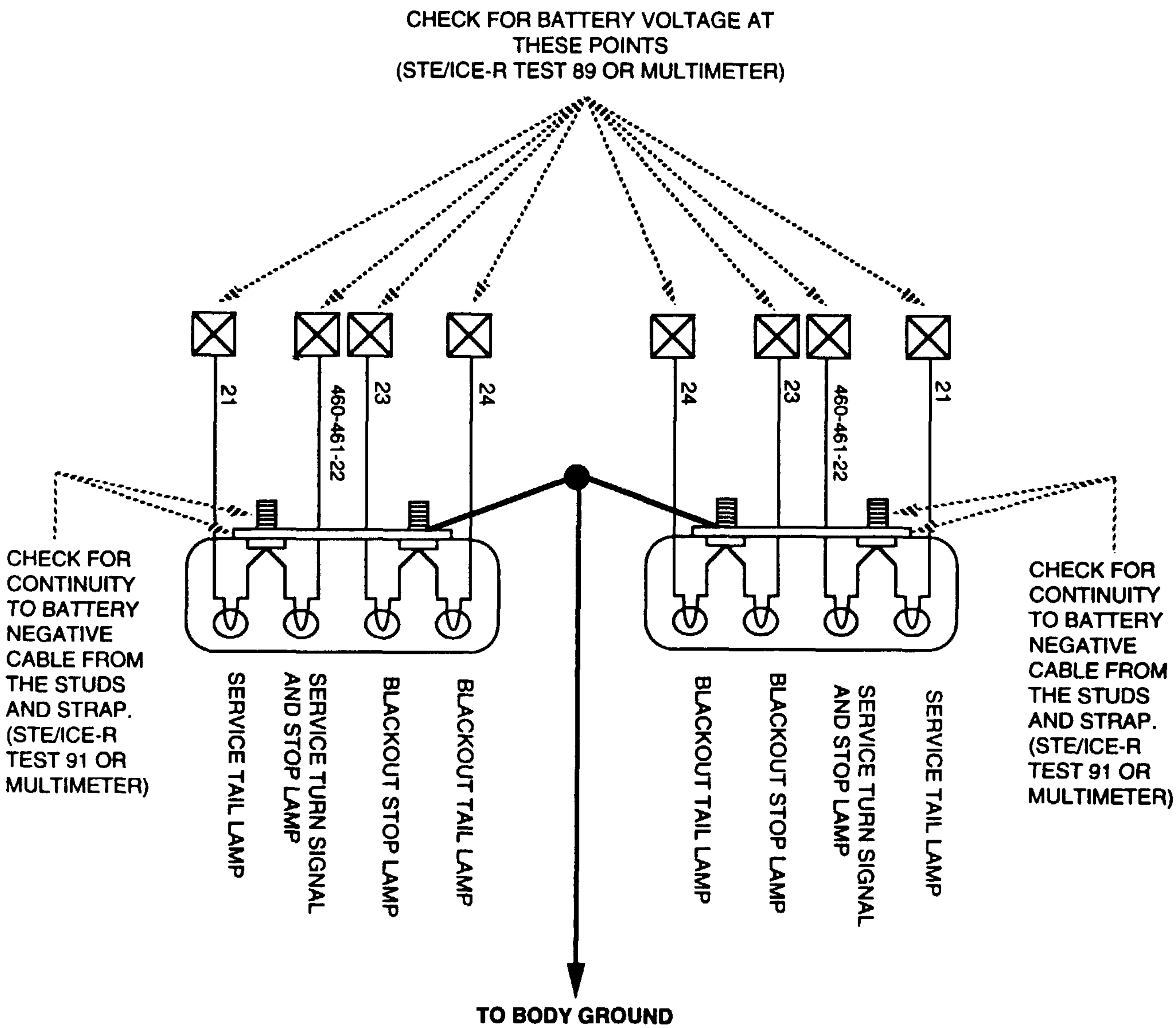


LIGHT SWITCH CONNECTOR HARNESS



NOTE:
TO MOVE SELECTOR SWITCH LEVER FROM OFF TO ANY ON POSITION EXCEPT B.O. MARKER, UNLOCK SWITCH MUST BE LIFTED TO "UNLOCK"

(NOT INCLUDING BACKUP LAMPS AND SIDE MARKERS)

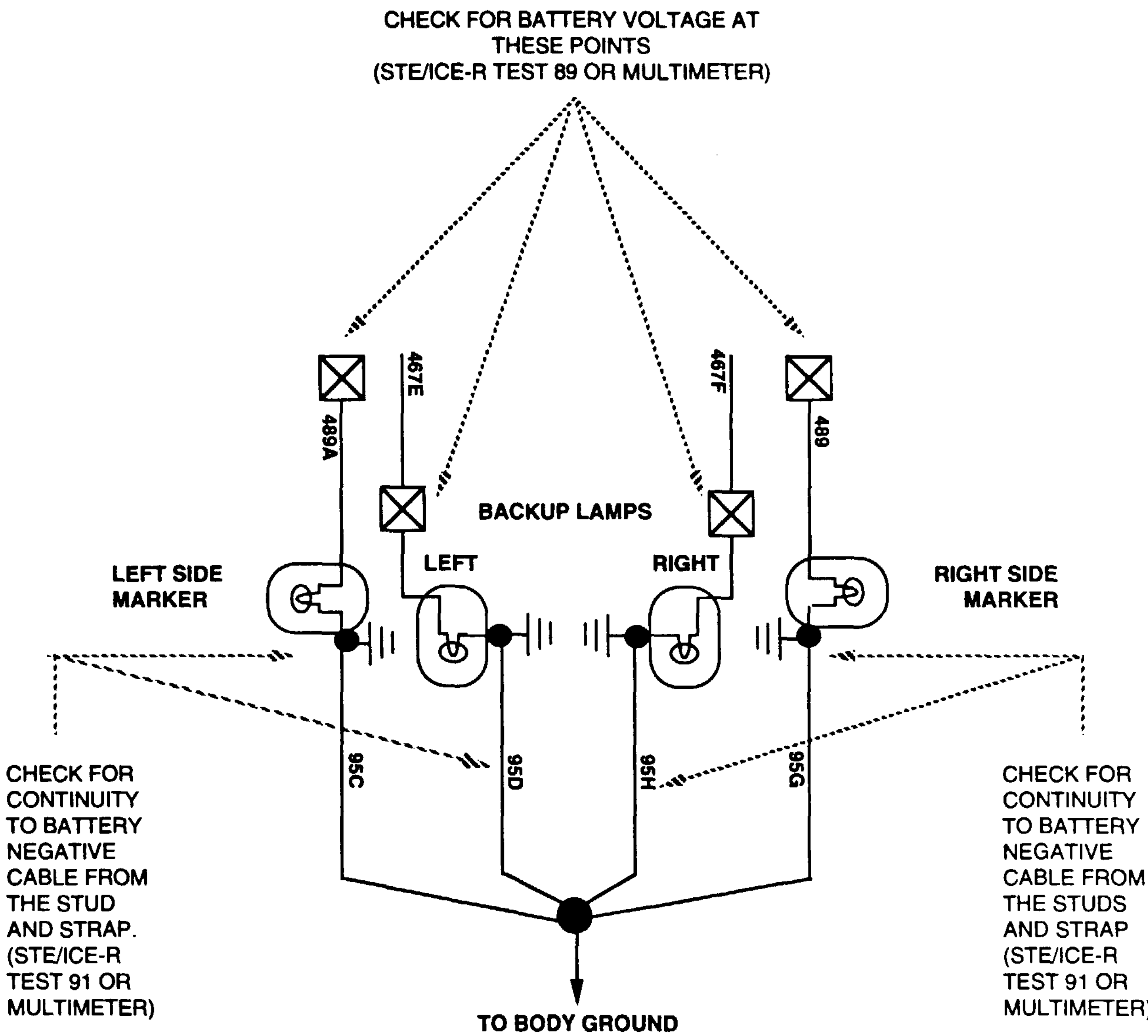


1. WHEN CHECKING FOR VOLTAGE, MAKE SURE THAT THE LAMP YOU ARE CHECKING IS SUPPOSED TO BE ON (CHECK THE LIGHTS SWITCH, TURN SIGNAL SWITCH, TRANSMISSION, ETC.).

CAUTION

DISCONNECT NEGATIVE BATTERY CABLE PRIOR TO MAKING CONTINUITY MEASUREMENTS

2. CHECK CONTINUITY TO BODY GROUND.



1. WHEN CHECKING FOR VOLTAGE, MAKE SURE THAT THE LAMP YOU ARE CHECKING IS SUPPOSED TO BE ON (CHECK THE LIGHTS SWITCH, TURN SIGNAL SWITCH, TRANSMISSION, ETC.).

CAUTION

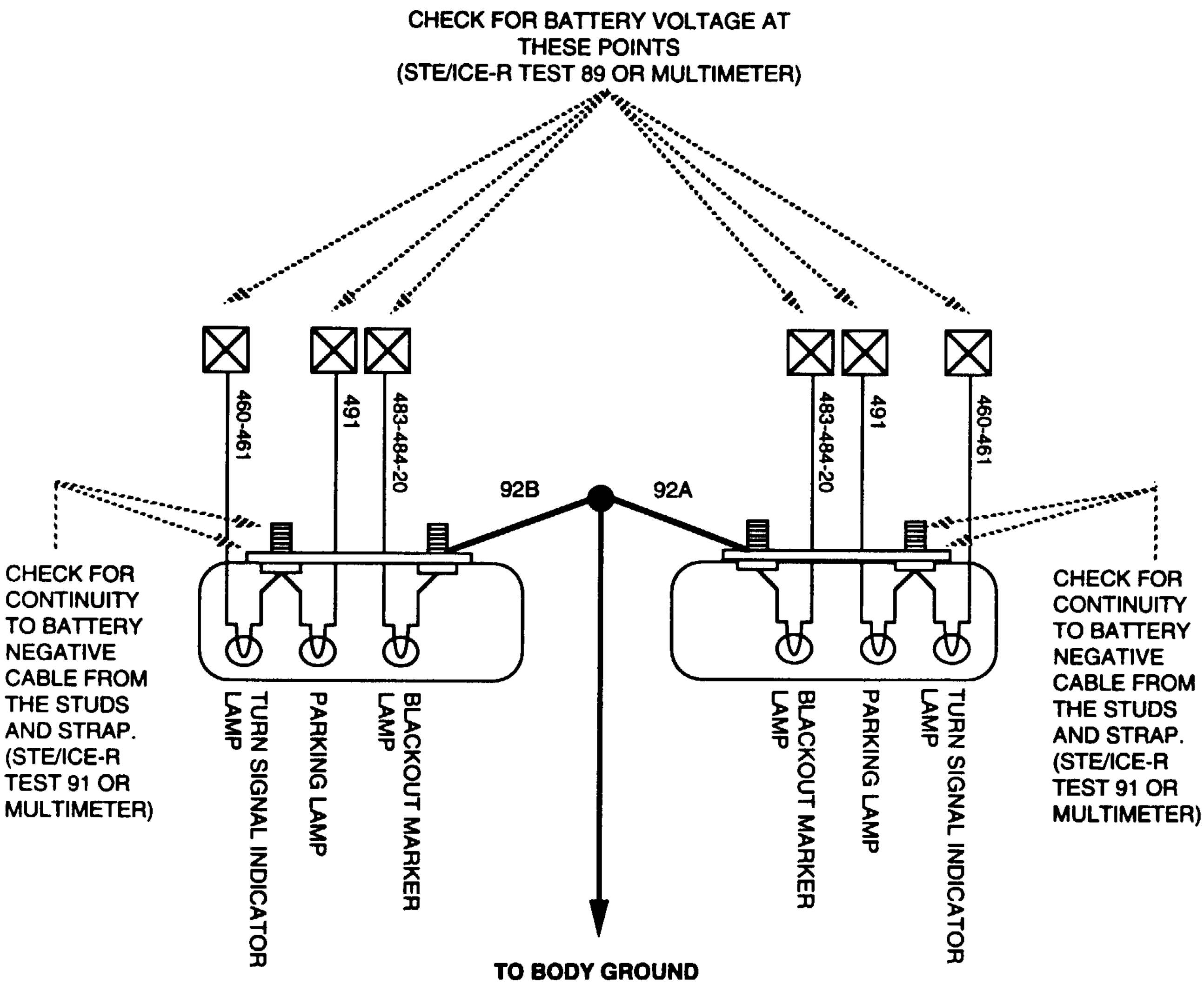
DISCONNECT NEGATIVE BATTERY CABLE PRIOR TO MAKING CONTINUITY MEASUREMENTS

2. CHECK CONTINUITY TO BODY GROUND.

LIGHTS

FRONT LIGHTS

**(PARK LIGHTS,
TURN SIGNAL LAMPS,
BLACKOUT MARKERS)**



1. WHEN CHECKING FOR VOLTAGE, MAKE SURE THAT THE LAMP YOU ARE CHECKING IS SUPPOSED TO BE ON (CHECK THE LIGHTS SWITCH, TURN SIGNAL SWITCH, TRANSMISSION, ETC.).

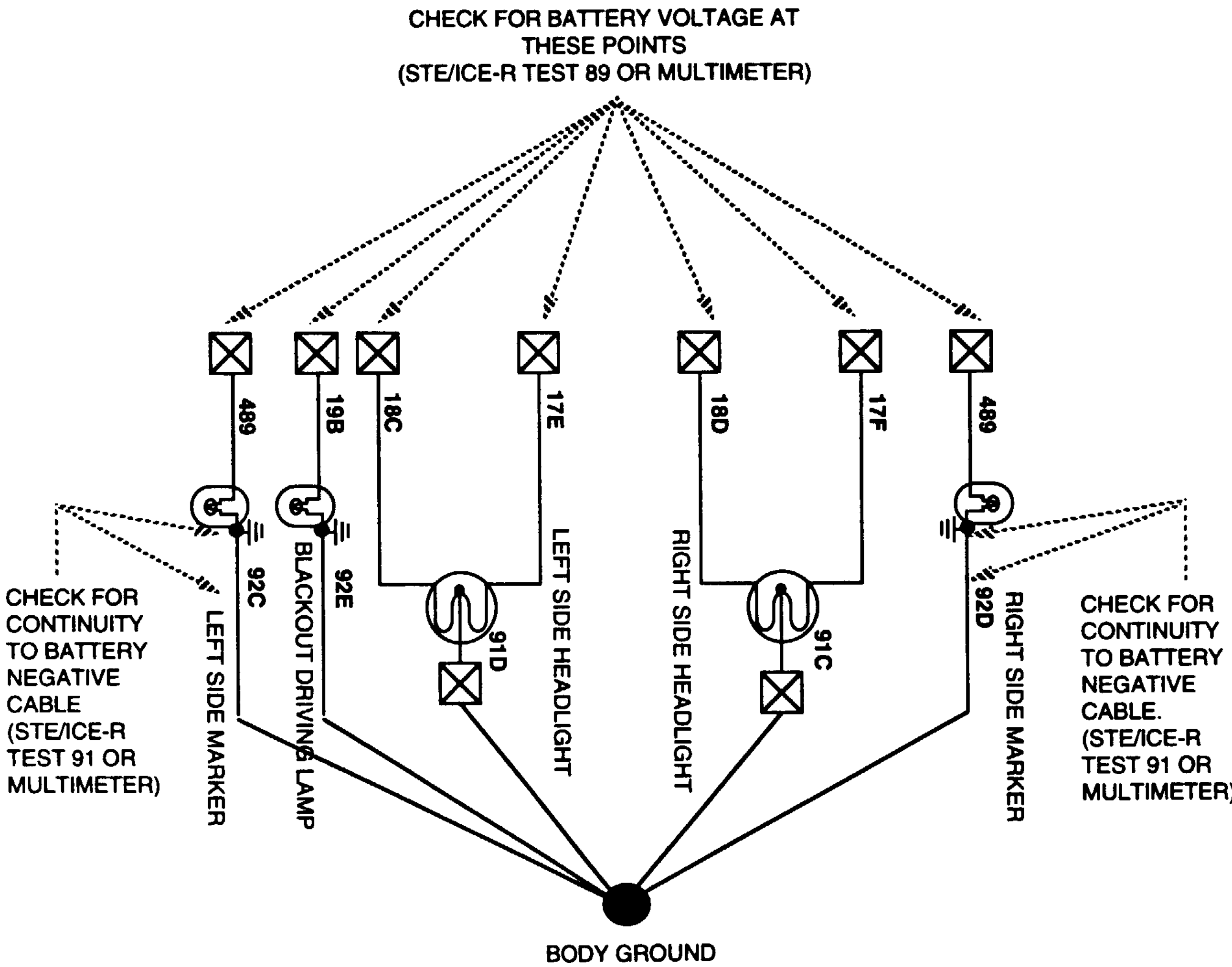
CAUTION

DISCONNECT NEGATIVE BATTERY CABLE PRIOR TO MAKING CONTINUITY MEASUREMENTS.

2. CHECK CONTINUITY TO BODY GROUND.

FRONT LIGHTS **LIGHTS**

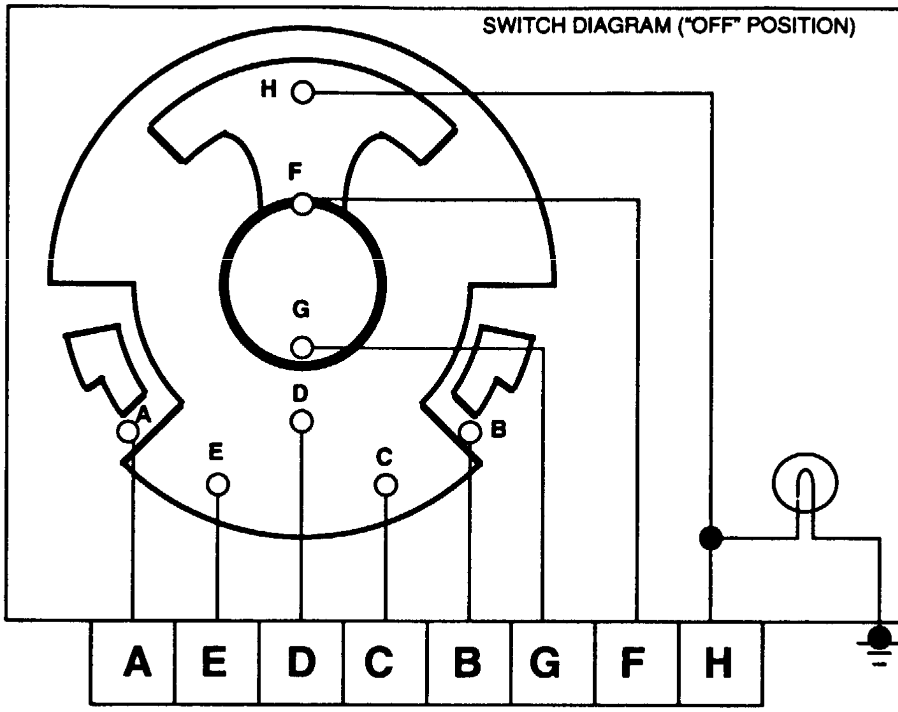
HEADLAMPS, BLACKOUT DRIVING LAMP, SIDE MARKERS



1. WHEN CHECKING FOR VOLTAGE, MAKE SURE THAT THE LAMP YOU ARE CHECKING IS SUPPOSED TO BE ON (CHECK THE LIGHTS SWITCH, TURN SIGNAL SWITCH, TRANSMISSION, ETC.).

CAUTION
DISCONNECT NEGATIVE BATTERY CABLE PRIOR TO MAKING CONTINUITY MEASUREMENTS.

2. CHECK CONTINUITY TO BODY GROUND.



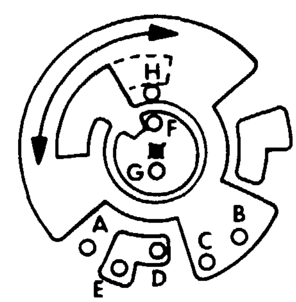
SUMMARY OF CONNECTIONS:

TERMINAL	CONNECTION	WIRE NUMBER
A	RIGHT FRONT TURN SIGNAL	460A
B	LEFT FRONT TURN SIGNAL	461A
C	LEFT REAR TURN SIGNAL/STOP LAMP	22-461A
D	LIGHT SWITCH TERMINAL "C"	22A
E	RIGHT REAR TURN SIGNAL	22-460A
F	HAZARD/TURN SIGNAL FLASHER TERM. "B"	325B
G	LIGHT SWITCH TERMINAL "J" (24 VOLTS)	467B
H	HAZARD/TURN SIGNAL FLASHER TERM. "A"	325A

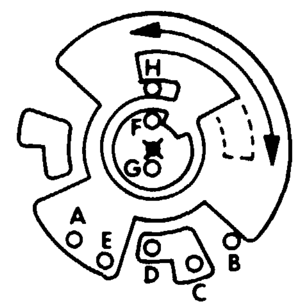
CAUTION

DISCONNECT NEGATIVE BATTERY CABLE PRIOR TO MAKING CONTINUITY MEASUREMENTS.

1. WITH THE SWITCH IN THE ’LEFT” POSITION, YOU SHOULD HAVE CONTINUITY FROM PIN “H” TO PINS “B” AND “C”, PIN “D” TO “E”, AND PIN “F” TO “G”.
2. WITH THE SWITCH IN THE “RIGHT” POSITION, YOU SHOULD HAVE CONTINUITY FROM PIN “H” TO PINS “A” AND “E”, PIN “C” TO “D”, AND PIN “F TO “G”.



LEFT TURN

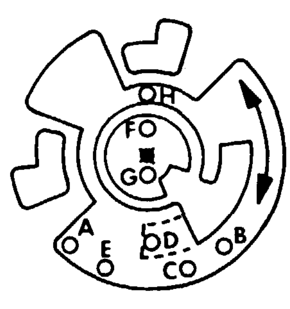


RIGHT TURN

NOTE

- IF VEHICLE IS EQUIPPED WITH BRAKE LIGHT OVERRIDE DIRECTIONAL SIGNAL CONTROL ASSEMBLY (P/N12339312-1), REFER TO STEP 3.
- IF VEHICLE IS EQUIPPED WITH DIRECTIONAL SIGNAL CONTROL ASSEMBLY (P/N 12339312), REFER TO STEP 4.

3. WITH SWITCH IN HAZARD POSITION, YOU SHOULD HAVE CONTINUITY FROM PIN H TO PINS “A”, “B”, “C”, “D”, AND “E” AND PIN “F” TO “G”.
4. WITH SWITCH IN HAZARD POSITION, YOU SHOULD HAVE CONTINUITY FROM PIN H TO PINS “A”, “B”, “C”. AND “E” AND PIN “F” TO “G”.



HAZARD

2-34. TRANSMISSION SYSTEM TESTS (3L80)

These Transmission System tests may be run any time you think you have a transmission problem or if you were sent hereby another test chain. Just follow the path, answering the questions. Additional information and notes are given on the facing page when necessary. (4L80-E) Transmission system tests, refer to (para. 2-35).

Fold-out page FO-12 may be left open for reference while testing.

TRANSMISSION SYSTEM (3L80)

DIAGNOSTIC FLOWCHART

START

KNOWN INFO
NOTHING

POSSIBLE PROBLEMS
FLUID
SHIFTER
MODULATOR
KICKDOWN SYSTEM
COOLING SYSTEM
TRANSMISSION

1
CHECK THE TRANSMISSION FLUID. IS IT OK ?

TEST OPTIONS
VISUAL - SEE NOTE AT RIGHT.

REASON FOR QUESTION
Transmission fluid level and appearance give a good indication of the system's condition.

NO → SEE NOTE AT RIGHT

YES ↓

KNOWN INFO
FLUID OK

POSSIBLE PROBLEMS
SHIFTER
MODULATOR
KICKDOWN SYSTEM
COOLING SYSTEM
TRANSMISSION

2
PERFORM THE ROAD TEST PROCEDURE AT RIGHT. DID THE VEHICLE PASS THE ROAD TEST?

TEST OPTIONS
PROCEDURE AT RIGHT.

REASON FOR QUESTION
Road testing the transmission is the easiest way to check the system.

NO → GO TO A, Page 2-404

YES ↓

KNOWN INFO
FLUID OK
BANDS & CLUTCHES OK
SHIFTER OK

POSSIBLE PROBLEMS
MODULATOR
COOLING SYSTEM
KICKDOWN SYSTEM
TRANSMISSION

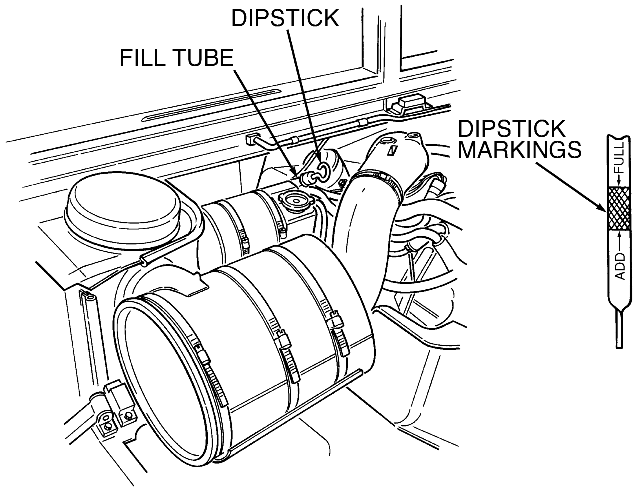
3
WITH THE VEHICLE COASTING IN 3RD GEAR, FLOOR THE ACCELERATOR. DOES THE TRANSMISSION DOWNSHIFT?

TEST OPTIONS
TRY IT. BE SURE NOT TO EXCEED ANY POSTED SPEED LIMITS.

REASON FOR QUESTION
You want to check out the kickdown system.

NO → GO TO B, Page 2-406

YES ↓ GO TO 4, Page 2-402



Procedure for checking transmission fluid

1. Start engine.
2. Hold down brake pedal and move transmission shift lever through all ranges including reverse. Leave the lever in each range for 2 seconds.
3. Engage parking brake and place shift lever in neutral. Check fluid level on dipstick.
4. Proper level is between FULL and ADD marks on dipstick.

NOTE

Check fluid for a burnt smell, grit, discoloration, air bubbles, or a milky appearance.

- Burnt smell, discoloration, or grit indicates worn or damaged internal components. Notify DS maintenance.
- Bubbles indicate an overfilled system or air leaks in the system. Drain the fluid and refill to proper level. Refer to (para 5-2).
- Milky appearance is due to water in the system. Change the fluid and filter.
- Check fill tube for indications of fluid being blown out. If fluid is being blown out, check vent line for obstructions, and refill transmission to proper level. Refer to (para 5-2).
- Transmission fluid coming out of dipstick filler tube indicates a restriction in the ventilation system. Check for clogged, melted, or crushed lines and/or fittings between transmission and atmosphere vent on air cleaner canister. Replace where needed. Refer to (para 5-16).

Road Test Procedure

1.Position transmission shift lever in “D” (drive) and accelerate vehicle from 0 mph. A 1-2 and 2-3 shift should occur at all throttle openings. Allow vehicle to coast down to about 0 mph and 3-2 and 2-1 shifts should occur.
2.Position transmission shift lever in “2” (low two) and accelerate vehicle from 0 mph. A 1-2 shift should occur at all throttle openings. No 2-3 shift can be obtained in this range. A 1-2 shift in 2 is somewhat firmer than in “D”. This is normal.
3.Position shift lever in “1” and accelerate the vehicle from 0 mph. No upshifts should occur in this range.
4.Position shift lever in “D” and with the vehicle speed at approximately 35 mph, close throttle and move lever to “2”. Transmission should downshift to 2nd gear. An increase in engine rpm and engine braking effect should be noticed.
5.Position shift lever “2” and with the vehicle speed at approximately 25 mph, close thethrottle and move lever to “1”. Transmission should downshift to 1st gear. An increase in engine RPM and engine braking effect should be noticed.
6. Position shift lever in “R” and check for reverse operation.
7. Hard shifting may be indicative of an underfilled or clogged system.

The kickdown system is used to shift the transmission to a lower gear under heavy acceleration. The system also disengages the engine cooling fan so as to allow maximum engine power to be used for moving the vehicle.

TRANSMISSION SYSTEM (3L80) — **DIAGNOSTIC FLOWCHART**

FROM 3, Page 2-400

4

KNOWN INFO
FLUID OK BANDS & CLUTCHES OK SHIFTER OK KICKDOWN OK

POSSIBLE PROBLEMS
MODULATOR COOLING

SHUT THE ENGINE OFF. DOES THE MODULATOR CABLE MOVE AS YOU STEP ON THE ACCELERATOR?

TEST OPTIONS

VISUAL INSPECTION.

REASON FOR QUESTION

The modulator is needed for telling the transmission when to shift.

NO → **REPLACE TRANSMISSION MODULATOR**

YES ↓

5

KNOWN INFO
FLUID OK BANDS & CLUTCHES OK SHIFTER OK KICKDOWN OK MODULATOR OK

POSSIBLE PROBLEMS
LEAKS COOLING

INSPECT THE TRANSMISSION SYSTEM FOR LEAKS. IS EVERYTHING OK?

TEST OPTIONS

VISUAL.

REASON FOR QUESTION

To see if anything is leaking

NO → **REPAIR OR REPLACE AS NECESSARY**

YES ↓

6

KNOWN INFO
EVERYTHING IS OK SO FAR

POSSIBLE PROBLEMS
INTERNAL TRANSMISSION PROBLEMS.

IF YOU STILL SUSPECT A PROBLEM, YOU CAN RUN THE PRESSURE TESTS AT THE RIGHT. DOES THE TRANSMISSION PASS THE PRESSURE TESTS?

TEST OPTIONS

1. SEE PROCEDURE AT RIGHT. USE STE/ICE-R TEST 50 AND THE BLUE TRANSDUCER. USE CONTROL FUNCTION 01 TO INTERLEAVE PRESSURE WITH RPM.
2. PRESSURE GAUGE.

REASON FOR QUESTION

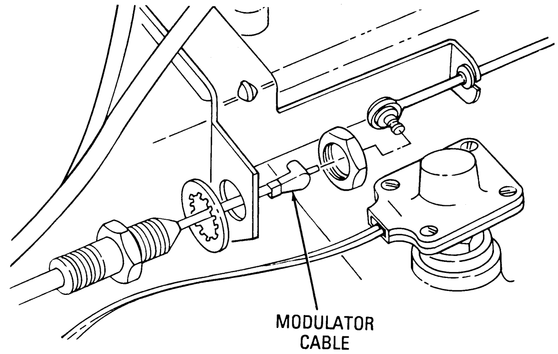
There may be a problem not previously discovered in the testing.

NO → **NOTIFY DS MAINTENANCE**

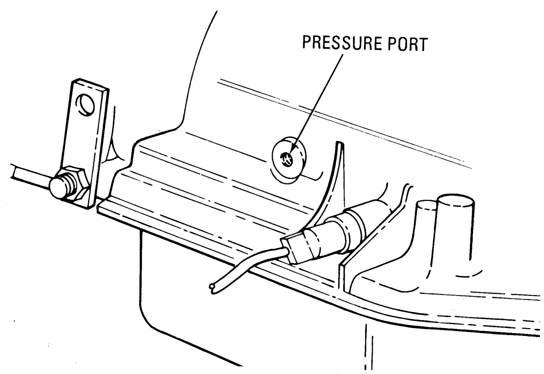
YES ↓

NO FAULTS

Replace transmission modulator, refer to (para. 5-14).



STE/ICE-R TEST #50 0 TO 1000 PSIG PRESSURE INTERLEAVED WITH RPM
1. Connect blue pressure transducer (1000 PSI) to system under test, and other end to a W4 cable. Make sure the system under test is not pressurized. 2. Dial 01 into VTM, and then 50 when prompted. 3. Perform offset test. 4. Start engine and VTM will display pressure interleaved with RPM.



Transmission oil pressure test

1. Remove plug from pressure port on left side of transmission.
2. Connect transducer to port using appropriate fittings.
3. Perform offset test.
4. Start engine and check for leaks at connections.
5. Bring engine to operating temperature.
6. Place shift lever in N and bring engine to 1000 RPM (STE/ICE-R test 10). Pressure should be 55-70 psi (379-483 kPa). If not notify DS Maintenance.
7. Apply service brakes and place shifter in D. Operate engine at 1000 RPM. Pressure should be 60-90 psi (414-621 kPa). If not, notify DS Maintenance.
8. Apply brakes and place lever in 2. With engine at 1000 RPM, pressure should be 135-160 psi (931- 1103 kPa). If not, notify DS Maintenance.
9. Apply brakes and place lever in 1. With engine at 1000 RPM, pressure should be 135-160 psi (931-1103 kPa). If not, notify DS Maintenance.
10. Apply brakes and place lever in R. With engine at 1000 RPM, pressure should be 95-150 psi (655-1034 kPa). If not, notify DS Maintenance.
11. Apply brakes and place lever in D. With engine idling, pressure should be 60-85 psi (414-586 kPa). If not, notify DS Maintenance.

NOTE

NEXT TEST MUST BE PERFORMED DURING A ROAD TEST OR WITH VEHICLE RAISED AND TIRES OFF THE GROUND. RECORD PRESSURE WITH THROTTLE CLOSED.

12. Place lever in D and take foot off brake. With engine at 2000 RPM, close throttle and read pressure between 1200 and 2000 RPM. Pressure should be 65-70 psi (448-485 kPa). If not, notify DS Maintenance.
13. Shut off engine, remove transducer and reinstall plug.

TRANSMISSION SYSTEM (3L80)

DIAGNOSTIC FLOWCHART

A
FROM 2,
Page 2-400

KNOWN INFO

TRANSMISSION FAILS ROAD TEST

POSSIBLE PROBLEMS

SHIFTER
TRANSMISSION

A1

DID THE VEHICLE MOVE AT ALL DURING THE ROAD TEST?

TEST OPTIONS

VISUAL.

REASON FOR QUESTION

The failure could be in the drive train or in the transmission if the vehicle doesn't move.

NO → RUN THE DRIVE TRAIN TESTS. RETURN TO A2.

YES ↓

KNOWN INFO

TRANSMISSION FAILS ROAD TEST
VEHICLE MOVES.

POSSIBLE PROBLEMS

SHIFTER
TRANSMISSION
MODULATOR

A2

WITH THE VEHICLE OFF, MOVE THE GEARSHIFT. IS THE SHIFTER WORKING PROPERLY?

TEST OPTIONS

VISUAL.

REASON FOR QUESTION

Make sure the shifter is connected to and moving the transmission linkages.

NO → ADJUST OR REPAIR AS NEEDED CONTINUE WITH A3.

YES ↓

KNOWN INFO

SHIFTER OK
FINAL DRIVE OK
TRANSMISSION FAILS ROAD TEST

POSSIBLE PROBLEMS

MODULATOR
TRANSMISSION

A3

WITH THE VEHICLE OFF, STEP ON THE THROTTLE. DOES THE MODULATOR CABLE MOVE AS YOU STEP ON THE THROTTLE?

TEST OPTIONS

VISUAL INSPECTION

REASON FOR QUESTION

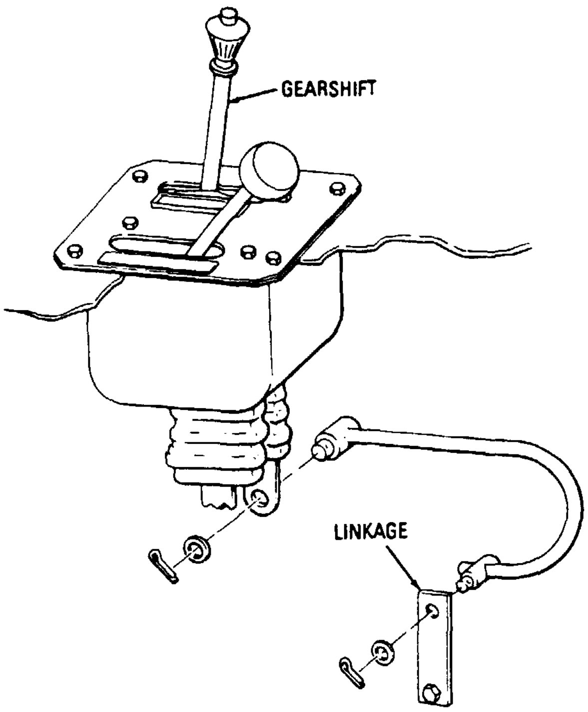
The modulator tells the transmission when to shift.

NO → NOTIFY DS MAINTENANCE

YES ↓

SEE NOTE AT RIGHT

If the drivetrain system checks out OK, the problem is either the transmission itself, the shifter or the modulator. The DRIVETRAIN tests are located in (para. 2-38) of this manual.



Make sure that the detents in the shifter correspond to the shift posittions shown on the plate. Have an assistant move the shifter and look to see that the linkage is moving at the transmission.

Linkage repair and adjustment procedures are shown in (para. 5-12).

Look for a modulator problem if fhe vehicle was not shifting, or wee not shifting as well as it should be.

NOTE

Run the BRAKES and DRIVETRAIN tests in this manual. If you don't find any faults, notify DS maintenance.

TRANSMISSION SYSTEM (3L80) DIAGNOSTIC FLOWCHART

B
FROM 3,
Page 2-400

B1

KNOWN INFO

KICKDOWN SYSTEM DOESN'T WORK

POSSIBLE PROBLEMS

TIME DELAY MODULE
KICKDOWN SWITCH
KICKDOWN SOLENOID
WIRING
TRANSMISSION

DISCONNECT THE TIME DELAY MODULE HARNESS. DOES THE KICKDOWN SYSTEM STILL NOT WORK?

TEST OPTIONS

FLOOR THE ACCELERATOR WITH THE VEHICLE IN THIRD GEAR. DO NOT EXCEED POSTED SPEED LIMITS.

REASON FOR QUESTION

A shorted time delay module could affect kickdown operation.

NO → GO TO THE COOLING SYSTEM TESTS, Page 2-155

YES ↓

B2

KNOWN INFO

KICKDOWN DOESN'T WORK
TIME DELAY MODULE OK

POSSIBLE PROBLEMS

KICKDOWN SWITCH
KICKDOWN SOLENOID
WIRING
TRANSMISSION

DISCONNECT WIRE 315C AT THE KICKDOWN SOLENOID. MEASURE THE RESISTANCE FROM THE SOLENOID TO THE TRANSMISSION CASE. IS THE RESISTANCEABOUT 65 OHMS?

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER.

REASON FOR QUESTION

To test the kickdown solenoid - this resistance measurement will tell you if the solenoid is ok

NO → NOTIFY DS MAINTENANCE

YES ↓

B3

KNOWN INFO

SOLENOID OK
TIME DELAY MODULE OK

POSSIBLE PROBLEMS

SWITCH
WIRING
TRANSMISSION

TURN THE ROTARY SWITCH TO "STOP". DISCONNECT WIRE 315B FROM THE KICKDOWN SWITCH AND 315C FROM THE SOLENOID. IS THERE CONTINUITY FROM WIRE 315B TO WIRE 315C?

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER.

REASON FOR QUESTION

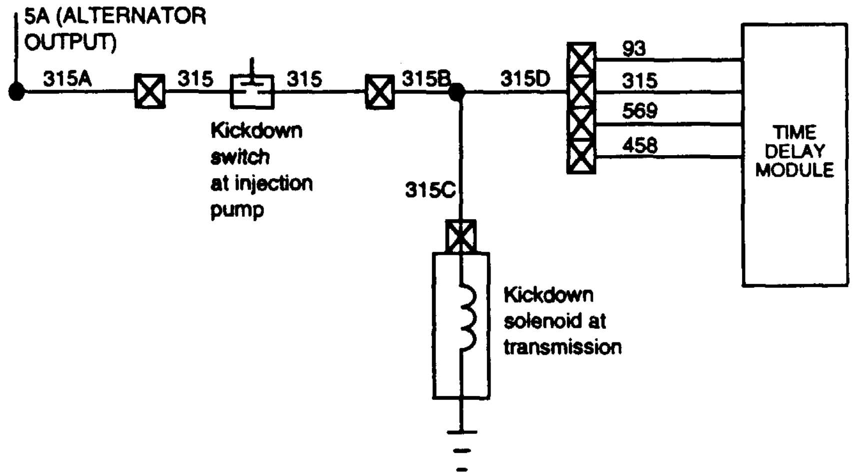
Check the wiring between the switch and the solenoid.

NO → REPAIR OR REPLACE WIRING

YES ↓

GO TO B4, Page 2-408

A NO answer here means the kickdown works with the time delay module disconnected.



0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the test points indicated in the question. RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

A measurement of zero or infinity means the solenoid is no good.

CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms. 2. Connect the RED and BLACK leads to the connections stated in the question. 3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

TRANSMISSION SYSTEM (3L80)

DIAGNOSTIC FLOWCHART

FROM B3, Page 2-406

KNOWN INFO
SOLENOID OK WIRING AFTER SWITCH OK TIME DELAY MODULE OK
POSSIBLE PROBLEMS
SWITCH WIRING BEFORE SWITCH TRANSMISSION ALTERNATOR

B4

DISCONNECT WIRE 315A FROM THE KICKDOWN SWITCH. IS THERE CONTINUITY FROM WIRE 5A AT THE ALTERNATOR TO WIRE 315A AT THE KICKDOWN SWITCH?

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER.

REASON FOR QUESTION

Test the wiring from the alternator to the switch.

NO → REPAIR OR REPLACE WIRING AS NEEDED

YES ↓

KNOWN INFO
SOLENOID OK WIRING OK TIME DELAY MODULE OK
POSSIBLE PROBLEMS
SWITCH TRANSMISSION ALTERNATOR

B5

IS THE KICKDOWN SWITCH FUNCTIONING PROPERLY?

TEST OPTIONS

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER.

REASON FOR QUESTION

Test out the kickdown switch.

NO → ADJUST OR REPLACE SWITCH

YES ↓

KNOWN INFO
SOLENOID OK WIRING OK SWITCH OK TIME DELAY MODULE OK
POSSIBLE PROBLEMS
NO VOLTAGE AT ALTERNATOR OUTPUT TRANSMISSION

B6

RECONNECT EVERYTHING. DISCONNECT WIRE 315A FROM THE KICKDOWN SWITCH. WITH THE ROTARY SWITCH IN RUN, IS THERE BATTERY VOLTAGE AT WIRE 315A?

TEST OPTIONS

1. STE/ICE-R TEST 89 (Page 2-750)
2. MULTIMETER.

REASON FOR QUESTION

Check for voltage input to the circuit.

NO → GO TO ALTERNATOR, Page 2-195

YES ↓

SEE NOTE AT RIGHT

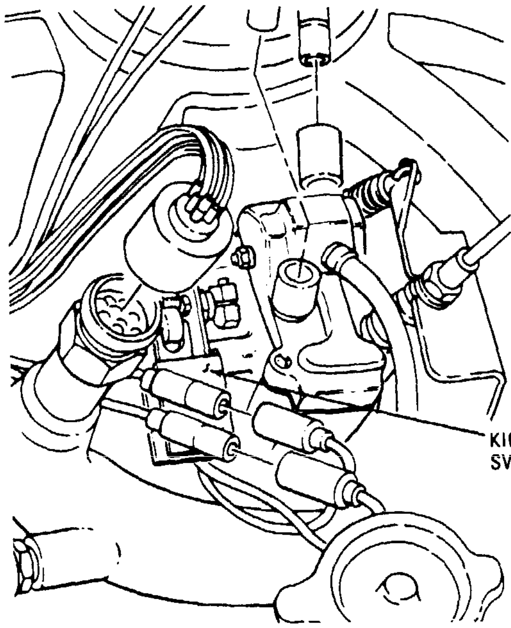
0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in the question. RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms. 2. Connect the RED and BLACK leads to the connections stated in the question. 3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

Repair or raplace of wiring, refer to (para 4-85).

There should be continuity when the injector pump is wide open, and an open circuit when it isn't. Check out both positions.

Adjust or replace kickdown switch, refer to (para 4-43).



NOTE

Recheck everything in the circuit. If you don't find anything wrong, notify DS maintenance. The problem is probably in the transmission itself.

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.

2-35. TRANSMISSION SYSTEM TESTS (4L80-E)

The 4L80-E Transmission system is equipped with a computer called the Transmission Control Module (TCM) (located left rear seat compartment; for M996A2 and M997A2 vehicles, located in the left exterior stowage compartment) which interprets, analyzes and records electronic signals form sensors and switches located on the engine, brake pedal, and transmission. The recorded codes stored in the TCM are known as TROUBLE CODES which are retrieved using the Diagnostic Switch Cable on the J2 connector of the TCM. The TCM can protect the transmission from damage by locking it in Second Gear, with maximum fluid pressure, until the problem has been corrected. The following procedures will detail diagnostic testing, troubleshooting and corrective action for any existing faults. These Transmission System tests may be run any time you think there is a transmission problem or if you were sent here by another test chain. This paragraph has a different kind of flow chart to guide you through testing because of the may problems that can occur. The most common problems are loose or corroded wiring connections. To troubleshoot the transmission, you will need a diagnostic switch cable, digital multimeter and a throttle position (TP) sensor test cable.

CAUTION

Do not disconnect battery without recording Trouble Codes. Failure to do so will result in loss of diagnostic test codes.

The diagnostic test codes (DTC) are transmitted from the TCM to transmission lamp located next to the shift lever. When Diagnostic Switch Cable is connected to the J2 connector, the system is placed in the diagnostic mode, which causes the transmission lamp to flash. The transmission lamp will flash once, pause, flash twice (meaning code 12) pause, flash once, pause, flash twice (code 12 again), and do this one more time for a total of three times, which means the system is operational.

NOTE

Diagnostic test code 63 will be set at all times.

For example if the TCM is sending the trouble code 74, the lamp will flash 12 three times, flash 63 three times, which is set all the time and is to be disregarded, flash code 7 and 4,7 and 4, 7 and 4 for code 74, and then 12, 12, 12, which ends the diagnostic check. These codes will repeat again, if not taken out of diagnostic mode.

The TCM J1 connector will be used to diagnose and troubleshoot wiring, sensor connectors, pins, solenoids, and brake switch, to insure all external problems are checked and corrected prior to TCM and transmission faults.

On the following pages you will find diagrams and charts of the major portions of the transmission circuits. These are designed to help you isolate a problem and correct it.

TRANSMISSION SYSTEM (4L80-E)

DIAGNOSTIC FLOWCHART

START

1

KNOWN INFO
NOTHING
POSSIBLE PROBLEMS
FLUID SHIFTER FAN CUT-OFF SWITCH TP SENSOR COOLING SYSTEM TRANSMISSION

CHECK THE TRANSMISSION FLUID. IS IT OK ?

TEST OPTIONS

VISUAL - SEE NOTE AT RIGHT.

REASON FOR QUESTION

Transmission fluid level and appearance give a good indication of the system's condition.

NO → SEE NOTE AT RIGHT

YES ↓

2

KNOWN INFO
FLUID OK
POSSIBLE PROBLEMS
SHIFTER FAN CUT-OFF SWITCH TP SENSOR COOLING SYSTEM TRANSMISSION

PERFORM THE ROAD TEST PROCEDURE AT RIGHT. DID THE VEHICLE PASS THE ROAD TEST?

TEST OPTIONS

PROCEDURE AT RIGHT.

REASON FOR QUESTION

Road testing the transmission is the easiest way to check the system.

NO → GO TO A1, Page 2-416

YES ↓

3

KNOWN INFO
FLUID OK BANDS & CLUTCHES OK SHIFTER OK
POSSIBLE PROBLEMS
FAN CUT-OFF SWITCH COOLING SYSTEM TP SENSOR TRANSMISSION

WITH THE VEHICLE COASTING IN 4TH GEAR, FLOOR THE ACCELERATOR. DOES THE TRANSMISSION DOWNSHIFT?

TEST OPTIONS

TRY IT. BE SURE NOT TO EXCEED ANY POSTED SPEED LIMITS.

REASON FOR QUESTION

You want to check out the fan cut-off switch.

NO → GO TO B1, Page 2-418

YES ↓

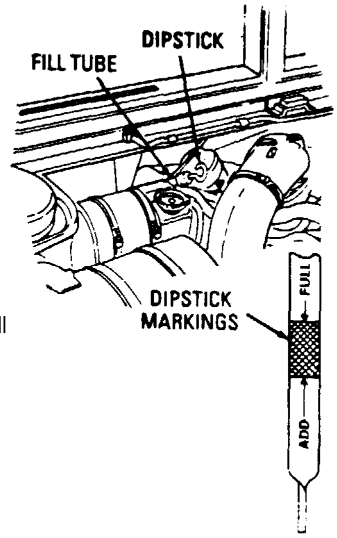
GO TO 4, Page 2-414

REFERENCE INFORMATION

TRANSMISSION SYSTEM (4L80-E)

<u>Procedure for checking transmission fluid</u>

1. Start engine
2. Hold down brake pedal and move transmission shift lever through all ranges including raverse. Leave the lever in each range for 2 seconds.
3. Engage parking brake and place shift lever in neutral. Check fluid level on dipstick.
4. Proper level is between FULL and ADD marks on dipstick.



NOTE

Check fluid for a burnt small, grit, discoloration, air bubbles, or a milky appearance.

- Burnt smell, discoloration, or grit indicates worn or damaged internal components. Notify DS maintenance
- Bubbles indicate an overfilled system or air leaks in the system. Drain the fluid and refill to proper level. Refer to (para 5-2).
- Milky appearance is due to water in the system. Change the fluid and filter.
- Check fill tube for indications of fluid being blown out. If fluid is being blown out, cheek vent line for obstructions, and refill transmission to proper level. Refer to (para. 5-2).

<u>**Road Test Procedure**</u>

1. Position shift lever in "Ⓓ" (overdrive) and accelerate vehicle from 0 mph. A 1-2, 2-3 and 3-4 shift should occur at all throttle openings. Allow vehicle to coast down to about 0 mph and 4-3, 3-2 and 2-1 shifts should occur.
2. Position transmission shift lever in "D" (drive) and accelerate vehicle from 0 mph. A 1-2 and 2-3 shift should occur at all throttle openings. Allow vehicle to coast down to about 0 mph and 3-2 and 2-1 shifts should occur.
3. Position transmission shift lever in "2" (low two) and accelerate vehicle from 0 mph. A 1-2 shift should occur at all throttle openings. No 2-3 shift can be obtained in this range. A 1-2 shift in 2 is somewhat firmer than in “D”. This is normal.
4. Position shift lever in "1" and accelerate the vehicle from 0 mph. No upshifts should occur in this range.
5. Position shift lever in "Ⓓ" and with the vehicle speed at approximately 45 mph, close throttle and move lever to "3". Transmission should downshift to 3rd gear. An increase in engine rpm and engine braking effect should be noticed.
6. Position shift lever in "D" and with the vehicle speed at approximately 35 mph, close throttle and move lever to "2". Transmission should downshift to 2nd gear. An increase in engine rpm and engine braking effect should be noticed.
7. Position shift lever "2" and with the vehicle speed at approximately 25 mph, close the throttle and move lever to "1". Transmission should downshift to 1st gear. An increase in engine RPM and engine braking effect should be noticed.
8. Position shift lever in "R" and check for reverse operation.
9. Hard shifting may be indicative of an underfilled or dogged system.

The fan cut off switch and TP sensor are used to shift the transmission to a lower gear under heavy acceleration. The system also disengages the engine cooling fan so as to allow maximum engine power to be used for moving the vehicle.

TRANSMISSION SYSTEM (4L80-E)

DIAGNOSTIC FLOWCHART

FROM 3, Page 2-412

KNOWN INFO

FLUID OK
BANDS & CLUTCHES OK
SHIFTER OK
TP SENSOR OK

POSSIBLE PROBLEMS

FAN CUT-OFF SWITCH
COOLING

4

SHUT THE ENGINE OFF. DOES THE FAN CUT-OFF SWITCH ROD MOVE AS YOU STEP ON THE ACCELERATOR?

TEST OPTIONS

VISUAL INSPECTION.

REASON FOR QUESTION

The fan cut-off switch is needed for telling the transmission when to shift.

NO → REPAIR OR REPLACE AS NECESSARY

YES ↓

KNOWN INFO

FLUID OK
BANDS & CLUTCHES OK
SHIFTER OK
TP SENSOR OK
FAN CUT-OFF SWITCH OK

POSSIBLE PROBLEMS

LEAKS
COOLING

5

INSPECT THE TRANSMISSION SYSTEM FOR LEAKS. IS EVERYTHING OK?

TEST OPTIONS

VISUAL.

REASON FOR QUESTION

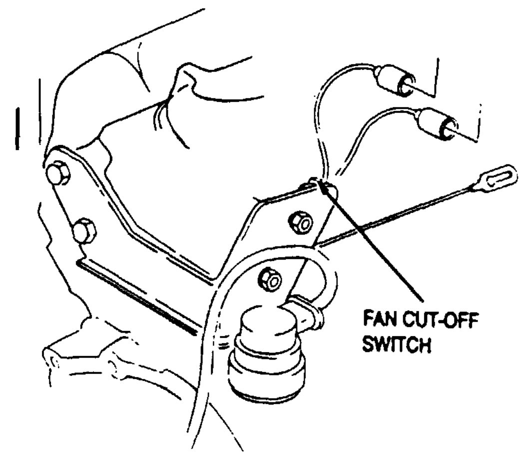
To see if anything is leaking

NO → REPAIR OR REPLACE AS NECESSARY

YES ↓

GO TO B, Page 2-418

Repair or replace fen cut-off switch, refer to (para 4-44).



TRANSMISSION SYSTEM (4L80-E)

DIAGNOSTIC FLOWCHART

A
FROM 2,
Page 2-412

KNOWN INFO

TRANSMISSION FAILS ROAD TEST

POSSIBLE PROBLEMS

SHIFTER
TRANSMISSION

A1

DID THE VEHICLE MOVE AT ALL DURING THE ROAD TEST?

TEST OPTIONS

VISUAL.

REASON FOR QUESTION

The failure could be in the drive train or in the transmission if the vehicle doesn't move.

NO → RUN THE DRIVE TRAIN TESTS. RETURN TO A2.

YES ↓

KNOWN INFO

TRANSMISSION FAILS ROAD TEST
VEHICLE MOVES

POSSIBLE PROBLEMS

SHIFTER
TRANSMISSION
FAN CUT-OFF SWITCH

A2

WITH THE VEHICLE OFF, MOVE THE GEARSHIFT. IS THE SHIFTER WORKING PROPERLY?

TEST OPTIONS

VISUAL.

REASON FOR QUESTION

Make sure the shifter is connected to and moving the transmission linkages.

NO → ADJUST OR REPAIR AS NEEDED CONTINUE WITH A3.

YES ↓

KNOWN INFO

SHIFTER OK
FINAL DRIVE OK
TRANSMISSION FAILS ROAD TEST

POSSIBLE PROBLEMS

FAN CUT-OFF SWITCH
TRANSMISSION

A3

WITH THE VEHICLE OFF, STEP ON THE THROTTLE. DOES THE FAN CUT OFF SWITCH ROD MOVE AS YOU STEP ON THE THROTTLE?

TEST OPTIONS

VISUAL INSPECTION

REASON FOR QUESTION

The fan cut-off switch tells the transmission when to shift.

NO → REPAIR OR REPLACE AS NECESSARY

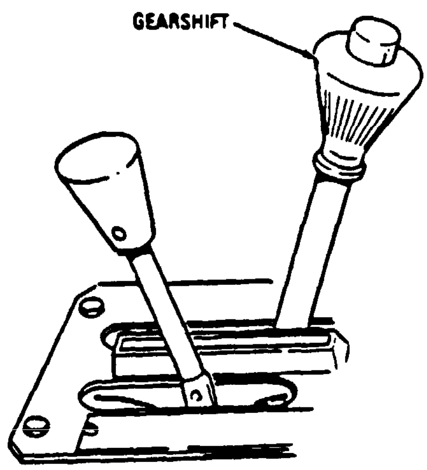
YES ↓

SEE NOTE AT RIGHT

If the drivetrain system checks out OK, the problem is either the transmission itself, the shifter or the modulator. The DRIVETRAIN tests are located in Paragraph 2-33 of this manual.

Make sure that the detents in the shifter correspond to the shift positions shown on the plate. Have an assistant move the shifter and look to see that the linkage is moving at the transmission.

Linkage repair and adjustment procedures are shown in Paragraph 5-13.



Look for a fan cut-off switch problem if the vehicle was not shifting, or was not shifting as well as it should be.

NOTE

Run the BRAKES and DRIVETRAIN tests in this manual. If you don't find any faults, notify DS maintenance.

TRANSMISSION SYSTEM (4L80-E) DIAGNOSTIC FLOWCHART

B
FROM 3,
Page 2-412

B1

KNOWN INFO
NO LEAKS
FLUID OK
SHIFTER OK

POSSIBLE PROBLEMS
TRANSMISSION

CONNECT DIAGNOSTIC SWITCH CABLE TO THE TRANSMISSION CONTROL MODULE (TCM) J2 CONNECTOR. DISCONNECT GLOWPLUG CONTROLLER. TURN VEHICLE IGNITION TO THE RUN POSITION. DOES TRANSMISSION CHECK LAMP STEADILY ILLUMINATE?

TEST OPTIONS
Visual inspection

REASON FOR QUESTION
Transmisssion check lamp may be faulty.

YES → GO TO STEP B3

NO ↓

B2

KNOWN INFO
NO LEAKS
FLUID OK
SHIFTER OK

POSSIBLE PROBLEMS
TRANSMISSION

CHECK VOLTAGE ON TRANSMISSION CHECK LAMP LEADS. DID YOU GET:
>12 V ON PIN 1 (CKT 6578)?
0 V ON PIN 2 (CKT 657A)?

TEST OPTIONS
MULTIMETER

REASON FOR QUESTION
Transmission check lamp or harness leads may be faulty.

NO → REPLACE TRANS. CHECK LAMP (Para. 4-39)

YES ↓

B3

KNOWN INFO
NO LEAKS
FLUID OK
SHIFTER OK

POSSIBLE PROBLEMS
TRANSMISSION

POSITION SWITCH TO ON. DOES THE TRANSMISSION CHECK LAMP FLASH THREE CODE 12s INDICATING THE TCM IS CAPABLE OF DIAGNOSTICS?

TEST OPTIONS
Procedure at right

REASON FOR QUESTION
Transmission check lamp must flash three code 12s indicating the TCM is capable at diagnostics.

NO → REFER TO CHART AT RIGHT

YES ↓

GO TO B4, Page 2-420

Will Not Display DTC Code 12, or Check Transmission "ON" Steady

(NOTE: TRANSMISSION CHECK LAMP IS THE LAMP NEXT TO THE SHIFT LEVER MARKED TRANS-ONLY.)

IGNITION ON, ENGINE OFF AND GLOWPLUG CONTROLLER DISCONNECTED (PARA 4-29).

REMOVE DIAGNOSTIC SWITCH CABLE. INSTALL JUMPER CABLE BETWEEN PINS A AND E of J2 ON TCM. ASS'Y.

NO DTC 12

DTC 12 FLASHES

CHECK DIAGNOSTIC CABLE FOR OPEN AND REPAIR.

READ CODES AND REMOVE JUMPER.

- IGNITION OFF.
- DISCONNECT TCM CONNECTOR.
- IGNITION ON.

TRANS CHECK LAMP OFF.

TRANS CHECK LAMP ON.

REPAIR SHORT TO GROUND IN CKT 657A. (REFER TO PARA. 4-85).

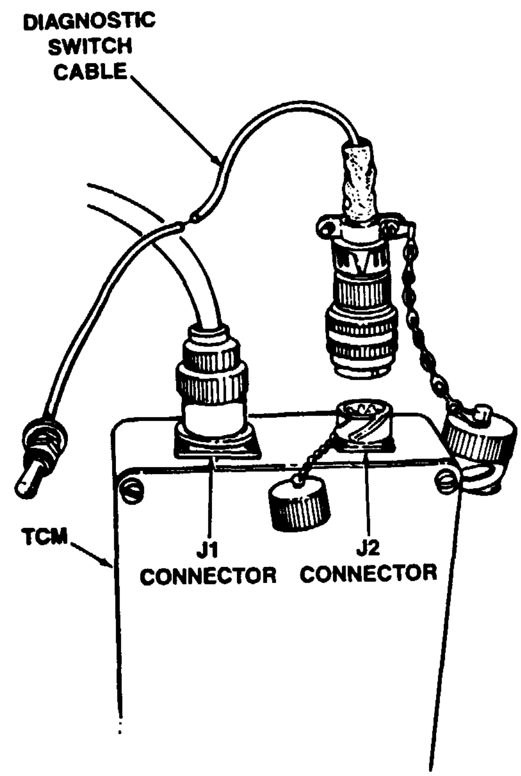
- IGNITION OFF.
- DIAGNOSTIC TERMINAL NOT GROUNDED.
- RECONNECT TCM CONNECTOR.
- IGNITION ON AND ENGINE OFF.
- PROBE PIN E ON J2 TO GROUND.

NO DTC 12

DTC 12 FLASHES

REPLACE DEFECTIVE TCM. (REFER TO PARA 4-42).

OPEN CKT PIN A J2. REPLACE TCM. (REFER TO PARA 4-42).



NOTE: AFTER TROUBLESHOOTING, RECONNECT GLOWPLUG CONTROLLER. VEHICLE WILL HAVE TO BE OPERATED IN ORDER FOR TCM TO RECEIVE TROUBLE CODES. AFTER REPAIRS, CHECK TRANS LAMP OPERATION.

TRANSMISSION SYSTEM (4L80-E)

DIAGNOSTIC FLOWCHART

FROM B3, Page 2-418

KNOWN INFO
NO LEAKS FLUID OK SHIFTER OK
POSSIBLE PROBLEMS
TRANSMISSION

B4

FOLLOWING THE CODE 12 DISPLAYS, EACH STORED CODE WILL BE FLASHED THREE TIMES IN NUMERIC ORDER FROM LOWEST TO HIGHEST. WHEN ALL CODES HAVE BEEN DISPLAYED, THREE CODE 12s WILL FLASH AGAIN. TURN THE SWITCH OFF IF YOU DO NOT WISH TO REPEAT THE SEQUENCE.

B5

RECORD THE CODES AND REFER TO THE J1 CABLE DIAGNOSTICS CHART ON PAGES 2-428 THROUGH 2-443 AND COMPLETE THE DIAGNOSTICS. REFER TO PAGE 2-421 FOR DESCRIPTION OF TROUBLE CODES.

B6

IF CODE 51 SHOWS, REPLACE TCM. REFER TO PARA. 4-42.

END OF TESTING

REFERENCE INFORMATION

TRANSMISSION SYSTEM (4L80-E)

The following chart will help you find the code you need. The J1 cable diagnostics checks (page 2-428) must be performed. Always correct the lower code number first. If code 51 shows up, replace TCM (para. 4-42), operate vehicle, and recheck for trouble codes.

TROUBLE CODE	CIRCUIT	PAGE NO.
21	Throttle Position High	2-422
22	Throttle Position Low	2-422
24	Transmission Output Speed Sensor (TOSS)	2-422
28	Transmission Range Pressure Switch	2-422
37	Torque Converter Clutch (TCC) Brake Switch Stuck “ON”	2-422
38	TCC Brake Switch Stuck “OFF”	2-422
39	TCC Stuck “OFF”	2-423
51	Transmission Control Module (TCM) Bad	2-423
52	System Voltage High Long	2-423
53	System Voltage High	2-423
58	Transmission Temperature High	2-423
59	Transmission Temperature Low	2-423
68	Transmission Component Slipping	2-424
69	Torque Converter Clutch (TCC) Stuck “ON”	2-424
71	Engine Speed Sensor Circuit Low	2-424
73	Pressure Control Solenoid (PCS) Current	2-424
74	Transmission Input Speed Sensor (TISS) Circuit	2-425
75	System Voltage Low	2-425
79	Transmission Fluid Overtemp	2-425
81	2-3 Shift Solenoid Circuit Fault	2-425
82	1-2 Shift Solenoid Circuit Fault	2-426
83	TCC Solenoid (PWM) Circuit Fault	2-426
85	Undefined Ratio	2-426
86	Low Ratio	2-427
87	High Ratio	2-427

DTC 21/22
Throttle Position (TP) Sensor Circuit High/ Throttle Position Sensor Circuit Low

Circuit Description:

The TP sensor contains a resistor strip with one end connected to a 5-volt supply and the other to ground. The signal is connected to a movable contact within the TP sensor. As the accelerator pedal is applied, and the throttle shaft rotates, the voltage signal will increase from approximately 0.5 to 4.5 volts.

DTC 21 Will Set When:

- Engine is operating.
- TP sensor signal voltage is greater than 4.9 voits.
- Conditions are met for one second.

DTC 22 Will Set When:

- Engine is operating.
- TP sensor signal voltage is less than 0.2 volt.
- Conditions are met for one second.

DTC 24
Output Speed Sensor Signal

Circuit Decription:

The Output Speed sensor is a magnetic induction type sensor. Gear teeth pressed onto the output shaft induce an alternating voltage into the sensor.

DTC 24 Will Set When:

- Not in P/N.
- CKT voltage is constant.
- Engine speed is greater than 3000 rpm.
- Output speed is less than 200 rpm.
- TP is between 10% and 100%.
- All conditions are met for 3 seconds.

DTC 28
Transmission Range (TR) Pressure Switch Assembly (PSA) Fault

Circuit Description:

The Transmission Range (TR) switch assembly consists of five normally open pressure switches mounted on the valve body. The TCM supplies battery voltage to each range signal. BY grounding one or more of these circuits through various combinations of the pressure switches, the TCM assembly detects what transmission range has been selected by the vehicle operator. When the transmission electrical connector is disconnected, the ground potential for the three range signals to the TCM will be removed and D2 gear will be indicated

DTC 28 Will Set When:

- Range signals "A" and "C" are both zero volts.
- Condition is met for 2 seconds.

DTC 37/38
Torque Converter Clutch (TCC) Brake Switch Stuck "ON"/ TCC Brake Switch Stuck "OFF"

Circuit Description:

The normally closed brake switch supplies a B+ signal volt when the TCC brake switch is closed (brake pedal not applied).

DTC 37 Will Set When:

CKT 810B is open.

- Then vehicle speed is between 5 mph (8 kph) and 20 mph (32 kph) for greater than 6 seconds.
- Then vehicle speed is greater than 20 mph (32 kph) for greater than 6 seconds.
- For a complete total of seven times.

DTC 38 Will Set When:

TCC brake switch feed CKT 810B has constant voltage.

- Vehicle speed is greater than 20 mph (32 kph) for greater than 6 seconds.
- Then vehicle speed is between 5 mph (8 kph) and 20 mph (32 kph) for greater than 6 seconds.
- For a complete total of seven times.

DTC 39
TCC Stuck "OFF"

Circuit Description:

The TCM commands the TCC PWM solenoid "ON" by modulating TCC signal fluid acting on the converter clutch shift valve. Then TCC fluid applies the torque converter clutch.

DTC 39 Will Set When:

- TCC is commanded "ON."
- TCC slip speed greater than 65 RPM.
- Trans range in D3 or D4.
- 2nd or 3rd gear.
- All conditions are met for two seconds.

DTC 51
Faulty or Incorrect

Circuit description:

The transmission Control Module (TCM) , an on board computer, receives and processes input signals from sensors on the vehicle and delivers output signals to the solenoids located on the control valve assembly. These solenoids control the transmission operating pressures, upshift and downshift patterns and torque converter clutch (TCC) operation.

DTC 51 Will Set When:

- There is an uncorrectable computational error, or an input is in error intermittently.

DTC 52/53
System Voltage High Long/
System Voltage High

Circuit Description:

Ignition voltage is supplied to the control module to indicate the status of the ignition switch. Battery voltage is supplied to the control module to, in part, maintain memory of learned functions and parameters.

DTC 52 Will Set When:

- The ignition is "ON" and the system voltage is greater than 16 volts.
- Condition is met for 109 minutes.

DTC 53 Will Set When:

- The ignition is "ON" and the system voltage is greater than 19.5 volts.
- Condition is met for 2 minutes.

DTC 58
Transmission Fluid Temperature (TFT) Sensor Circuit Low
(High Temperature Indicated)

Circuit Description:

The TFT sensor is a thermistor that controls the signal voltage to the TCM, The TCM supplies a 5-volt reference signal to the sensor on TWC pin "L." When the transmission fluid is cold, the sensor resistance is high and the TCM will sense high signal voltage.

As the transmission fluid temperature warms to normal transmission operating temperature 212°F (100°C), the sensor resistance becomes less and the voltage decreases to approximately 1.5 to 2.0 volts. With DTC 79 also set, check the transmission cooling system.

DTC 58 Will Set When:

- Signal voltage indicates TFT greater than 304°F (151°C).
- Condition is met for 1 second.

DTC 59
Transmission Fluid Temperature (TFT) Sensor Circuit High (Low Temperature Indicated)

Circuit Description:

The TFT sensor is a thermistor that controls the signal voltage to the TCM. The TCM supplies a 5-volt reference signal to the sensor on TWC Pin "L." When the transmission fluid is cold, the sensor resistance is high and the TCM will sense high signal voltage.

As the transmission fluid temperature warms to normal transmission operating temperature 212°F (100°C), the sensor resistance becomes less and the voltage decreases to approximately 1.5 to 2.0 volts.

DTC 59 Will Set When:

- Signal voltage indicates TFT less than -34°F (-37°C).
- Condition is met for 1 second.

DTC 68
Transmission Component Slipping

Circuit Description:

The TCM monitors the difference in engine Speed and input Speed.

DTC 68 Will Set When:

- TCC slip speed greater than 200 RPM.
- Fourth gear is indicated.
- TCC is locked.
- Not in park/neutral.
- All conditions are met for 2 seconds.

- Trans range switch indicates D3 or D4.
- Commanded gear indicates 2nd or 3rd gear.
- All conditions are met for 2 seconds.

DTC 69
Torque Converter Clutch (TCC) Stuck "ON"

Circuit Description:

The TCM commands the TCC PWM solenoid "ON" by modulating TCC signal fluid acting on the converter clutch shift vaIve. Then TCC fluid applies the torque converter clutch.

DTC 69 Will Set When:

- TCC slip speed RPM indicates between -5 and +10 RPM.
- TCC solenoid is commanded "OFF."
- TP sensor signal is greater than 25%.

DTC 71
Engine Speed, Sensor Circuit Low

Circuit Description:

The camshaft position sensor (CPS) detects the rotational speed of the camshaft. As the camshaft rotates, an AC signal is generated in the circuit. This signal provides the input to determine engine speed for use in various calculations including TCC slip speed and overdrive ratio.

DTC 71 Will Set When:

- Engine speed less than 50 rpm
- Transmission range indicates, R, D4, D3, or D1.
- Conditions are met for 2 seconds.

DTC 73
Pressure Control Solenoid (PCS) Circuit Current Error (Force Motor Circuit)

Circuit Description:

The pressure control solenoid is a TCM-controlled device used to regulate transmission line pressure. The TCM compares TP voltage, engine rpm and other inputs to determine the appropriate line pressure of a given load. The TCM will regulate the pressure by applying a varying amperage to the pressure control solenoid. The applied amperage can vary from 0.1 to 1.1 amp. The TCM then monitors the amperage at the return line.

DTC 73 Will Set When:

- The return amperage varies greater than 0.16 amps from the commanded amperage.
- All conditions are met for 1 second.

DTC 74
Transmission Input Speed Sensor (TISS) Circuit

Circuit Description:

The TISS sensor consists of a permanent magnet surrounded by a coil of wire. As the forward clutch housing rotates, an AC voltage is induced in the circuit. The signal voltage and frequency vary directly with the forward clutch rotational speed.

DTC 74 Will Set When"

- Trans range not in park or neutral.
- Engine speed greater than 300 rpm.
- Trans output speed greater than 200 rpm.
- Trans input speed less than 50 rpm.
- All conditions are met for 2 seconds.

DTC 75
System Voltage Low

Circuit Description:

Ignition voltage is supplied to the control module to indicate the status of the ignition switch. Battery voltage is supplied to the control module to, in part, maintain memory of learned functions and parameters.

DTC 75 Will Set When:

- The ignition is "ON."
- Ignition feed voltage to the control module is less than the graduated scale of:
  - -40°F (-40°C) = 7.3 volts.
  - 194°F (-90°C) = 10.3 volts.
  - 302°F (-150°C) = 11.7 volts.
- Engine speed greater than 1000 rpm.
- All conditions are met for 4 seconds.

DTC 79
Transmission Fluid Overtemp

Circuit Description:

The Transmission Fluid Temperature (TFT) sensor is a thermistor that controls the signal voltage to the TCM. The TCM supplies a 5-volt reference signal to the sensor on CKT 923A. When the transmission fluid is cold, the sensor resistance is high and the TCM will sense high signal voltage.

As the transmission fluid temperature warms to normal transmission operating temperature 212°F (100°C), the sensor resistance becomes less and the voltage decreases to approximately 1.5 to 2.0 volts.

DTC 79 Will Set When:

- Trans fluid temp greater than 295°F (146°C).
- All conditions are met for 30 minutes.

DTC 81
2-3 Shift Solenoid Circuit Fault

Circuit Description:

Ignition voltage is supplied directly to the 2-3 shift solenoid. The TCM controls the solenoid by providing the ground path through CKT 315A to TCM.

DTC 81 Will Set When:

- The TCM commands the solenoid "ON" and voltage remains high.
- The TCM commands the solenoid "OFF" and voltage remains low.
- All conditions are met for 2 seconds.

DTC 82
1-2 Shift Solenoid Fault

Circuit Description:

Ignition voltage is supplied directly to the 1-2 shift solenoid. The TCM controls the solenoid by providing the ground path through CKT 237A to TCM.

DTC 82 Will Set When:

- The TCM commands the solenoid "ON" and voltage remains high.
- The TCM commands the solenoid "OFF" and voltage remains low.
- All conditions are met for 2 seconds.

DTC 83
TCC Solenoid (PWM) Circuit Fault

Circuit Description:

The control module supplies a ground through an internal Quad-Driver Module (QDM) allowing current to flow through the solenoid coil according to the duty cycle (percentage of "ON" and "OFF" time). This current flow through the solenoid coil creates a magnetic field that magnetizes the solenoid core. The magnetized core attracts the check-ball to seat against spring pressure. This blocks the exhaust for the TCC signal fluid and allows 2-3 drive fluid to feed the TCC signal circuit. The TCC signal fluid pressure acts on the TCC regulator valve to regulate line pressure and to apply fluid pressure to the TCC shift valve. When the TCC shift valve is in the "apply" position, regulated apply fluid pressure is directed through the TCC valve to apply the torque converter clutch.

DTC 83 Will Set When:

- The TCM commands the solenoid "ON" and voltage remains high.
- The TCM commands the solenoid "OFF" and voltage remains low.
- AU conditions are met for 2 seconds.

DTC 85
Undefined Ratio Error

Circuit Description:

The control module calculates ratio based on the transmission input speed and output speed sensor reading. The control module compares the known transmission ratio to the calculated ratio for the particular gear range selected.

DTC 85 Will Set When:

- TP is greater than 25%.
- Not in park neutral, or 4th gear.
- Engine speed is greater than 300 rpm.
- Vehicle speed is greater than 7 mph (11 kph).

COMMANDED GEAR	IF CALCULATED RATIO IS:	
	LESS THAN	MORE THAN
1st	2.38	2.63
2nd	1.43	1.58
3rd	0.95	1.05
REV	1.97	2.17

- All conditions are met for 2 seconds.

DTC 86
Low Ratio Error

Circuit Description:

The control module calculates ratio based on the transmission input speed and output speed sensor readings. The control module compares the known transmission ratio to the calculated ratio for the particular gear range selected.

DTC 86 Will Set When:

- Not in park, reverse, or neutral.
- Engine speed greater than 300 rpm.
- TP greater than 25%.
- Vehicle speed is greater than 7 mph (11 kph).
- Trans gear ratio is less than 1.06 in first or second gear.
- All conditions are met for 2 seconds.

DTC 87
High Ratio Error

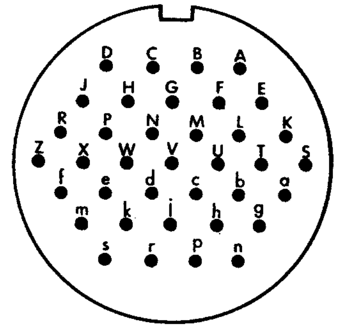
Circuit Description:

The control module calculates ratio based on the transmission input speed and output speed sensor readings. The control module compares the known transmission ratio to the calculated ratio for the particular gear range selected.

DTC 87 Will Set When:

- TP greater than 25%.
- Not in park, reverse, or neutral.
- Engine speed greater than 300 rpm.
- Vehicle speed greater than 7 mph (11 kph).
- Transmission temperature is greater than 68°F (20°C).
- All conditions are met for 2 seconds.

TRANSMISSION SYSTEM (4L80-E) **DIAGNOSTIC FLOWCHART**



J1

NOTE

- The following diagnostics will help isolate and repair problem circuits, wires, pins, connectors, sensors, circuit breakers, and solenoids.
- For repair of all wiring, refer to para. 4-85.
- Check connector pins before inserting probes.

J1 CABLE DIAGNOSTICS CHART

J1 Voltage Measurements With Ignition ON, Engine OFF, and Glow Plug Controller Disconnected. Refer to para 4-29.

CKT NOM.	CKT #	PIN	TO	PIN	EXP READ		
IGN PWR	291D	j		a or b	12VDC	No	Go to pg 2-430
Battery Pos	537D	Z		a or b	12VDC	No	Go to pg 2-431
Trans Lp	657A	U*		a or b	LED Lights	No	Go to pg 2-432
Brake Sw	810B	W		a or b	12V (Brake OFF)	No	Go to pg 2-433
Brake Sw	810B	W		a or b	O (Brake ON)	No	Go to pg 2-433

* Jumper wire from U to a or b.

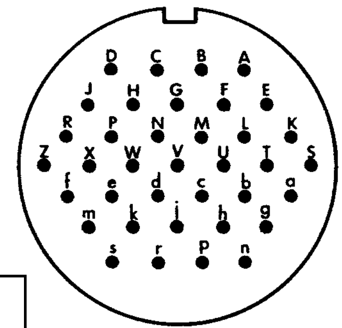
Reconnect Glow Plug Controller; refer to para 4-29. J1 Voltage Measurement With Ignition ON, Engine ON, and Transmission in PARK.

CKT NOM.	CKT #	PIN	TO	PIN	EXP READ		
Engine RPM	349A	h		c or p	0.3 Volts min @ idle		Go to pg 2-434
Press SW A	765A	A		a or b	Open wire	No	Go to pg 2-442
Press SW B	763A	B		a or b	0 to 1 ohms	No	Go to pg 2-442
Press SW C	764A	C		a or b	Open wire	No	Go to pg 2-442

DIAGNOSTIC FLOWCHART **TRANSMISSION SYSTEM (4L80-E)**

NOTE

Check connector pins before inserting probes.



J1 CABLE DIAGNOSTICS CHART (Cont'd)

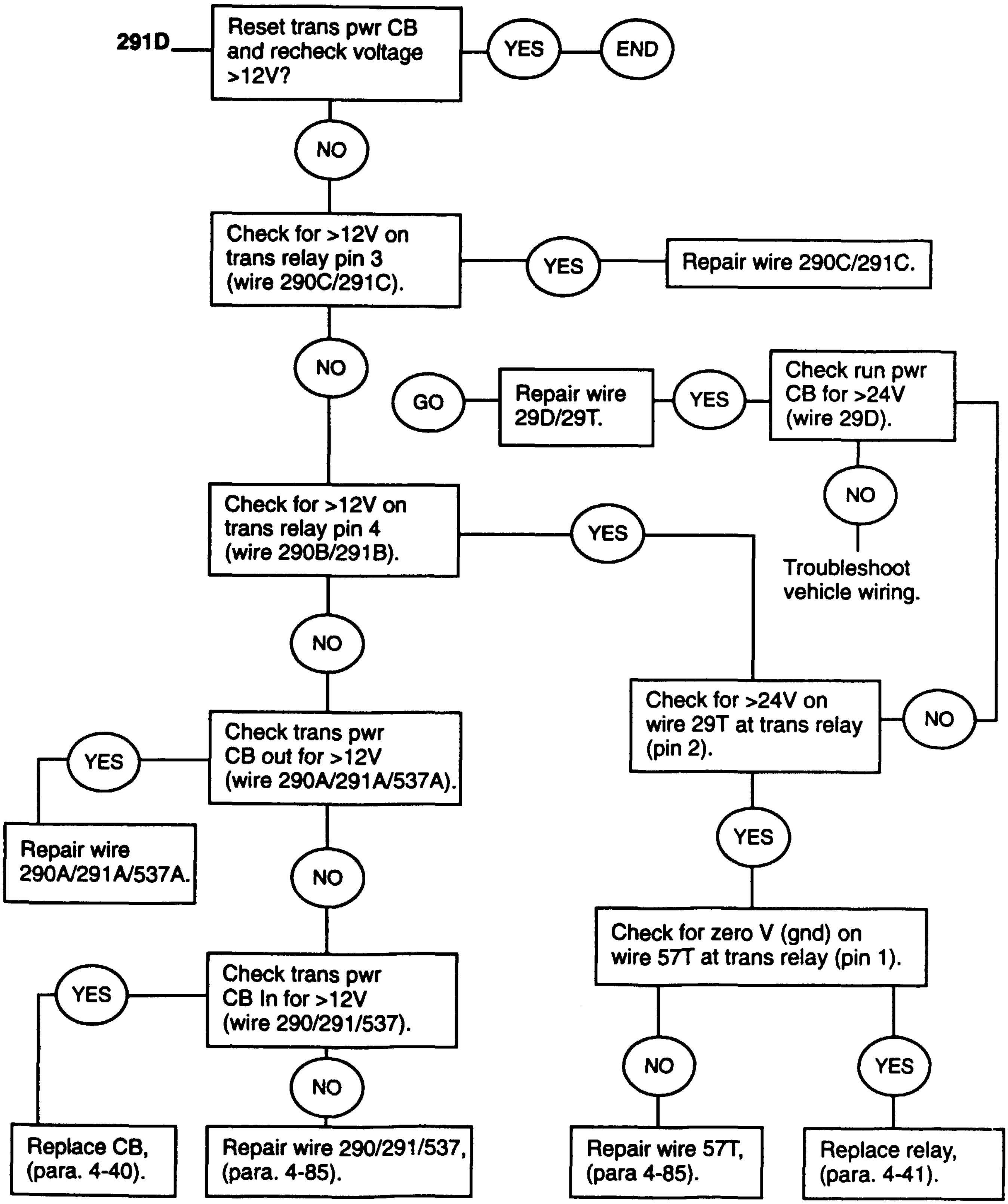
J1 Resistance Measurements With Ignition OFF

CKT NOM.	CKT #	PIN	TO	PIN	EXP READ	
Battery Neg	599A	a		Shunt	O ohms	No → Go to pg 2-431
Battery Neg	599B	b		Shunt	O ohms	No → Go to pg 2-431
TPS	355A	s		c or p	~ 1 to 2 Kohms	No → Go to pg 2-435
TPS	350A	d		c or p	4 to 6 Kohms	No → Go to pg 2-435
TISS	495A 496A	m		n	1 to 2 Kohms	No → Go to pg 2-436
TOSS	497A 498A	S		R	1 to 2 Kohms	No → Go to pg 2-437
TCC SOL	924A	X		j	~ 8 to 12 ohms	No → Go to pg 2-438
SHIFT SOL A	237A	E		j	~18 to 24 ohms	No → Go to pg 2-439
SHIFT SOL B	375A	D		j	~18 to 24 ohms	No → Go to pg 2-440
FORCE MTR	264A 265A	g		k	3.5 to 5.2 ohms	No → Go to pg 2-441
Trans Temp Sensor	923A	e		c or p	40 ohm to 5 Kohm (High Temp → Low Resist.)	No → Go to pg 2-443

Upon completion of J1 cable diagnostics, operate the vehicle and recheck for codes to insure codes have cleared. If codes have not cleared, refer to DS Maintenance.

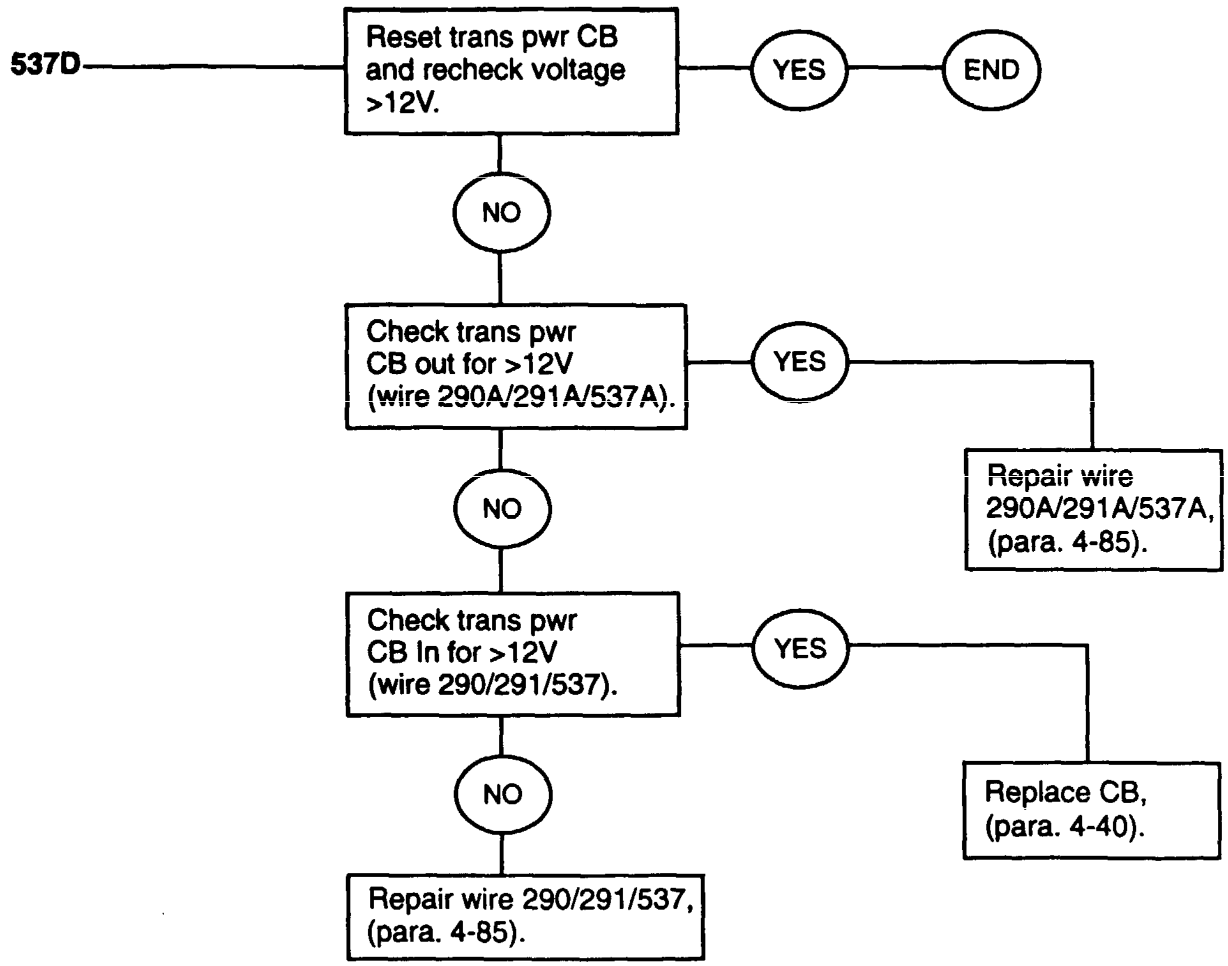
TRANSMISSION SYSTEM (4L80-E) **DIAGNOSTIC FLOWCHART**

IGN POWER CIRCUIT

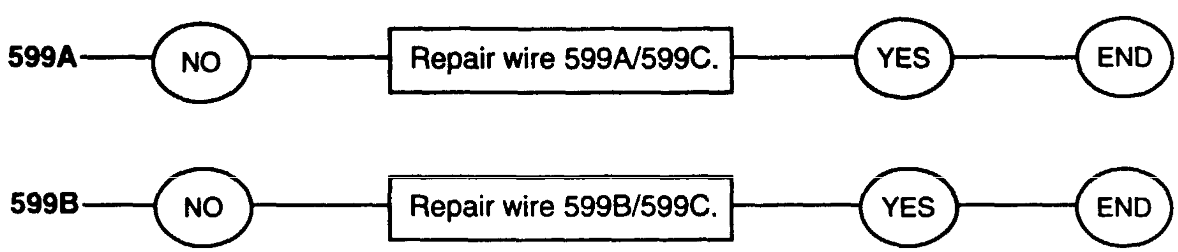


DIAGNOSTIC FLOWCHART **TRANSMISSION SYSTEM (4L80-E)**

BATTERY CIRCUIT



VEHICLE GROUND CIRCUIT



TRANSMISSION SYSTEM (4L80-E) **DIAGNOSTIC FLOWCHART**

TRANSMISSION LIGHT CIRCUIT

657A

Check for >12V on pin 1 (wire 657B) of harness connector at trans check lamp.

NO

Check pin j of J1 (wire 291D) for >12V.

NO

Follow diagnostic procedure for pin j of J1 to obtain >12V on wire 291D.

Go to page 2-428.

YES

Repair wire 657B, (para. 4-85).

YES

Check for continuity on wire 657A from J1 pin U to pin 2 of harness connector at trans check lamp.

NO

Repair wire 657A, (para. 4-85).

YES

Replace transfer case check lamp, (para. 4-38).

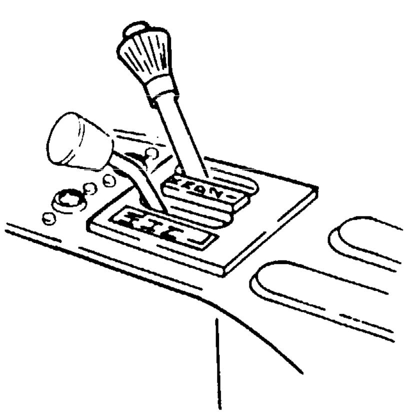
Does transfer case check lamp light?

NO

Faulty TCM ground replace TCM, (para. 4-42).

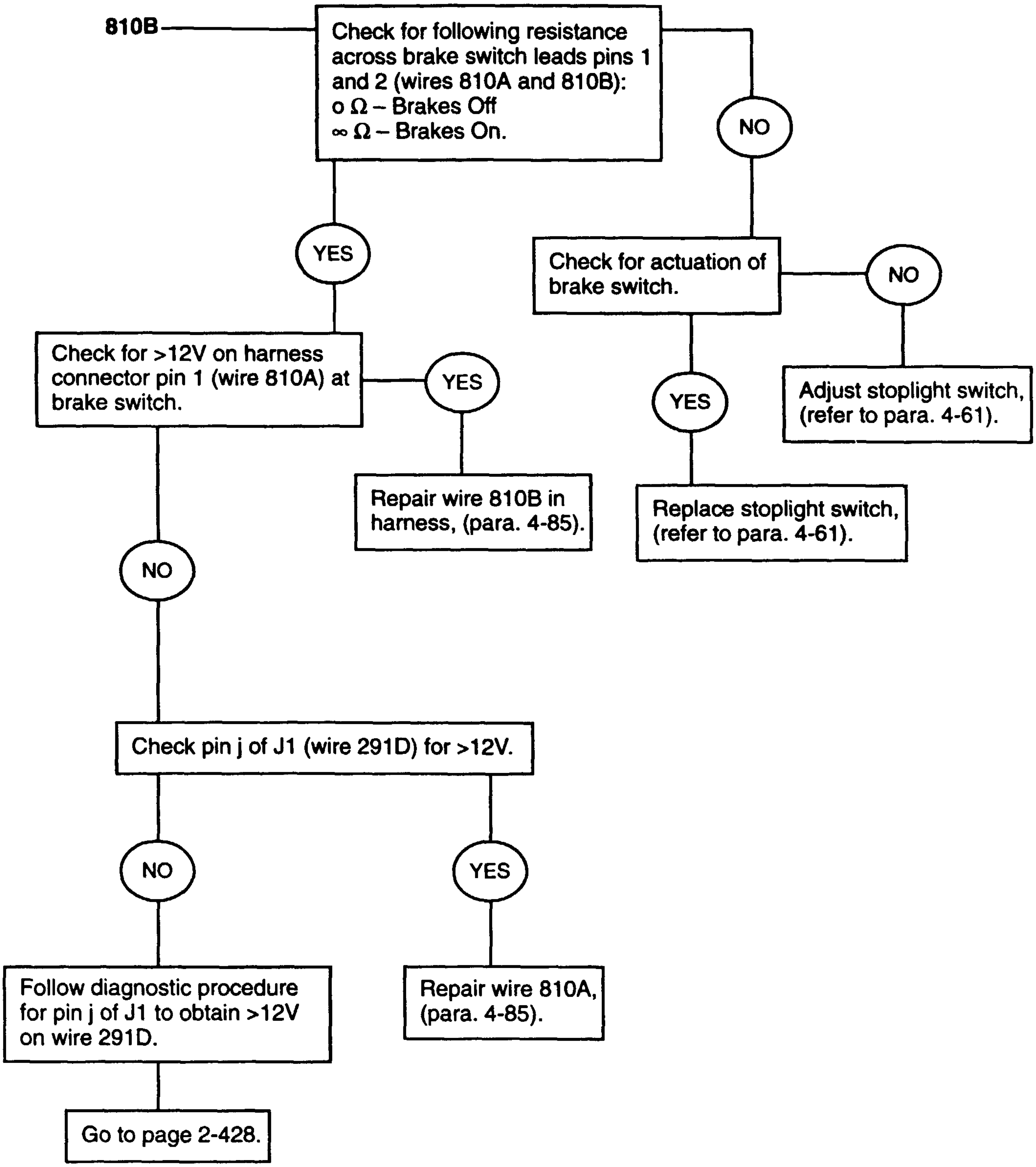
YES

Go to page 2-429.



DIAGNOSTIC FLOWCHART **TRANSMISSION SYSTEM (4L80-E)**

BRAKE SWITCH CIRCUIT



TRANSMISSION SYSTEM (4L80-E) **DIAGNOSTIC FLOWCHART**

ENGINE RPM SENSOR

349A — Check resistance across pins 1 and 2 of engine rpm sensor (located on engine front cover) leads 1 to 2 kohms.

YES

Check for continuity from pin h wire 349A of J1 to pin 1 wire 349B and check for continuity from P wire 359B of J1 to 2 wire 359J on engine harness connector to rpm sensor.

YES

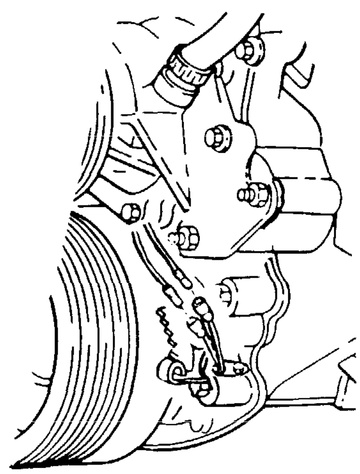
Replace engine rpm sensor, (para. 4-33).

NO

Repair wire 349A/349B, and/or wire 359B/359J, (para. 4-85).

NO

Replace engine rpm sensor, (para. 4-33).



DIAGNOSTIC FLOWCHART

TRANSMISSION SYSTEM (4L80-E)

THROTTLE POSITION SENSOR CIRCUIT

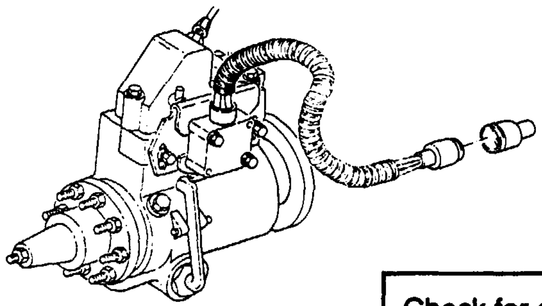
355A

Check for continuity from pin s wire 355A of J1 to pin B wire 355B of engine harness connector to TPS.

NO

Repair wire 355A, (para. 4-85).

YES



Check for continuity from pin c wire 359A of J1 to pin C wire 359H of engine harness connector to TPS.

NO

Repair wire 359A/359G, (para. 4-85).

YES

350A

Check for continuity from pin d wire 350A of J1 to pin A wire 350C of engine harness connector to TPS.

NO

Repair wire 350A/350C, (para. 4-85).

YES

YES

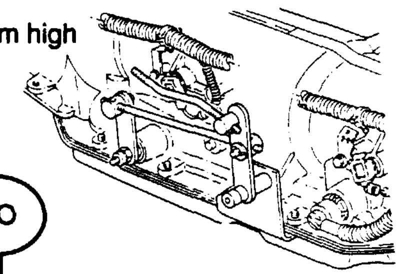
Vehicle wiring is ok. Proceed to the TPS adjustment procedure in para. 4-45 to determine whether the TPS or the adjustment is faulty.

TRANSMISSION SYSTEM (4L80-E) **DIAGNOSTIC FLOWCHART**

TRANSMISSION INPUT SPEED SENSOR (TISS) CIRCUIT

NOTE

If reading from J1 diagnostics chart is greater than 2, perform high resistance - less than 1 perform low resistance.



HIGH RESISTANCE

495A
496A

Check transmission input speed sensor connector and pins for continuity.

NO → Repair pin(s) or connector, (para. 4-85).

YES ↓

Check continuity of wire 495A on J1 pin m to transmission input speed connector pin a, and check continuity of wire 496A on J1 pin n to transmission input speed connector pin b.

NO → Repair wire 495A, and/or wire 496A, (para. 4-85).

YES ↓

Check continuity of transmission input speed sensor and pins A and B (TISS) 1 Kohm to 2 Kohms Ω.

NO → Replace TISS, (para. 4-46).

END

LOW RESISTANCE

Disconnect TISS and check continuity between pins M and N at J1.

YES → Repair wire 495A/496A, (para. 4-85).

NO ↓

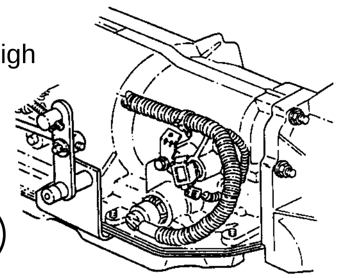
Replace TISS, (para. 4-46). → END

DIAGNOSTIC FLOWCHART **TRANSMISSION SYSTEM (4L80-E)**

TRANSMISSION OUTPUT SPEED
SENSOR (TOSS) CIRCUIT

NOTE

If reading from J1 diagnostics chart is greater than 2, perform high resistance - less than 1 perform low resistance.



HIGH RESISTANCE

497A
498A

Check transmission output speed sensor connector and pins for continuity.

NO → Repair pin(s) or connector, (para. 4-85)

YES ↓

Disconnect and check continuity of wire 495A on J1 pin S to transmission output speed connector pin A, and check continuity of wire 498A on J1 pin R to transmission output speed connector pin B.

NO → Repair wire 497A, and/or wire 498A, (para. 4-85).

YES ↓

Check continuity of transmission output speed sensor and pins A and B (TOSS) 1 Kohm to 2 Kohms Ω.

NO → Replace TOSS, (para. 4-46).

END

LOW RESISTANCE

Disconnect TOSS and check continuity between pins M and N at J1.

YES → Repair wire 497A/498A, (para. 4-85).

NO ↓

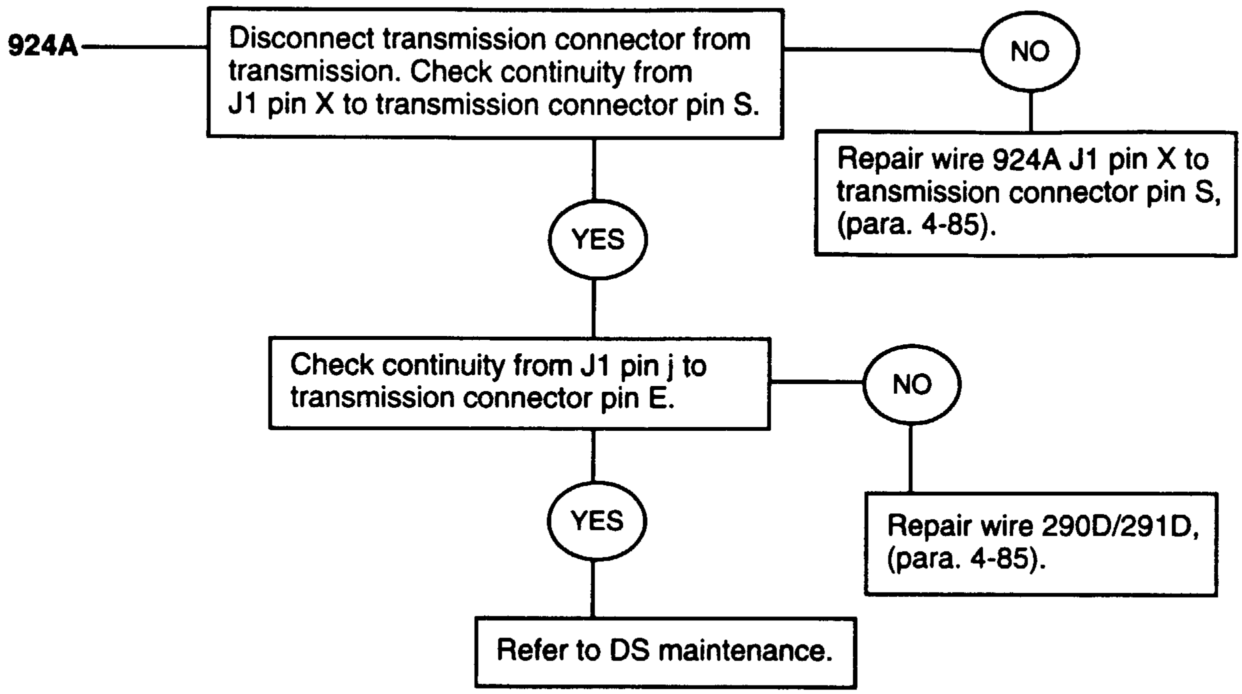
Replace TOSS, (para. 4-46). → END

TRANSMISSION SYSTEM (4L80-E)

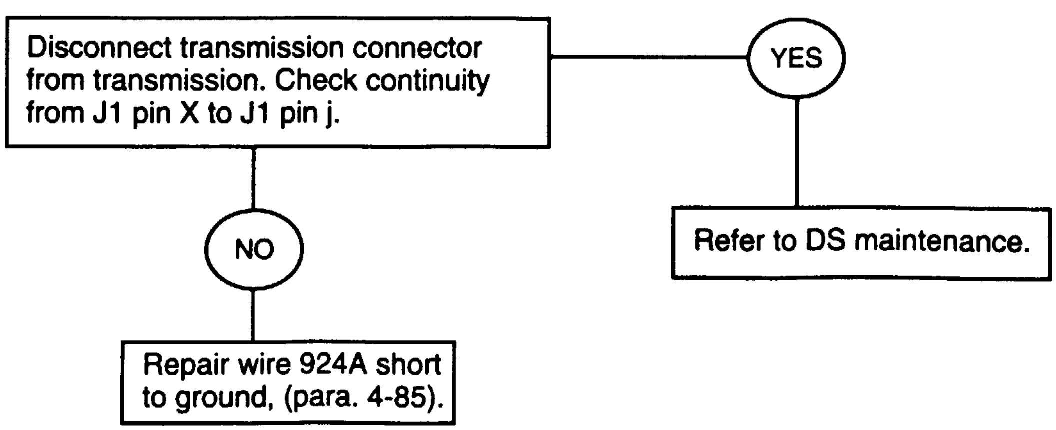
DIAGNOSTIC FLOWCHART

TORQUE CONVERTER CLUTCH SOLENOID CIRCUIT

HIGH RESISTANCE



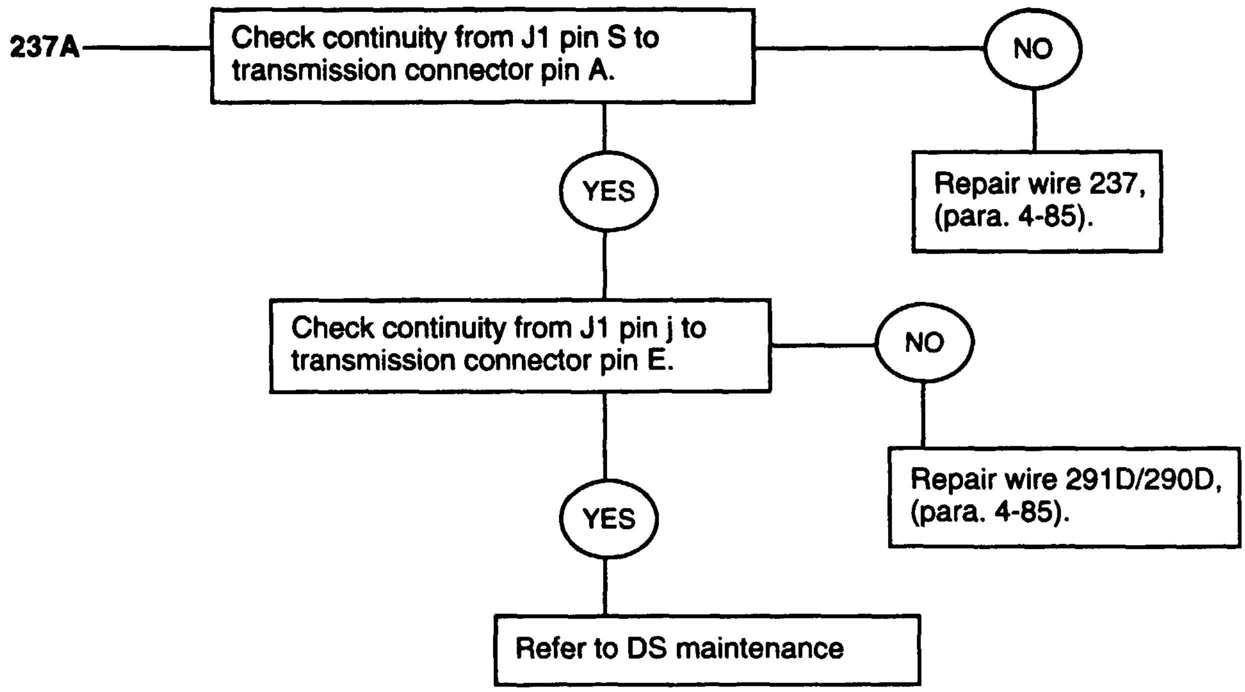
LOW RESISTANCE



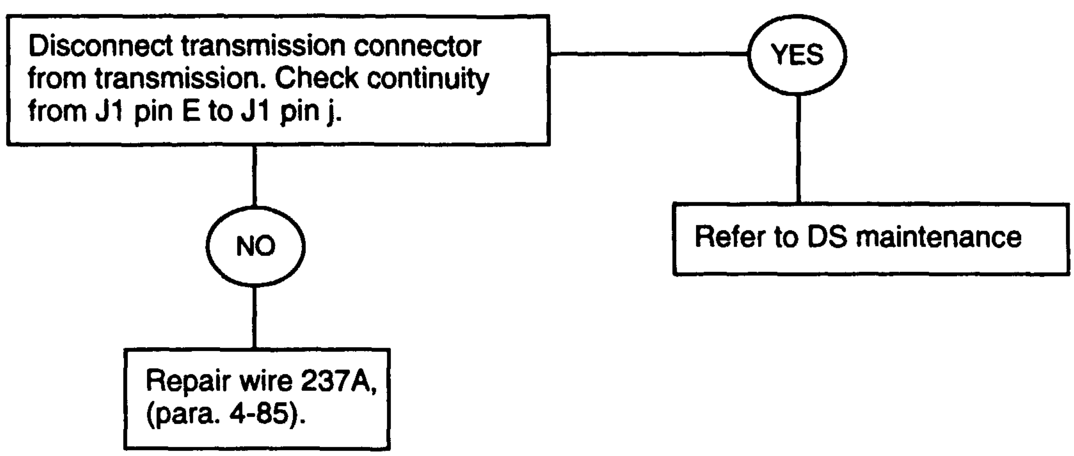
DIAGNOSTIC FLOWCHART **TRANSMISSION SYSTEM (4L80-E)**

1-2 SHIFT SOLENOID CIRCUIT SHIFT SOLENOID A

HIGH RESISTANCE



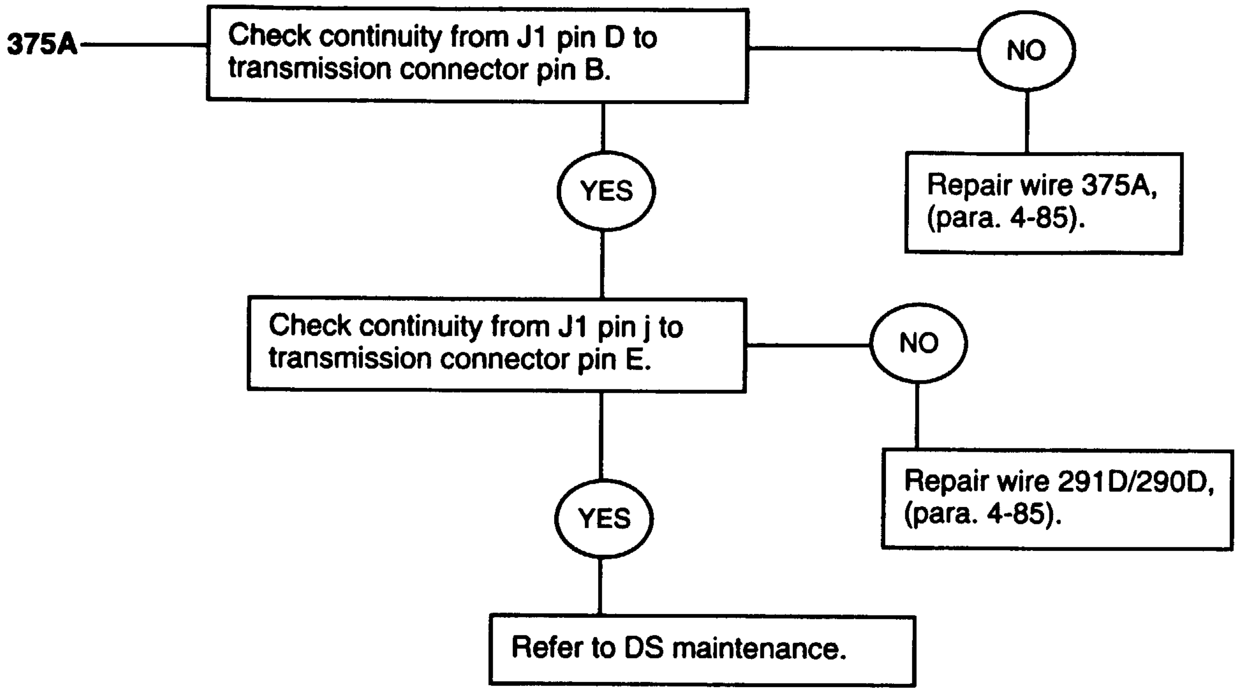
LOW RESISTANCE



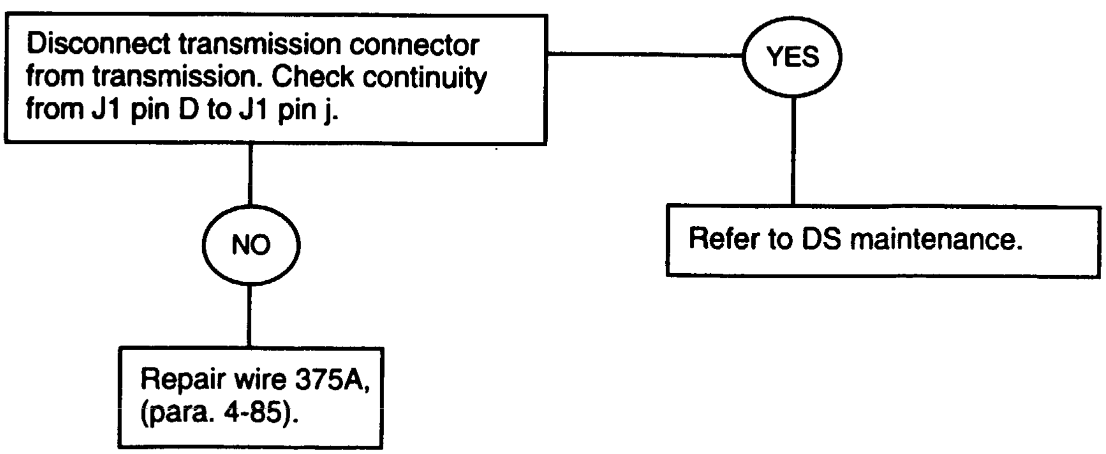
TRANSMISSION SYSTEM (4L80-E) **DIAGNOSTIC FLOWCHART**

2-3 SHIFT SOLENOID CIRCUIT SHIFT SOLENOID B

HIGH RESISTANCE



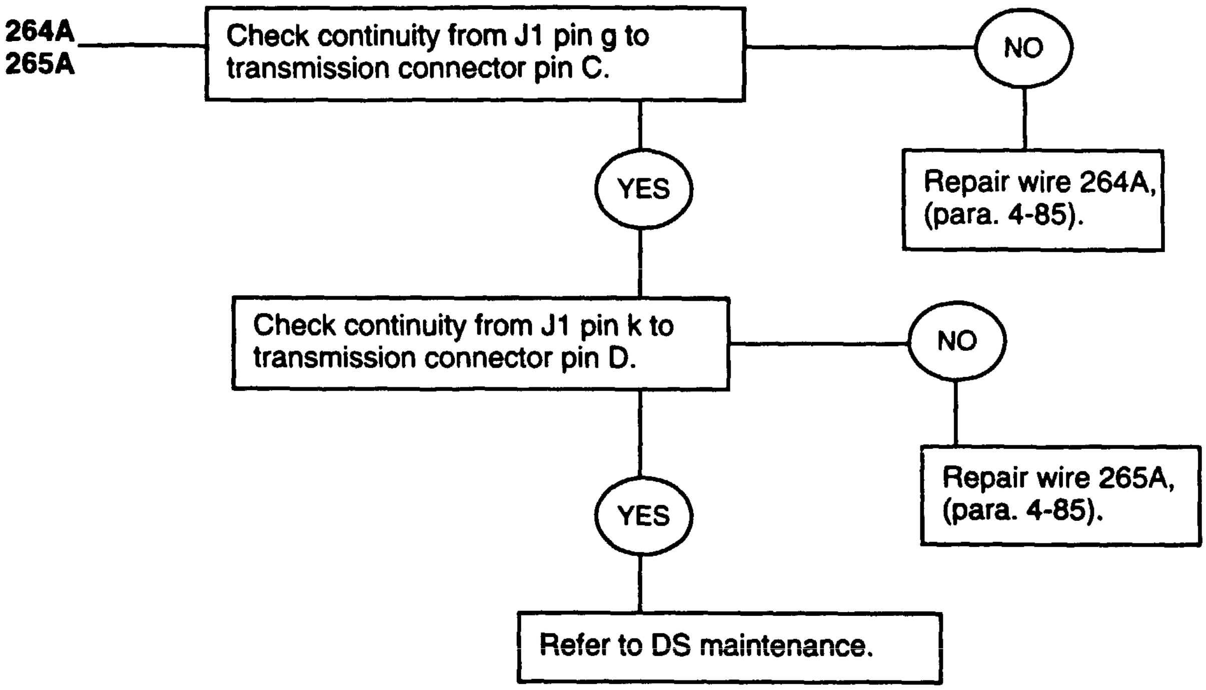
LOW RESISTANCE



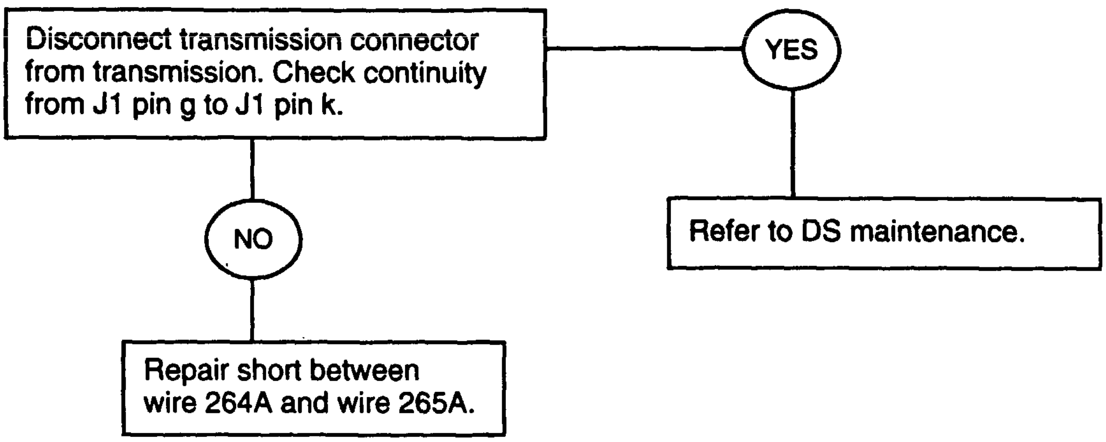
DIAGNOSTIC FLOWCHART **TRANSMISSION SYSTEM (4L80-E)**

PRESSURE CONTROL SOLENOID CIRCUIT
FORCE MOTOR HIGH

HIGH RESISTANCE



LOW RESISTANCE



TRANSMISSION SYSTEM (4L80-E) **DIAGNOSTIC FLOWCHART**

TRANSMISSION RANGE PRESSURE SWITCH, CIRCUIT PRESSURE SWITCH A

765A — Disconnect the transmission connector from transmission. Check continuity from J1 pin A to chassis ground at shunt.

- NO — Repair short to ground in wire 765A, (para. 4-85).
- YES — Refer to DS maintenance.

TRANSMISSION RANGE PRESSURE SWITCH, CIRCUIT PRESSURE SWITCH B

763A — Disconnect the transmission connector from transmission. Check continuity from J1 pin B to chassis ground at shunt.

- NO — Repair short to ground in wire 763A, (para. 4-85).
- YES — Refer to DS maintenance.

TRANSMISSION RANGE PRESSURE SWITCH, CIRCUIT PRESSURE SWITCH C

764A — Disconnect the transmission connector from transmission. Check continuity from J1 pin C to chassis ground at shunt.

- NO — Repair short to ground in wire 764A, (para. 4-85).
- YES — Refer to DS maintenance.

DIAGNOSTIC FLOWCHART

TRANSMISSION SYSTEM (4L80-E)

TRANSMISSION TEMPERATURE SENSOR

The transmission temperature sensor is a thermistor. The resistance decreases as the temperature increases at 68°F (20°C) the resistance should be from 2980 to 4020 ohms, at 248°F (120°C) the resistance should be 90 to 111 ohms.

RESISTANCE TOO LOW

923A

Disconnect transmission connector from transmission. Check continuity from J1 pin e to J1 pin c.

NO

Repair short from wire 923A to wire 359A/B/C/D, (para. 4-85).

YES

Check continuity from J1 pin e to chassis ground.

NO

Repair wire 923A, (para. 4-85).

YES

Refer to DS maintenance.

RESISTANCE TOO HIGH

Disconnect transmission connector from transmission. Check continuity from J1 pin e to transmission connector pin L.

NO

Repair short from wire 923A, (para. 4-85).

YES

Check continuity from J1 pin c to transmission connector pin M.

NO

Repair wire 359A/B/C/D, (para. 4-85).

YES

Refer to DS maintenance.

2-36. BRAKE SYSTEM TESTS

These Brake System tests may be run any time you think you have a braking problem or if you were sent here by another test chain. Just follow the path, answering the questions. Additional information and notes are given on the facing page when necessary.

Fold-out page FO-13 may be left open for reference while testing.

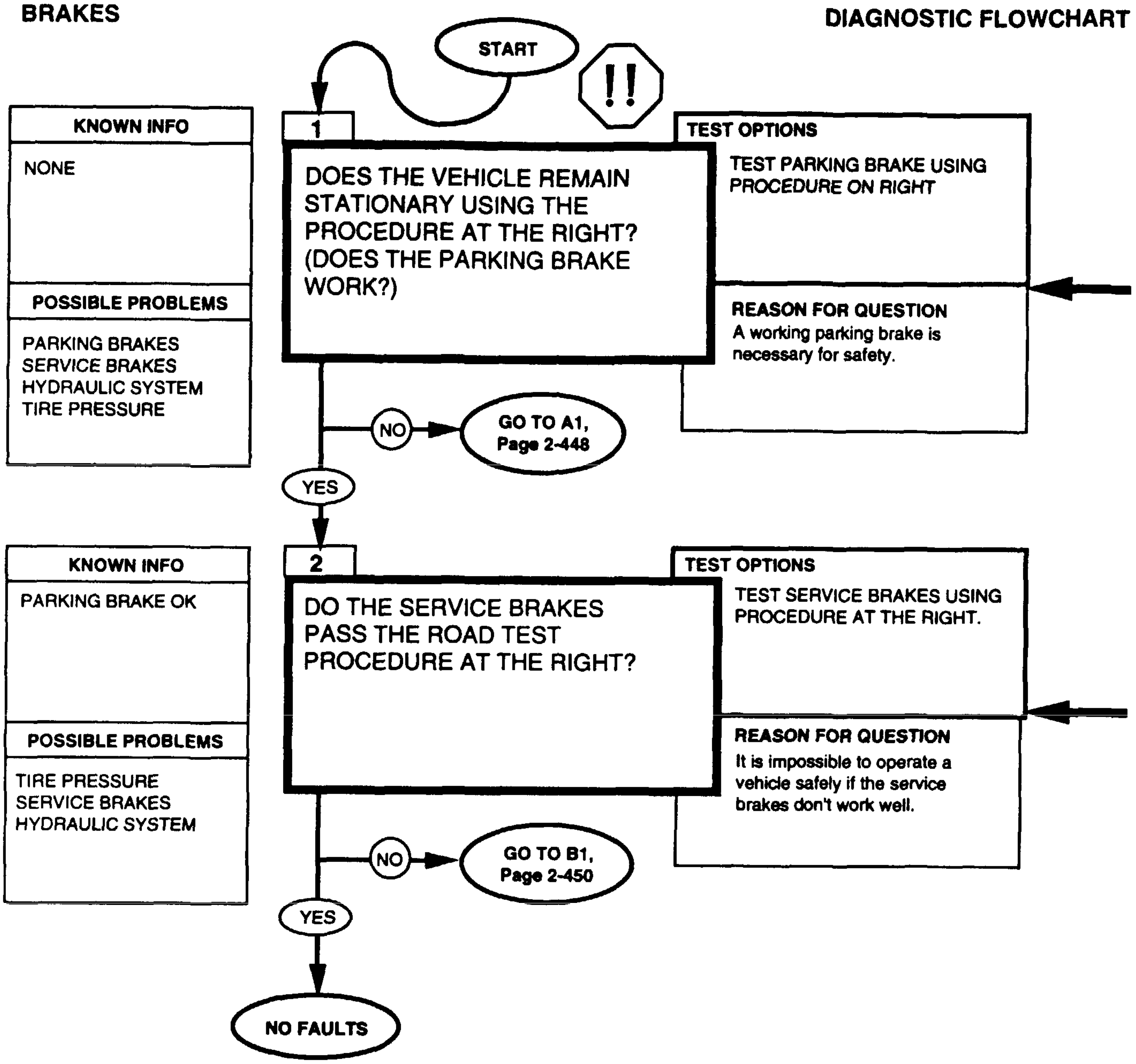
NOTE

- The brake lights and the parking brake warning lamp are not diagnosed here. If you are having trouble with these parts, and you are sure the brakes are OK, go to Instruments, Page 2-319, for the warning lamp, or Lights, Page 2-389, for the brake lights.

- When parking brake handle is pulled, the parking brake is applied to the left and right rear service brake rotors.

BRAKES

DIAGNOSTIC FLOWCHART



WARNING

Make sure the area is clear of personnel and obstacles prior to performing this test. Failure to do so may result in serious injury.

PARKING BRAKE TEST PROCEDURE:

1. Depress service brake pedal and start engine.
2. Place transmission shift lever in D (drive) and transfer case shift lever in H (high).
3. Apply parking brake. Slowly let up on service brake pedal. Vehicle should remain stationary.

SERVICE BRAKE ROAD TEST PROCEDURE:

1. On an open, smooth, flat surface, accelerate to a steady, reasonable, safe speed (below posted limits).
2. Apply pressure on the brake pedal and bring the vehicle to a stop.
3. Repeat this procedure several times, applying a different brake pedal pressure each time. Look for the following symptoms, which may indicate a problem with the service brakes:
   1) Spongy or pulsating brake pedal,
   2) Incomplete brake pedal return,
   3) Excessive pull to one side,
   4) Unusually long braking distance,
   5) Front wheels lock-up before rear wheels,
   6) Brake warning light comes on while braking, and
   7) A squealing, grinding, or chattering noise while braking.

BRAKES **DIAGNOSTIC FLOWCHART**

A FROM 1, Page 2-446

A1

HAVE YOU TRIED ADJUSTING THE PARKING BRAKE?

KNOWN INFO

PARKING BRAKE INOPERATIVE

POSSIBLE PROBLEMS

PADS
CALIPER
ROTOR
CABLE
BRAKE LEVER

TEST OPTIONS

SEE TEST PROCEDURE AT RIGHT.

REASON FOR QUESTION

Parking brake may not be broken, it may just need adjustment.

NO → TRY ADJUSTING THE PARKING BRAKE

YES ↓

A2

ARE THE PARKING BRAKE PADS, CALIPER, ROTOR, AND CABLE IN GOOD WORKING ORDER?

KNOWN INFO

PARKING BRAKE INOPERATIVE

POSSIBLE PROBLEMS

PADS
CALIPER
ROTOR
CABLE
BRAKE LEVER

TEST OPTIONS

VISUAL INSPECTION.

REASON FOR QUESTION

If there is a problem with any one of these components, the parking brake will not work properly.

NO → REPLACE/ REPAIR BAD COMPONENTS

YES ↓

A3

IS THE PARKING BRAKE SHIFTING LINKAGE IN GOOD WORKING ORDER?

KNOWN INFO

PARKING BRAKE INOPERATIVE
PADS OK
CALIPER OK
ROTOR OK
CABLE OK

POSSIBLE PROBLEMS

PARKING BRAKE LEVER AND LINKAGE

TEST OPTIONS

OPERATE PARKING BRAKE FOR VISUAL INSPECTION.

REASON FOR QUESTION

If the linkage is broken or binding, the parking brake will not function properly.

NO → REPAIR/REPLACE LINKAGE

YES ↓

NO FAULTS

PARKING BRAKE ADJUSTMENT:

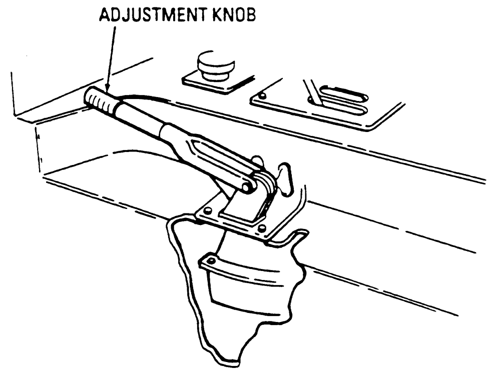
A. Chock wheels and release parking brake handle.

B. Turn adjusting knob at the tip of the brake handle clockwise as tight as possible by hand.

C. Apply parking brake handle.

D. If parking brake cannot be applied, turn adjusting knob counterclockwise until parking brake can be applied.

E. Test parking brake.



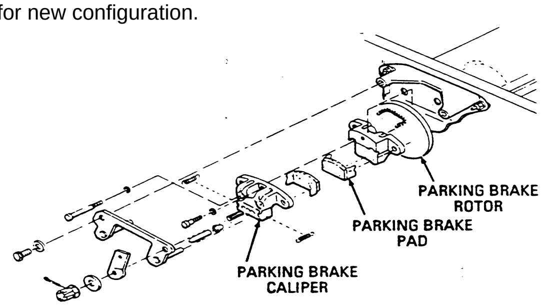
WARNING

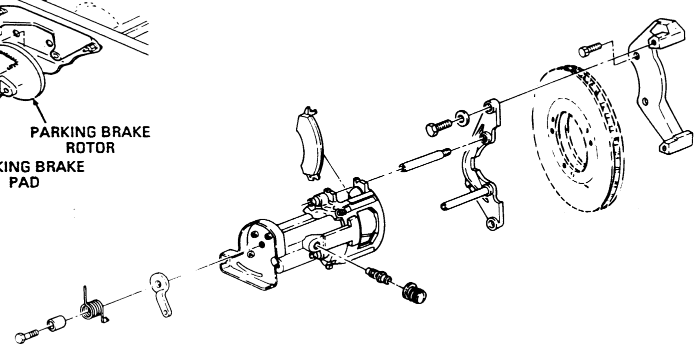
Make sure the area is clear of personnel and obstacles prior to performing this test. Failure to do so may result in serious injury.

(1) Remove chocks.
(2) Depress service brake pedal and start engine.
(3) Place transmission shift lever in drive and transfer case shift lever in high.
(4) Apply parking brake and slowly let up on service brake pedal. Vehicle should remain stationary.

Replace or repair parts, refer to (para. 7-3) for old configuration.

Replace or repair parts, refer to (para 7-20) for new configuration.





Repair or replace linkage, refer to (paras. 7-5, 7-23, and 7-24).

BRAKES

DIAGNOSTIC FLOWCHART

B
FROM 2,
Page 2-446

B1

KNOWN INFO

PARKING BRAKES OK

POSSIBLE PROBLEMS

SERVICE BRAKES
HYDRAULIC SYSTEM

IS THE FLUID IN THE MASTER CYLINDER FREE OF CONTAMINATION AND FILLED TO THE PROPER LEVEL?

TEST OPTIONS

VISUAL INSPECTION.

REASON FOR QUESTION

Contaminants in fluid or low fluid level decreases braking efficiency, resulting in little or no braking action.

NO → FILL/FLUSH SYSTEM WITH CLEAN BRAKE FLUID

YES ↓

B2

KNOWN INFO

PARKING BRAKE OK
FLUID CLEAN AND FULL

POSSIBLE PROBLEMS

BRAKE COMPONENTS
HYDRAULIC COMPONENTS
MECHANICAL COMPONENTS

IS THE MASTER CYLINDER WORKING PROPERLY AND FREE OF LEAKS?

TEST OPTIONS

VISUAL INSPECTION. FOLLOW TEST PROCEDURE AT THE RIGHT.

REASON FOR QUESTION

A leaky or malfunctioning master cylinder cannot produce sufficient braking forces to safely stop the vehicle.

NO → REPLACE MASTER CYLINDER

YES ↓

B3

KNOWN INFO

PARKING BRAKE OK
MASTER CYLINDER OK

POSSIBLE PROBLEMS

BRAKE COMPONENTS
HYDRAULIC COMPONENTS
MECHANICAL COMPONENTS

ARE THE BRAKE LINES, HYDRAULIC LINES, AND CALIPER PISTON SEALS FREE OF EVIDENCE OF LEAKING AND STRUCTURAL DAMAGE?

TEST OPTIONS

VISUAL CHECK FOR LEAKS, DAMAGE, BINDING, KINKING, ETC.

REASON FOR QUESTION

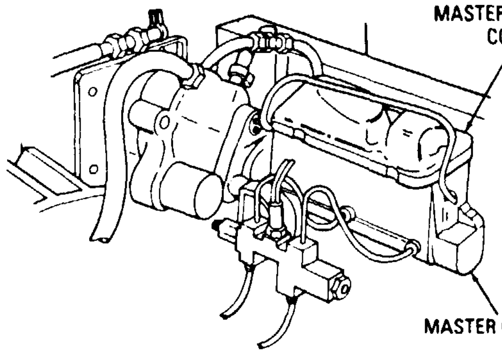
If the braking system is losing fluid, stopping distances will increase until the brakes fail due to lack of fluid and fluid pressure.

NO → REPLACE LEAKING LINES AND SEALS

YES ↓

GO TO B4,
Page 2-452

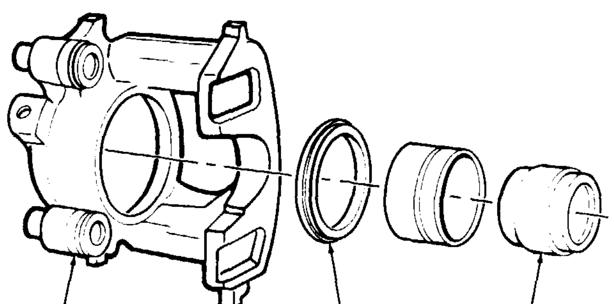
Flush and bleed the brake system, refer to (para 7-10).



Master cylinder test procedure:

1. With the engine off, pump the brake pedal six or seven times, or until the pedal becomes noticeably stiffer and harder to depress.
2. Press hard on the brake pedal. If the pedal keeps going down to the floor, either the master cylinder is bad, or there is a leak in the hydraulic system.

Replace master cylinder, refer to (para 7-13).



Check the individual lines going to each brake. Check the supply and return lines to the hydro- boost unit. Replace brake line, refer to (para 7-15).

NOTE
Brake hydraulic system must be bled of air whenever hydraulic lines are broken.
Bleed service brake, refer to (para 7-10).

BRAKES **DIAGNOSTIC FLOWCHART**

FROM B3, Page 2-450

B4

ARE THE BRAKE PADS FREE FROM CONTAMINATION, DIRT, DISTORTION, AND EXCESSIVE WEAR?

KNOWN INFO

PARKING BRAKE OK
MASTER CYLINDER OK
NO VISIBLE LEAKS

POSSIBLE PROBLEMS

BRAKE PADS
CALIPERS
ROTORS
PROPORTIONING VALVE
HYDRO-BOOSTER
MECHANICAL COMPONENTS

TEST OPTIONS

VISUAL INSPECTION.

REASON FOR QUESTION

Dirty, bent, or thin brake pads could cause problems such as noisy brakes, erratic braking, or excessive pedal pressure.

NO → REPLACE PADS IN PAIRS (FRONT OR REAR)

YES ↓

B5

ARE THE FOUR SERVICE BRAKE ROTORS FREE FROM HEAVY SCORING, EXCESSIVE WEAR, WARPING, HEAT SPOTTING, GLAZING AND CHIPPING?

KNOWN INFO

PARKING BRAKE OK
MASTER CYLINDER OK
BRAKE PADS OK

POSSIBLE PROBLEMS

ROTORS
CALIPERS
PROPORTIONING VALVE
HYDRO-BOOSTER
MECHANICAL COMPONENTS

TEST OPTIONS

VISUAL INSPECTION.

REASON FOR QUESTION

Damaged rotors reduce braking ability and speed up brake failure due to excessive heat buildup.

NO → REPLACE BAD ROTORS

YES ↓

B6

DO THE FOUR SERVICE BRAKE ROTORS ROTATE FREELY?

KNOWN INFO

PARKING BRAKE OK
MASTER CYLINDER OK
BRAKE PADS OK

POSSIBLE PROBLEMS

ROTORS BINDING
CALIPERS BINDING
PROPORTIONING VALVE
HYDRO-BOOSTER
MECHANICAL COMPONENTS

TEST OPTIONS

TRY TO ROTATE ROTORS WHILE WHEELS ARE RAISED.

REASON FOR QUESTION

Sticky rotors can cause erratic braking behavior.

NO → SEE NOTE AT RIGHT

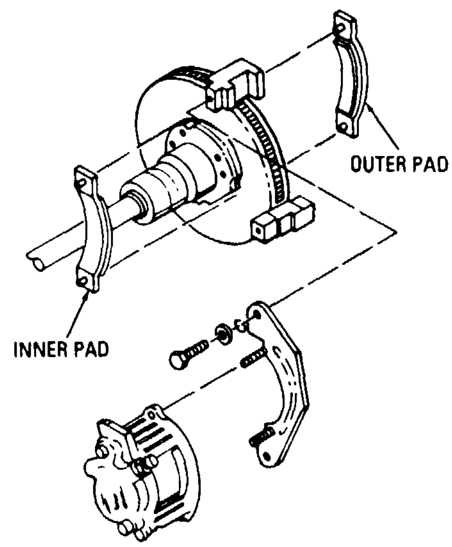
YES ↓

GO TO B7, Page 2-454

Replace brake pad, refer to (para 7-11).

NOTE

The minimum brake pad thickness is 1/8 of an inch (3.2mm).



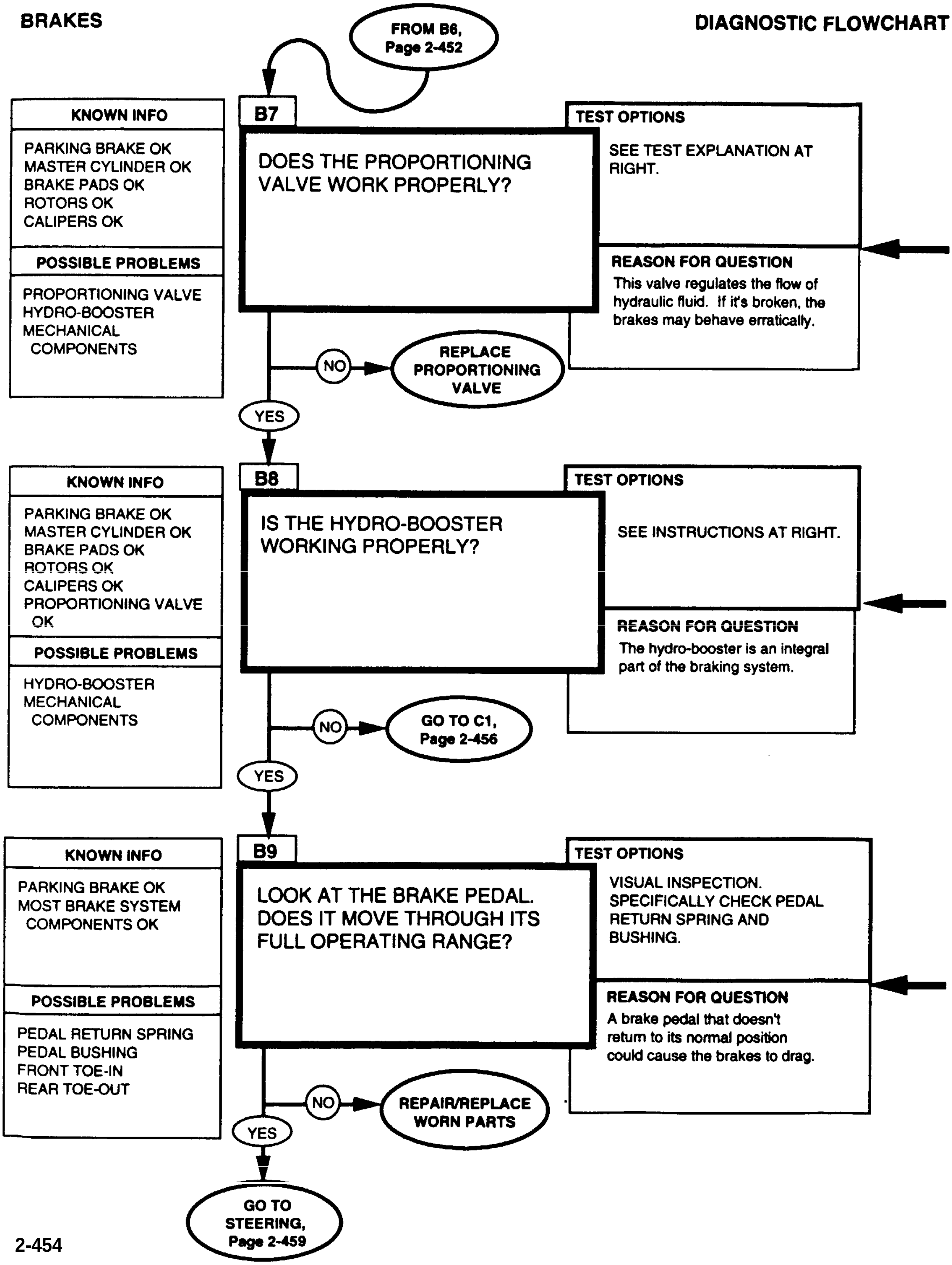
Replace service brake rotor, refer to (para 7-1 9).

NOTE

The only way the rotors can be sticking is if the calipers are not releasing fully.

Remove calipers. clean and lubricate guide pins with grease.

Replace and clean brake caliper, refer to (para 7-12).

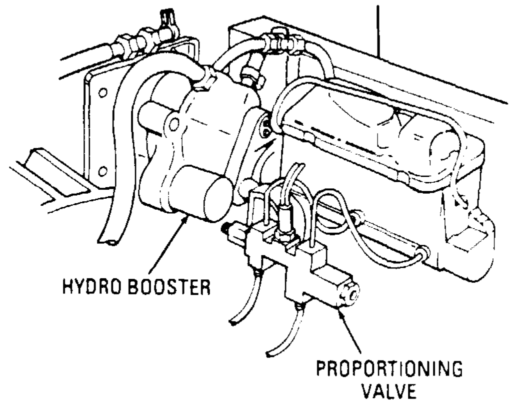

FROM B6,
Page 2-452
KNOWN INFO
PARKING BRAKE OK
MASTER CYLINDER OK
BRAKE PADS OK
ROTORS OK
CALIPERS OK
POSSIBLE PROBLEMS
PROPORTIONING VALVE
HYDRO-BOOSTER
MECHANICAL COMPONENTS
B7
DOES THE PROPORTIONING VALVE WORK PROPERLY?
TEST OPTIONS
SEE TEST EXPLANATION AT RIGHT.
REASON FOR QUESTION
This valve regulates the flow of hydraulic fluid. If it's broken, the brakes may behave erratically.
NO
REPLACE PROPORTIONING VALVE
YES
KNOWN INFO
PARKING BRAKE OK
MASTER CYLINDER OK
BRAKE PADS OK
ROTORS OK
CALIPERS OK
PROPORTIONING VALVE OK
POSSIBLE PROBLEMS
HYDRO-BOOSTER
MECHANICAL COMPONENTS
B8
IS THE HYDRO-BOOSTER WORKING PROPERLY?
TEST OPTIONS
SEE INSTRUCTIONS AT RIGHT.
REASON FOR QUESTION
The hydro-booster is an integral part of the braking system.
NO
GO TO C1,
Page 2-456
YES
KNOWN INFO
PARKING BRAKE OK
MOST BRAKE SYSTEM COMPONENTS OK
POSSIBLE PROBLEMS
PEDAL RETURN SPRING
PEDAL BUSHING
FRONT TOE-IN
REAR TOE-OUT
B9
LOOK AT THE BRAKE PEDAL. DOES IT MOVE THROUGH ITS FULL OPERATING RANGE?
TEST OPTIONS
VISUAL INSPECTION. SPECIFICALLY CHECK PEDAL RETURN SPRING AND BUSHING.
REASON FOR QUESTION
A brake pedal that doesn't return to its normal position could cause the brakes to drag.
NO
REPAIR/REPLACE WORN PARTS
YES
GO TO STEERING,
Page 2-459

Test for faulty proportioning valve:

Drive the vehicle and have an assistant observe during the performance of this test.

With vehicle at curb weight, decelerate vehicle from 46 to 40mph (72 to 69 kph) on dry concrete mad and apply sufficient pressure to lockup front brakes. If rear brakes lock up before front brakes, then the proportioning valve should be replaced.

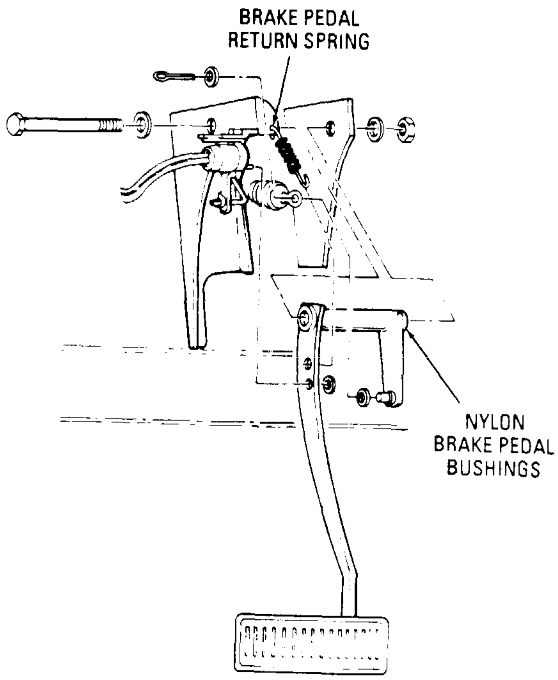
Replace proportioning valve, refer to (para 7-18).



Method for checking hydrobooster:

Depress brake pedal several times to exhaust accumulator pedal. Depress brake pedal and start engine. Brake pedal should fall, then push back against operators foot.

Replace hydro-booster, refer to (para 7-14).



Replace service brake pedal, refer to (para 7-16).

The steering tests will check for suspension problems that will affect braking.

BRAKES

DIAGNOSTIC FLOWCHART

C FROM B8, Page 2-454

C1

KNOWN INFO

HYDRO-BOOSTER SYSTEM NOT WORKING PROPERLY

POSSIBLE PROBLEMS

HYDRO-BOOSTER
POWER STEERING FLUID
BELTS LOOSE
POWER STEERING SYSTEM

IS THE FLUID LEVEL IN THE POWER STEERING PUMP RESERVOIR OK?

TEST OPTIONS

VISUAL INSPECTION.

REASON FOR QUESTION

The hydro-booster gets its power from the power steering pump.

NO → FILL TO PROPER LEVEL AND BLEED IF NECESSARY

YES ↓

C2

KNOWN INFO

HYDRO-BOOSTER SYSTEM NOT WORKING PROPERLY
POWER STEERING FLUID OK

POSSIBLE PROBLEMS

HYDRO-BOOSTER BELTS LOOSE
POWER STEERING SYSTEM

ARE THE POWER STEERING BELTS ADJUSTED TO THE CORRECT TENSION?

TEST OPTIONS

USE BELT TENSION GAUGE.

REASON FOR QUESTION

If power steering system isn't working properly, the hydro-booster may not get enough power to work properly.

NO → ADJUST TO PROPER TENSION

YES ↓

C3

KNOWN INFO

HYDRO-BOOSTER SYSTEM NOT WORKING PROPERLY
POWER STEERING FLUID OK
BELTS OK

POSSIBLE PROBLEMS

HYDRO-BOOSTER
POWER STEERING SYSTEM

ARE ALL THE POWER STEERING HYDRAULIC COMPONENTS KNOWN TO BE OK?

TEST OPTIONS

CHECK COMPONENTS. YOU CAN RUN THE TESTS IN PARAGRAPH 2-37 TO TEST THE STEERING.

REASON FOR QUESTION

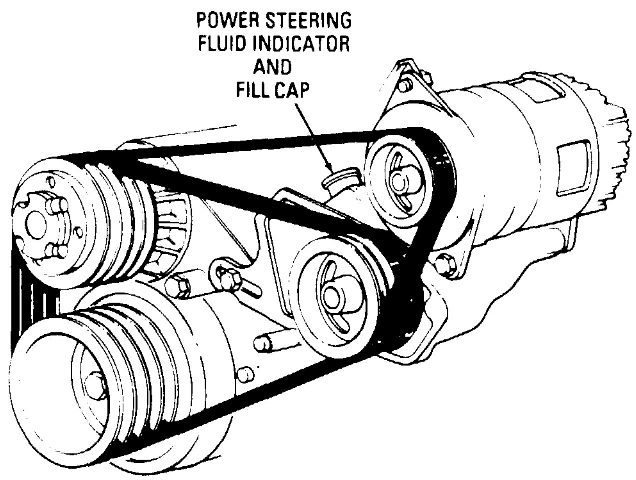
Power steering system and brake system share some of the same hydraulic components to run the hydro-booster.

NO → REPLACE AS REQUIRED

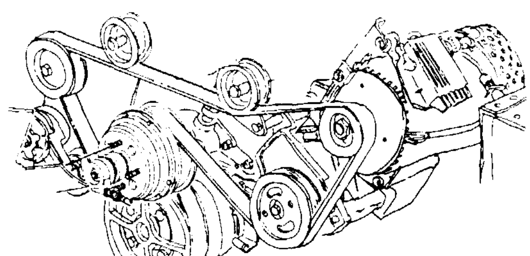
YES ↓

REPLACE HYDRO-BOOSTER

Bleed power steering system, refer to (para 8-29).



Check belts using the belt tension gauge, refer to (pars 3-82) (All except "A2" vehicles).



"A2"
CONFIGURATION

A defective power steering pump, gear, hoses, or control valve could affect hydro-booster operation.

2-37. STEERING SYSTEM TESTS

These Steering System tests may be run any time you have a steering problem or if you were sent here by another test chain. Just follow the path, answering the questions. Additional information and notes are given on the facing page when necessary.

The fold-out page shows the location of the major components of the steering in case you are not familiar with them. These parts are shown in a schematic manner. Illustrations of the actual components are given wherever applicable on the reference pages of the diagnostics.

Fold-out page FO-14 may be left open for reference while testing. The functional flow diagram shows the mechanical and hydraulic parts of the system and how they interact. Even if the hydraulic system fails, you will still be able to steer the vehicle, although it will require more effort.

STEERING SYSTEM **DIAGNOSTIC FLOWCHART**

START

1

KNOWN INFO

NOTHING

POSSIBLE PROBLEMS

POWER STEERING PUMP
POWER STEERING COMPONENTS
STEERING LINKAGES
SUSPENSION
BRAKES

DOES THE VEHICLE STEER STRAIGHT WHILE BRAKING (WHILE GOING FORWARDS AND BACKWARDS)?

TEST OPTIONS

DRIVE VEHICLE AND MAKE SEVERAL STOPS FROM MODERATE SPEEDS FROM FORWARD AND REVERSE DIRECTIONS.

REASON FOR QUESTION

If vehicle pulls to one side or other while braking, the problem is likely to be in the brake system.

NO → GO TO BRAKES, Page 2-445. RETURN IF NO FAULTS FOUND.

YES ↓

2

KNOWN INFO

BRAKING SYSTEM OK

POSSIBLE PROBLEMS

POWER STEERING PUMP
POWER STEERING COMPONENTS
STEERING LINKAGES
SUSPENSION
BRAKES GRABBING

DOES THE VEHICLE STEER STRAIGHT WHILE DRIVING ON A LEVEL ROAD AT A MODERATE SPEED?

TEST OPTIONS

TRY IT. THE VEHICLE SHOULD NOT WANDER, BUT TRACK STRAIGHT WITH A MINIMUM OF STEERING EFFORT

REASON FOR QUESTION

The vehicle should travel in a straight line with a minimum of steering correction.

NO → GO TO A, Page 2-464

YES ↓

3

KNOWN INFO

BRAKES OK
STRAIGHT LINE BEHAVIOR OK

POSSIBLE PROBLEMS

POWER STEERING PUMP
POWER STEERING COMPONENTS
STEERING LINKAGES
SUSPENSION

DOES THE VEHICLE STEER NORMALLY DURING TURNS (WITHOUT UNDUE EFFORT)?

TEST OPTIONS

DRIVE VEHICLE AND MAKE TURNS.

REASON FOR QUESTION

Hard or noisy steering is usually due to power steering system failures.

NO → GO TO B, Page 2-466

YES ↓

GO TO 4 Page 2-462

WARNING

Make sure that the area where you conduct these teats is free of natural and man-made obstructions. Failure to do so may result in serious injury.

PRIOR TO PERFORMING THESE TESTS:

Visualty inspect steering components:

1. Check all four tires and rims for wear, inflation, damage, or warping.
   a. Adjust tire pressure (TM 9-2320-280-10).
   b. Replace my unserviceable rims (para 8-4).
2. check steering linkage for damage.
   a. Replace any damaged steering linkage components (para 3-12).
   b. Lubricate steering linkage (TM 9-2320-280-10).
3. Check power steeing fluid for contamination and level (TM 9-2320-280-10).
   a. Drain and replace any fluid that appears black and smells burned.
   b. Bleed air from system where fluid appears milky white (para 8-29).
4. Check pump drivebelts for fraying, cracks, damage, or misadjustrnent.
   a. Replace unserviceable power steering drivebelts (para 3-80).
   b. Adjust loose power steering drivebelts (para 3-82).

While travelling at a moderate speed (20mph) (32 kmph), apply the brakes while applying minimal pressure to the steering wheel. If pull to one side or the other occurs, make a note of the speed at which it occurs and on what side of the vehicle it occurs. Repeat this procedure for different speeds and braking forces. If the vehicle seems to steer straight while braking, then there probably isn't a problem with the brakes (at least not one that affects the steering). If the braking action feels strange in anyway, then the brake diagnostics should be run to assure vehicle safety. TM test will usually reveal problems with frozen brake calipers.

If the wheels are out of alignment or if the tires are worn unevenly, vehicle may wander.

Symptoms of bad steering characteristics include hard steering, excesssive play in steering, a momentary increase in steering effort when turning wheel quickly, end jerking of the steering wheel when turning.

STEERING SYSTEM **DIAGNOSTIC FLOWCHART**

FROM 3
Page 2-460

KNOWN INFO

BRAKES OK
STRAIGHT LINE BEHAVIOR OK
POWER STEERING SYSTEM OK

POSSIBLE PROBLEMS

SUSPENSION

4

IS THE VEHICLE FREE FROM RATTLING NOISES AND STRANGE VIBRATIONS WHEN TURNING OR GOING OVER ROUGH TERRAIN?

TEST OPTIONS

TEST DRIVE - LISTEN AND FEEL FOR VIBRATION AND OTHER NOISE.

REASON FOR QUESTION

If there was no noise on smooth ground and there is now, there is probably a problem with the suspension.

NO → GO TO C, Page 2-472

YES → NO FAULTS

Drive the vehicle until the fires warm up. If the condition goes away it was probably caused by a burst lube pack or a flat spot on a tire. Both of these conditions are OK since the vehicle will operate normally after the fires warm up.

STEERING SYSTEM **DIAGNOSTIC FLOWCHART**

A
FROM 2,
Page 2-460

KNOWN INFO
VEHICLE EXHIBITS POOR STRAIGHT LINE STEERING

POSSIBLE PROBLEMS
TIRES
ALIGNMENT
SUSPENSION

A1
ARE THE TIRES AND WHEELS OK?

TEST OPTIONS
CHECK THE TIRES FOR PROPER INFLATION AND FOR UNEVEN OR EXCESSIVE WEAR. CHECK THE WHEELS FOR LARGE DENTS OR WARPAGE.

REASON FOR QUESTION
You can't expect the vehicle to steer OK if the tires are not good.

NO → REPAIR OR REPLACE AS NEEDED

YES ↓

KNOWN INFO
WHEELS AND TIRES OK

POSSIBLE PROBLEMS
FRONT AND REAR WHEEL ALIGNMENT
SUSPENSION

A2
DO THE FRONT WHEELS HAVE THE PROPER AMOUNT OF TOE-IN?

TEST OPTIONS
MEASURE TOE.

REASON FOR QUESTION
Poorly adjusted toe-in could have an effect on directional stability.

NO → ADJUST TOE-IN

YES ↓

KNOWN INFO
WHEELS AND TIRES OK
FRONT ALIGNMENT OK

POSSIBLE PROBLEMS
SUSPENSION
REAR ALIGNMENT

A3
DO THE REAR WHEELS HAVE THE PROPER AMOUNT OF TOE-OUT?

TEST OPTIONS
MEASURE TOE.

REASON FOR QUESTION
Poorly adjusted toe-out could have an effect on directional stability.

NO → ADJUST TOE-OUT

YES ↓

GO TO C,
Page 2-472

Uneven tire wear can be caused by improper inflation, suspension misalignment or damage, hard service, or wheel imbalance. For wheel and tire replacement and maintenance procedures, refer to (para 8-3).

For instructions on adjusting front wheel toe-in, refer to (para 8-10).

For instructions on adjusting rear wheel toe-out, refer to (para 8-11). Part C will test out the suspension parts to see if they are OK.

STEERING SYSTEM — DIAGNOSTIC FLOWCHART

B
FROM 3,
Page 2-460

B1

ARE THE POWER STEERING BELTS TIGHTENED PROPERLY AND IN GOOD CONDITION?

KNOWN INFO

STRAIGHT LINE BEHAVIOR OK
BRAKES OK
HARD STEERING EFFORT

POSSIBLE PROBLEMS

POWER STEERING PUMP
POWER STEERING COMPONENTS
SUSPENSION

TEST OPTIONS

LOOK AT BELTS FOR STRETCHING AND FRAYING. USE BELT TENSION GAUGE TO MEASURE BELT TENSION.

REASON FOR QUESTION

If the belts are loose or broken, the power steering unit may not work properly.

NO → ADJUST OR REPLACE BELTS

YES ↓

B2

IS THE FLUID LEVEL NORMAL IN THE POWER STEERING PUMP?

KNOWN INFO

WHEELS AND TIRES OK
BRAKES OK
HARD STEERING
BELTS OK

POSSIBLE PROBLEMS

POWER STEERING PUMP
POWER STEERING COMPONENTS
SUSPENSION

TEST OPTIONS

CHECK THE CAP/DIPSTICK FOR PROPER FLUID LEVEL.

REASON FOR QUESTION

Low fluid level may cause power steering pump to work improperly.

NO → ADD FLUID AND BLEED SYSTEM

YES ↓

B3

ARE THE POWER STEERING PUMP, PULLEY, AND BRACKET FIRMLY ATTACHED AND IN GOOD WORKING ORDER?

KNOWN INFO

WHEELS AND TIRES OK
BRAKES OK
HARD STEERING
BELTS OK
FLUID LEVEL OK

POSSIBLE PROBLEMS

POWER STEERING PUMP
POWER STEERING COMPONENTS
SUSPENSION

TEST OPTIONS

CHECK THEM.

REASON FOR QUESTION

Loose or broken power steering components could cause power steering assist to work improperly.

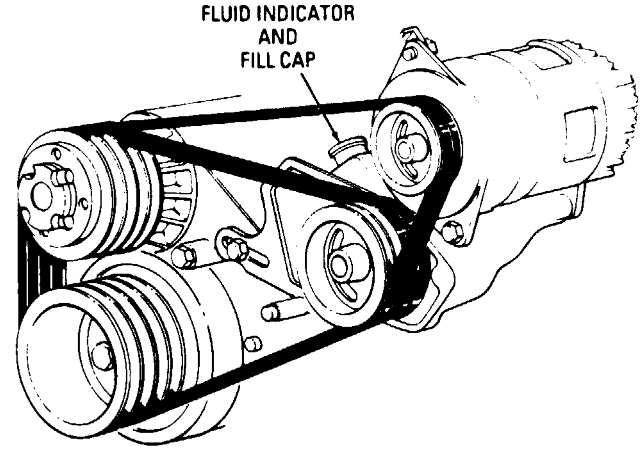
NO → REPAIR/REPLACE POWER STEERING COMPONENTS

YES ↓

GO TO B4,
Page 2-468

REFERENCE INFORMATION

Check belts using the belt tension gauge, refer to (para 3-82) (All except "A2" Vehicles).

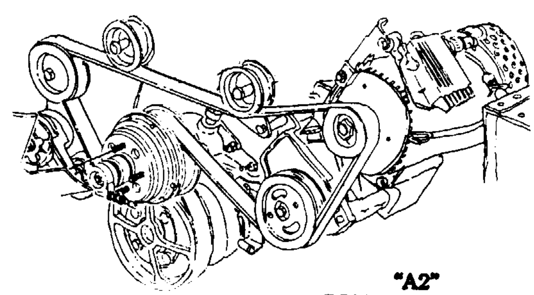


CAUTION

Do not overfill hydraulic fluid.

See TM 9-2320-280-10 for fluid replacement procedure. For bleeding procedure, refer to (para 8-29).

Low fluid level could indicate a problem elsewhere in the system, either leaking hydraulic lines or a leaking or demaged power steering pump. If adding fluid seems to cure the problem, you should probably run the reat of the tests to make sure there aren't any other problem.



"A2" CONFIGURATION

A loose pump, pulley, or bracket could cause excess noise, slipping belts, or other malfunctions. For appropriate repair or replacement procedures, refer to (para 8-24).

STEERING SYSTEM **DIAGNOSTIC FLOWCHART**

FROM B3, Page 2-466

KNOWN INFO

WHEELS AND TIRES OK
BRAKES OK
HARD STEERING
BELTS, FLUID OK
PUMP, PULLEY, BRACKET LOOK OK

POSSIBLE PROBLEMS

LEAKS
HYDRAULIC SYSTEM
POWER STEERING COOLER

B4

ARE THE COMPONENTS LISTED AT THE RIGHT CLEAN TIGHT, AND FREE OF EVIDENCE OF LEAKING FLUID?

NO → REPLACE DEFECTIVE HOSES

YES ↓

TEST OPTIONS

VISUAL CHECK.

REASON FOR QUESTION

Leaking fluid from the hydraulic hoses could indicate a bad hose or a bad component.

KNOWN INFO

WHEELS AND TIRES OK
BRAKES OK
HARD STEERING
BELTS, FLUID OK
PUMP, PULLEY, BRACKET LOOK OK

POSSIBLE PROBLEMS

POWER STEERING
HYDRAULICS
HYDRO-BOOSTER
STEERING GEAR
FAN DRIVE
POWER STEERING COOLER

B5

THE NEXT THREE QUESTIONS DON'T HAVE A "NO" PATH. REMEMBER THE ANSWERS UNTIL THE END OF THE TEST CHAIN.

YES ↓

TEST OPTIONS

1. THIS TEST CHAIN
2. POWER STEERING ANALYZER (SEE NOTE AT RIGHT REGARDING USE.)

REASON FOR TESTS

You can't determine what is wrong in the hydraulics until you test everything.

KNOWN INFO

HARD OR ABNORMAL STEERING

POSSIBLE PROBLEMS

POWER STEERING PUMP
POWER STEERING GEAR
FAN DRIVE
HYDRO-BOOSTER
POWER STEERING COOLER

B6

DOES THE COOLING FAN DISENGAGE PROPERLY?

NO → REMEMBER FOR END OF TEST → GO TO B7, Page 2-470

YES → GO TO B7, Page 2-470

TEST OPTIONS

SEE NOTE AT RIGHT.

REASON FOR QUESTION

If the power steering pump can develop enough pressure to disengage the fan, the pump and gear are probably OK.

Check hydraulic hoses, power steering pump, power steering cooler, hydraulic control valve, hydro-boost unit, steering gear, fan shroud, and fan clutch. See hose replacement procedures (refer to para 8-25). Check power steering cooler for bent fins or any other airflow restrictions. Straighten fins or replace power steering cooler (para. 8-28) if damaged beyond repair.

NOTE

- If you have a power steering analyzer, you can use it here to test the power steering pump and gear and the rest of the hydraulic system. If you use a power steering analyzer, you don't have to follow the test chain further.
- Refer to the Diagnostic Connector Assembly (DCA) Functional Flow Diagram (FO-16) for DCA to Transducer Kit (TK) cross reference when using the STE/ICE-R.

Power steering analyzer procedure

1. Disconnect high pressure hose from hydro-boost leading to power steering pump. Connect analyzer to hydro-boost and pressure hose. Open valve on analyzer.

1.1. Remove oil cooler and hydraulic control valve from hydraulic circuit by running a 54 in. (137 cm) piece of power steering pump return line from gear return tube straight to pump return tube. Plug the disconnected hoses to prevent air from getting in.

2. Disconnect harness connector at hydraulic control valve (para. 8-26). Check fluid level in power steering pump and add fluid as necessary.
3. Connect STE/ICE-R for purpose of recording engine rpm in step 8.
4. Start engine and allow it to idle for 3-5 minutes or until system is hot. Check for leaks.
5. Record pump pressure and flow rate. Pressure should be 220-250 psi (1,516-1,724 kPa) and a minimum of 3.0 - 3.25 gpm (11.35 - 12.3 Lpm) flow. If pressure is too high and/or flow is too low, check for restrictions in pressure lines by passing air through them. Remove pressure relief cartridge (para. 8-30), clean the screen and bore of relief valve with compressed air and drycleaning solvent. Check pressure and flow again. If readings are not within specifications, replace power steering pump (para. 8-24).
6. Partially close valve on analyzer to increase pressure to 700 psi (4,826 kPa) and record flow. Subtract flow rate from measurement in step 5.If flow varies by more than 1 gpm (3.8 Lpm), replace power steering pump (para. 8-24).

CAUTION

Do not leave valve fully closed for more than 5 seconds or pump damage will result.

7. Close and partially open valve on analyzer three times. Record highest pressure reading each time. All three readings must be 1,300 psi (8,964 kPa) or above. If not, replace power steering pump (para. 8-24).
8. Open valve on analyzer and increase engine speed to 1,500 rpm. Record flow and compare to measurement in step 6. If flow varies by more than 1 gpm (3.8 Lpm), remove pressure relief cartridge (para. 8-30), clean bore and screen with compressed air and drycleaning solvent. Repeat step. If flow still varies by more then 1 gpm (3.8 Lpm) from measurement in step 6, replace power steering pump (para. 8-24).
9. Turn steering wheel fully to the left and right and record flow at each stop. Flow should drop to 1 gpm (3.8 Lpm) or less. If not, replace steering gear (para. 8-21).
10. Push brake pedal to floor and hold. Flow should drop to 0.5-1.5 gpm (1.9-5.7 Lpm) or less. If not, replace hydro-boost (para. 7-14).
11. Turn steering wheel slightly to left or right and release quickly while watching pressure gauge. Pressure gauge should snap back quickly. If pressure gauge returns slowly, replace steering gear (para. 8-21).
12. Push brake pedal down and release quickly while watching pressure gauge. Pressure gauge should snap back quickly. If not, replace hydro-boost (para. 7-14).
13. When testing is done, connect harness connector to hydraulic control valve. Remove power steering analyzer, connect steering lines, and bleed power steering system (para. 8-29).

NOTE

You must be certain that the engine cooling system is working ok, or this test won't tell you anything. If the engine is cold, and everything is working ok, the fan should be disengaged. You can tell by gently revving the engine in neutral with the hood open. If the fan is engaged you will feel a breeze outside the driver's door. If it's disengaged, you won't feel it. If you aren't sure if it's working ok, run the tests in Paragraph 2-25.

STEERING SYSTEM — DIAGNOSTIC FLOWCHART

FROM B6, Page 2-468

KNOWN INFO

HARD OR ABNORMAL STEERING

POSSIBLE PROBLEMS

POWER STEERING PUMP
POWER STEERING GEAR
FAN DRIVE
HYDRO-BOOSTER

B7

IS THE HYDRO-BOOSTER WORKING PROPERLY?

TEST OPTIONS

SEE INSTRUCTIONS AT RIGHT.

REASON FOR QUESTION

The hydro-booster will affect the operation of the steering system.

NO → REMEMBER FOR END OF TEST

YES

KNOWN INFO

HARD OR ABNORMAL STEERING

POSSIBLE PROBLEMS

POWER STEERING PUMP
POWER STEERING GEAR
FAN DRIVE
HYDRO-BOOSTER

B8

TURN STEERING WHEEL SLIGHTLY TO LEFT OR RIGHT AND RELEASE WHEEL QUICKLY. THE STEERING WHEEL SHOULD CENTER ITSELF. DOES THIS HAPPEN?

TEST OPTIONS

TRY IT

REASON FOR QUESTION

The steering gear is working properly if this happens.

NO → REMEMBER FOR END OF TEST

YES

KNOWN INFO

HARD OR ABNORMAL STEERING

POSSIBLE PROBLEMS

POWER STEERING PUMP
POWER STEERING GEAR
FAN DRIVE
HYDRO-BOOSTER

B9

LOOK AT THE CHART TO THE RIGHT TO DETERMINE WHAT IS WRONG AND REPAIR IT AS DIRECTED.

TEST OPTIONS

N/A

REASON FOR TESTS

N/A

Method for checking hydro-booster. Depress brake pedal several times to exhaust accumulator. Depress brake pedal and start engine. Brake pedal should fall, then push back against operator's foot.

ANSWERS TO QUESTION: B6	B7	B8	COMPONENT TO REPLACE
NO	NO	NO	POWER STEERING PUMP
NO	NO	YES	SEE NOTE BELOW
NO	YES	NO	SEE NOTE BELOW
NO	YES	YES	RUN ENGINE COOLING TEST (PARA 2-19)
YES	NO	NO	POWER STEERING PUMP
YES	NO	YES	HYDRO-BOOSTER
YES	YES	NO	DS LEVEL STEERING GEAR
YES	YES	YES	NO FAULTS

NOTE

To diagnose the second and third cases to one item, it is necessary to have a power steering analyzer. Additionally, for all cases, check the hoses for the particular part to make sure they are OK.

STEERING SYSTEM — DIAGNOSTIC FLOWCHART

C
FROM 4, Page 2-462
OR A3, Page 2-464

C1

KNOWN INFO

WHEELS AND TIRES OK
BRAKES OK
ALIGNMENT OK

POSSIBLE PROBLEMS

STEERING COMPONENTS
SUSPENSION COMPONENTS

CHECK THE TIE ROD ENDS, CENTER LINK PITMAN ARM AND IDLER ARM, AND ALL OF THE MOUNTING HARDWARE FOR THESE PARTS. ARE THEY ALL OK?

TEST OPTIONS

VISUAL INSPECTION - LOOK FOR BENT PARTS, LOOSE MOUNTINGS AND BAD BUSHINGS.

REASON FOR QUESTION

These are the parts that turn the front wheels in response to the steering wheel movements.

NO → REPLACE AS NEEDED

YES ↓

C2

KNOWN INFO

WHEELS AND TIRES OK
BRAKES OK
STEERING LINKAGES OK

POSSIBLE PROBLEMS

DRIVEBELT & PULLEY
CAPSCREWS
SUSPENSION COMPONENTS

CHECK POWER STEERING DRIVEBELT PULLEY FOR GROOVES AND SCORING, AND MAKE SURE BELT TENSION IS OK. ARE THESE OK?

TEST OPTIONS

1. VISUAL INSPECTION.
2. BELT TENSION GAUGE.

REASON FOR QUESTION

A damaged pulley will ruin the drivebelt. A loose belt will slip, causing the power steering to loose power or fail.

NO → REPLACE DAMAGED/WORN BELT OR PULLEY

YES ↓

C3

KNOWN INFO

WHEELS AND TIRES OK
BRAKES OK
POWER STEERING BELTS OK
STEERING LINKAGES OK

POSSIBLE PROBLEMS

BALL JOINTS
OTHER SUSPENSION COMPONENTS
OTHER STEERING COMPONENTS

ARE THE BALL JOINTS OK (NOT WORN)?

TEST OPTIONS

PROCEDURE AT RIGHT

REASON FOR QUESTION

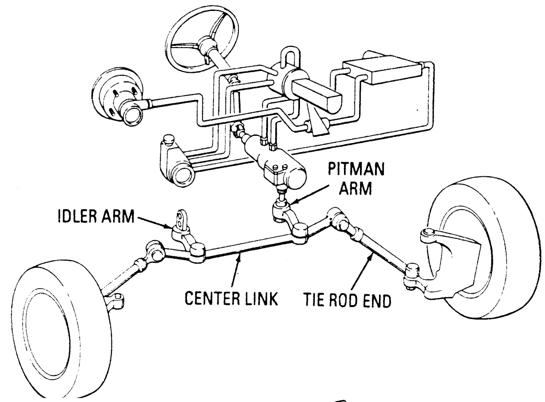
Worn ball joints can result in difficult or noisy steering.

NO → REPLACE BALL JOINTS

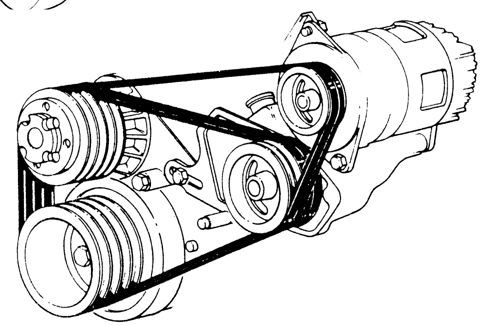
YES ↓

GO TO C4, Page 2-474

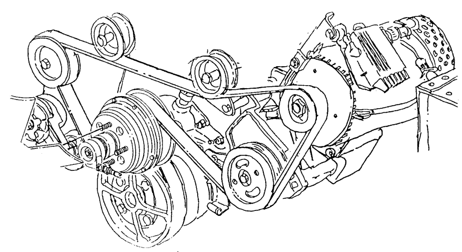
REFERENCE INFORMATION STEERING SYSTEM



Check for looseness in idler arm and pitman arm, refer to (para. 8-18 and 8-14). For replacing center link refer to (para. 8-15). For replacing tie rods refer to (para. 8-17).



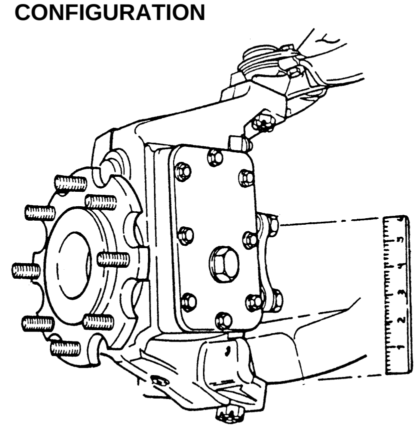
For adjusting the drivebelt tension, refer to (para. 3-82, all except M1123 and "A2" vehicles), and replacing the pulley, refer to (para 8-24).



M1123 and "A2" CONFIGURATION

CAUTION

Do not loosen slotted nut to install cotter pin. Loosening the nut may result in damage to the equipment.



To check for proper operation of ball joints:
(i) Chock rear wheels front and back.
(ii) Raise front wheels about two inches off the ground and support on a jack stand.
(a)Lower ball joints.
(iii) Mark a line across the head of the top bolt holding the steering arm cover. Make sure the mark is parallel to the lower control arm.
(iv) Put a prybar between the cover control arm and geared hub.
(v) Set a 6-inch ruler upright between the lower control arm and the marked screw.
(vi) Push down the prybar to try to move the hub.
(vii) Measure movement in the hub assembly. If movement is more than 1/8 inch (3 mm), replace lower ball joint (refer to para. 6-27).
(b) Upper ball joints.
(viii) Grasp top of tire and attempt to move it in and out.
(ix) Measure any movement at top outer edge of tire. Replace upper ball joints if tire movement is 3/8 inch (10 mm) or more (refer to para. 6-26).

STEERING SYSTEM **DIAGNOSTIC FLOWCHART**

FROM C3, Page 2-472

C4

ARE THE CONTROL ARMS AND THEIR BUSHINGS OK?

KNOWN INFO
WHEELS AND TIRES OK
BRAKES OK
POWER STEERING SYSTEM OK
BALL JOINTS OK

POSSIBLE PROBLEMS
OTHER SUSPENSION COMPONENTS
OTHER STEERING COMPONENTS

TEST OPTIONS
VISUAL INSPECTION. LOOK FOR BROKEN OR WORN BUSHINGS AND BENT CONTROL ARMS. ALSO CHECK MOUNTING HARDWARE.

REASON FOR QUESTION
Worn control arms reduce steerability of the vehicle and reduce tire life.

NO → REPLACE CONTROL ARMS/BUSHINGS

YES ↓

C5

ARE THE SHOCK ABSORBERS AND COIL SPRINGS OPERATING EFFECTIVELY?

KNOWN INFO
WHEELS AND TIRES OK
BRAKES OK
POWER STEERING SYSTEM OK
BALL JOINTS OK
CONTROL ARMS OK

POSSIBLE PROBLEMS
OTHER SUSPENSION COMPONENTS
OTHER STEERING COMPONENTS

TEST OPTIONS
PROCEDURE AT RIGHT

REASON FOR QUESTION
Broken or fatigued shock absorbers and coils can lead to loss of steering control on rough surfaces.

NO → REPLACE SHOCKS/ COIL SPRINGS

YES ↓

C6

ARE THE RADIUS RODS OK (NOT WORN OUT)?

KNOWN INFO
WHEELS, TIRES, BRAKES OK
POWER STEERING SYSTEM OK
BALL JOINTS, CONTROL ARMS, SHOCKS/SPRINGS OK

POSSIBLE PROBLEMS
OTHER SUSPENSION COMPONENTS
OTHER STEERING COMPONENTS

TEST OPTIONS
VISUAL INSPECTION. CHECK FOR EXCESSIVE WEAR, UNSERVICEABLE BUSHINGS.

REASON FOR QUESTION
The radius rods serve to keep the rear wheels pointed in the proper direction.

NO → REPLACE RADIUS ROD

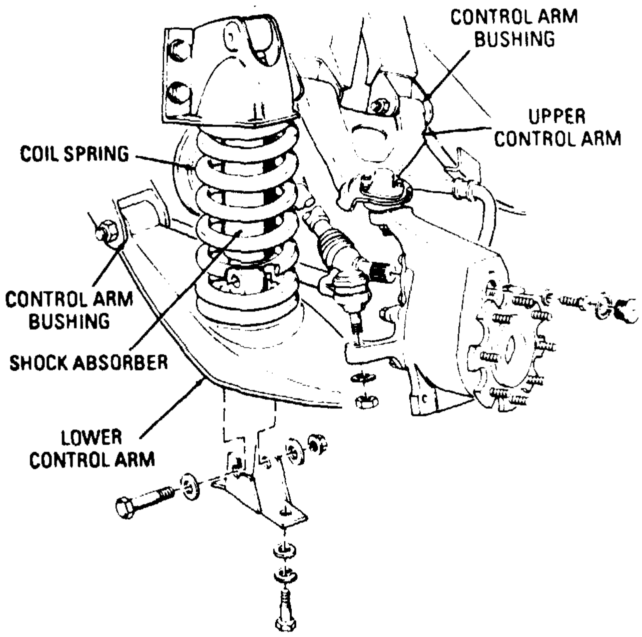
YES ↓

GO TO C7, Page 2-476

REFERENCE INFORMATION

STEERING SYSTEM

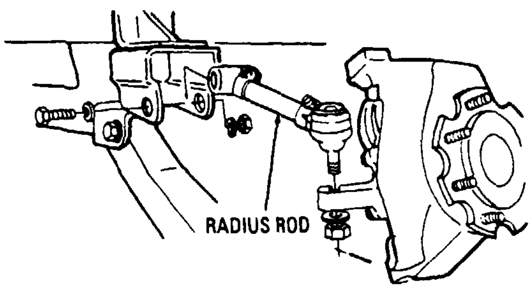
For upper and lower control arm and bushing replacement instructions, refer to (para 6-28 and 6-29).



To test the shocks and springs, drive the vehicle over a variety of terrain. If the vehicle continues to bounce after hitting a bump, the shocks may be worn. If the vehicle bottoms out on the suspension, the shocks may be worn. If the vehicle sags when loaded, the springs maybe worn. If the shock absorber bodies are not warm after driving the vehicle, the shocks are no good.

For coil spring and shock absorber replacement instructions, refer to (para 6-30 and 6-31).

For instructions on replacing the radius rod, refer to (para 6-25).



STEERING SYSTEM DIAGNOSTIC FLOWCHART

FROM C6, Page 2-474

C7

KNOWN INFO

MOST STEERING AND SUSPENSION PARTS ARE OK

POSSIBLE PROBLEMS

STEERING SHAFTS
CAPSCREWS
STABILIZER BAR

CHECK THE STEERING COLUMN AND THE INTERMEDIATE STEERING SHAFT. ARE THEY OK?

TEST OPTIONS

VISUAL INSPECTION - LOOK FOR BROKEN HARDWARE AND WORN SPLINES.

REASON FOR QUESTION

These parts carry the motion of the steering wheel to the steering gear.

NO → REPLACE AS NEEDED

YES ↓

C8

KNOWN INFO

WHEELS,TIRES,BRAKES OK
POWER STEERING SYSTEM OK
SUSPENSION OK
MOST STEERING COMPONENTS OK

POSSIBLE PROBLEMS

STABILIZER BAR
CAPSCREWS

IS THE STABILIZER BAR OK (BAR AND BAR MOUNTS)?

TEST OPTIONS

VISUAL INSPECTION.

REASON FOR QUESTION

If the bar is broken or loose, the vehicle could be hard to control at moderate to high speeds during turns.

NO → REPLACE STABILIZER BAR

YES ↓

C9

KNOWN INFO

WHEELS,TIRES,BRAKES OK
POWER STEERING SYSTEM OK
BALL JOINTS OK
CONTROL ARMS OK
SHOCKS/SPRINGS OK
DRIVEBELT & PULLEY OK

POSSIBLE PROBLEMS

CAPSCREWS

ARE STEERING GEAR MOUNTING CAPSCREWS ADEQUATELY TIGHT? THEY SHOULD BE TIGHTENED TO 60 FT-LB (81 N•M).

TEST OPTIONS

1. VISUAL INSPECTION.
2. CHECK WITH TORQUE WRENCH.

REASON FOR QUESTION

If the capscrews get loose or fall out, the steering gearbox could move, causing serious problems with steering.

NO → TIGHTEN CAPSCREWS IF NECESSARY

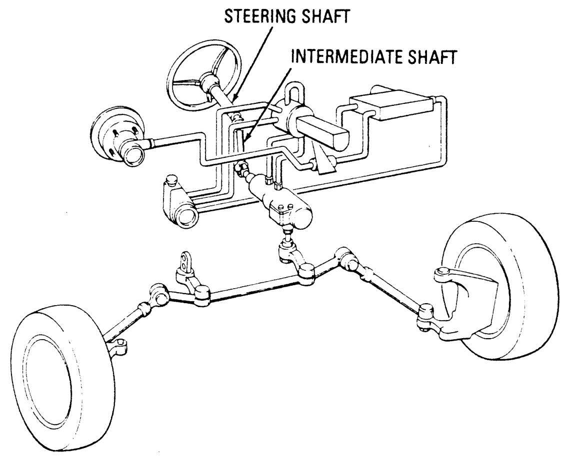
YES ↓

NO FAULTS

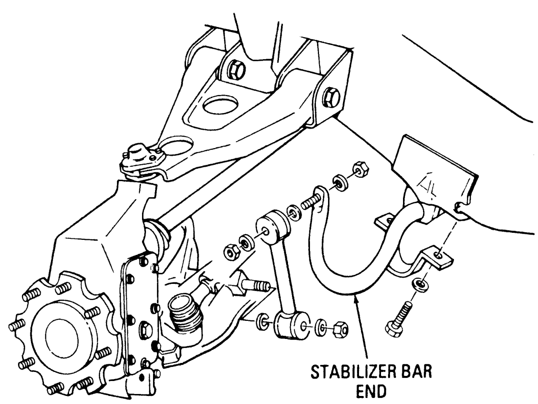
NOTE

Inspect intermediate shaft U-joints for wear, binding, or missing/damaged grease fittings. Replace or lubricate as necessary. Refer to (para. 8-22) for replacement and TM 9-2320-280-10, Appendix G, for lubrication instructions.

Replace the steering column and intermediate shaft, refer to (paras 8-19 and 8-20).



Replace the stabilizer bar, refer to (para 6-23).



If you still have a problem, rerun the test chain to make sure you didn't miss anything. If you didn't go down the “A” chain, you may want to run those tests in order to check out the hydraulic parts of the steering system.

2-38. DRIVETRAIN TESTS

These Drivetrain tests maybe run anytime you think you have a drivetrain problem or if you were sent here by another test chain. Just follow the path, answering the questions. Additional information and notes are given on the facing page when necessary.

The fold-out page shows the location of the major components of the drivetrain system in case you are not familiar with them.

Fold-out page FO-15 may be left open for reference while testing. Also, due to the design of the functional flow diagram, it is not necessary to have a location of parts diagram, so it has been omitted.

NOTE

Problems with the transmission and drivetrain cooling system are dealt with in Paragraph 2-34 or 2-35.

DRIVETRAIN — DIAGNOSTIC FLOWCHART

START

1

KNOWN INFO

NOTHING

POSSIBLE PROBLEMS

TRANSFER CASE
DIFFERENTIALS
HALF AND PROPELLER SHAFTS
CV & U-JOINTS
GEARED HUBS

IS THE TRANSMISSION FLUID OK?

TEST OPTIONS

VISUAL - SEE NOTE AT RIGHT.

REASON FOR QUESTION

Transmission fluid passes through the transfer oil cooler located inside the transfer case.

NO → SEE NOTE AT RIGHT

YES ↓

2

KNOWN INFO

FLUID OK

POSSIBLE PROBLEMS

TRANSFER CASE
DIFFERENTIALS
HALF AND PROPELLER SHAFTS
CV & U-JOINTS
GEARED HUBS

ROAD TEST THE VEHICLE. DOES IT PASS?

TEST OPTIONS

TRY ALL TRANSFER CASE OPTIONS AND NOTE UNUSUAL BEHAVIOR.

REASON FOR QUESTION

A road test is the best way to test the drivetrain.

NO → GO TO A, Page 2-486

YES ↓

3

KNOWN INFO

SHIFTER OK
FLUID OK
VEHICLE PASSES ROAD TEST

POSSIBLE PROBLEMS

TRANSFER CASE
DIFFERENTIALS
HALF AND PROPELLER SHAFTS
CV & U-JOINTS
GEARED HUBS

DOES THE SPEEDOMETER WORK?

TEST OPTIONS

VISUAL INSPECTION.

REASON FOR QUESTION

The speedometer is driven by the rear output shaft of the transfer case.

NO → GO TO C, Page 2-494

YES ↓

GO TO 4, Page 2-482

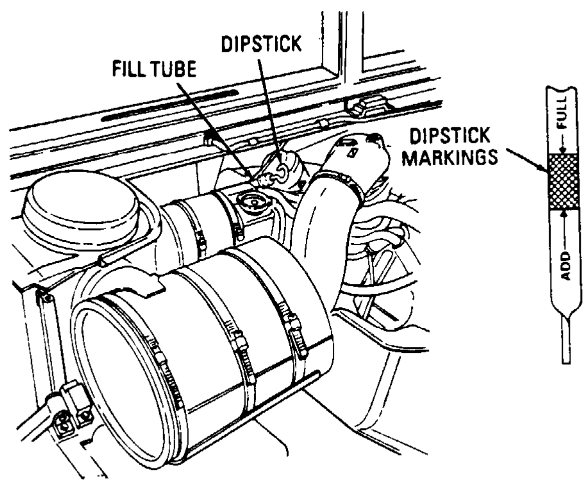
Procedure for checking transmission fluid

1. Start engine
2. Hold down brake pedal and move transmission shift lever through ail ranges including reverse.
3. Engage parking brake and place shift lever in neutral. Check fluid level on dipstick.
4. Proper level is between FULL and ADD marks on dipstick

NOTE

Check fluid for a burnt smell, grit, discoloration, air bubbles, or a milky appearance.

- Burnt smell, discolration, or grit indicates worn or damaged internal components. Notify DS maintenance.
- Bubbles indicate of an overfilled system or air leaks in the syetem. Drain the fluid and refill to proper level, refer to (para 5-2).
- Milky appearance is due to watar in the system. Replace fluid, and replace fifter.



If the speedometer works, but the vehicle doesn't move, the transmission is OK and the problem is in the final drive. Most likely the fault is in the splined output shafts of the transfer case. Listen for unusual noise.

DRIVETRAIN **DIAGNOSTIC FLOWCHART**

FROM 3, Page 2-480

KNOWN INFO
SHIFTER OK TRANSFER CASE OK
POSSIBLE PROBLEMS
HALFSHAFTS PROPELLER SHAFTS U- AND CV JOINTS GEARED HUBS

4

INSPECT THE HALFSHAFTS AND THE CONSTANT VELOCITY (CV) JOINTS. ARE THEY OK?

TEST OPTIONS

VISUAL INSPECTION.

REASON FOR QUESTION

The halfshafts transmit power from the differentials to the geared hubs.

NO → REPAIR OR REPLACE AS NEEDED

YES ↓

KNOWN INFO
SHIFTER OK TRANSFER CASE OK HALFSHAFTS AND CV JOINTS OK
POSSIBLE PROBLEMS
PROPELLER SHAFTS U-JOINTS GEARED HUBS

5

INSPECT THE FRONT AND REAR PROPELLER SHAFTS AND U-JOINTS. ARE THEY OK?

TEST OPTIONS

VISUAL INSPECTION.

REASON FOR QUESTION

The propeller shafts transmit power from the transfer case to the differentials.

NO → REPAIR OR REPLACE AS NEEDED

YES ↓

KNOWN INFO
PROPELLER SHAFTS OK U-JOINTS OK SHIFTER OK TRANSFER CASE OK HALFSHAFTS AND CV JOINTS OK
POSSIBLE PROBLEMS
GEARED HUBS DIFFERENTIALS

6

INSPECT THE GEARED HUBS. ARE THEY OK?

TEST OPTIONS

VISUAL INSPECTION.

REASON FOR QUESTION

The geared hubs transmit power from the drivetrain to the wheels.

NO → REPAIR OR REPLACE AS NEEDED

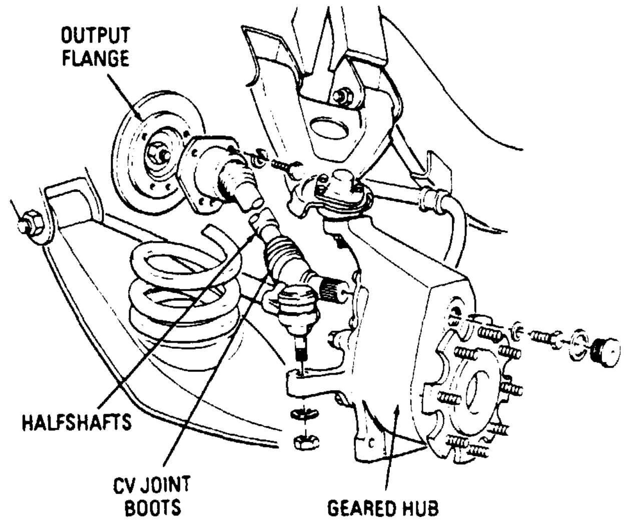
YES ↓

GO TO 7, Page 2-484

Check for torn boots on the CV joints, stripped splines, smooth joint operation, and proper mounting torques.

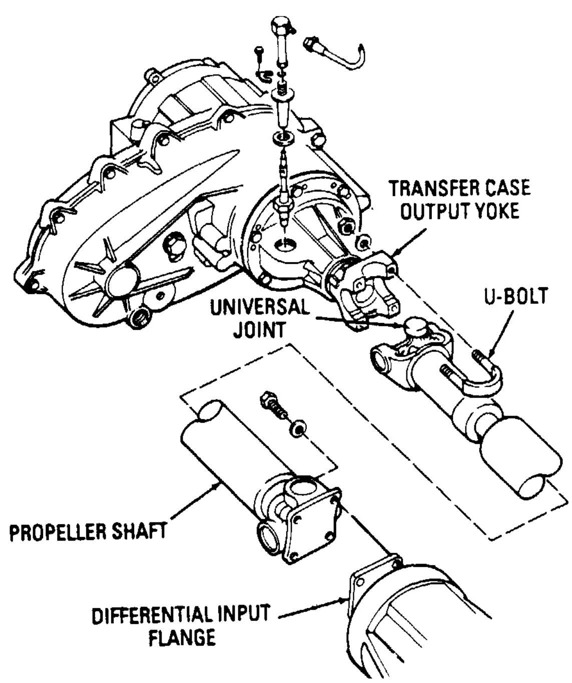
Replace halfshafts and CV joints, refer to (para 6-9).

Lube in accordance with TM 9-2320-280-10.



Check for smooth operation of U-joints, stripped splines, bent yokes, or other problems. Also check to see if the shaft itself is bent. Replace propeller shafts or U-joints, refer to (para 6-2 through 6-7).

Lube in accordance with TM 9-2320-280-10.

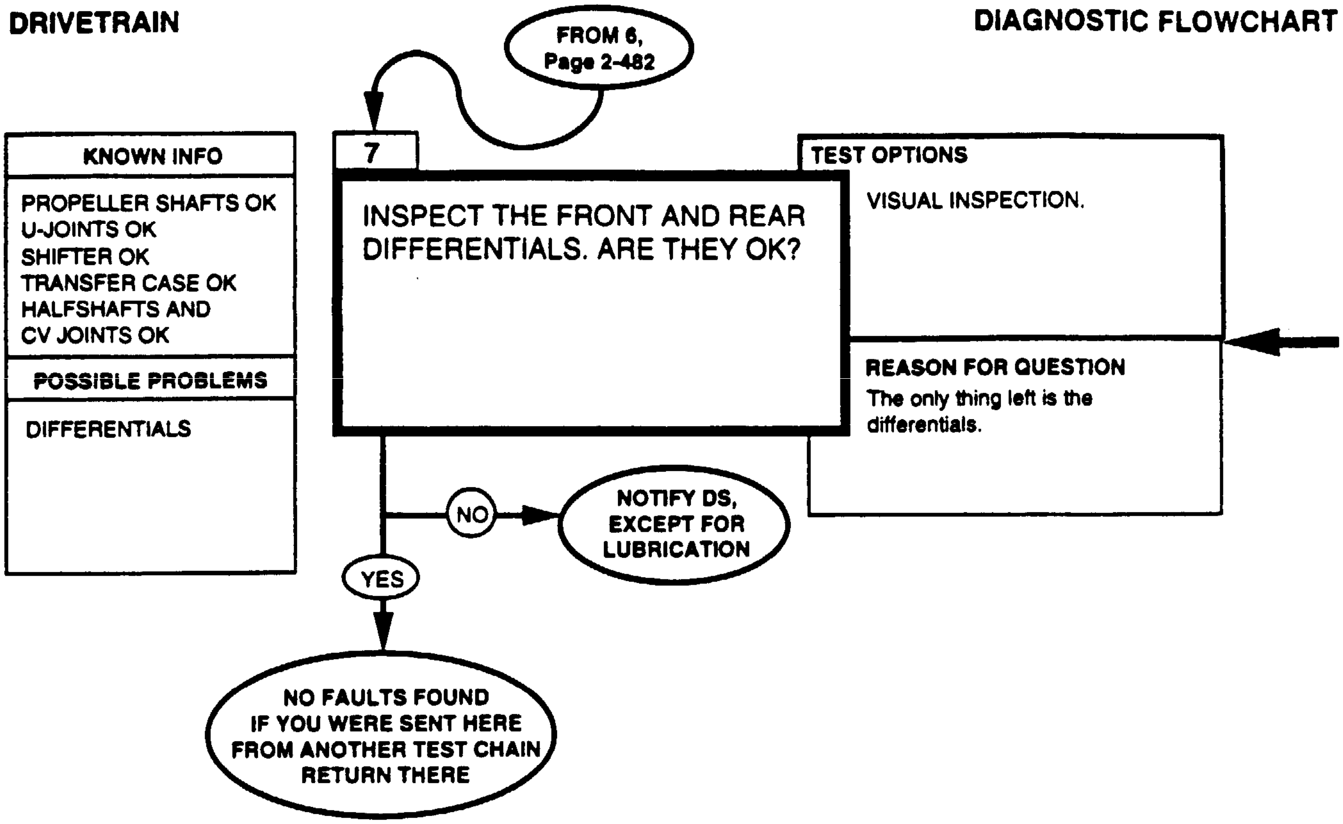


Make sure the geared hubs turn freely. Check mounting hardware for proper installation

Lube in accordance with TM 9-2320-280-10.

Replace geared hubs, refer to (para 6-11).

DRIVETRAIN DIAGNOSTIC FLOWCHART



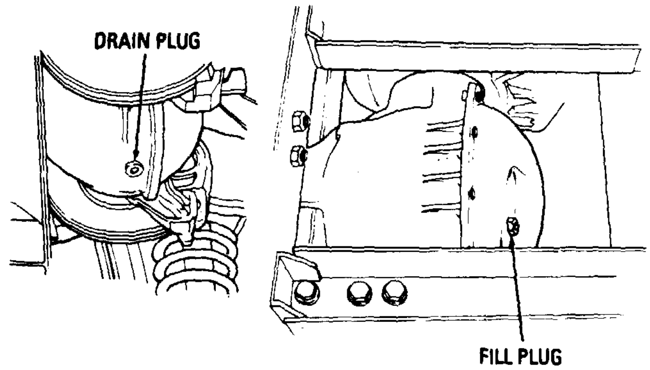
REFERENCE INFORMATION

DRIVETRAIN

Check for loose mounting and broken parts.

Check fluid in accordance with TM 9-2320-280-10.

Notify DS maintenance for other faults.



DRIVETRAIN **DIAGNOSTIC FLOWCHART**

A
FROM 2,
Page 2-480

KNOWN INFO
VEHICLE FAILS ROAD TEST
FLUID OK

POSSIBLE PROBLEMS
SHIFTER
PROPELLER SHAFTS
HALFSHAFTS
GEARED HUBS
TRANSMISSION
TRANSFER CASE

A1

WITH THE VEHICLE OFF, HAVE AN ASSISTANT MOVE THE SELECTOR LEVER. DOES THE LINKAGE AT THE TRANSFER CASE WORK PROPERLY?

TEST OPTIONS
VISUAL INSPECTION.

REASON FOR QUESTION
To make sure the shifter works.

NO → REPAIR SHIFTER AS NEEDED

YES ↓

KNOWN INFO
VEHICLE FAILS ROAD TEST
FLUID OK
SHIFTER OK

POSSIBLE PROBLEMS
SHAFTS
GEARED HUBS
TRANSFER CASE
TRANSMISSION

A2

DOES THE VEHICLE MOVE AT ALL?

TEST OPTIONS
VISUAL.

REASON FOR QUESTION
If the vehicle doesn't move, it means the transmission or transfer case are probably at fault.

NO → GO TO B, Page 2-490

YES ↓

KNOWN INFO
VEHICLE FAILS ROAD TEST
FLUID OK
SHIFTER OK
VEHICLE MOVES

POSSIBLE PROBLEMS
SHAFTS
GEARED HUBS
TRANSFER CASE
TRANSMISSION

A3

DOES THE TRANSMISSION WORK PROPERLY?

TEST OPTIONS
TRY TO FEEL IF THE TRANSMISSION IS SHIFTING PROPERLY, OR GO TO TRANSMISSION, PAGE 2-399 or 2-411.

REASON FOR QUESTION
A road test failure could be due to the transmission.

NO → GO TO TRANSMISSION Page 2-399 or 2-411

YES ↓

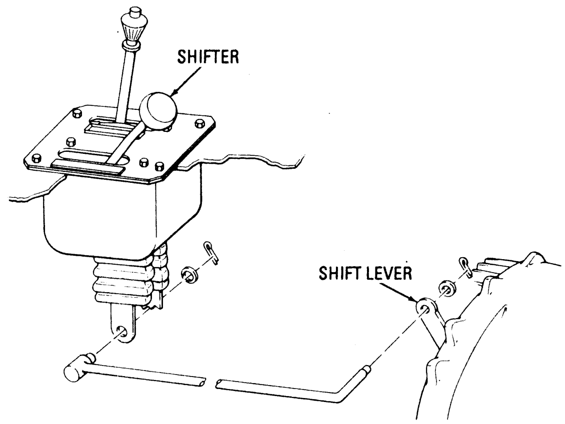
GO TO A4, Page 2-488

Lube in accordance with table 2-1.

Adjust and repair linkage, refer to (para 5-8 or 5-11). Make sure the detents in the shifter correspond with the positions on the name plate.

If difficulty occurs when shifting transfer range with engine running, perform Engine Idle Speed Adjustment prior to troubleshooting drivetrain.

If engine was turned OFF in order to shift transfer to desired range, notify DS maintenance.



For the vehicle not to move, there must be a major problem in the drivetrain.

If you've already run the transmission tests, and you still can't find the problem, continue down this test chain.

DRIVETRAIN **DIAGNOSTIC FLOWCHART**

FROM A3, Page 2-486

A4

ARE BOTH PROPELLER SHAFTS AND U-JOINTS OK?

KNOWN INFO

VEHICLE FAILS ROAD TEST
FLUID OK
SHIFTER OK
VEHICLE MOVES

POSSIBLE PROBLEMS

DIFFERENTIALS
SHAFTS
GEARED HUBS
TRANSFER CASE

TEST OPTIONS

VISUAL INSPECTION.

REASON FOR QUESTION

The propeller shafts transmit power to the differentials.

NO → REPLACE AS NEEDED

YES ↓

A5

ARE ALL 4 HALFSHAFTS AND CONSTANT VELOCITY JOINTS OK?

KNOWN INFO

VEHICLE FAILS ROAD TEST
FLUID OK
SHIFTER OK
VEHICLE MOVES
PROPELLER SHAFTS OK

POSSIBLE PROBLEMS

DIFFERENTIALS
HALFSHAFTS
GEARED HUBS
TRANSFER CASE

TEST OPTIONS

VISUAL.

REASON FOR QUESTION

Halfshafts transmit power from the differentials to the geared hubs.

NO → REPLACE AS NEEDED

YES ↓

A6

INSPECT THE GEARED HUBS. ARE THEY OK?

KNOWN INFO

VEHICLE FAILS ROAD TEST
FLUID OK
SHIFTER OK
VEHICLE MOVES
PROPELLER SHAFTS OK
HALFSHAFTS OK

POSSIBLE PROBLEMS

DIFFERENTIALS
GEARED HUBS
TRANSFER CASE

TEST OPTIONS

VISUAL INSPECTION.

REASON FOR QUESTION

The geared hubs transmit power from the drive train to the wheels.

NO → REPLACE AS NEEDED

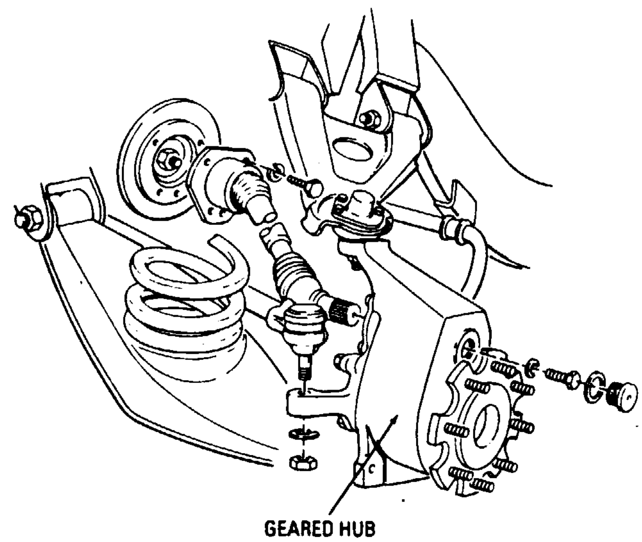
YES ↓

SEE NOTE AT RIGHT

Lube in accordance with TM 9-2320-280-10.

Check for smooth operation of U-Joints, stripped splines, bent yokes, or other problems. Also check to see if the shaft itself is bent.

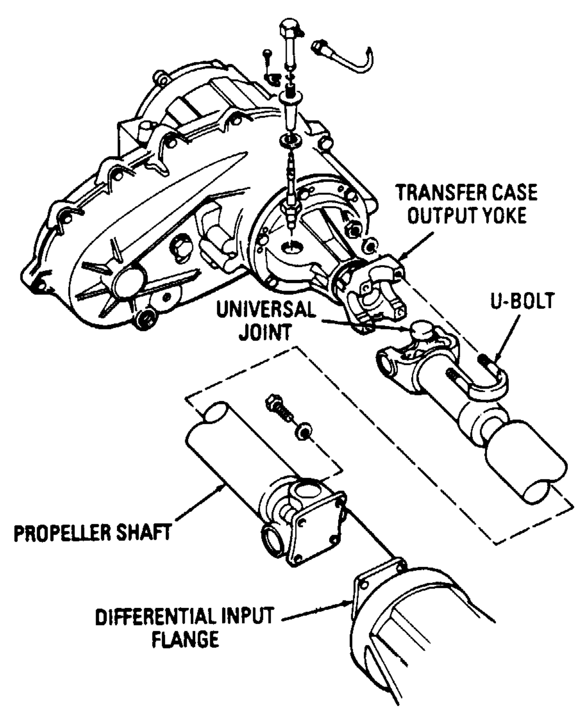
Repair and replace propeller shafts and U-joints, refer to (para 6-4 thru 6-7).



Check for torn boots on the CV joints, stripped splines, smooth joint operation, and proper mounting torques.

For halfshaft maintenance procedures, refer to (para 6-9).

Lube in accordance with TM 9-2320-280-10.



Make sure the geared hubs turn freely. Check mounting hardware for proper installation.

Lube in accordance with TM 9-2320-280-10.

NOTE

If you havan't found any faults, check the differential fluid in accordance with TM 9-2320-280-10. Otherwise notify DS maintenance.

DRIVETRAIN **DIAGNOSTIC FLOWCHART**

B
FROM A2,
Page 2-486

KNOWN INFO

VEHICLE DOESN'T MOVE
SHIFTER OK
FLUID OK

POSSIBLE PROBLEMS

TRANSFER CASE
TRANSMISSION
HALF AND PROPELLER SHAFTS
GEARED HUBS

B1

THE PROBLEM IS MOST LIKELY IN THE TRANSFER CASE OR TRANSMISSION. IF YOU FIND NO FAULTS IN THIS TEST CHAIN, AND YOU CAME FROM TRANSMISSION, NOTIFY DS MAINTENANCE.

KNOWN INFO

SHIFTER OK
TRANSFER CASE OK
TRANSMISSION OK
SPEEDOMETER WORKS

POSSIBLE PROBLEMS

PROPELLER SHAFTS
U-JOINTS
GEARED HUBS
HALFSHAFTS AND CV JOINTS OK

B2

INSPECT THE FRONT AND REAR PROPELLER SHAFTS AND U-JOINTS. ARE THEY OK?

TEST OPTIONS

VISUAL INSPECTION.

REASON FOR QUESTION

The propeller shafts transmit power from the transfer case to the differentials.

NO → REPLACE AS NEEDED

YES

KNOWN INFO

SHIFTER OK
TRANSFER CASE OK
TRANSMISSION OK
SPEEDOMETER WORKS
PROPELLER SHAFTS
U-JOINTS

POSSIBLE PROBLEMS

GEARED HUBS
HALFSHAFTS AND CV JOINTS OK

B3

INSPECT THE HALFSHAFTS AND THE CONSTANT VELOCITY JOINTS. ARE THEY O.K.?

TEST OPTIONS

VISUAL INSPECTION.

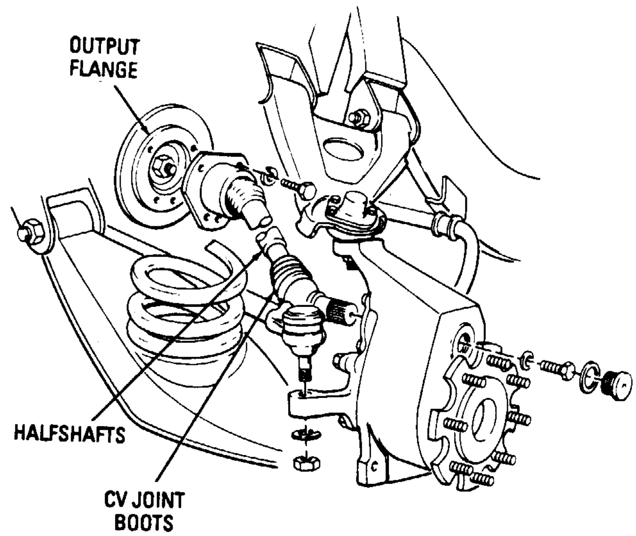
REASON FOR QUESTION

The halfshafts transmit power from the differentials to the geared hubs.

NO → REPLACE AS NEEDED

YES

GO TO B4, Page 2-492



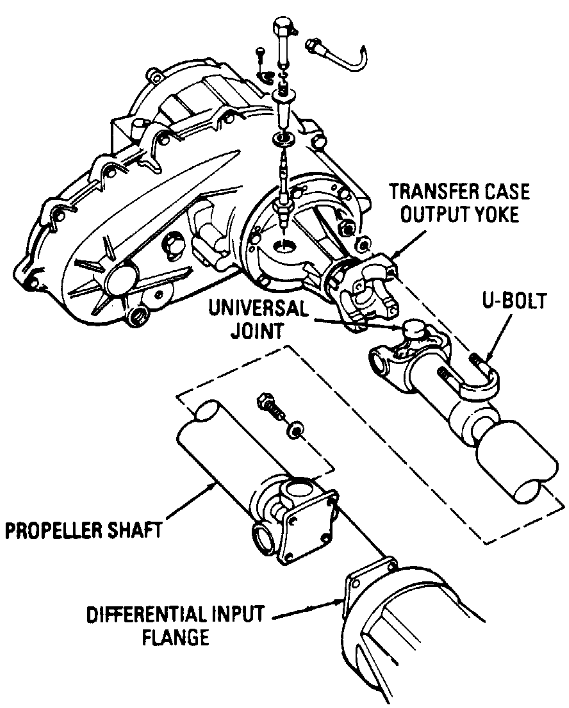
If the vehicle doesn't work, then both shafts would have to be broken.

Check for smooth operation of U-joints, stripped splines, bent yokes, or other problems.

Also check to see if the shaft itself is bent.

Replace propeller shafts, refer to (para 6-2 thru 6-6).

Lube in accordance with TM 9-2320-280-10.

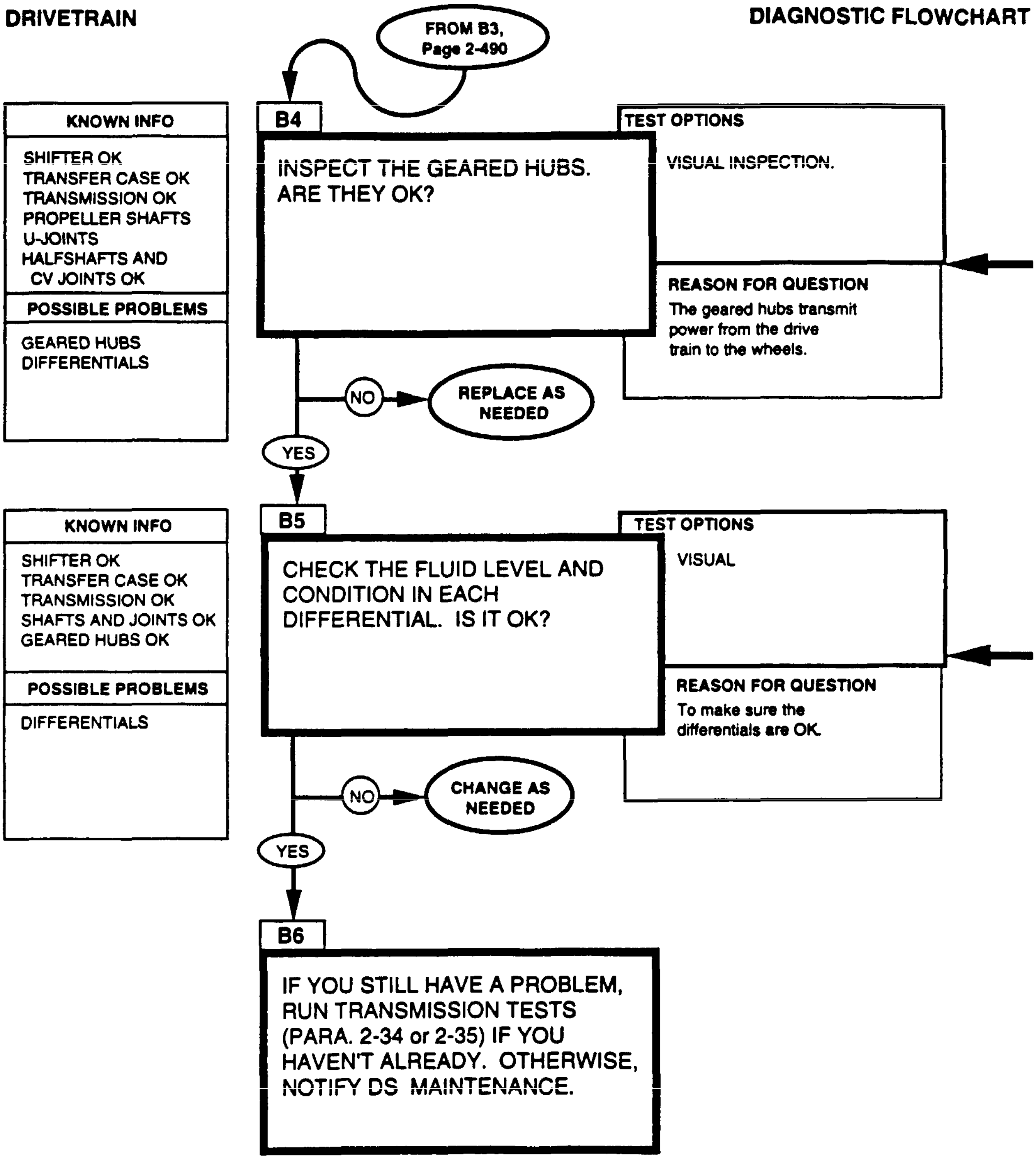


If the vehicle doesn't move, all four shafts maybe broken. Check for tom boots on the CV joints, stripped splines, smooth joint operation, and proper mounting torques.

For halfshaft maintenance pro-cddures, refer to (para 6-9).

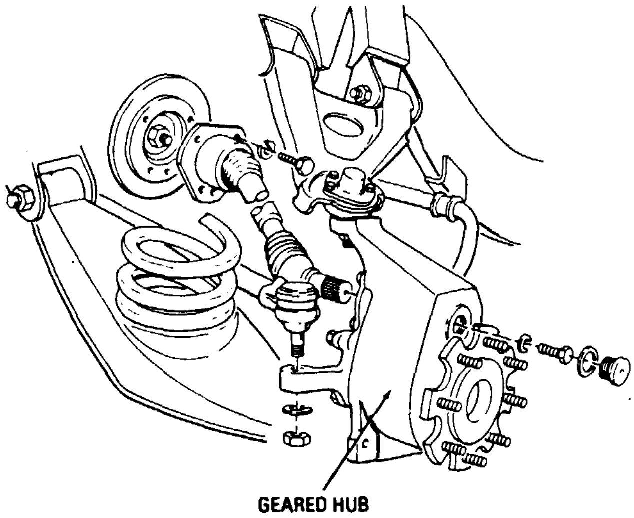
Lube in accordance with TM 9-2320-280-10.

DRIVETRAIN DIAGNOSTIC FLOWCHART



Make sure the geared hubs turn freely. For geared hub replacement procedure, refer to (para 6-11). Check mounting hardware for proper installation.

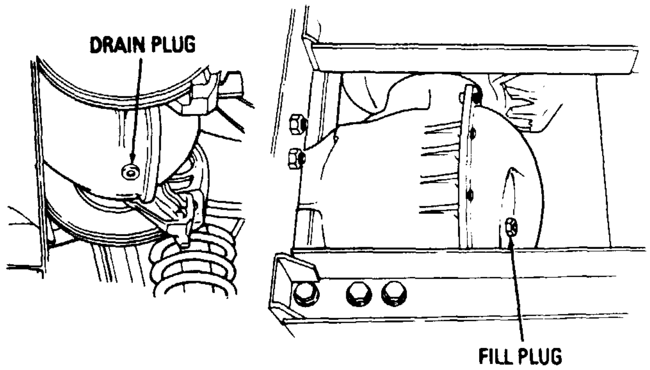
Lube in accordance with TM 9-2320-280-10.



Check for loose mounting and broken parts. Notify DS maintenance.

Check fluid level in accordance with TM 9-2320-280-10.

Notify DS maintenance for other faults.



DRIVETRAIN **DIAGNOSTIC FLOWCHART**

C
FROM 3,
Page 2-480

KNOWN INFO

SPEEDOMETER DOESN'T WORK

POSSIBLE PROBLEMS

DRIVEN GEAR
CABLE
SPEEDOMETER HEAD

C1

DISCONNECT THE SPEEDOMETER CABLE FROM THE TRANSFER CASE. TURN THE CABLE BY HAND. DOES THE SPEEDOMETER RESPOND TO THE CABLE?

TEST OPTIONS

TURN THE CABLE AND HAVE AN ASSISTANT SEE IF THE NEEDLE MOVES. IT WILL ONLY MOVE A LITTLE, SO WATCH CLOSELY.

REASON FOR QUESTION

If the speedometer moves in response to the cable, it means the driven gear or the drive gear is no good.

NO → **SEE NOTE AT RIGHT**

YES ↓

KNOWN INFO

SPEEDOMETER DOESN'T WORK
DRIVEN GEAR OK

POSSIBLE PROBLEMS

CABLE
SPEEDOMETER

C2

DISCONNECT THE SPEEDOMETER CABLE FROM THE SPEEDOMETER. AGAIN, TURN THE CABLE BY HAND AT THE TRANSFER CASE. DID THE SPEEDOMETER END OF THE CABLE TURN?

TEST OPTIONS

HAVE AN ASSISTANT TURN ONE END WHILE YOU WATCH THE OTHER.

REASON FOR QUESTION

This will tell you if the cable is OK.

NO → **REPLACE CABLE**

YES ↓

REPLACE SPEEDOMETER

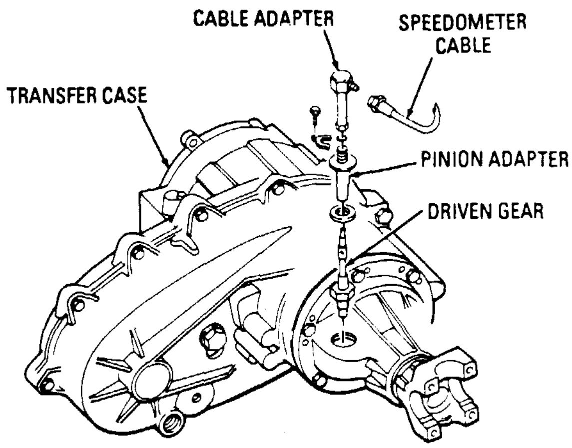
REFERENCE INFORMATION

A no answer means the speedometer did move.

NOTE

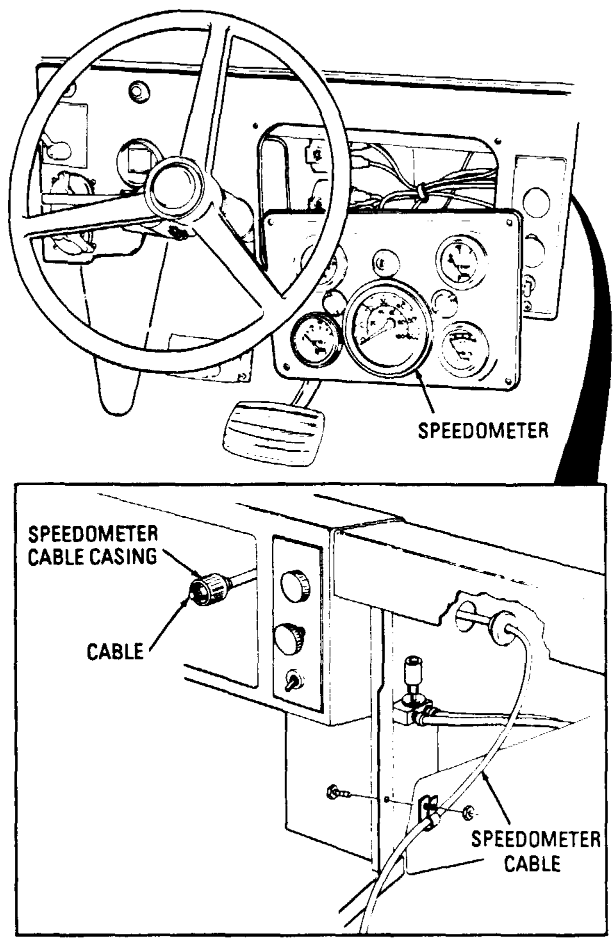
If you answer NO, check the driven gear in the transfer case. if it's OK, the problem is the drive gear. Notify DS maintenance.

Replace the driven gear, refer to (para 5-24).



Replace the cable, refer to (para 4-15).

Replace speedometer, refer to (para 4-14).



2-39. AMBULANCE ELECTRICAL SYSTEM TESTS

This section provides information to diagnose and correct malfunctions of the ambulance electrical system.

Each malfunction symptom given for an individual component or system is followed by step(s) that you should take to determine the cause and corrective action necessary to remedy the problem.

Before taking any action to correct a possible malfunction, the following rules should be followed:

(1) Question the operator to obtain any information that might help you determine the cause of the problem.

(2) Never overlook the chance that the problem could be of simple origin because it could be corrected with minor adjustment.

(3) Use all senses to observe and locate trouble spots.

(4) Use test instruments or gauges to help you determine and isolate problem.

(5) Always isolate the system where the malfunction occurs and then locate the defective component.

(6) Use standard automotive theories and principles when troubleshooting the vehicles covered in this manual.

(7) Functional Schematics for ambulance electrical systems are located on pages 2-685 thru 2-691.

AMBULANCE
(All Dome Lamps)
With Ambulance Compartment Front Door, Rear Door, and Rear Step closed (Refer to Fig. 11.)

DIAGNOSTIC FLOWCHART

START

1

REPLACE OLD BULBS WITH NEW ONES. IS LIGHT SWITCH ON CONTROL BOX IN NORMAL OPERATING POSITION?

KNOWN INFO
NOTHING

POSSIBLE PROBLEMS
LIGHT SWITCH POSITION
BATTERY
CABLE 660
LIGHT SWITCH
RELAY 1

TEST OPTIONS
VISUAL

REASON FOR QUESTION
Improper switch position would cause dome lights not to illuminate.

NO → PLACE LIGHT SWITCH TO NORMAL POSITION

YES ↓

2

IS BATTERY IN PROPER WORKING ORDER?

KNOWN INFO
LIGHT SWITCH POSITION OK

POSSIBLE PROBLEMS
BATTERY
CABLE 660
LIGHT SWITCH
RELAY 1

TEST OPTIONS
1. STE/ICE-R TEST 89, Page 2-750
2. MULTIMETER

REASON FOR QUESTION
Battery malfunction will cause any dependent circuit to malfunction.

NO → GO TO 1, Page 2-252

YES ↓

3

IS THERE BATTERY VOLTAGE IN CONTROL BOX AT POWER STUD?

KNOWN INFO
LIGHT SWITCH POSITION OK
BATTERY OK

POSSIBLE PROBLEMS
CABLE 660
LIGHT SWITCH
RELAY 1

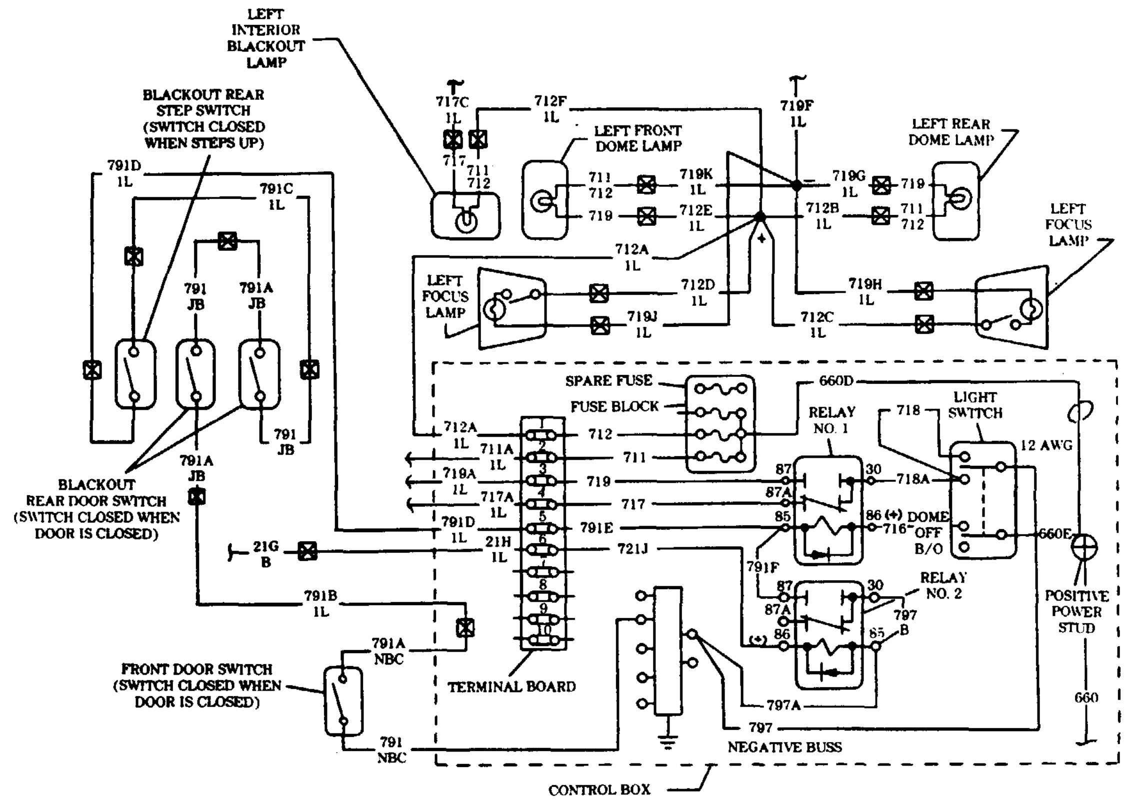
TEST OPTIONS
1. STE/ICE-R TEST 89, Page 2-750
2. MULTIMETER

REASON FOR QUESTION
No power at power stud would indicate a damaged cable from power source.

NO → REPAIR CABLE 660

YES ↓

GO TO 4, Page 2-500



Repair cable, refer to DS Maintenance.

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.

AMBULANCE
(All Dome Lamps)

With Ambulance Compartment Front Door, Rear Door, and Rear Step closed (Refer to Fig. 11.)

DIAGNOSTIC FLOWCHART

FROM 3, Page 2-498

KNOWN INFO

LIGHT SWITCH POSITION OK
BATTERY OK
CABLE 660 OK

POSSIBLE PROBLEMS

LIGHT SWITCH
RELAY 1

4

IS THERE BATTERY VOLTAGE IN CONTROL BOX AT RELAY 1, TERMINAL 86?

TEST OPTIONS

1. STE/ICE-R TEST 89, PAGE 2-750
2. MULTIMETER

REASON FOR QUESTION

If you have battery voltage here, then light switch is ok.

NO → REPLACE LIGHT SWITCH

YES ↓

KNOWN INFO

LIGHT SWITCH POSITION OK
BATTERY OK
CABLE 660 OK
LIGHT SWITCH OK

POSSIBLE PROBLEMS

RELAY 1

5

PLACE JUMPER WIRE FROM TERMINAL 87 TO TERMINAL 30 OF RELAY 1. DO DOME LAMPS ILLUMINATE?

TEST OPTIONS

TRY IT

REASON FOR QUESTION

If dome lights operate, then relay 1 is malfunctioning.

NO → GO TO 6, Page 2-502

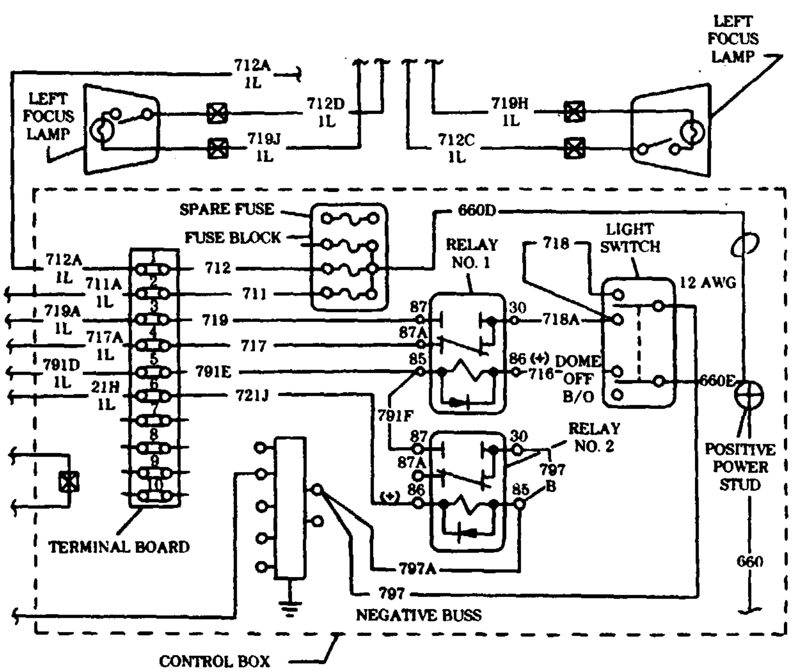
YES → REPLACE RELAY 1

Replace light switch, refer to (para. 4-118).

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.

Replace relay 1, refer to (para. 4-120).



AMBULANCE
(All Dome Lamps)
With Ambulance Compartment Front Door, Rear Door, and Rear Step closed (Refer to Fig. 11.)

DIAGNOSTIC FLOWCHART

FROM 5, Page 2-500

KNOWN INFO

PREVIOUSLY CORRECTED INFORMATION

POSSIBLE PROBLEMS

LEAD 791 E
LEAD 791 D
BLACKOUT REAR STEP SWITCH LEAD 791 A
BLACKOUT REAR DOOR SWITCH LEAD 791 B
LEAD 791 A
FRONT DOOR SWITCH LEAD 791

6

IS THERE CONTINUITY IN THE CONTROL BOX BETWEEN TERMINAL 85 OF RELAY 1 AND TERMINAL BOARD (TB) TERMINAL 5?

TEST OPTIONS

1. STE/ICE-R TEST 91, PAGE 2-752
2. MULTIMETER

REASON FOR QUESTION

No continuity would indicate a damaged lead.

NO → REPLACE LEAD 791 E

YES ↓

KNOWN INFO

POSSIBLE PROBLEMS

LEAD 791 D
BLACKOUT REAR STEP SWITCH LEAD 791 C
BLACKOUT REAR DOOR SWITCH LEAD 791 A
BLACKOUT REAR DOOR SWITCH LEAD 791 B
LEAD 791 A
FRONT DOOR SWITCH LEAD 791

7

IS THERE CONTINUITY IN THE CONTROL BOX BETWEEN TB TERMINAL 5 AND BLACKOUT REAR STEP SWITCH?

TEST OPTIONS

1. STE/ICE-R TEST 91, PAGE 2-752
2. MULTIMETER

REASON FOR QUESTION

No continuity would indicate a damaged lead.

NO → REPAIR LEAD 791 D

YES ↓

KNOWN INFO

LEAD 791 E OK
LEAD 791 D OK

POSSIBLE PROBLEMS

BLACKOUT REAR STEP SWITCH LEAD 791 C
BLACKOUT REAR DOOR SWITCH LEAD 791 A
BLACKOUT REAR DOOR SWITCH LEAD 791 B
LEAD 791 A
FRONT DOOR SWITCH LEAD 791

8

IS THERE CONTINUITY ACROSS BLACKOUT REAR STEP SWITCH?

TEST OPTIONS

1. STE/ICE-R TEST 91, PAGE 2-752
2. MULTIMETER

REASON FOR QUESTION

No continuity would indicate a malfunction of the switch.

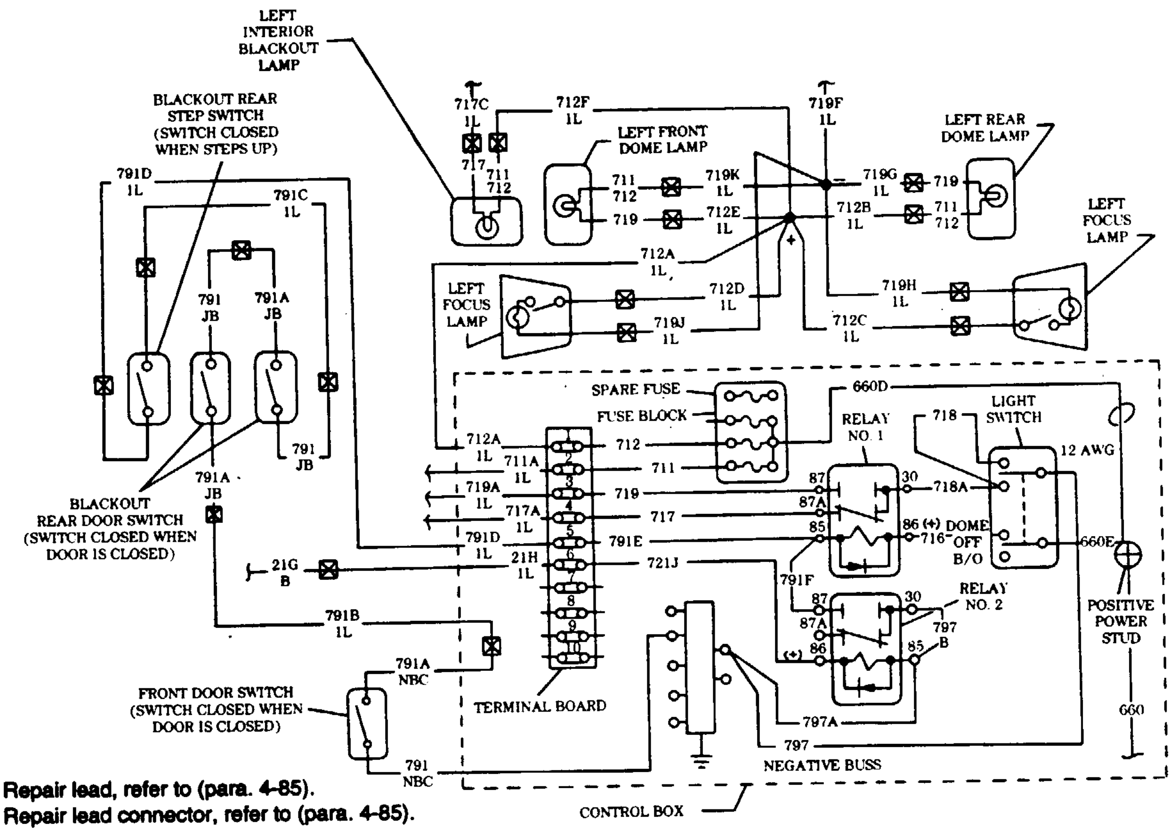
NO → ADJUST AND/OR REPLACE BLACKOUT REAR STEP SWITCH

YES ↓

GO TO 9, Page 2-504

REFERENCE INFORMATION

AMBULANCE



Repair lead, refer to (para. 4-85).
Repair lead connector, refer to (para. 4-85).

Replace blackout rear step switch, refer to (para. 4-92).

0-4500 DC OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second. 2. Start test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms. 2. Connect the RED and BLACK leads to the connections stated in the question. 3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

AMBULANCE
(All Dome Lamps)
With Ambulance Compartment Front Door, Rear Door, and Rear Step closed (Refer to Fig. 11.)

DIAGNOSTIC FLOWCHART

FROM 8, Page 2-502

KNOWN INFO

LEAD 791 E OK
LEAD 791 D OK
BLACKOUT REAR STEP SWITCH OK

POSSIBLE PROBLEMS

LEAD 791 C
BLACKOUT REAR DOOR SWITCH LEAD 791 A
BLACKOUT REAR DOOR SWITCH 791 B
LEAD 791 A
FRONT DOOR SWITCH LEAD 791

9

IS THERE CONTINUITY BETWEEN BLACKOUT REAR STEP SWITCH AND BLACKOUT REAR DOOR SWITCH?

TEST OPTIONS

1. STE/ICE-R TEST 91, PAGE 2-752
2. MULTIMETER

REASON FOR QUESTION

No continuity would indicate a damaged lead.

NO → REPLACE LEAD 791 C

YES ↓

KNOWN INFO

LEAD 791 C OK
LEAD 791 E OK
LEAD 791 D OK
BLACKOUT REAR STEP SWITCH OK

POSSIBLE PROBLEMS

BLACKOUT REAR STEP SWITCH LEAD 791 A
BLACKOUT REAR DOOR SWITCH LEAD 791 B
LEAD 791 A
FRONT DOOR SWITCH LEAD 791

10

IS THERE CONTINUITY ACROSS BLACKOUT REAR DOOR SWITCH?

TEST OPTIONS

1. STE/ICE-R TEST 91, PAGE 2-752
2. MULTIMETER

REASON FOR QUESTION

No continuity would indicate a malfunction of the switch.

NO → ADJUST AND/OR REPLACE BLACKOUT REAR DOOR SWITCH

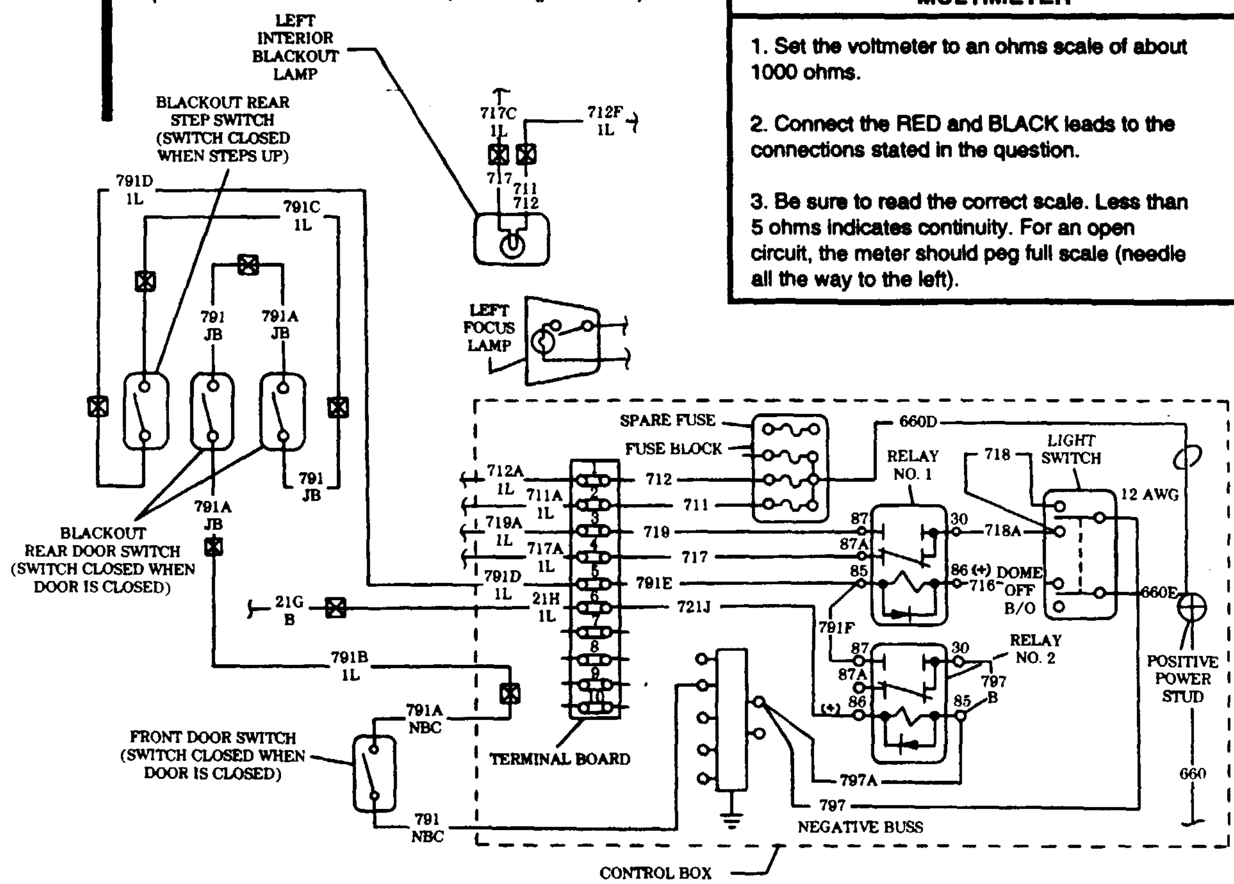
YES ↓

GO TO 11, Page 2-506

0-4500 DC OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second. 2. Start test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms. 2. Connect the RED and BLACK leads to the connections stated in the question. 3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

Replace blackout rear door switch, refer to (para. 4-93).



AMBULANCE
(All Dome Lamps)
With Ambulance Compartment Front Door, Rear Door, and Rear Step Closed (Refer to Fig. 11.)

DIAGNOSTIC FLOWCHART

FROM 10, Page 2-504

KNOWN INFO

LEAD 791 E OK
LEAD 791 D OK
BLACKOUT REAR STEP SWITCH OK
BLACKOUT REAR DOOR SWITCH OK

POSSIBLE PROBLEMS

BLACKOUT REAR DOOR SWITCH LEAD 791 B
LEAD 791 A
FRONT DOOR SWITCH LEAD 791

11

IS THERE CONTINUITY ACROSS SECOND BLACK-OUT REAR DOOR SWITCH?

TEST OPTIONS

1. STE/ICE-R TEST 91, PAGE 2-752
2. MULTIMETER

REASON FOR QUESTION

No continuity would indicate a malfunction of the switch.

NO → ADJUST AND/OR REPLACE BLACKOUT REAR DOOR SWITCH

YES ↓

KNOWN INFO

LEAD 791 E OK
LEAD 791 D OK
BLACKOUT REAR STEP SWITCH OK
LEAD 791 C OK
BLACKOUT REAR DOOR SWITCH OK
BLACKOUT REAR DOOR SWITCH OK

POSSIBLE PROBLEMS

LEAD 791 B
LEAD 791 A
FRONT DOOR SWITCH LEAD 791

12

IS THERE CONTINUITY OF LEAD 791 B?

TEST OPTIONS

STE/ICE-R TEST 91, PAGE 2-752

REASON FOR QUESTION

No continuity would indicate a damaged lead.

NO → GO TO 1, PAGE 2-196

YES ↓

KNOWN INFO

LEAD 791 E OK
LEAD 791 D OK
BLACKOUT REAR STEP SWITCH OK
LEAD 791 C OK
BLACKOUT REAR DOOR SWITCH OK
BLACKOUT REAR DOOR SWITCH OK
LEAD 791 B OK

POSSIBLE PROBLEMS

LEAD 791 A
FRONT DOOR SWITCH LEAD 791

13

IS THERE CONTINUITY BETWEEN FRONT DOOR SWITCH AND LEAD 791 B?

TEST OPTIONS

STE/ICE-R TEST 91, PAGE 2-752

REASON FOR QUESTION

No continuity would indicate a damaged lead.

NO → REPAIR LEAD 791 A

YES ↓

GO TO 14, Page 2-508

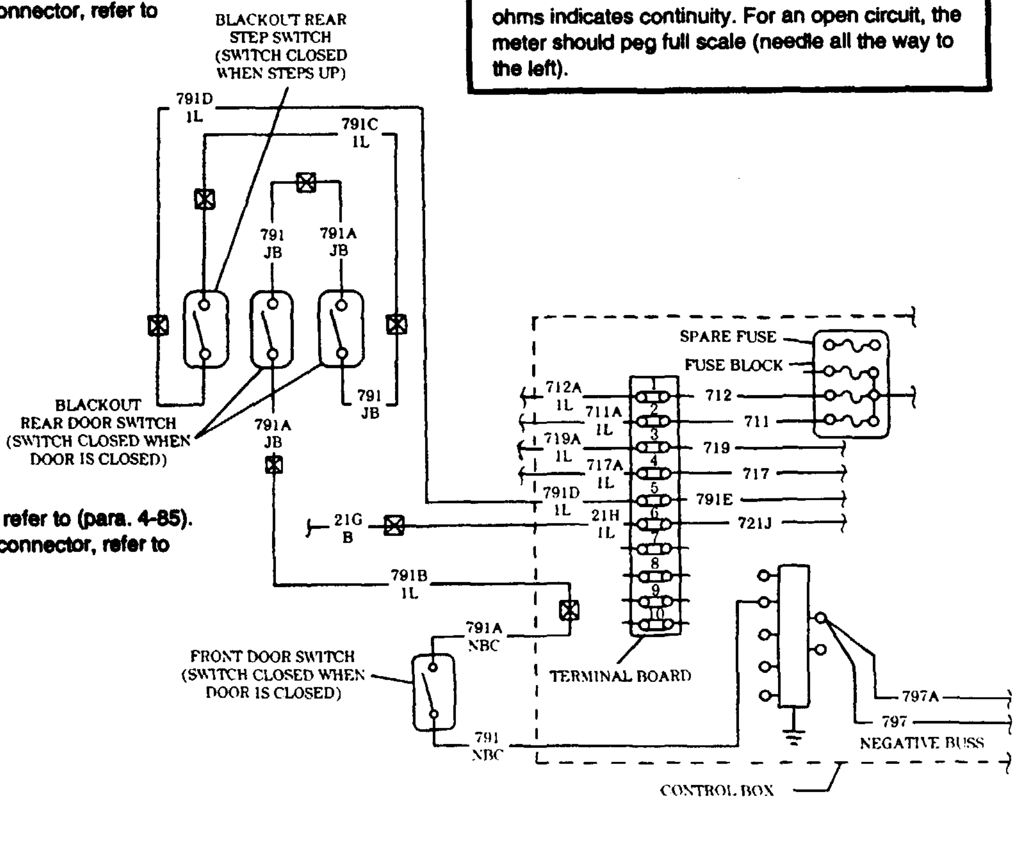
Replace blackout rear door switch, refer to (para. 4-93).

0-4500 DC OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second. 2. Start test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms. 2. Connect the RED and BLACK leads to the connections stated in the question. 3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

Repair lead, refer to (para. 4-85).
Repair lead connector, refer to (para. 4-85).

Repair lead, refer to (para. 4-85).
Repair lead connector, refer to (para. 4-85).



AMBULANCE (All Dome Lamps)

With Ambulance Compartment Front Door, Rear Door, and Rear Step Closed (Refer to Fig. 11.)

DIAGNOSTIC FLOWCHART

FROM 13, Page 2-506

14

KNOWN INFO
LEAD 791 E OK LEAD 791 D OK BLACKOUT REAR STEP SWITCH OK BLACKOUT REAR DOOR SWITCH OK BLACKOUT REAR DOOR SWITCH OK LEAD 791 B OK LEAD 791 A OK
POSSIBLE PROBLEMS
FRONT DOOR SWITCH LEAD 791

IS THERE CONTINUITY ACROSS FRONT DOOR SWITCH?

TEST OPTIONS

1. STE/ICE-R TEST 91, PAGE 2-752
2. MULTIMETER

REASON FOR QUESTION

No continuity would indicate a malfunction of the switch.

NO → ADJUST AND/OR REPLACE FRONT DOOR SWITCH

YES ↓

15

KNOWN INFO
LEAD 791 E OK LEAD 791 D OK BLACKOUT REAR STEP SWITCH OK LEAD 791 C OK BLACKOUT REAR DOOR SWITCH OK BLACKOUT REAR DOOR SWITCH OK LEAD 791 B OK LEAD 791 A OK FRONT DOOR SWITCH OK
POSSIBLE PROBLEMS
LEAD 791

IS THERE CONTINUITY BETWEEN FRONT DOOR SWITCH AND NEGATIVE BUSS TERMINAL?

TEST OPTIONS

STE/ICE-R TEST 91, PAGE 2-752

REASON FOR QUESTION

No continiuty would indicate a damaged lead, thus complete circuit is not grounded.

NO → REPAIR LEAD 791

YES ↓

16

KNOWN INFO
LEAD 791 E OK LEAD 791 D OK BLACKOUT REAR STEP SWITCH OK LEAD 791 C OK BLACKOUT REAR DOOR SWITCH OK BLACKOUT REAR DOOR SWITCH OK LEAD 791 B OK LEAD 791 A OK FRONT DOOR SWITCH OK LEAD 791 OK
POSSIBLE PROBLEMS

DO DOME LAMPS ILLUMINATE?

TEST OPTIONS

TRY IT

REASON FOR QUESTION

All ground leads should be checked and problem should be tracked for proper powering.

NO → GO TO 17, Page 2-510

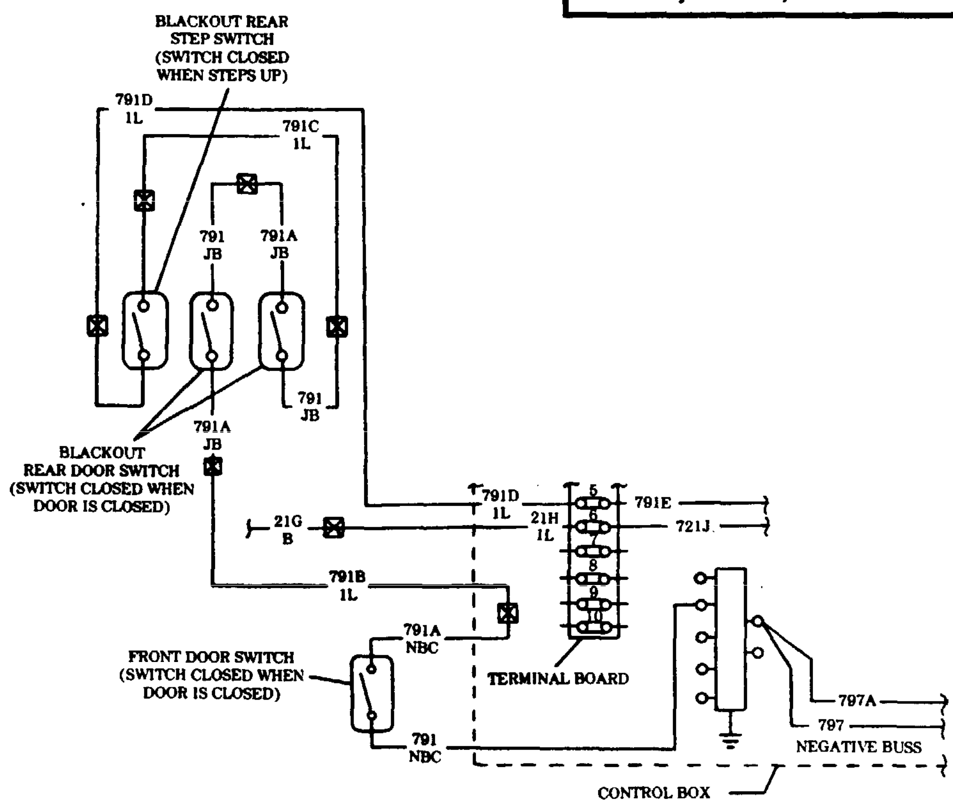
YES → END OF TESTING

Replace front door switch, refer to (para. 4-94).

Repair lead, refer to (para. 4-85).

0-4500 DC OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in question. RED to the first, BLACK to the second. 2. Start test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms. STE/ICE displays "9.9.9.9."

CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms. 2. Connect the RED and BLACK leads to the connections stated in the question. 3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).



AMBULANCE
(All Dome Lamps)
With Ambulance Compartment Front Door, Rear Door, and Rear Step Closed (Refer to Fig. 11.)

DIAGNOSTIC FLOWCHART

FROM 16, Page 2-508

17

KNOWN INFO

PREVIOUSLY CORRECTED INFORMATION

POSSIBLE PROBLEMS

LEAD 660 D
BLOWN FUSES
LEAD 712
LEAD 711
DAMAGED LEADS

IS THERE BATTERY VOLTAGE IN CONTROL BOX AT FUSE BLOCK?

TEST OPTIONS

1. STE/ICE-R TEST 89, PAGE 2-750
2. MULTIMETER

REASON FOR QUESTION

No voltage wound indicate a damaged power supply lead, thus no power.

NO → REPLACE LEAD 660 D

YES ↓

18

KNOWN INFO

LEAD 660 D OK

POSSIBLE PROBLEMS

BLOWN FUSES
LEAD 712
LEAD 711
DAMAGED LEADS

CHECK FUSE BLOCK IN CONTROL BOX. ARE FUSES OK?

TEST OPTIONS

VISUAL

REASON FOR QUESTION

Damaged fuses causes the power circuit to be incomplete.

NO → REPLACE BLOWN FUSES

YES ↓

19

KNOWN INFO

LEAD 660 D OK
FUSES OK

POSSIBLE PROBLEMS

LEAD 712
LEAD 711
DAMAGED LEADS

IS THERE BATTERY VOLTAGE IN CONTROL BOX AT:
TB TERMINAL 1?
TB TERMINAL 2?

TEST OPTIONS

1. STE/ICE-R TEST 89, PAGE 2-750
2. MULTIMETER

REASON FOR QUESTION

No power would indicate damaged leads.

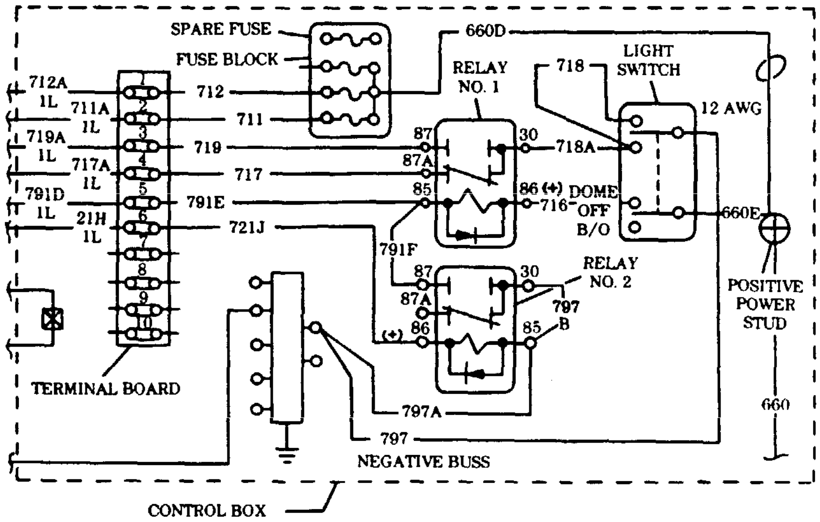
NO → REPLACE LEAD 712 AND/OR LEAD 711

YES ↓

GO TO 20, Page 2-512

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start test 89, DC volts. 3. Displayed reading is in volts.

BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.



AMBULANCE
(All Dome Lamps)
With Ambulance Compartment Front Door, Rear Door, and Rear Step Closed (Refer to Fig. 11.)

DIAGNOSTIC FLOWCHART

FROM 19, Page 2-510

KNOWN INFO

LEAD 660 D OK
FUSES OK
LEAD 712 OK
LEAD 711 OK

POSSIBLE PROBLEMS

DAMAGED LAMPS

20

IS THERE BATTERY VOLTAGE AT DOME LAMPS THROUGH:
LEADS 712 A, 712 E, AND 712 B?
LEADS 711 A, 711 F, AND 711 C?

TEST OPTIONS

1. STE/ICE-R TEST 89, PAGE 2-750
2. MULTIMETER

REASON FOR QUESTION

No power would indicate damaged leads.

NO → REPAIR DAMAGED LEADS AND/OR LAMP ASSEMBLIES

YES ↓

KNOWN INFO

LEAD 660 D OK
FUSES OK
LEAD 712 OK
LEAD 711 OK
LEADS OK

POSSIBLE PROBLEMS

21

DO DOME LAMPS ILLUMINATE?

TEST OPTIONS

TRY IT

REASON FOR QUESTION

No power would indicate damaged leads.

NO → GO TO 22, Page 2-514

YES ↓

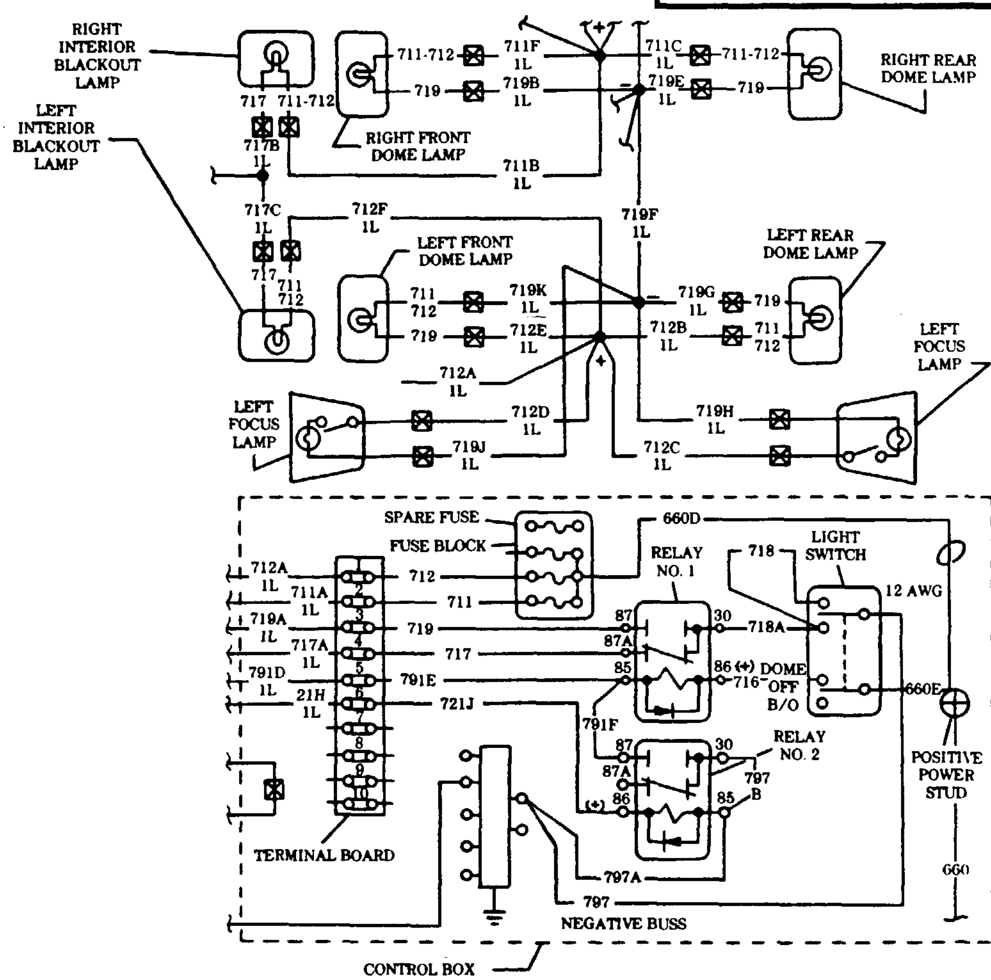
END OF TESTING

Replace dome lamp assembly, refer to (para. 4-87).

Repair lead connector, refer to (para. 4-85).

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start test 89, DC volts. 3. Displayed reading is in volts.

BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.



AMBULANCE
(All Dome Lamps)
With Ambulance Compartment Front Door, Rear Door, and Rear Step Closed (Refer to Fig. 11.)

DIAGNOSTIC FLOWCHART

FROM 21, Page 2-512

KNOWN INFO

PREVIOUSLY CORRECTED INFORMATION

POSSIBLE PROBLEMS

LEAD 797
LIGHT SWITCH
LEAD 718
LEAD 718 A
LEAD 719
DAMAGED LEADS
DOME LAMP SOCKETS

22

IS THERE CONTINUITY IN CONTROL BOX BETWEEN NEGATIVE BUSS AND LIGHT SWITCH?

TEST OPTIONS

STE/ICE-R TEST 91, PAGE 2-752

REASON FOR QUESTION

No continuity would indicate a damaged lead.

NO → REPAIR LEAD 797

YES ↓

KNOWN INFO

LEAD 797 OK

POSSIBLE PROBLEMS

LIGHT SWITCH
LEAD 718
LEAD 718 A
LEAD 719
DAMAGED LEADS
DOME LAMP SOCKETS

23

IS THERE CONTINUITY IN CONTROL BOX ACROSS LIGHT SWITCH?

TEST OPTIONS

1. STE/ICE-R TEST 91, PAGE 2-752
2. MULTIMETER

REASON FOR QUESTION

No continuity would indicate a damaged switch.

NO → REPLACE LIGHT SWITCH

YES ↓

KNOWN INFO

LEAD 797 OK
LIGHT SWITCH OK

POSSIBLE PROBLEMS

LEAD 718
LEAD 718 A
LEAD 719
DAMAGED LEADS
DOME LAMP SOCKETS

24

IS THERE CONTINUITY IN CONTROL BOX, AT LIGHT SWITCH, OF LEAD 718?

TEST OPTIONS

STE/ICE-R TEST 91, PAGE 2-752

REASON FOR QUESTION

No continuity would indicate a damaged lead.

NO → REPLACE LEAD 718

YES ↓

GO TO 25, Page 2-516

Repair lead, refer to (para. 4-85).

Replace light switch, refer to (para. 4-118).

0-4500 DC OHMS
STE/ICE-R TEST 91

1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second.

2. Start Test 91, 0-4500 ohms.

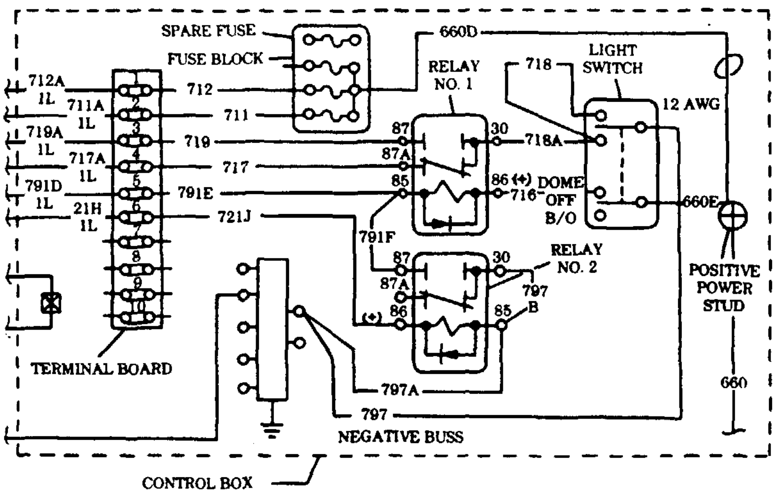
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

CONTINUITY (RESISTANCE)
MULTIMETER

1. Set the voltmeter to an ohms scale of about 1000 ohms.

2. Connect the RED and BLACK leads to the connections stated in the question.

3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).



AMBULANCE
(All Dome Lamps)
With Ambulance Compartment Front Door, Rear Door, and Rear Step Closed (Refer to Fig. 11.)

DIAGNOSTIC FLOWCHART

FROM 24, Page 2-514

25

KNOWN INFO
LEAD 797 OK LIGHT SWITCH OK LEAD 718 OK
POSSIBLE PROBLEMS
LEAD 718 A LEAD 719 DAMAGED LEADS DOME LAMP SOCKETS

IS THERE CONTINUITY IN CONTROL BOX BETWEEN RELAY 1, TERMINAL 30, AND LIGHT SWITCH?

TEST OPTIONS
STE/ICE-R TEST 91, PAGE 2-752

REASON FOR QUESTION
No continuity would indicate a damaged lead.

NO → REPLACE LEAD 718 A

YES ↓

26

KNOWN INFO
LEAD 797 OK LIGHT SWITCH OK LEAD 718 OK LEAD 718A OK
POSSIBLE PROBLEMS
LEAD 719 DAMAGED LEADS DOME LAMP SOCKETS

IS THERE CONTINUITY IN CONTROL BOX BETWEEN TB TERMINAL 3, RELAY 1, AND TERMINAL 87?

TEST OPTIONS
STE/ICE-R TEST 91, PAGE 2-752

REASON FOR QUESTION
No continuity would indicate a damaged lead.

NO → REPLACE LEAD 719

YES ↓

27

KNOWN INFO
LEAD 797 OK LIGHT SWITCH OK LEAD 718 OK LEAD 718 A OK LEAD 719 OK
POSSIBLE PROBLEMS
DAMAGED LEADS DOME LAMP SOCKETS

IS THERE CONTINUITY IN CONTROL BOX BETWEEN TB TERMINAL 3 AND DOME LAMPS THROUGH:
LEADS 719 A, 719 B, AND719 E?
LEADS 719 A, 719 F, 719 K, AND 719 G?

TEST OPTIONS
1. STE/ICE-R TEST 91, PAGE 2-752
2. MULTIMETER

REASON FOR QUESTION
No continuity would indicate damaged leads.

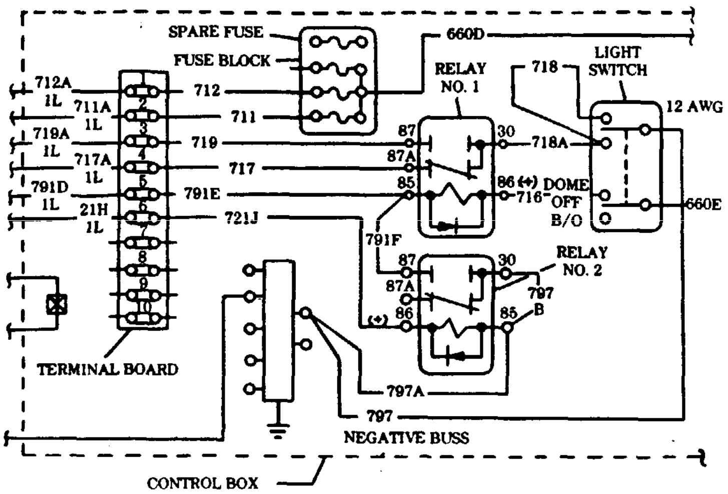
NO → REPAIR DAMAGED LEADS

YES ↓

GO TO 28, Page 2-518

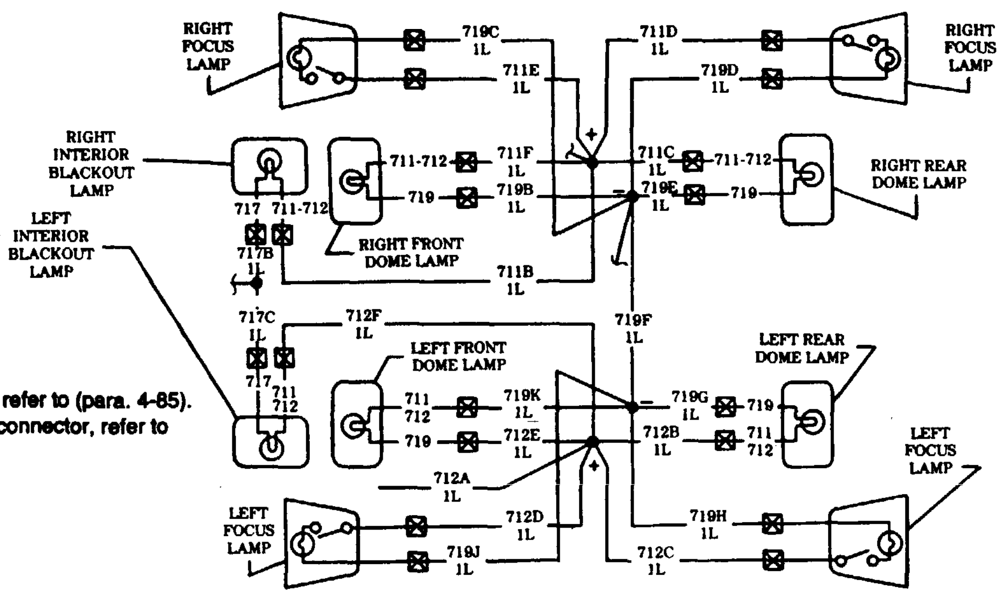
REFERENCE INFORMATION

AMBULANCE



0-4500 DC OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms. 2. Connect the RED and BLACK leads to the connections stated in the question. 3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).



Repair lead, refer to (para. 4-85).
Repair lead connector, refer to (para. 4-85).

AMBULANCE
(All Dome Lamps)
With Ambulance Compartment Front Door, Rear Door, and Rear Step Closed (Refer to Fig. 11.)

DIAGNOSTIC FLOWCHART

FROM 27, Page 2-516

28

KNOWN INFO

LEAD 797 OK
LIGHT SWITCH OK
LEAD 718 OK
LEAD 718 A OK
LEAD 719 OK
DAMAGED LEADS OK

POSSIBLE PROBLEMS

DAMAGED LAMPS

IS THERE CONTINUITY THROUGH DOME LAMPS?

TEST OPTIONS

1. STE/ICE-R TEST 91, PAGE 2-752
2. MULTIMETER

REASON FOR QUESTION

No continuity would indicate damaged lamp sockets.

NO → REPLACE DAMAGED DOME LAMPS

YES ↓

29

KNOWN INFO

LEAD 660 D OK
FUSES OK
LEAD 712 OK
LEAD 711 OK
LEADS OK

POSSIBLE PROBLEMS

DO DOME LAMPS ILLUMINATE?

TEST OPTIONS

TRY IT

REASON FOR QUESTION

If lamps do not illuminate, that would indicate a malfunction not handled at this level.

NO → NOTIFY DS MAINTENANCE

YES ↓

END OF TESTING

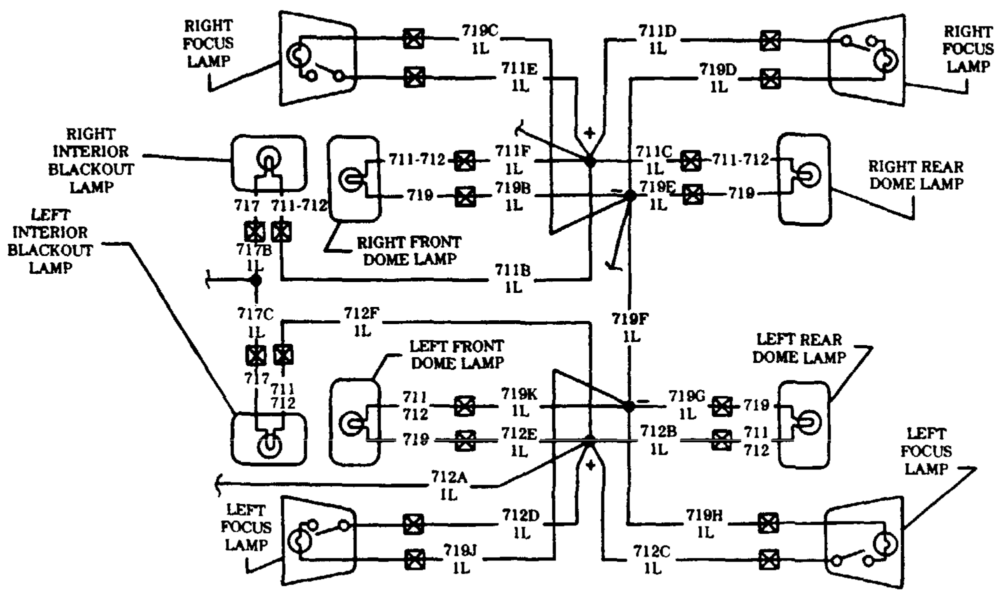
REFERENCE INFORMATION

AMBULANCE

Replace dome lamps, refer to (para. 4-87).

0-4500 DC OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Dilsplayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms. 2. Connect the RED and BLACK leads to the connections stated in the question. 3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).



AMBULANCE
(All Dome Lamps)

With Ambulance compartment front door, rear door, and rear step open and vehicle light switch in service position. (Refer to Fig. 11.)

DIAGNOSTIC FLOWCHART

START

1

REPLACE OLD BULBS WITH NEW ONES. IS VEHICLE LIGHT SWITCH OK?

KNOWN INFO: NOTHING

POSSIBLE PROBLEMS: VEHICLE LIGHT SWITCH; VEHICLE LIGHT SWITCH POSITION; RELAY 2

TEST OPTIONS: VISUAL

REASON FOR QUESTION: Loose connection can be the cause of a malfunction.

NO: REPAIR/REPLACE VEHICLE LIGHT SWITCH

YES:

2

IS VEHICLE LIGHT SWITCH IN PROPER OPERATING POSITION?

KNOWN INFO: VEHICLE LIGHT SWITCH OK

POSSIBLE PROBLEMS: VEHICLE LIGHT SWITCH POSITION; RELAY 2

TEST OPTIONS: VISUAL

REASON FOR QUESTION: Improper switch position would cause dome lamps to illuminate.

NO: PLACE VEHICLE LIGHT SWITCH TO SERVICE DRIVE POSITION

YES:

3

PERFORM STEPS 1-3, PAGE 2-498 AND STEP 4, PAGE 2-500 AND GO TO 4, PAGE 2-522.

KNOWN INFO: VEHICLE LIGHT SWITCH OK; VEHICLE LIGHT SWITCH POSITION OK

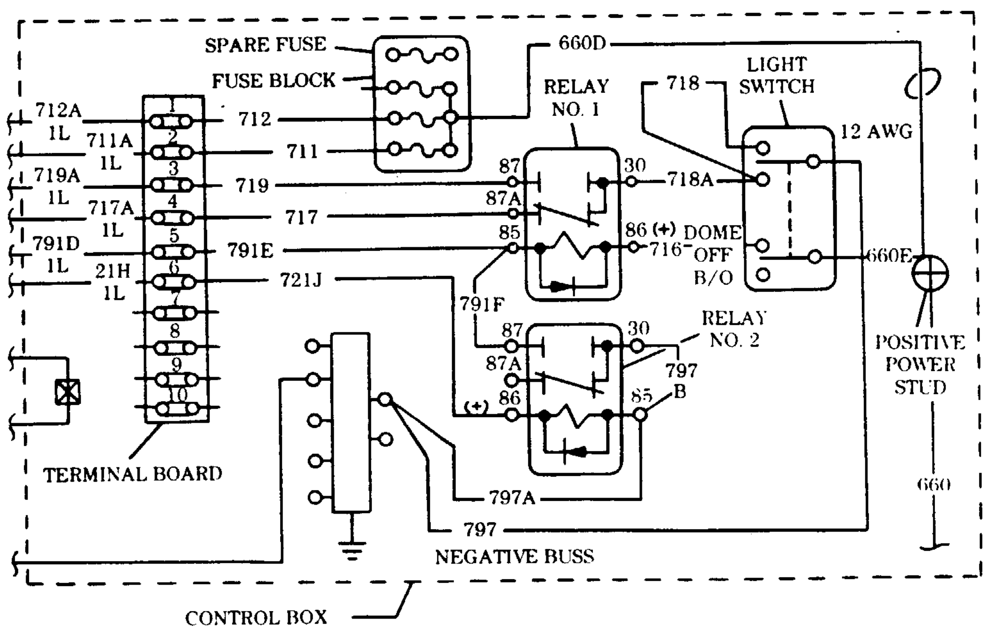
POSSIBLE PROBLEMS: RELAY 2

TEST OPTIONS: TRY IT

REASON FOR QUESTION: No power would indicate a relay 2 malfunction.

GO TO 4, Page 2-522

Replace main light switch, refer to (para. 4-59).



AMBULANCE
(All Dome Lamps)
With Ambulance compartment front door, rear door, or rear step open and vehicle light switch in service position (Refer to Fig. 11.)

DIAGNOSTIC FLOWCHART

FROM 3, Page 2-520

4

KNOWN INFO
VEHICLE LIGHT SWITCH OK VEHICLE LIGHT SWITCH POSITION OK BATTERY OK CABLE 660 OK
POSSIBLE PROBLEMS
RELAY 2

IS THERE BATTERY VOLTAGE IN CONTROL BOX AT RELAY 2, TERMINAL 86?

TEST OPTIONS

1. STE/ICE-R TEST 89, PAGE 2-750
2. MULTIMETER

REASON FOR QUESTION

No power would indicate a vehicle light switch malfunction.

NO → REPLACE VEHICLE LIGHT SWITCH

YES ↓

5

KNOWN INFO
VEHICLE LIGHT SWITCH OK VEHICLE LIGHT SWITCH POSITION OK BATTERY OK CABLE 660 OK
POSSIBLE PROBLEMS
RELAY 2

PLACE JUMPER WIRE FROM TERMINAL 87 TO TERMINAL 30 OF RELAY.
DO DOME LAMPS ILLUMINATE?

TEST OPTIONS

TRY IT

REASON FOR QUESTION

If lamps illuminate, that would indicate a malfunction in relay 2.

NO → GO TO 6, Page 2-524

YES → REPLACE RELAY 2

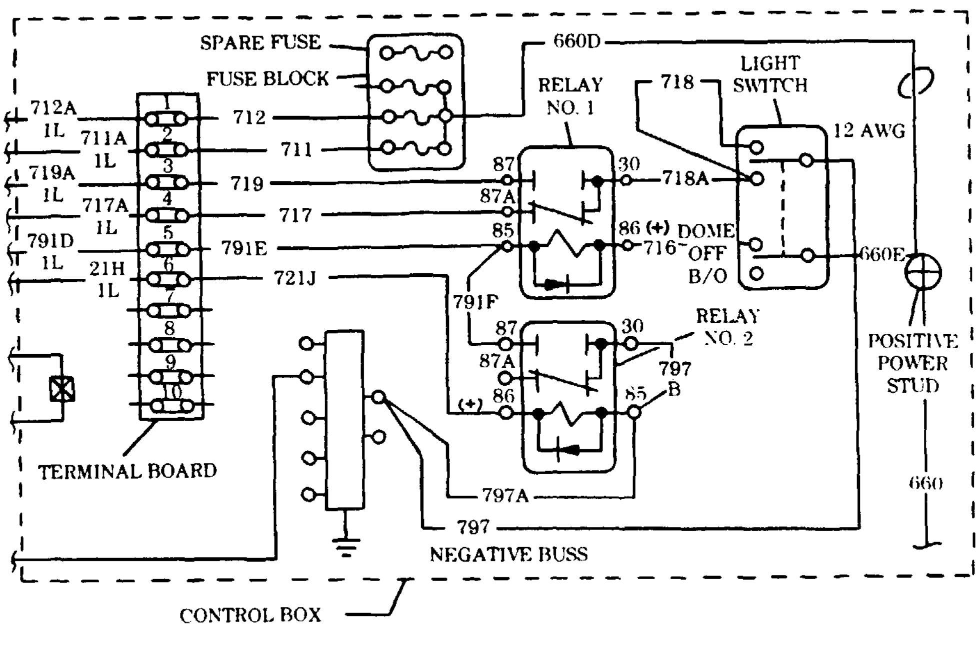
REFERENCE INFORMATION **AMBULANCE**

0-45DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to volts scale of at least 40 volts.
2. Connect the RED lead to positive and the black lead to negative.
3. Be sure to read the correct scale.

Replace main light switch, refer to (para. 4-59).

Replace relay 2, refer to (para. 4-120).



(All Dome Lamps)
With Ambulance compartment front door, rear door, or rear step open and vehicle light switch in service position (Refer to Fig. 11.)

DIAGNOSTIC FLOWCHART

FROM 5, Page 2-522

KNOWN INFO
PREVIOUSLY CORRECTED INFORMATION
POSSIBLE PROBLEMS
LEAD 797 A LEAD 797 B LEAD 791 F

6

PERFORM STEPS 18-22 ON PAGES 2-510 THROUGH 2-514. GO TO 7 BELOW IF THE ANSWER TO 21, PAGE 2-512, IS NO.

TEST OPTIONS

TRY IT

REASON FOR QUESTION

No power would indicate damaged leads.

KNOWN INFO
PREVIOUSLY CORRECTED INFORMATION
POSSIBLE PROBLEMS
LEAD 797 A LEAD 797 B LEAD 791 F

7

IS THERE CONTINUITY IN CONTROL BOX BETWEEN NEGATIVE BUSS AND TERMINAL 85 OF RELAY 2?

TEST OPTIONS

STE/ICE-R TEST 91, PAGE 2-752

REASON FOR QUESTION

No continuity would indicate a damaged lead.

NO → REPLACE LEAD 797 A

YES ↓

KNOWN INFO
LEAD 797 A OK
POSSIBLE PROBLEMS
LEAD 797 B LEAD 791 F

8

IS THERE CONTINUITY BETWEEN TERMINALS 85 AND 30 OF RELAY 2?

TEST OPTIONS

STE-ICE-R TEST 91, PAGE 2-752

REASON FOR QUESTION

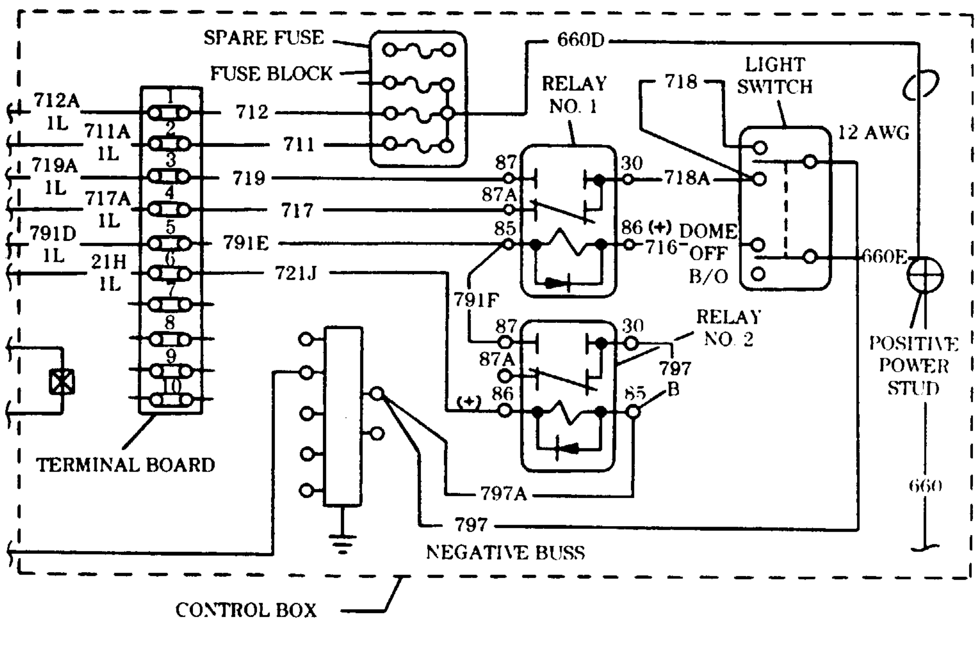
No continuity would indicate a damaged lead.

NO → REPLACE LEAD 797 B

YES ↓

GO TO 9, Page 2-526

0-4500 DC OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second. 2. Start test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."



AMBULANCE
(All Dome Lamps)
With Ambulance compartment front door, rear door, or rear step open and vehicle light switch in service position. (Refer to Fig. 11.)

FROM 8, Page 2-524

DIAGNOSTIC FLOWCHART

9

KNOWN INFO
LEAD 797 A OK LEAD 797 B OK
POSSIBLE PROBLEMS
LEAD 791 F

IS THERE CONTINUITY IN CONTROL BOX BETWEEN TERMINAL 87 OF RELAY 2 AND TERMINAL 85 OF RELAY 1?

TEST OPTIONS

STE-ICE-R TEST 91, PAGE 2-752

REASON FOR QUESTION

No continuity would indicate a damaged lead.

NO → REPLACE LEAD 791F

YES ↓

10

KNOWN INFO
LEAD 797 A OK LEAD 797 B OK LEAD 791 F OK
POSSIBLE PROBLEMS

PERFORM STEPS 22 THROUGH 29 ON PAGES 2-514 THROUGH 2-518

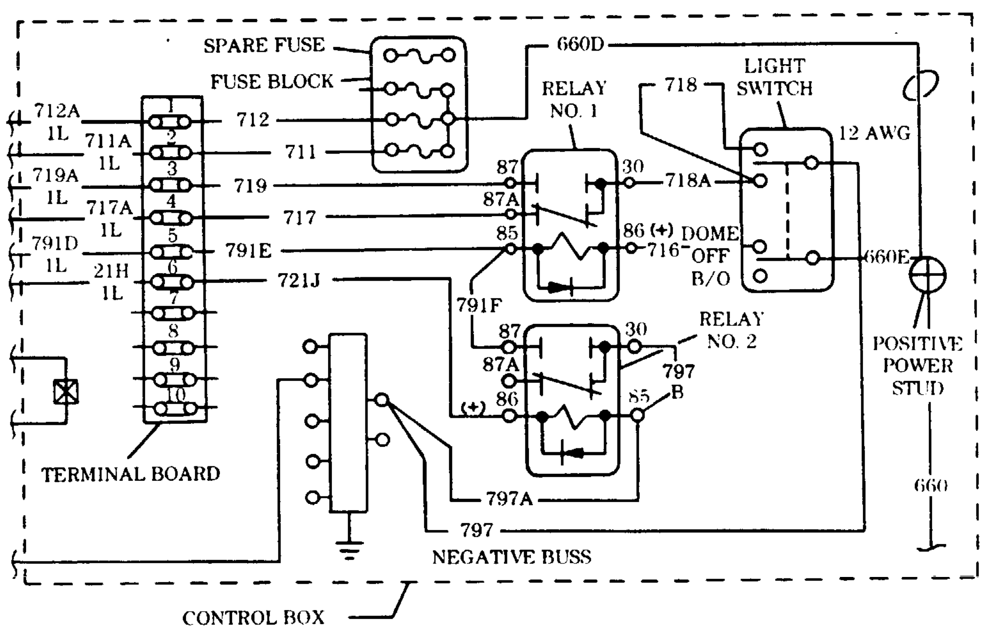
TEST OPTIONS

TRY IT

REASON FOR QUESTION

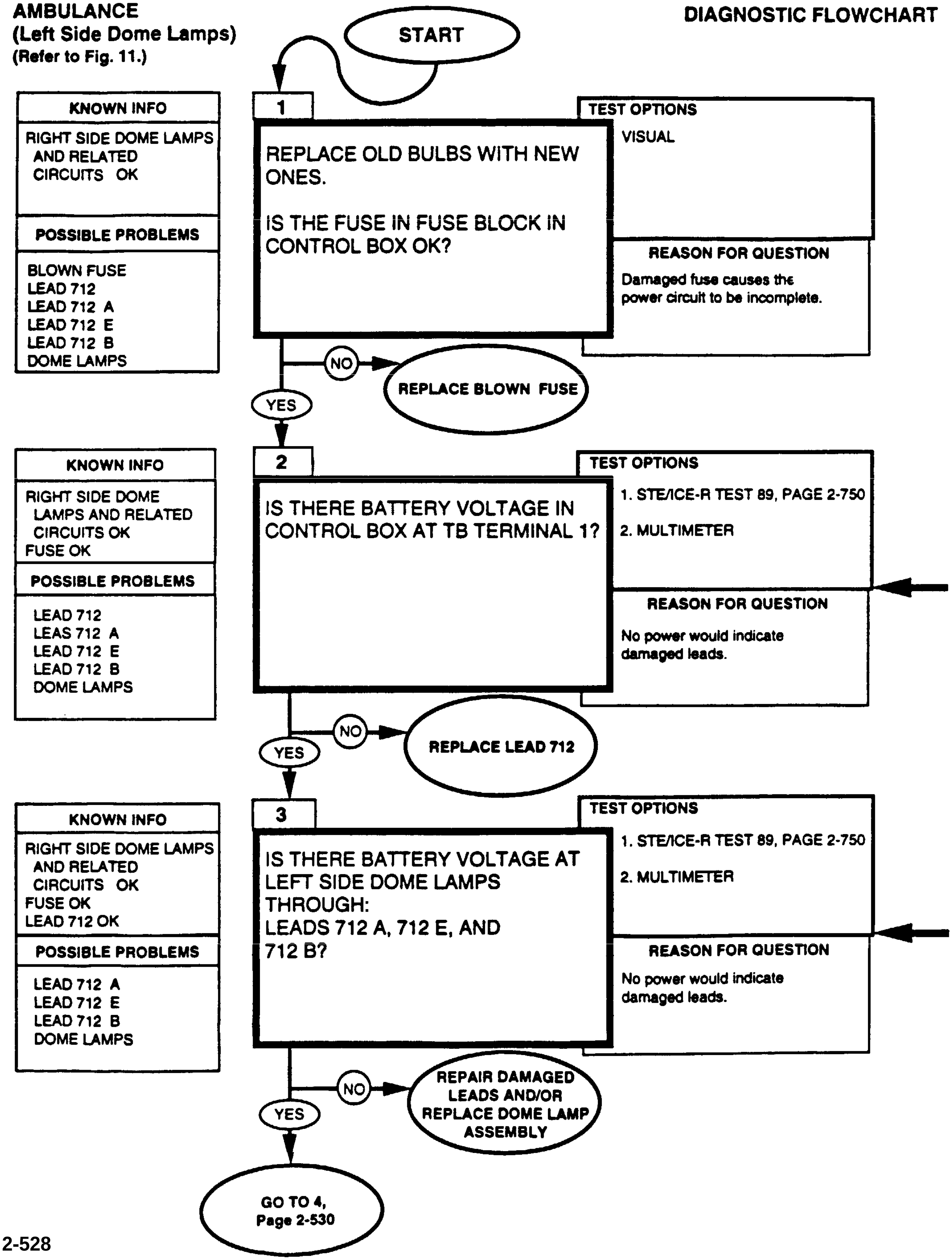
No continuity would indicate a damaged lead.

0-4500 DC OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second. 2. Start test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

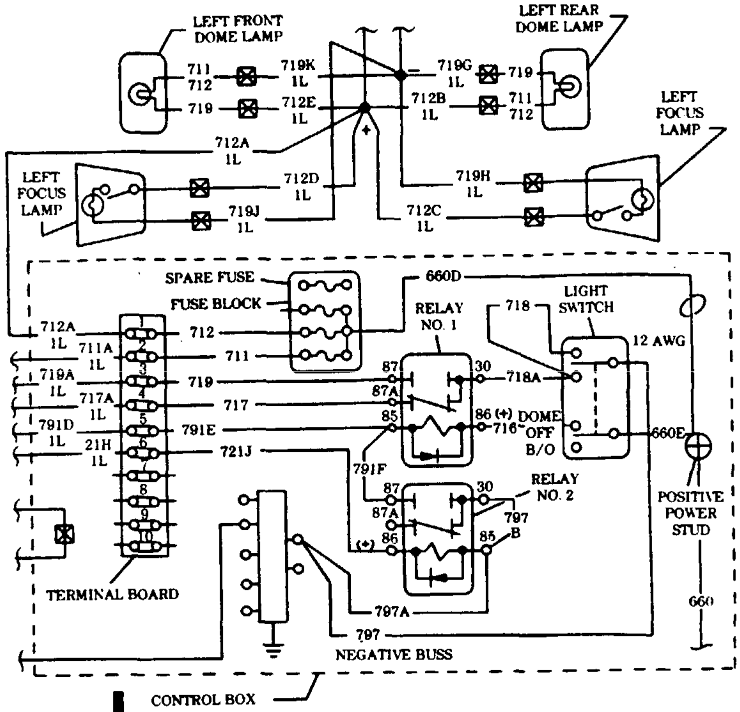


AMBULANCE
(Left Side Dome Lamps)
(Refer to Fig. 11.)

DIAGNOSTIC FLOWCHART



REFERENCE INFORMATION **AMBULANCE**



0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to a volts scale of at least 40 volts. 2. Connect the RED lead to positive and the black lead to negative. 3. Be sure to read the correct scale.

Replace dome lamp assembly, refer to (para. 4-87).
Repair lead, refer to (para. 4-85).
Repair lead connector, refer to (para. 4-85).

AMBULANCE
(Left Side Dome Lamps)
(Refer to Fig. 11.)

DIAGNOSTIC FLOWCHART

FROM 3,
Page 2-528

KNOWN INFO

RIGHT SIDE DOME LAMPS AND RELATED CIRCUITS OK
FUSE OK
LEAD 712 OK
LEAD 712 A OK
LEAD 712 E OK
LEAD 712 B OK
DOME LAMPS OK

POSSIBLE PROBLEMS

4

DO LEFT SIDE DOME LAMPS ILLUMINATE?

TEST OPTIONS

TRY IT

REASON FOR QUESTION

No power would indicate damaged leads.

NO → GO TO 5,
Page 2-532

YES → END OF TESTING

AMBULANCE
(Left Side Dome Lamps)
(Refer to Fig. 11.)

DIAGNOSTIC FLOWCHART

FROM 4, Page 2-530

5

KNOWN INFO
PREVIOUSLY CORRECTED INFORMATION
POSSIBLE PROBLEMS
LEAD 719 F LEAD 719 K LEAD 719 G DOME LAMPS

IS THERE CONTINUITY AT LEAD 719 F?

TEST OPTIONS

STE/ICE-R TEST 91, PAGE 2-752

REASON FOR QUESTION

No continuity would indicate a damaged lead.

NO → REPAIR LEAD 719 F

YES ↓

6

KNOWN INFO
LEAD 719 F OK
POSSIBLE PROBLEMS
LEAD 719 K LEAD 719 G DOME LAMPS

IS THERE CONTINUITY OF LEADS 719 K AND 719 G THROUGH TO LEFT SIDE DOME LAMPS LEADS?

TEST OPTIONS

STE/ICE-R TEST 91, PAGE 2-752

REASON FOR QUESTION

No continuity would indicate damaged leads.

NO → REPAIR DAMAGED LEADS AND/OR DOME LAMP ASSEMBLY

YES ↓

7

KNOWN INFO
LEAD 719 F OK LEAD 719 K OK LEAD 719 G OK DOME LAMPS OK
POSSIBLE PROBLEMS

DO LEFT SIDE DOME LAMPS ILLUMINATE?

TEST OPTIONS

TRY IT

REASON FOR QUESTION

If left side dome lamps do not illuminate, that would indicate a malfunction not handled at this level.

NO → NOTIFY DS MAINTENANCE

YES ↓

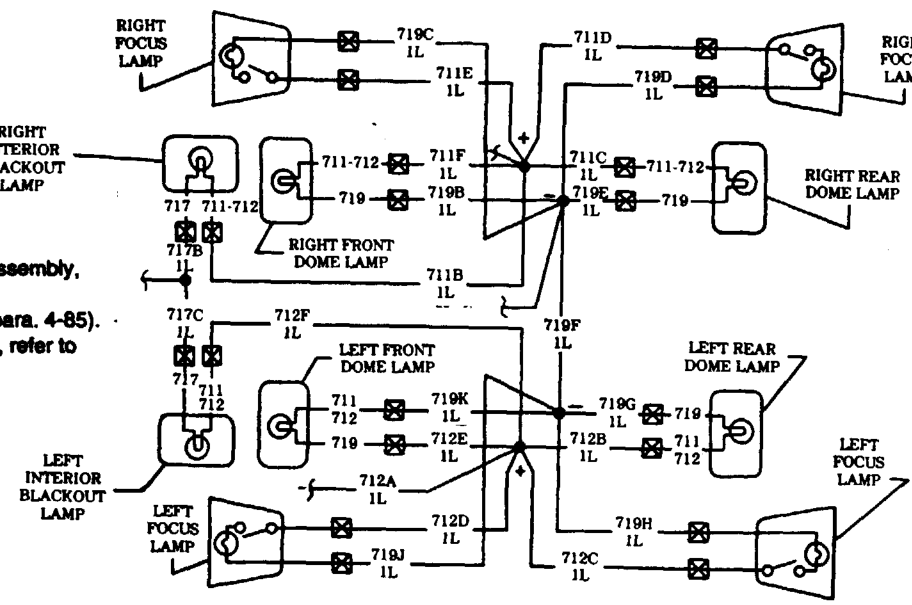
END OF TESTING

REFERENCE INFORMATION **AMBULANCE**

Repair lead, refer to (para. 4-85).

0-4500 DC OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

Replace dome lamp assembly, refer to (para. 4-87).
Repair lead, refer to (para. 4-85).
Repair lead connector, refer to (para. 4-85).



AMBULANCE
(Right Side Dome Lamps)
(Refer to Fig. 11.)

DIAGNOSTIC FLOWCHART

START

1

KNOWN INFO
LEFT SIDE DOME LAMPS AND RELATED CIRCUITS OK

POSSIBLE PROBLEMS
BLOWN FUSE LEAD 711 LEAD 711 A LEAD 711 F LEAD 711 C DOME LAMPS

REPLACE OLD BULBS WITH NEW ONES.

IS THE FUSE IN FUSE BLOCK IN CONTROL BOX OK?

TEST OPTIONS
VISUAL

REASON FOR QUESTION
Damaged fuse causes the power circuit to be incomplete.

NO → REPLACE BLOWN FUSE

YES ↓

2

KNOWN INFO
LEFT SIDE DOME LAMPS AND RELATED CIRCUITS OK FUSE OK

POSSIBLE PROBLEMS
LEAD 711 LEAS 711 A LEAD 711 F LEAD 711 C DOME LAMPS

IS THERE BATTERY VOLTAGE IN CONTROL BOX AT TB TERMINAL 2?

TEST OPTIONS
1. STE/ICE-R TEST 89, PAGE 2-750 2. MULTIMETER

REASON FOR QUESTION
No power would indicate damaged leads.

NO → REPLACE LEAD 711

YES ↓

3

KNOWN INFO
LEFT SIDE DOME LAMPS AND RELATED CIRCUITS OK FUSE OK LEAD 711 OK

POSSIBLE PROBLEMS
LEAD 711 A LEAD 711 F LEAD 711 C DOME LAMPS

IS THERE BATTERY VOLTAGE AT RIGHT SIDE DOME LAMPS THROUGH:
LEADS 711 A, 711 F, AND 711 C?

TEST OPTIONS
1. STE/ICE-R TEST 89, PAGE 2-750 2. MULTIMETER

REASON FOR QUESTION
No power would indicate damaged leads.

NO → REPAIR DAMAGED LEADS AND/OR REPLACE DOME LAMP ASSEMBLY

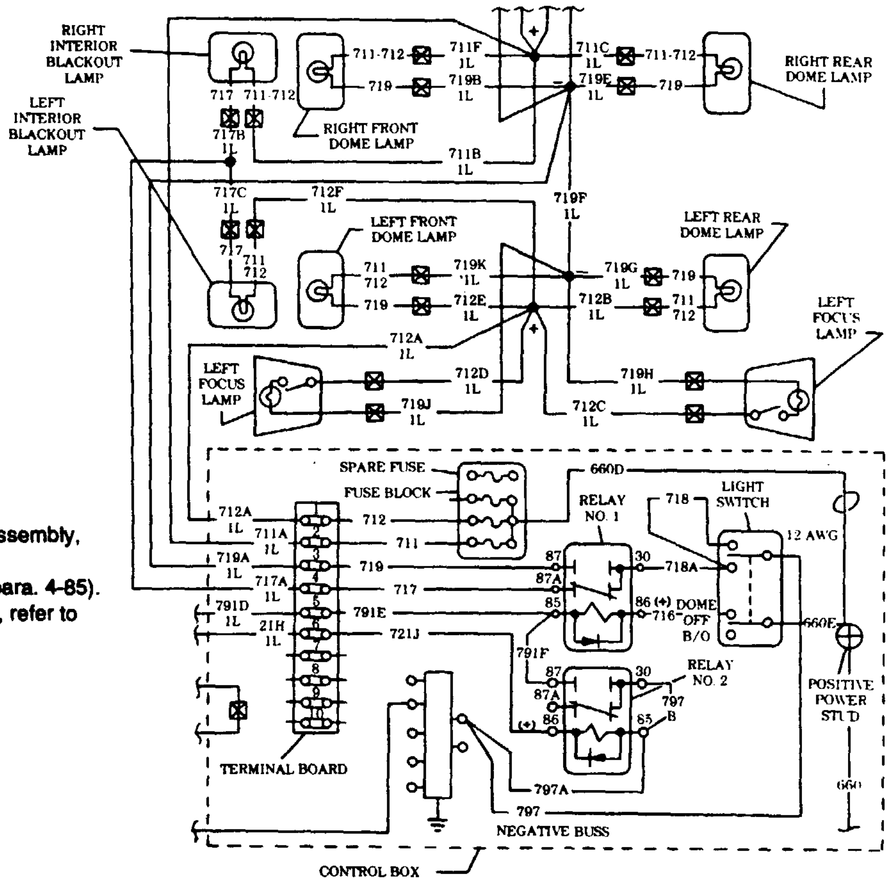
YES ↓

GO TO 4, Page 2-536

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

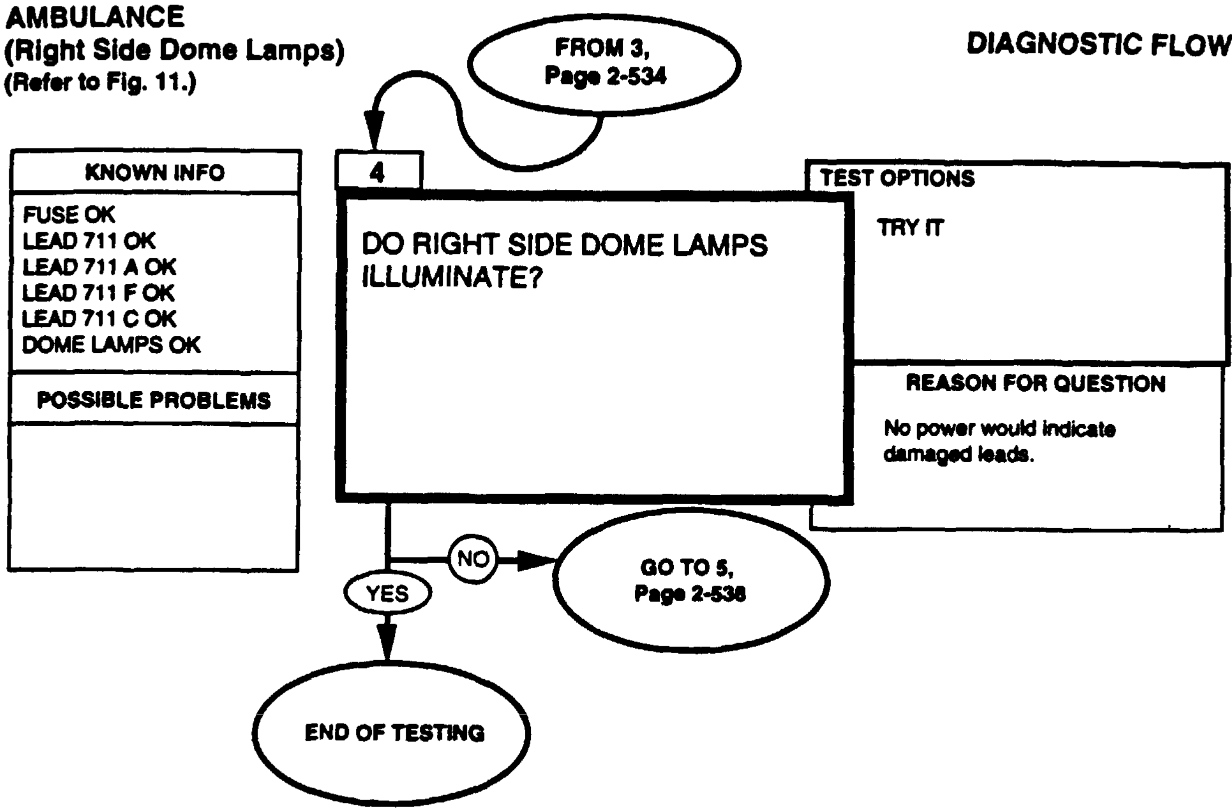
BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to volts scale of at least 40 volts. 2. Connect the RED lead to positive and the black lead to negative. 3. Be sure to read the correct scale.

Replace dome lamp assembly, refer to (para. 4-87).
Repair lead, refer to (para. 4-85).
Repair lead connector, refer to (para. 4-85).



AMBULANCE
(Right Side Dome Lamps)
(Refer to Fig. 11.)

DIAGNOSTIC FLOWCHART



AMBULANCE
(Right Side Dome Lamps)
(Refer to Fig. 11.)

DIAGNOSTIC FLOWCHART

FROM 4, Page 2-536

5

IS THERE CONTINUITY OF LEAD 719 F?

KNOWN INFO	POSSIBLE PROBLEMS
PREVIOUSLY CORRECTED INFORMATION	LEAD 719 F LEAD 719 B LEAD 719 E DOME LAMPS

TEST OPTIONS: STE/ICE-R TEST 91, PAGE 2-752

REASON FOR QUESTION: No continuity would indicate a damaged lead.

NO → REPAIR LEAD 719 F

YES ↓

6

IS THERE CONTINUITY AT LEADS 719 B AND 719 E THROUGH TO RIGHT SIDE DOME LAMPS LEADS?

KNOWN INFO	POSSIBLE PROBLEMS
LEAD 719 F OK	LEAD 719 E LEAD 719 B DOME LAMPS

TEST OPTIONS: STE/ICE-R TEST 91, PAGE 2-752

REASON FOR QUESTION: No continuity would indicate damaged leads.

NO → REPAIR DAMAGED LEADS AND/OR DOME LAMP ASSEMBLY

YES ↓

7

DO RIGHT SIDE DOME LAMPS ILLUMINATE?

KNOWN INFO	POSSIBLE PROBLEMS
LEAD 719 F OK LEAD 719 E OK LEAD 719 B OK DOME LAMPS OK	

TEST OPTIONS: TRY IT

REASON FOR QUESTION: If lamps do not illuminate, that would indicate a malfunction not handled at this level.

NO → NOTIFY DS MAINTENANCE

YES ↓

END OF TESTING

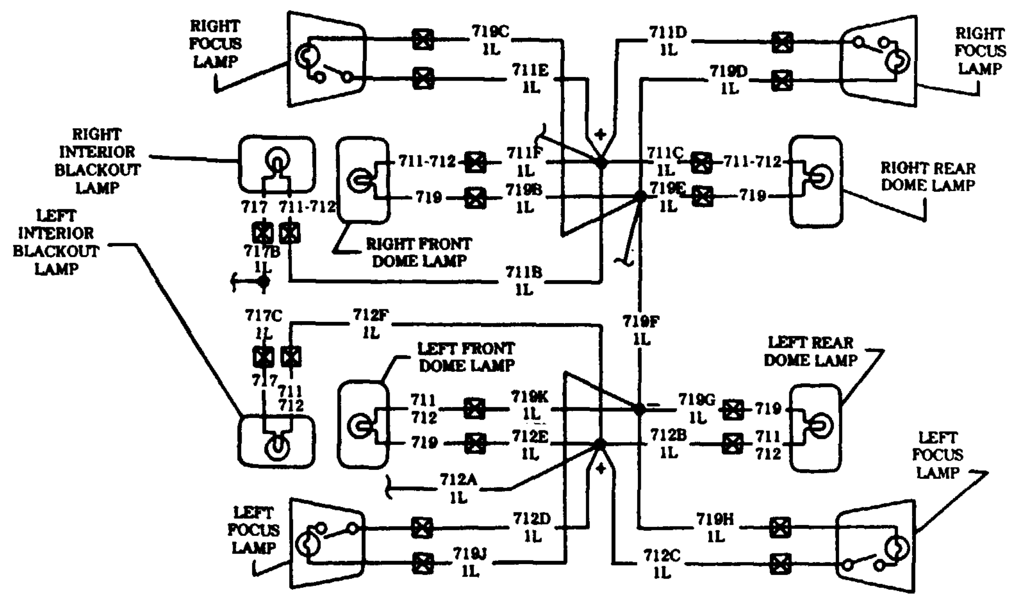
Repair lead, refer to (para. 4-85).

0-4500 DC OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

Replace dome lamp assembly, refer to (para. 4-87).

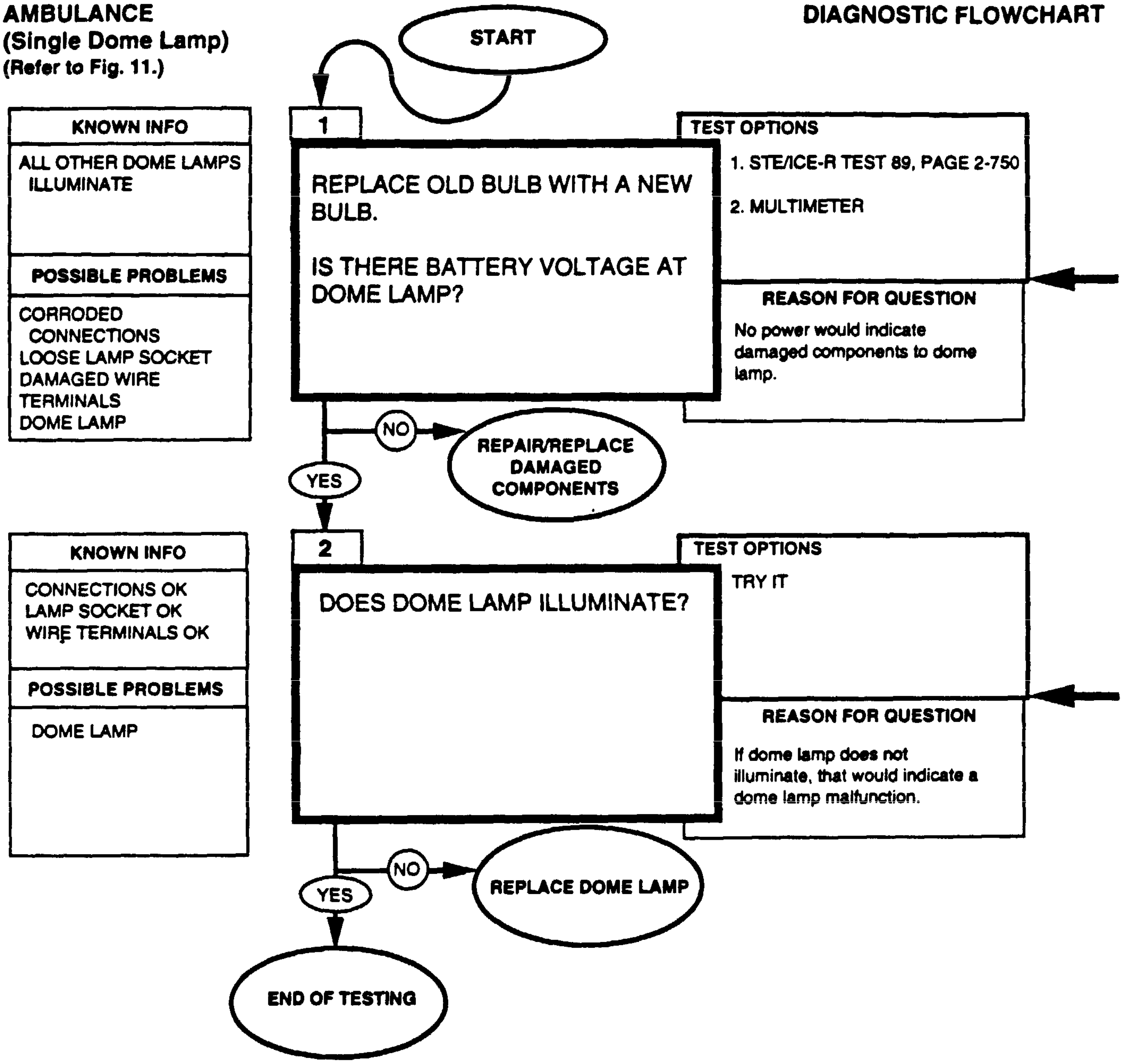
Repair lead, refer to (para. 4-85).

Repair lead connector, refer to (para. 4-85).



AMBULANCE
(Single Dome Lamp)
(Refer to Fig. 11.)

DIAGNOSTIC FLOWCHART



Repair leads, refer to (para. 4-85).

Repair lead connector, refer to (para. 4-85).

Replace dome lamp assembly, refer to (para. 4-87).

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the black lead to negative. 3. Be sure to read the correct scale.

AMBULANCE (SPOTLIGHT)
(Refer to Fig. 11.)

DIAGNOSTIC FLOWCHART

START

1

KNOWN INFO
NOTHING

POSSIBLE PROBLEMS
LIGHT SWITCH POSITION
SPOTLIGHT SWITCH POSITION
CORRODED CONNECTIONS
LOOSE LAMP SOCKET
DAMAGED WIRE
TERMINALS
DOME LAMPS
SPOTLIGHT

REPLACE OLD BULB WITH A NEW ONE. IS LIGHT SWITCH ON CONTROL BOX IN NORMAL OPERATING POSITION?

TEST OPTIONS
VISUAL

REASON FOR QUESTION
Spotlight will not illuminate if light switch is not in correct position.

NO → PLACE LIGHT SWITCH TO NORMAL POSITION

YES ↓

2

KNOWN INFO
LIGHT SWITCH POSITION OK

POSSIBLE PROBLEMS
SPOTLIGHT SWITCH POSITION
CORRODED CONNECTIONS
LOOSE LAMP SOCKET
DAMAGED WIRE
TERMINALS
DOME LAMPS
SPOTLIGHT

DO DOME LAMPS ILLUMINATE?

TEST OPTIONS
TRY IT

REASON FOR QUESTION
The spotlight is run off of the dome lamp circuit.

NO → GO TO 6, Page 2-546

YES ↓

3

KNOWN INFO
LIGHT SWITCH POSITION OK
DOME LAMPS OK

POSSIBLE PROBLEMS
SPOTLIGHT SWITCH POSITION
CORRODED CONNECTIONS
LOOSE LAMP SOCKET
DAMAGED WIRE
TERMINALS
SPOTLIGHT

IS SPOTLIGHT SWITCH IN PROPER POSITION?

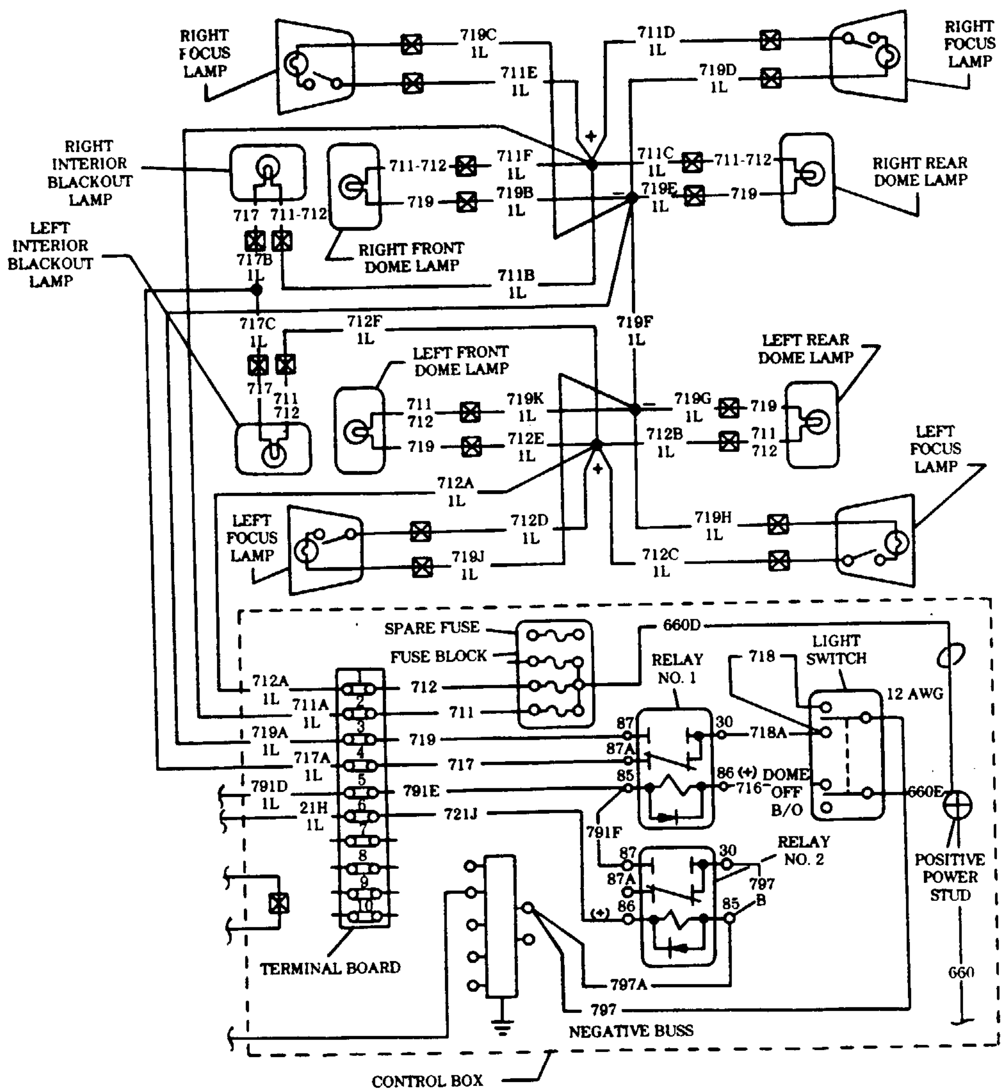
TEST OPTIONS
VISUAL

REASON FOR QUESTION
Spotlight will not illuminate if light switch is not in correct position.

NO → PLACE SPOTLIGHT SWITCH TO PROPER POSITION

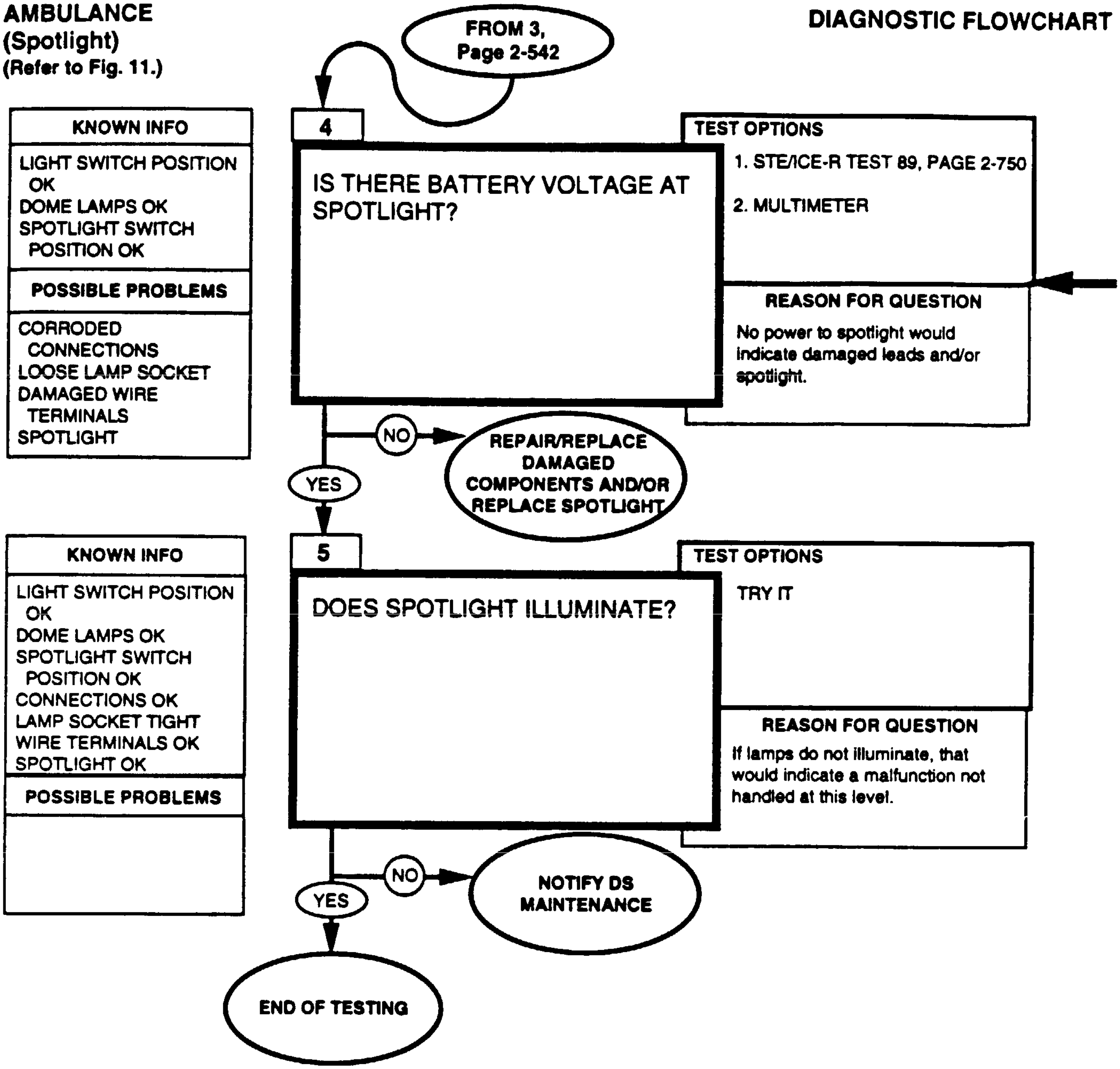
YES ↓

GO TO 4, Page 2-544


RIGHT FOCUS LAMP
719C 1L
711E 1L
711D 1L
719D 1L
RIGHT FOCUS LAMP
RIGHT INTERIOR BLACKOUT LAMP
711-712
711F 1L
719
719B 1L
711C 1L
719E 1L
RIGHT REAR DOME LAMP
717
717B 1L
RIGHT FRONT DOME LAMP
711B 1L
LEFT INTERIOR BLACKOUT LAMP
717C 1L
712F 1L
719F 1L
LEFT FRONT DOME LAMP
LEFT REAR DOME LAMP
711 712
719K 1L
719G 1L
712E 1L
712B 1L
712A 1L
LEFT FOCUS LAMP
712D 1L
719H 1L
719J 1L
712C 1L
SPARE FUSE
FUSE BLOCK
660D
RELAY NO. 1
718
LIGHT SWITCH
12 AWG
712A 1L
711A 1L
719A 1L
717A 1L
791D 1L
21H 1L
712
711
719
717
791E
721J
87
87A
85
30
718A
86 (+) DOME
716
OFF
B/O
660E
791F
RELAY NO. 2
797
B
(+)
86
POSITIVE POWER STUD
TERMINAL BOARD
797A
797
NEGATIVE BUSS
660
CONTROL BOX

AMBULANCE
(Spotlight)
(Refer to Fig. 11.)

DIAGNOSTIC FLOWCHART



Replace spotlight assembly, refer to (para. 4-88).
Repair leads, refer to (para. 4-85).
Repair lead connector, refer to (para. 4-85).

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.

AMBULANCE
(Spotlight)
(Refer to Fig. 11.)

DIAGNOSTIC FLOWCHART

FROM 2, Page 2-542

KNOWN INFO
LIGHT SWITCH POSITION OK
POSSIBLE PROBLEMS

6

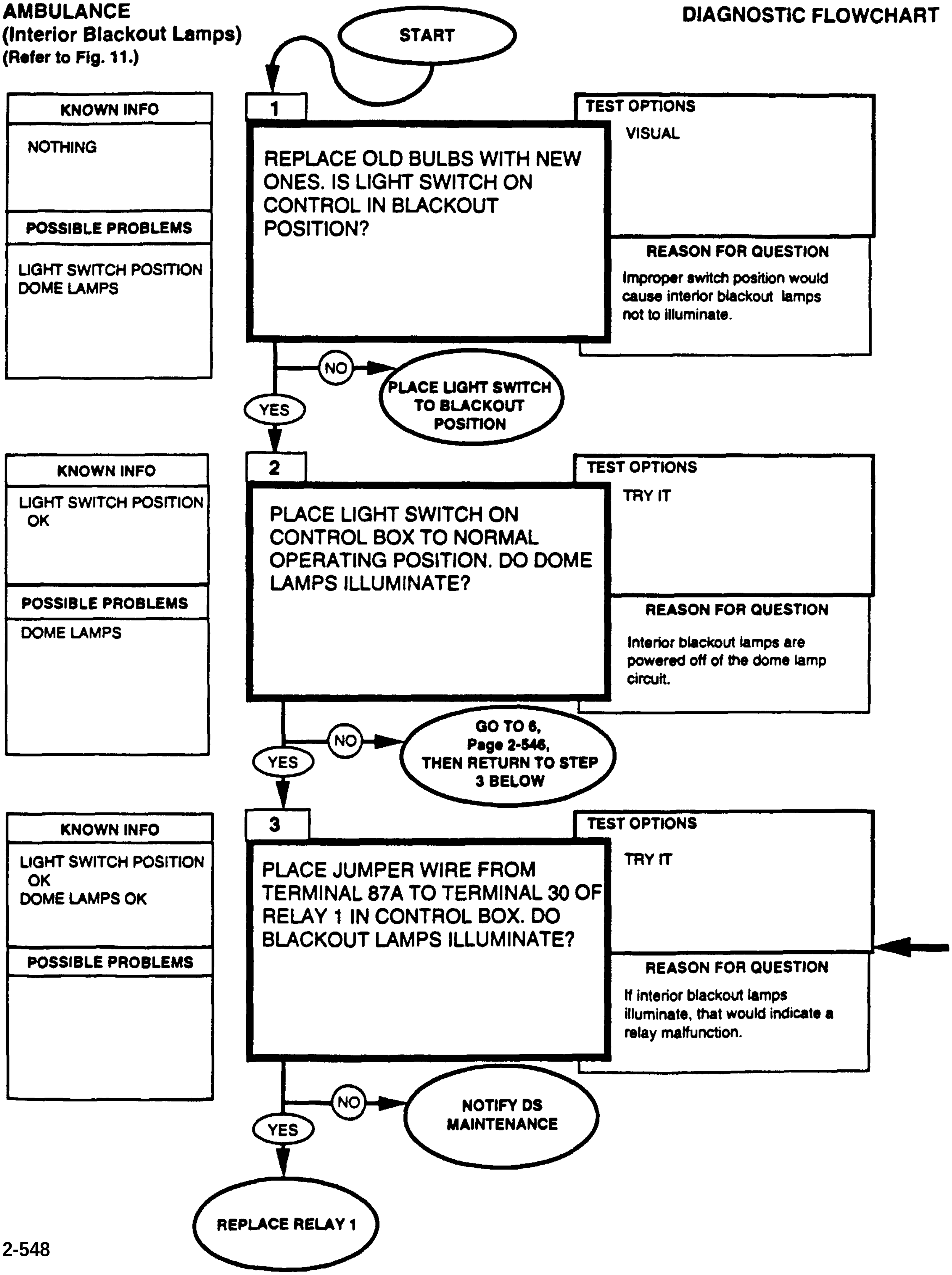
PERFORM STEPS 1 THROUGH 29, PAGES 2-498 THROUGH 2-518 IF VEHICLE LIGHT SWITCH IS IN THE BLACKOUT DRIVE POSITION. IF VEHICLE LIGHT SWITCH IS IN THE SERVICE DRIVE POSITION, PERFORM STEPS 1 THROUGH 10, PAGES 2-520 THROUGH 2-526, AND RETURN TO 3, PAGE 2-542.

TEST OPTIONS
TRY IT

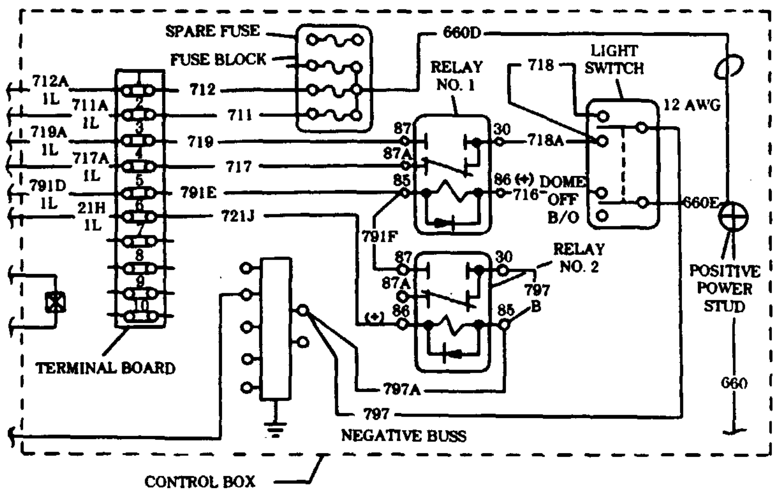
REASON FOR QUESTION
No power would indicate damage in electrical system.

AMBULANCE
(Interior Blackout Lamps)
(Refer to Fig. 11.)

DIAGNOSTIC FLOWCHART

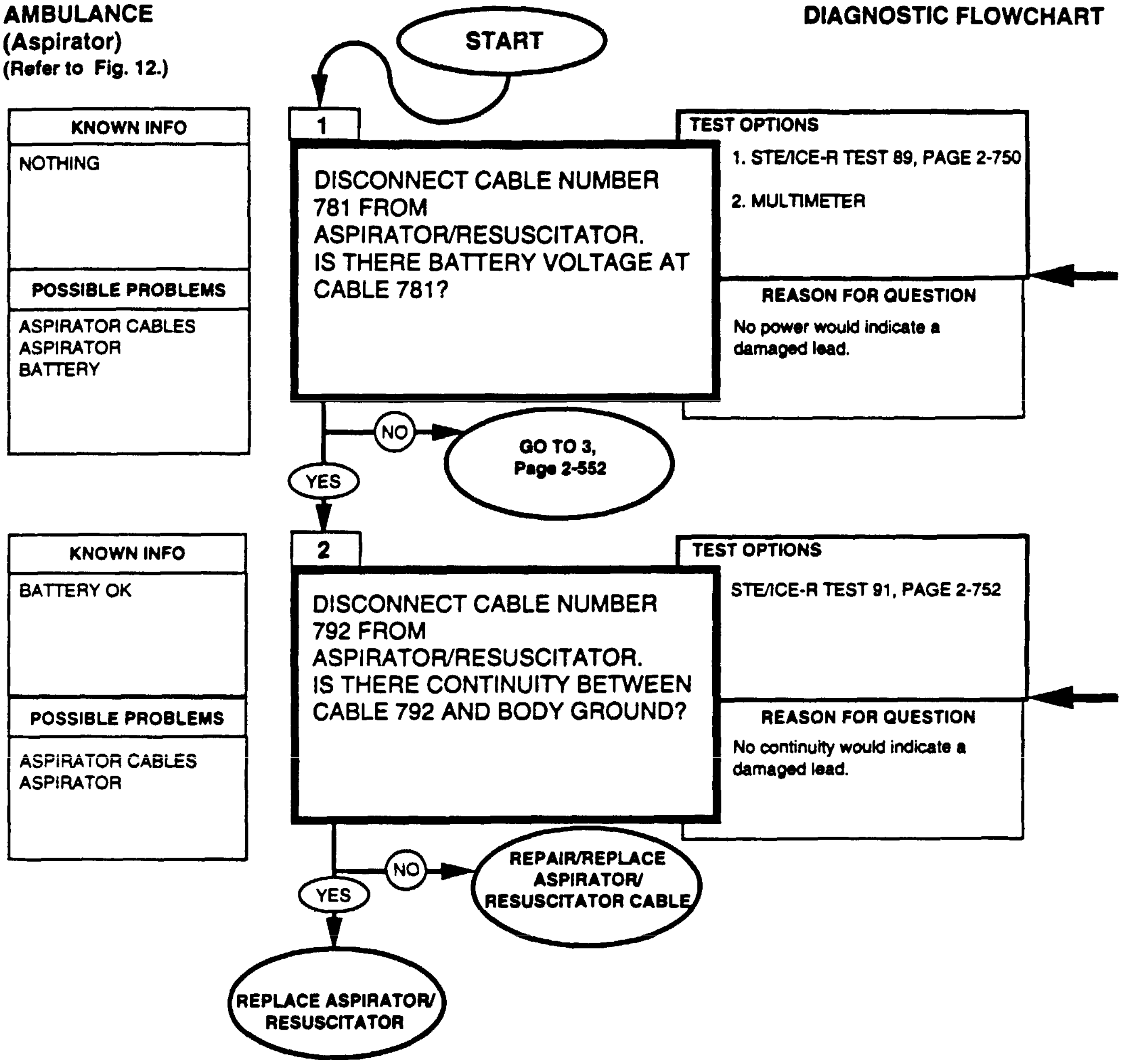


Replace relay, refer to (para. 4-120).

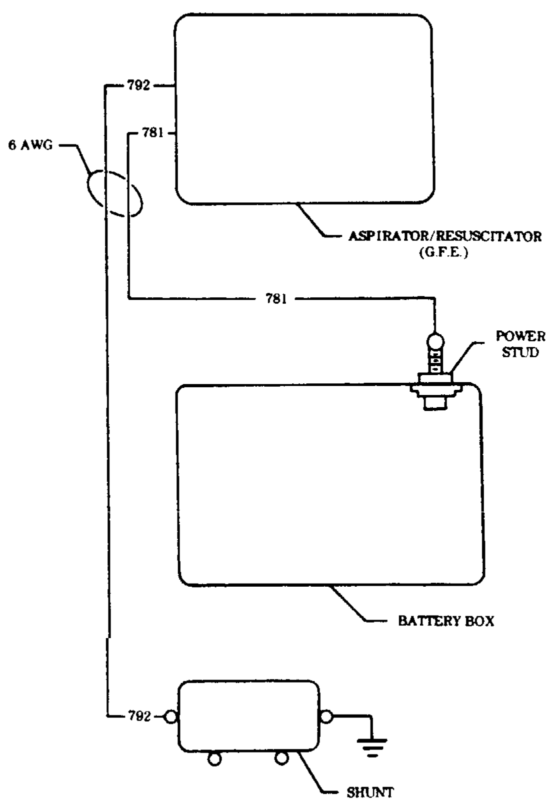


AMBULANCE
(Aspirator)
(Refer to Fig. 12.)

DIAGNOSTIC FLOWCHART



Replace Aspirator/Resuscitator cable, refer to (para. 4-104).
Repair cable, refer to DS Maintenance.



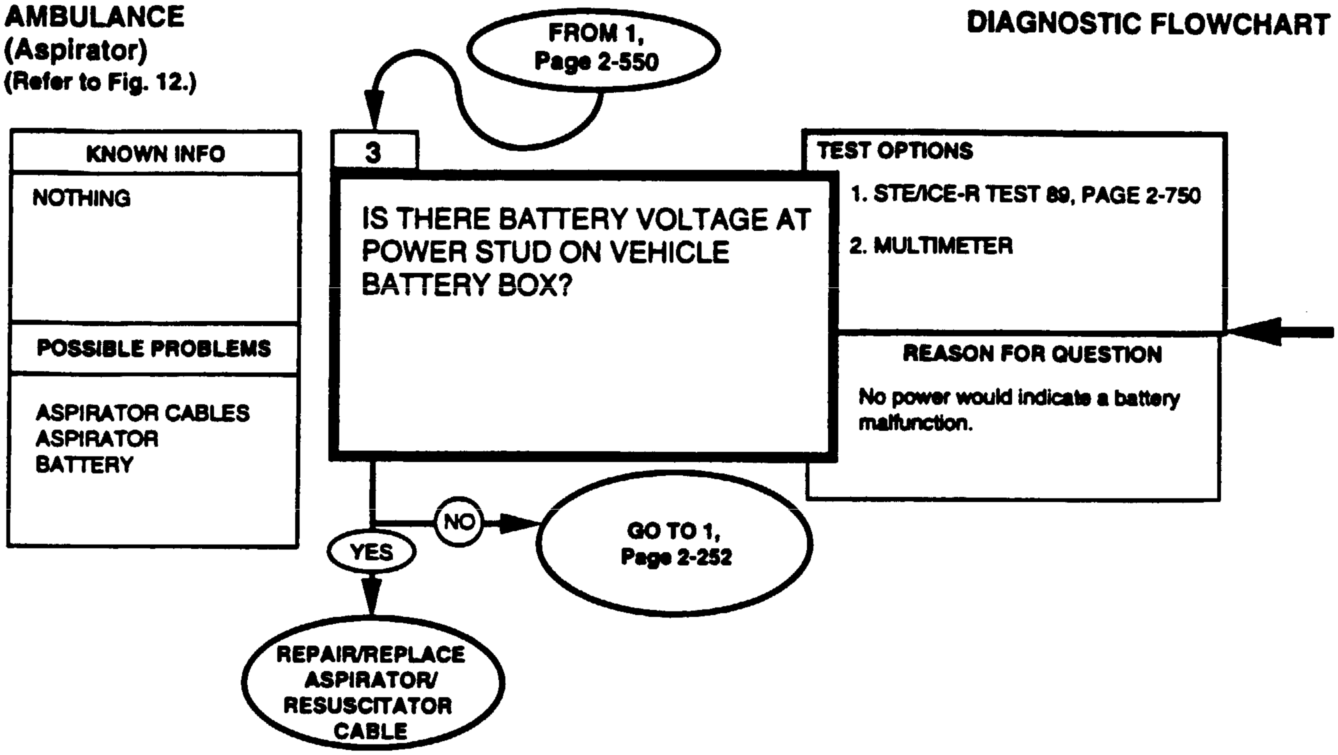
0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

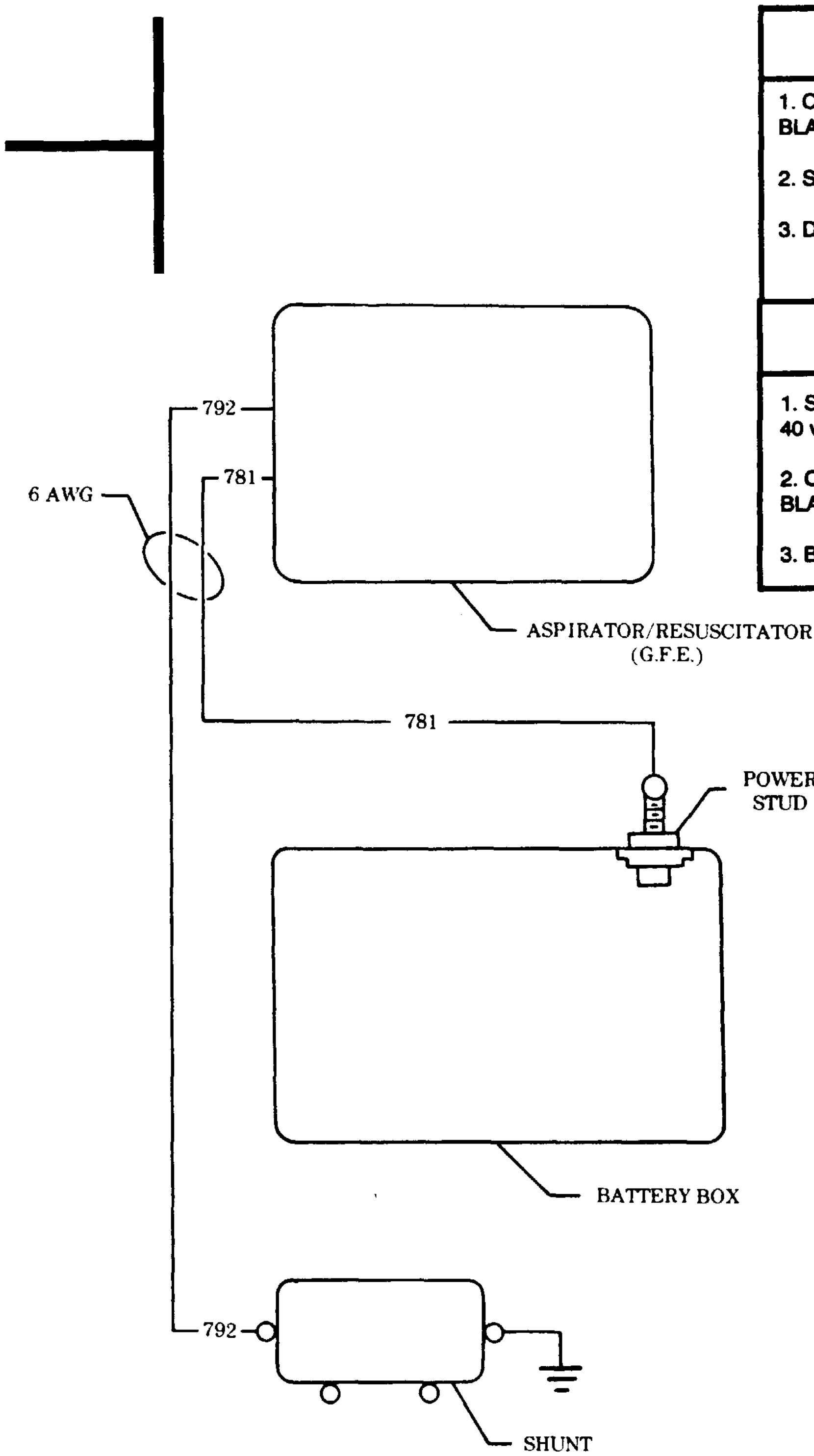
BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.

0-4500 DC OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

AMBULANCE
(Aspirator)
(Refer to Fig. 12.)

DIAGNOSTIC FLOWCHART





0-45 DC VOLTS
STE/ICE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

BATTERY VOLTAGE
MULTIMETER

1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

AMBULANCE
(Front DC Outlet)
(Refer to Fig. 13.)

DIAGNOSTIC FLOWCHART

START

1

KNOWN INFO
NOTHING

POSSIBLE PROBLEMS
FUSE BATTERY LEAD 660 D LEAD 714 LEAD 790

CHECK FUSE BLOCK ON CONTROL BOX COVER. IS FUSE OK?

TEST OPTIONS
VISUAL

REASON FOR QUESTION
If fuse is blown, circuit is incomplete.

NO → REPLACE BLOWN FUSE

YES ↓

2

KNOWN INFO
FUSE OK

POSSIBLE PROBLEMS
BATTERY LEAD 660 D LEAD 714 LEAD 790

IS THERE BATTERY VOLTAGE AT POWER STUD IN CONTROL BOX?

TEST OPTIONS
1. STE/ICE-R TEST 89, PAGE 2-750 2. MULTIMETER

REASON FOR QUESTION
No power would indicate a battery malfunction.

NO → GO TO 1, Page 2-252

YES ↓

3

KNOWN INFO
FUSE OK BATTERY OK

POSSIBLE PROBLEMS
LEAD 660 D LEAD 714 LEAD 790

DISCONNECT BOTH ENDS OF LEAD 660D. IS THERE CONTINUITY?

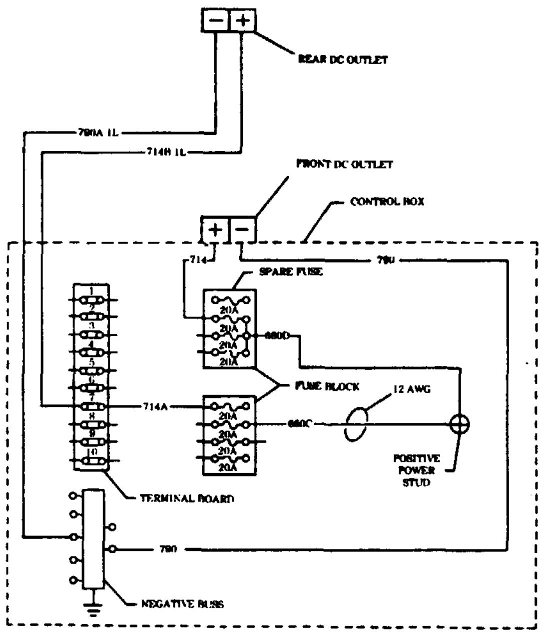
TEST OPTIONS
STE/ICE-R TEST 91, PAGE 2-752

REASON FOR QUESTION
No continuity would indicate a damaged lead.

NO → REPAIR LEAD 660 D

YES ↓

GO TO 4, Page 2-556



0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.

0-4500 DC OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

Repair lead, refer to (para. 4-85).
Repair lead connector, refer to (para. 4-85).

AMBULANCE
(Front DC Outlet)
(Refer to Fig. 13.)

DIAGNOSTIC FLOWCHART

FROM 3, Page 2-554

KNOWN INFO
FUSE OK
BATTERY OK
LEAD 660 D OK

POSSIBLE PROBLEMS
LEAD 714
LEAD 790

4

IS THERE BATTERY VOLTAGE AT POSITIVE TERMINAL OF FRONT DC OUTLET?

TEST OPTIONS
1. STE/ICE-R TEST 89, PAGE 2-750
2. MULTIMETER

REASON FOR QUESTION
No power would indicate a damaged lead.

NO → REPAIR LEAD 714

YES ↓

KNOWN INFO
FUSE OK
BATTERY OK
LEAD 660 D OK
LEAD 714 OK

POSSIBLE PROBLEMS
LEAD 790
DC OUTLET

5

IS THERE CONTINUITY BETWEEN FRONT DC OUTLET NEGATIVE TERMINAL AND BODY GROUND?

TEST OPTIONS
1. STE/ICE-R TEST 91, PAGE 2-752
2. MULTIMETER

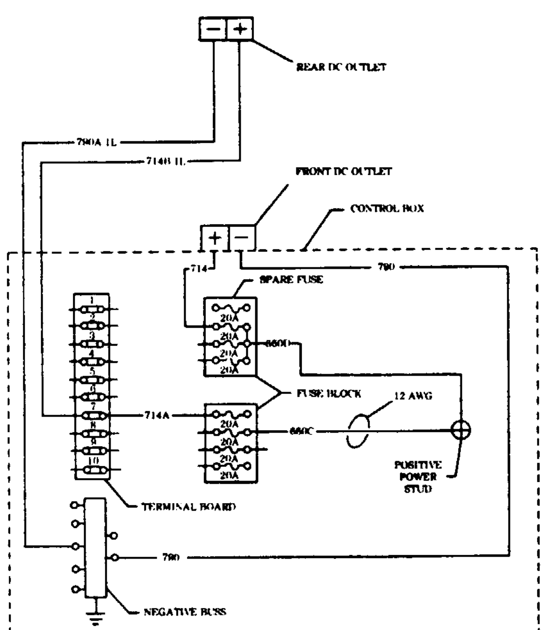
REASON FOR QUESTION
No continuity would indicate a damaged lead.

NO → REPAIR LEAD 790

YES → REPLACE FRONT DC OUTLET

Repair lead, refer to (para. 4-85).
Repair lead connector,
refer to (para. 4-85).

Repair lead connectors,
refer to (para. 4-85).
Repair lead, refer to (para. 4-85).
Replace front DC outlet,
refer to (para. 4-90).



0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.

0-4500 DC OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms. 2. Connect the RED and BLACK leads to the connections stated in the question. 3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

AMBULANCE
(Rear DC Outlet)
(Refer to Fig. 13.)

DIAGNOSTIC FLOWCHART

START

KNOWN INFO

NOTHING

POSSIBLE PROBLEMS

FUSE
BATTERY
LEAD 660 C
LEAD 714 A
LEAD 714 B
REAR DC OUTLET
LEAD 790 A

1

PERFORM STEPS 1 AND 2 OF PAGE 2-554, AND RETURN TO 2 BELOW.

TEST OPTIONS

TRY IT

REASON FOR QUESTION

If fuse is blown, circuit is incomplete.

KNOWN INFO

FUSE OK
BATTERY OK

POSSIBLE PROBLEMS

LEAD 660 C
LEAD 714 A
LEAD 714 B
REAR DC OUTLET
LEAD 790 A

2

DISCONNECT BOTH ENDS OF LEAD 660 C. IS THERE CONTINUITY?

TEST OPTIONS

1. STE/ICE-R TEST 91, PAGE 2-752
2. MULTIMETER

REASON FOR QUESTION

No continuity would indicate a damaged lead.

NO → REPAIR LEAD 660 C

YES ↓

KNOWN INFO

FUSE OK
BATTERY OK
LEAD 660 C OK

POSSIBLE PROBLEMS

LEAD 714 A
LEAD 714 B
REAR DC OUTLET
LEAD 790 A

3

IS THERE BATTERY VOLTAGE IN CONTROL BOX TB TERMINAL 7?

TEST OPTIONS

1. STE/ICE-R TEST 89, PAGE 2-750
2. MULTIMETER

REASON FOR QUESTION

No power would indicate damaged lead.

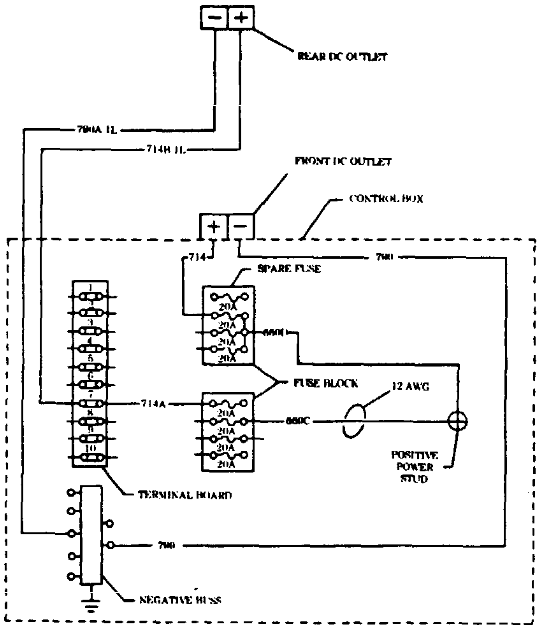
NO → REPAIR LEAD 714 A

YES ↓

GO TO 4, Page 2-560

REFERENCE INFORMATION

AMBULANCE



Repair lead, refer to (para. 4-85).
Repair lead connector, refer to (para. 4-85).

Repair lead, refer to (para. 4-85).
Repair lead connector, refer to (para. 4-85).

0-4500 OHMS
STE/ICE-R TEST 91

1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second.

2. Start Test 91, 0-4500 ohms.

3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

CONTINUITY (RESISTANCE)
MULTIMETER

1. Set the voltmeter to an ohms scale of about 1000 ohms.

2. Connect the RED and BLACK leads to the connections stated in the question.

3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

0-45 DC VOLTS
STE/ICE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.

2. Start Test 89, DC volts.

3. Displayed reading is in volts.

BATTERY VOLTAGE
MULTIMETER

1. Set the voltmeter to a volts scale of at least 40 volts.

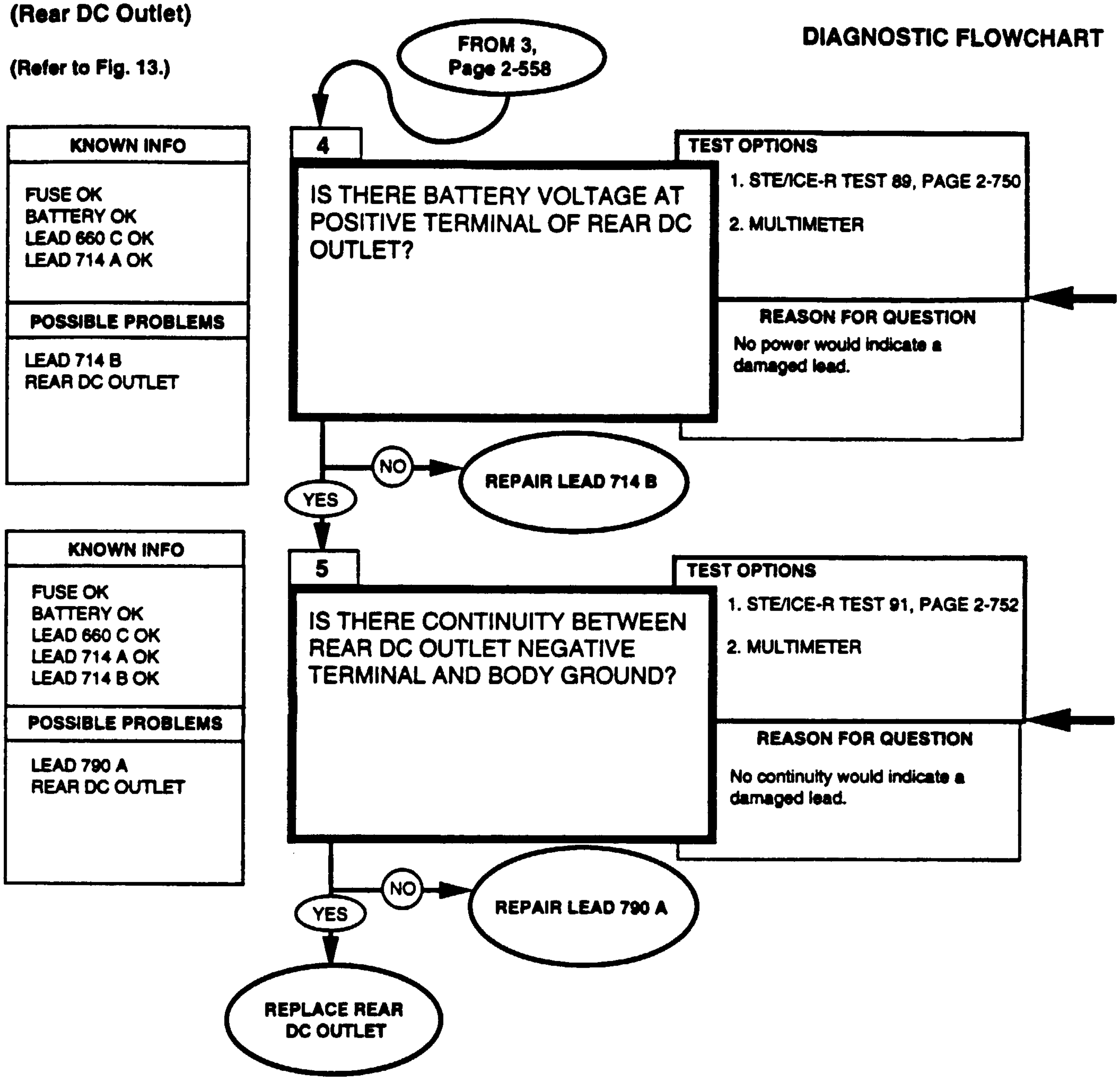
2. Connect the RED lead to positive and the BLACK lead to negative.

3. Be sure to read the correct scale.

AMBULANCE
(Rear DC Outlet)

(Refer to Fig. 13.)

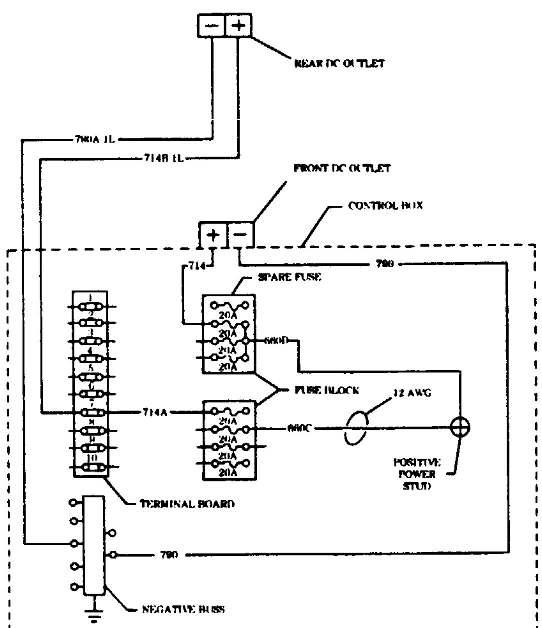
DIAGNOSTIC FLOWCHART



REFERENCE INFORMATION **AMBULANCE**

Repair lead, refer to (para. 4-85).
Repair lead connector, refer to (para. 4-85).

Repair lead, refer to (para. 4-85).
Replace rear DC outlet, refer to (para. 4-90).



0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.

0-4500 DC OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms. 2. Connect the RED and BLACK leads to the connections stated in the question. 3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

AMBULANCE
(Compressor Clutch)
(M997 Only)
(Refer to Fig. 14.)

DIAGNOSTIC FLOWCHART

START

KNOWN INFO

NOTHING

POSSIBLE PROBLEMS

A/C CONTROL SETTING
FUSE
CABLE 660
LEAD 660 B
LEAD 720
LEAD 720 A
DOOR SWITCH

1

IS AIR-CONDITIONER ON AND THE CONTROLS SET TO MAXIMUM COOLING AND BLOWER SPEED SETTINGS?

TEST OPTIONS

VISUAL

REASON FOR QUESTION

Controls must be in correct position for clutch to engage.

NO → TURN AIR CONDITIONER ON AND SET CONTROLS TO MAXIMUM COOLING AND BLOWER SPEED SETTINGS

YES ↓

KNOWN INFO

A/C CONTROL SETTINGS OK

POSSIBLE PROBLEMS

FUSE
CABLE 660
LEAD 660 B
LEAD 720
LEAD 720 A
DOOR SWITCH

2

CHECK FUSE BLOCK ON CONTROL BOX COVER. IS FUSE OK?

TEST OPTIONS

VISUAL

REASON FOR QUESTION

If fuse is blown, circuit to A/C is incomplete.

NO → REPLACE BLOWN FUSE

YES ↓

KNOWN INFO

A/C CONTROL SETTINGS OK
FUSE OK

POSSIBLE PROBLEMS

CABLE 660
LEAD 660 B
LEAD 720
LEAD 720 A
DOOR SWITCH

3

DISCONNECT LEAD 436 E AT COMPRESSOR. IS THERE BATTERY VOLTAGE AT LEAD 436 E?

TEST OPTIONS

STE/ICE-R TEST 89, PAGE 2-750

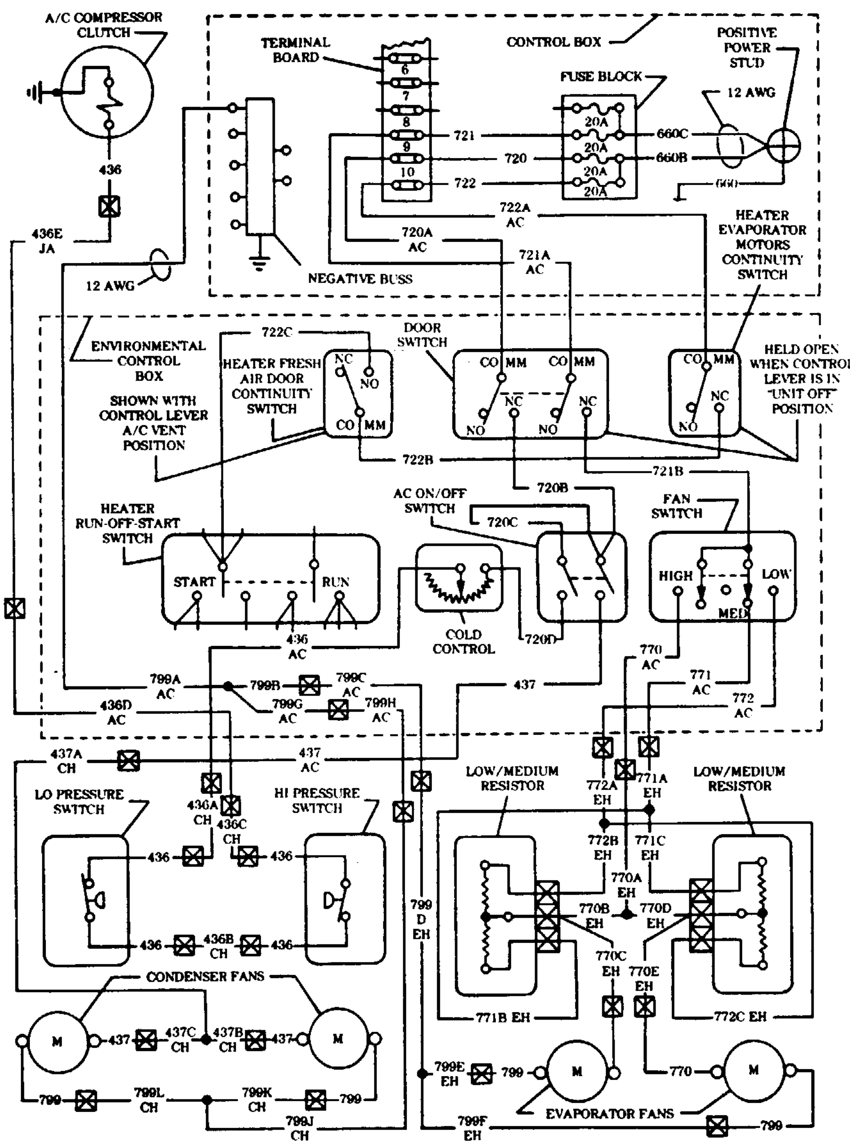
REASON FOR QUESTION

The presence of voltage would indicate a malfunction of compressor or related components.

NO → GO TO 4, Page 2-564

YES → GO TO 22, Page 2-578

REFERENCE INFORMATION **AMBULANCE**



0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

AMBULANCE
(Compressor Clutch)
(M997 Only)
(Refer to Fig. 14.)

DIAGNOSTIC FLOWCHART

FROM 3, Page 2-562

4

KNOWN INFO	
A/C CONTROL SETTINGS OK FUSE OK	

POSSIBLE PROBLEMS
CABLE 660 LEAD 660 B LEAD 720 LEAD 720 A DOOR SWITCH

IS BATTERY IN PROPER WORKING ORDER?

TEST OPTIONS

1. STE/ICE-R TEST 89, PAGE 2-750
2. MULTIMETER

REASON FOR QUESTION

Battery malfunction will cause any dependent circuit to malfunction.

NO → GO TO 1, Page 2-252

YES ↓

5

KNOWN INFO
A/C CONTROL SETTINGS OK FUSE OK BATTERY OK

POSSIBLE PROBLEMS
CABLE 660 LEAD 660 B LEAD 720 LEAD 720 A DOOR SWITCH

IS THERE BATTERY VOLTAGE IN CONTROL BOX AT POWER STUD?

TEST OPTIONS

1. STE/ICE-R TEST 89, PAGE 2-750
2. MULTIMETER

REASON FOR QUESTION

No voltage at power stud would indicate a damaged cable.

NO → REPAIR CABLE 660

YES ↓

6

KNOWN INFO
A/C CONTROL SETTINGS OK FUSE OK BATTERY OK CABLE 660 OK

POSSIBLE PROBLEMS
LEAD 660 B LEAD 720 LEAD 720 A DOOR SWITCH

IS THERE BATTERY VOLTAGE IN CONTROL BOX LEAD 660 B AT FUSE BLOCK?

TEST OPTIONS

STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION

No power would indicate a damaged lead.

NO → REPAIR LEAD 660 B

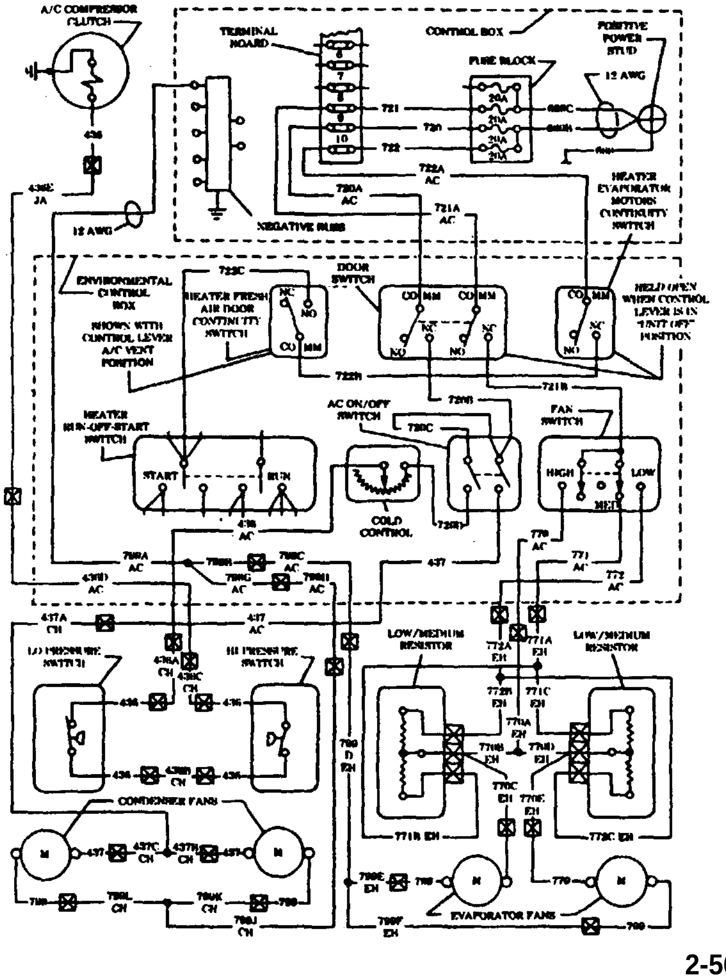
YES ↓

GO TO 7, Page 2-566

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.

Repair cable, refer to DS Maintenance.



Repair lead, refer to (para. 4-85).
Repair lead connector, refer to (para. 4-85).

AMBULANCE (Compressor Clutch) (M997 Only)
(Refer to Fig. 14.)

DIAGNOSTIC FLOWCHART

FROM 6, Page 2-564

KNOWN INFO
A/C CONTROL SETTINGS OK
FUSE OK
BATTERY OK
CABLE 660 OK
LEAD 660 B OK

POSSIBLE PROBLEMS
LEAD 720
LEAD 720 A
DOOR SWITCH

7
IS THERE BATTERY VOLTAGE IN CONTROL BOX AT TB TERMINAL 9?

TEST OPTIONS
STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION
No power would indicate a damaged lead.

NO → REPLACE LEAD 720

YES ↓

KNOWN INFO
A/C CONTROL SETTINGS OK
FUSE OK
BATTERY OK
CABLE 660 OK
LEAD 660B OK
LEAD 720 OK

POSSIBLE PROBLEMS
LEAD 720 A
DOOR SWITCH

8
IS THERE BATTERY VOLTAGE IN ENVIRONMENTAL CONTROL BOX AT DOOR SWITCH?

TEST OPTIONS
STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION
No power would indicate a damaged lead.

NO → REPAIR LEAD 720 A

YES ↓

KNOWN INFO
A/C CONTROL SETTINGS OK
FUSE OK
BATTERY OK
CABLE 660 OK
LEAD 660 B OK
LEAD 720 OK
LEAD 720 A OK

POSSIBLE PROBLEMS
DOOR SWITCH

9
PLACE JUMPER WIRE BETWEEN LEAD 720 A AND LEAD 720 B AT DOOR SWITCH IN ENVIRONMENTAL CONTROL BOX. DOES COMPRESSOR CLUTCH ENGAGE?

TEST OPTIONS
TRY IT

REASON FOR QUESTION
If compressor clutch engages, that would indicate a damaged switch.

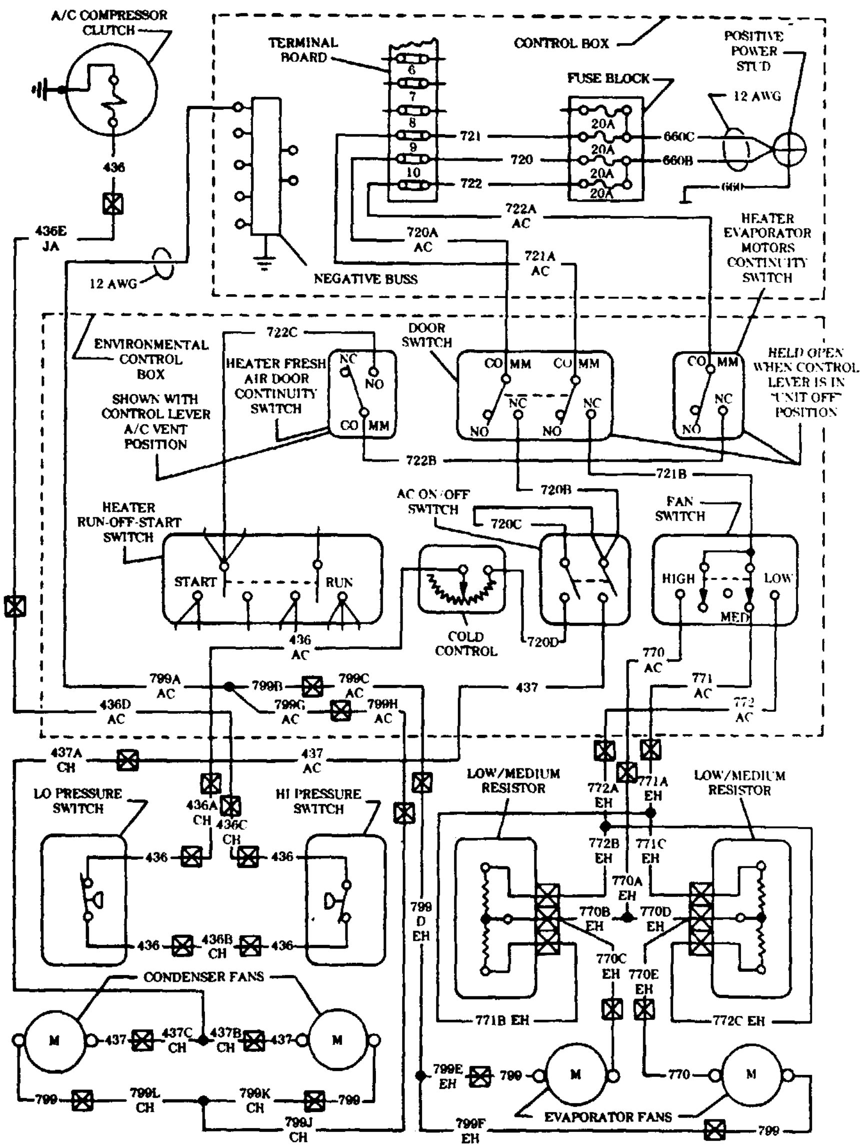
NO → GO TO 10, Page 2-568

YES → REPLACE DOOR SWITCH

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts..

Repair lead, refer to (para. 4-85). Repair lead connector, refer to (para. 4-85).

Replace door switch, refer to DS Maintenance.



AMBULANCE
(Compressor Clutch)
(M997 Only)
(Refer to Fig. 14.)

DIAGNOSTIC FLOWCHART

FROM 9, Page 2-566

KNOWN INFO

PREVIOUSLY CORRECTED INFORMATION

POSSIBLE PROBLEMS

LEAD 720 B
A/C ON/OFF SWITCH

10

IS THERE BATTERY VOLTAGE IN ENVIRONMENTAL CONTROL BOX AT A/C ON/OFF SWITCH?

TEST OPTIONS

STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION

No power at switch would indicate a damaged lead.

NO → REPAIR LEAD 720 B

YES ↓

KNOWN INFO

LEAD 720 B OK

POSSIBLE PROBLEMS

A/C ON/OFF SWITCH

11

PLACE JUMPER WIRE BETWEEN LEAD 720 C AND LEAD 720 D AT A/C ON/OFF SWITCH IN ENVIRONMENTAL CONTROL BOX. DOES COMPRESSOR CLUTCH ENGAGE?

TEST OPTIONS

TRY IT

REASON FOR QUESTION

If compressor engages, that would indicate a damaged switch.

NO → GO TO 12, Page 2-570

YES → REPLACE A/C ON/OFF SWITCH

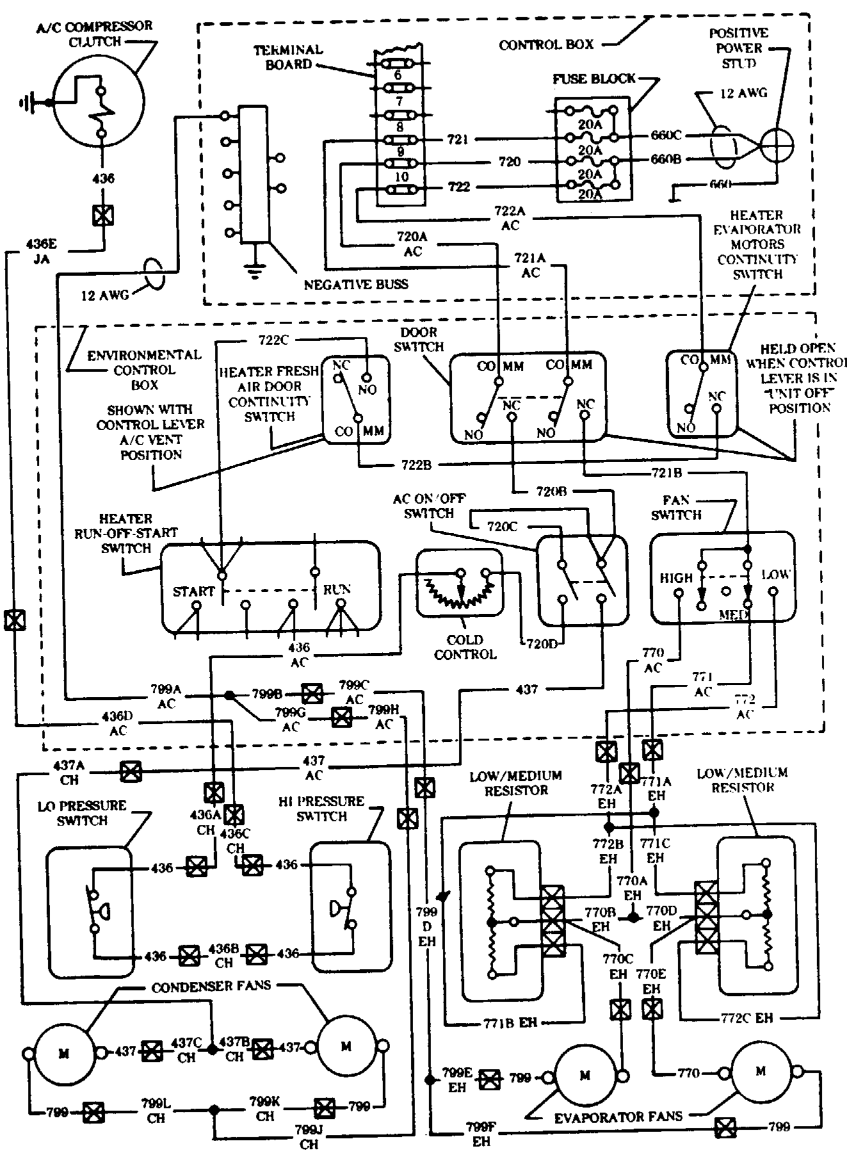
REFERENCE INFORMATION

AMBULANCE

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

Repair lead, refer to (para. 4-85).

Replace A/C ON/OFF switch, refer to (para. 4-127).



AMBULANCE (Compressor Clutch) (M997 Only)
(Refer to Fig. 14.)

DIAGNOSTIC FLOWCHART

FROM 11, Page 2-568

KNOWN INFO

PREVIOUSLY CORRECTED INFORMATION

POSSIBLE PROBLEMS

LEAD 720 D
COLD CONTROL

12

IS THERE BATTERY VOLTAGE IN ENVIRONMENTAL CONTROL BOX AT COLD CONTROL?

TEST OPTIONS

STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION

No power would indicate a damaged lead.

NO → REPLACE LEAD 720 D

YES ↓

KNOWN INFO

LEAD 720 D OK

POSSIBLE PROBLEMS

COLD CONTROL

13

PLACE JUMPER WIRE BETWEEN TERMINALS OF COLD CONTROL. DOES COMPRESSOR CLUTCH ENGAGE?

TEST OPTIONS

TRY IT

REASON FOR QUESTION

If compressor clutch engages, that would indicate a damaged cold control.

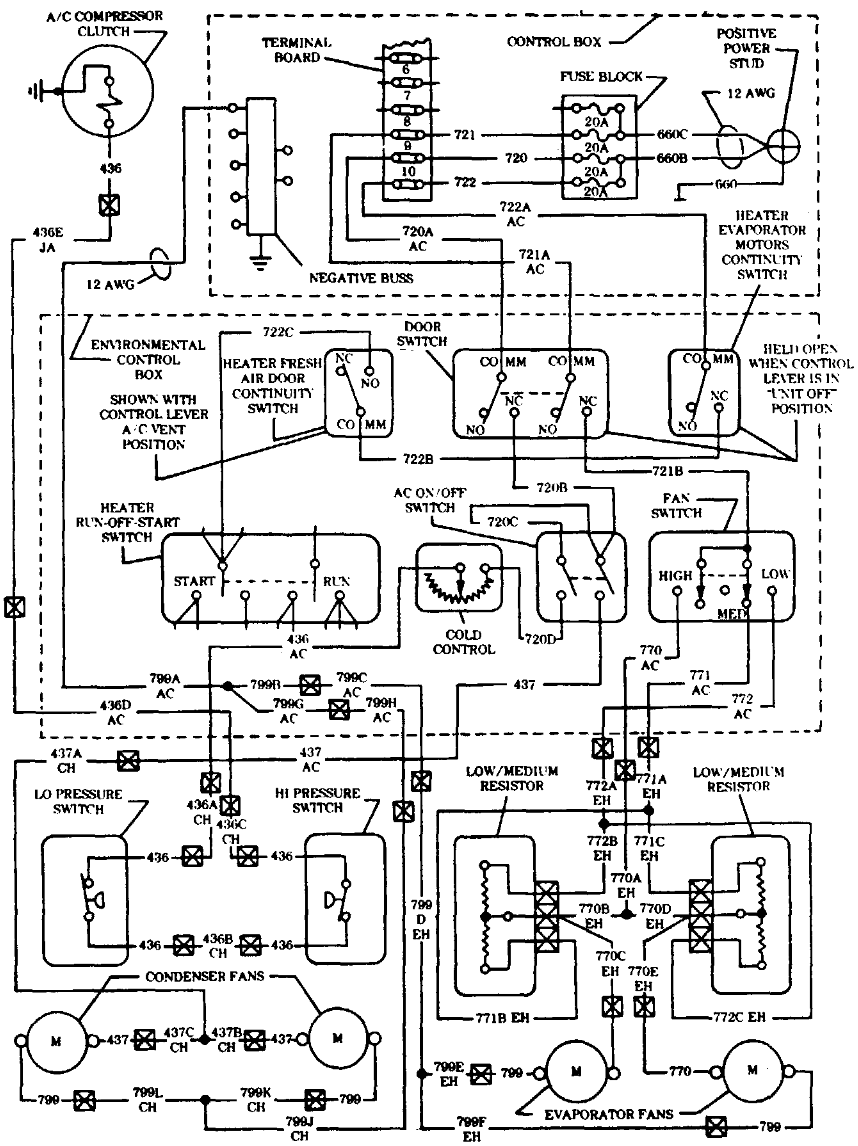
NO → GO TO 14, Page 2-572

YES → REPLACE COLD CONTROL

0-45 DC VOLTS
STE/ICE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

Replace cold control, refer to DS Maintenance.



AMBULANCE
(Compressor Clutch)
(M997 Only)
(Refer to Fig. 14.)

DIAGNOSTIC FLOWCHART

FROM 13, Page 2-570

KNOWN INFO

PREVIOUSLY CORRECTED INFORMATION

POSSIBLE PROBLEMS

- LEAD 436 A
- LO PRESSURE SWITCH
- LEAD 436 B
- HI PRESSURE SWITCH
- LEAD 436 C
- LEAD 436 D
- LEAD 436 E
- COMPRESSOR WIRING HARNESS
- LEAD 798 A
- COMPRESSOR

14

DISCONNECT LEAD 436 A FROM LO PRESSURE SWITCH. IS THERE BATTERY VOLTAGE AT LEAD 436 A?

TEST OPTIONS

STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION

No power would indicate a damaged lead.

NO → REPLACE LEAD 436 A

YES ↓

KNOWN INFO

LEAD 436 A OK

POSSIBLE PROBLEMS

- LO PRESSURE SWITCH
- LEAD 436 B
- HI PRESSURE SWITCH
- LEAD 436 C
- LEAD 436 D
- LEAD 436 E
- COMPRESSOR WIRING HARNESS
- LEAD 798 A
- COMPRESSOR

15

DISCONNECT LEAD 436 B FROM LO PRESSURE SWITCH. IS THERE BATTERY VOLTAGE AT LEAD 436 AT LO PRESSURE SWITCH?

TEST OPTIONS

1. STE/ICE-R TEST 89, PAGE 2-750
2. MULTIMETER

REASON FOR QUESTION

No power would indicate a damaged switch.

NO → REPLACE LO PRESSURE SWITCH

YES ↓

KNOWN INFO

LEAD 436 A OK
LO PRESSSURE SWITCH OK

POSSIBLE PROBLEMS

- LEAD 436 B
- HI PRESSURE SWITCH
- LEAD 436 C
- LEAD 436 D
- LEAD 463 E
- COMPRESSOR WIRING HARNESS
- LEAD 798 A
- COMPRESSOR

16

DISCONNECT LEAD 436 B FROM HI PRESSURE SWITCH. IS THERE BATTERY VOLTAGE AT LEAD 436 B?

TEST OPTIONS

STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION

No power would indicate damaged lead.

NO → REPLACE LEAD 436 B

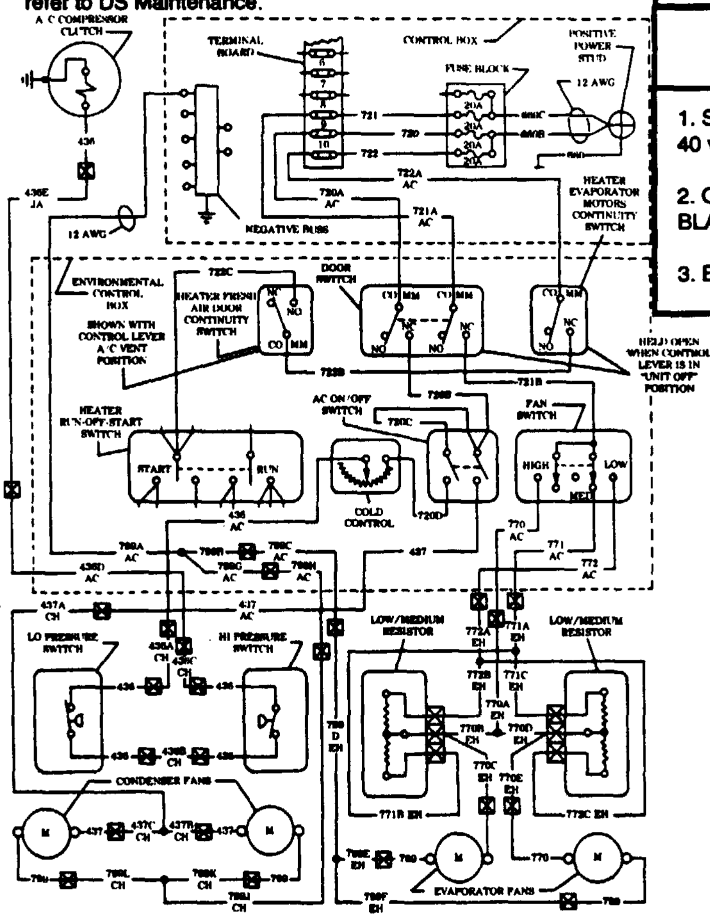
YES ↓

GO TO 17, Page 2-574

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

Replace LO pressure switch, refer to DS Maintenance.

BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.



AMBULANCE
(Compressor Clutch)
(M997 Only)
(Refer to Fig. 14.)

DIAGNOSTIC FLOWCHART

FROM 16, Page 2-572

17

KNOWN INFO
LEAD 436 A OK LO PRESSURE SWITCH OK LEAD 436 B OK

POSSIBLE PROBLEMS
HI PRESSURE SWITCH LEAD 436 C LEAD 436 D LEAD 436 E COMPRESSOR WIRING HARNESS LEAD 798 A COMPRESSOR

DISCONNECT LEAD 436 C FROM LEAD 436 OF HI PRESSURE SWITCH. IS THERE BATTERY VOLTAGE AT LEAD 436?

TEST OPTIONS

1. STE/ICE-R TEST 89, PAGE 2-750
2. MULTIMETER

REASON FOR QUESTION

No power would indicate a damaged switch.

NO → REPLACE HI PRESSURE SWITCH

YES ↓

18

KNOWN INFO
LEAD 436 A OK LO PRESSURE SWITCH OK LEAD 436 B OK HI PRESSURE SWITCH OK

POSSIBLE PROBLEMS
LEAD 436 C LEAD 436 D LEAD 436 E COMPRESSOR WIIRNG HARNESS LEAD 798 A COMPRESSOR

DISCONNECT LEAD 436 C FROM LEAD 436 D. IS THERE BATTERY VOLTAGE AT LEAD 436 C?

TEST OPTIONS

STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION

No power would indicate a damaged lead.

NO → REPLACE LEAD 436 C

YES ↓

19

KNOWN INFO
LEAD 436 A OK LO PRESSURE SWITCH OK LEAD 436 B OK HI PRESSURE SWITCH OK LEAD 436 C OK

POSSIBLE PROBLEMS
LEAD 436 D LEAD 436 E COMPRESSOR WIRING HARNESS LEAD 798 A COMPRESSOR

DISCONNECT LEAD 436 D FROM LEAD 436 E. IS THERE BATTERY VOLTAGE AT LEAD 436 D?

TEST OPTIONS

STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION

No power would indicate a damaged lead.

NO → REPLACE LEAD 436 D

YES ↓

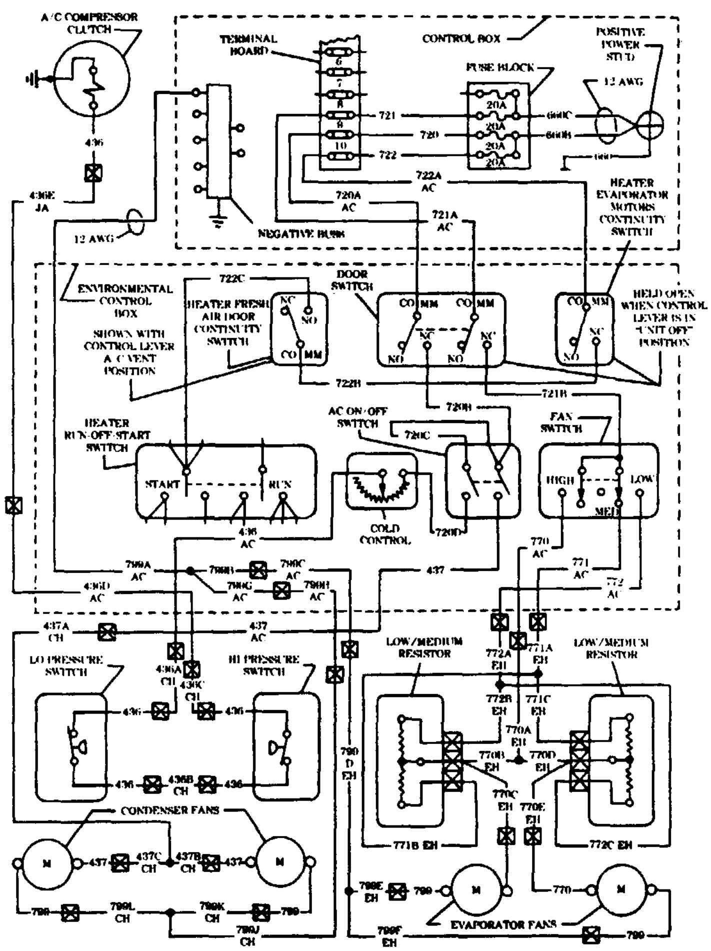
GO TO 20, Page 2-576

REFERENCE INFORMATION **AMBULANCE**

Replace high pressure switch, refer to DS Maintenance.

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.



AMBULANCE
(Compressor Clutch)
(M997 Only)
(Refer to Fig. 14.)

DIAGNOSTIC FLOWCHART

FROM 19, Page 2-574

KNOWN INFO

LEAD 436 A OK
LO PRESSURE SWITCH OK
LEAD 436 B OK
HIGH PRESSURE SWITCH OK
LEAD 436 C OK
LEAD 436 D OK

POSSIBLE PROBLEMS

LEAD 436 E
COMPRESSOR WIRING HARNESS
LEAD 798 A
COMPRESSOR

20

IS THERE NOW BATTERY VOLTAGE THROUGH LEAD 436 E?

TEST OPTIONS

STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION

No power would indicate a damaged lead.

NO → REPAIR LEAD 436 E OR REPLACE COMPRESSOR WIRING HARNESS

YES ↓

KNOWN INFO

LEAD 436 A OK
LO PRESSURE SWITCH OK
LEAD 436 C OK
LEAD 436 D OK
LEAD 436 E OK
COMPRESSOR WIRING HARNESS OK

POSSIBLE PROBLEMS

21

DOES COMPRESSOR CLUTCH ENGAGE?

TEST OPTIONS

TRY IT

REASON FOR QUESTION

Compressor clutch should engage now that power is supplied if properly grounded.

NO → GO TO 22, Page 2-578

YES ↓

END OF TESTING

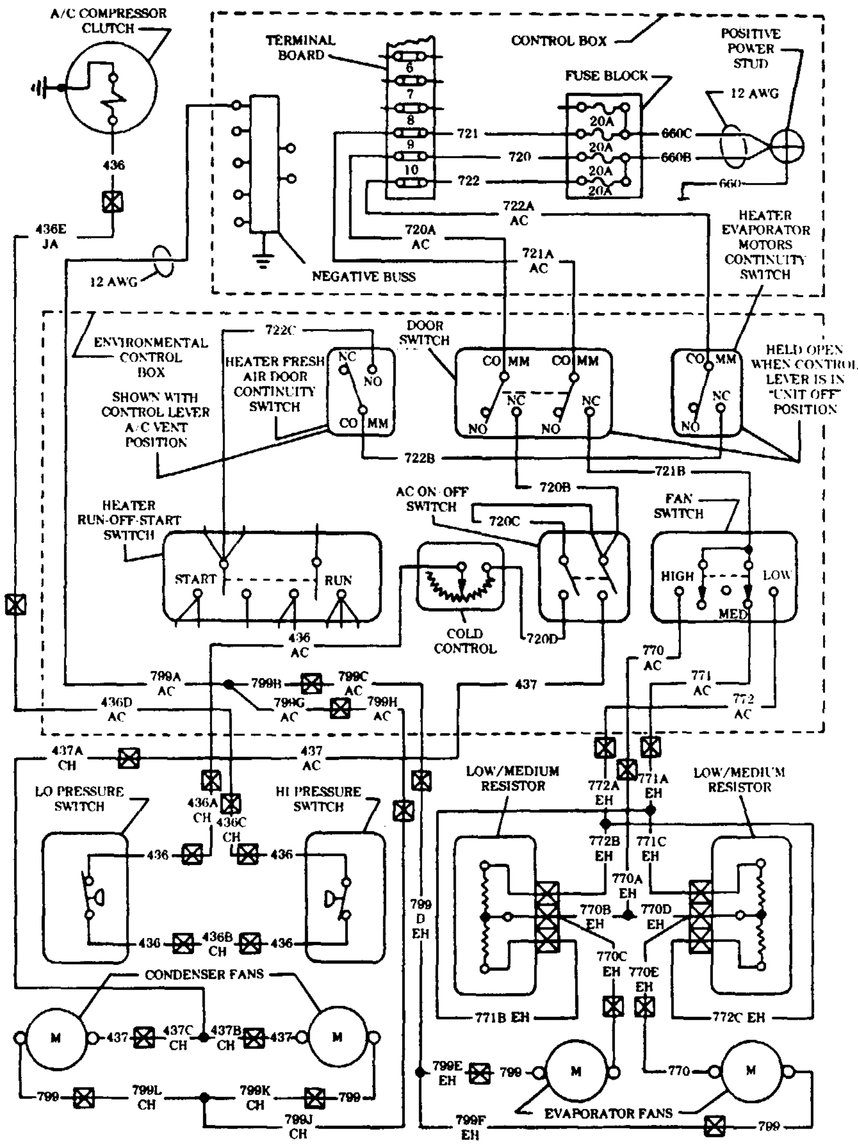
REFERENCE INFORMATION

AMBULANCE

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

Replace compressor wiring harness, refer to (para. 4-122).

Repair lead, refer to (para. 4-85).
Repair lead connector, refer to (para. 4-85).



AMBULANCE
(Compressor Clutch)
(M997 Only)
(Refer to Fig. 14.)

DIAGNOSTIC FLOWCHART

FROM 3, 2-562 AND 21, Page 2-576

KNOWN INFO

PREVIOUSLY CORRECTED INFORMATION

POSSIBLE PROBLEMS

LEAD 798 A
COMPRESSOR

22

DISCONNECT LEAD 798 A AT COMPRESSOR. IS THERE CONTINUITY OF LEAD 798 A TO GROUND?

TEST OPTIONS

STE/ICE-R TEST 91, PAGE 2-752

REASON FOR QUESTION

No continuity would indicate a damaged lead.

NO → REPAIR LEAD 798 A

YES ↓

KNOWN INFO

LEAD 798 A OK

POSSIBLE PROBLEMS

COMPRESSOR

23

DOES COMPRESSOR CLUTCH ENGAGE?

TEST OPTIONS

TRY IT

REASON FOR QUESTION

If compressor clutch does not engaage, that would indicate a malfunction not handled at this level.

NO → COMPRESSOR FAULTY: NOTIFY DS MAINTENANCE

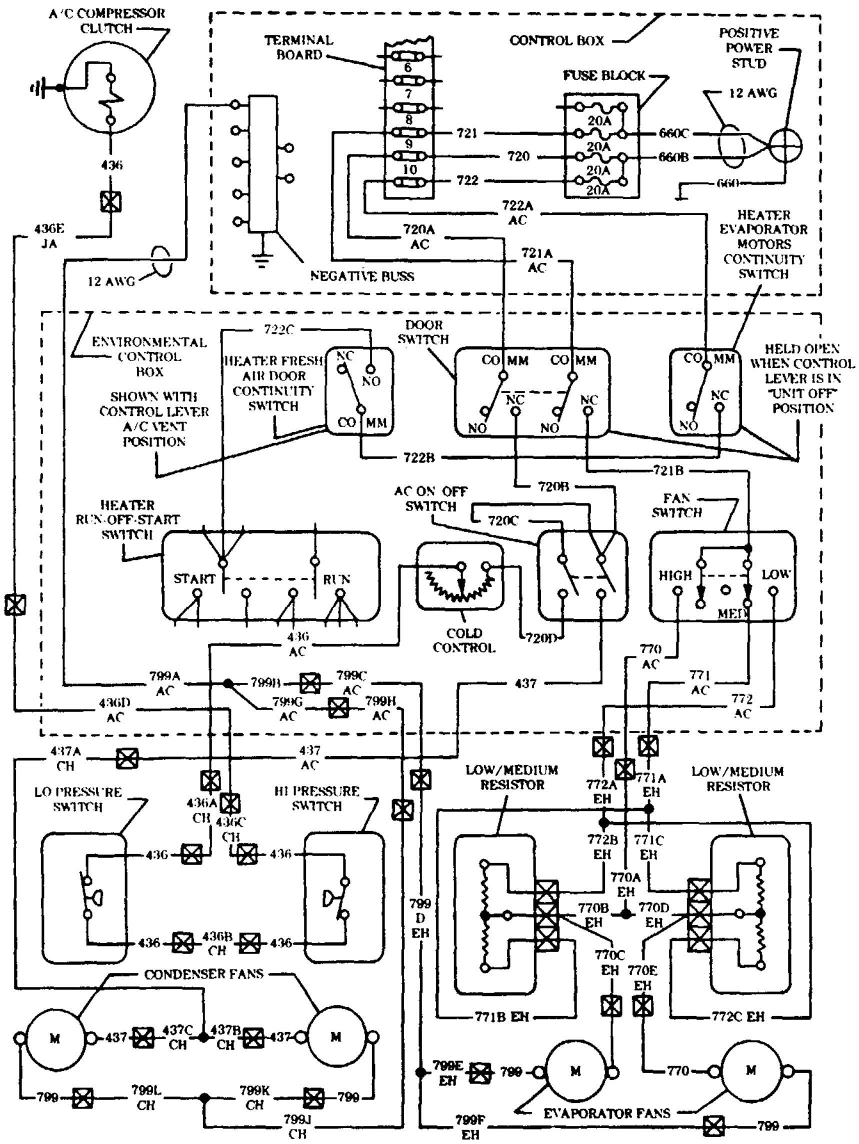
YES ↓

END OF TESTING

0-4500 DC OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

Repair lead, refer to (para. 4-85).

Repair lead connector, refer to (para. 4-85).



AMBULANCE (Evaporator Fans) (M997 Only)

(Refer to Fig. 14.)

DIAGNOSTIC FLOWCHART

START

1

KNOWN INFO

NOTHING

POSSIBLE PROBLEMS

A/C CONTROL LEVER POSITION
FAN SWITCH POSITION
FUSE
EVAPORATOR FANS

IS AIR-CONDITIONING CONTROL LEVER IN PROPER POSITION?

TEST OPTIONS

VISUAL

REASON FOR QUESTION

Control lever must be in correct position for fan to operate.

NO → PLACE CONTROL LEVER TO A/C NORMAL OR A/C MAX POSITION

YES ↓

2

KNOWN INFO

A/C CONTROL LEVER POSITION OK

POSSIBLE PROBLEMS

FAN SWITCH POSTION
FUSE
EVAPORATOR FANS

IS THE FAN SWITCH IN PROPER POSITION?

TEST OPTIONS

VISUAL

REASON FOR QUESTION

Fan switch must be in correct position for fan to operate.

NO → PLACE FAN SWITCH TO HIGH POSITION

YES ↓

3

KNOWN INFO

A/C CONTROL LEVER POSITION OK
FAN SWITCH POSITION OK

POSSIBLE PROBLEMS

FUSE
EVAPORATOR FANS

CHECK FUSE BLOCK ON CONTROL BOX COVER. IS FUSE OK?

TEST OPTIONS

VISUAL

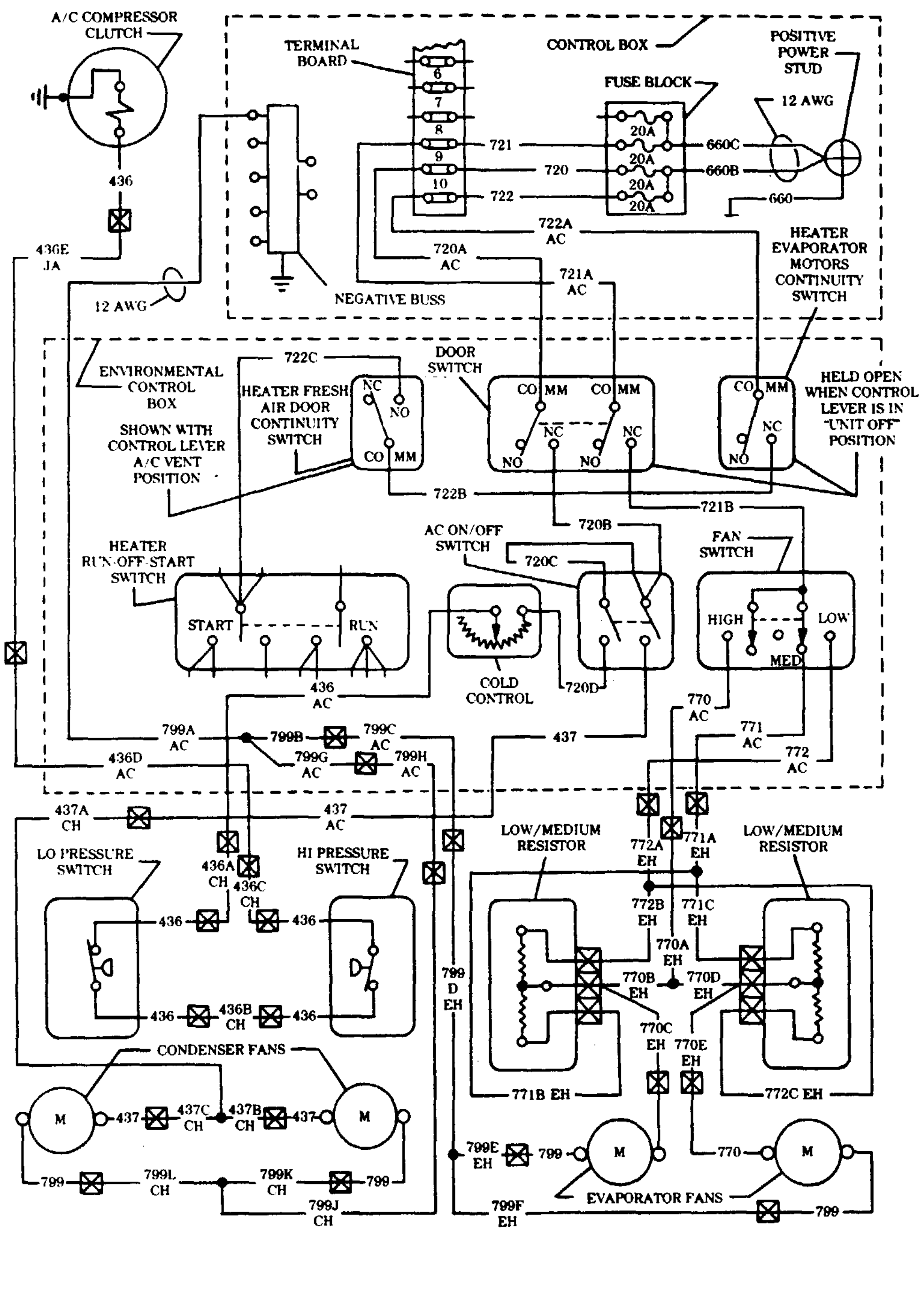
REASON FOR QUESTION

If fuse is blown, circuit is incomplete.

NO → REPLACE BLOWN FUSE

YES ↓

GO TO 4, Page 2-582


A/C COMPRESSOR CLUTCH
CONTROL BOX
TERMINAL BOARD
POSITIVE POWER STUD
FUSE BLOCK
12 AWG
20A
721
720
722
660C
660B
660
722A AC
720A AC
721A AC
436
436E JA
12 AWG
NEGATIVE BUSS
HEATER EVAPORATOR MOTORS CONTINUITY SWITCH
ENVIRONMENTAL CONTROL BOX
722C
DOOR SWITCH
HEATER FRESH AIR DOOR CONTINUITY SWITCH
SHOWN WITH CONTROL LEVER A/C VENT POSITION
HELD OPEN WHEN CONTROL LEVER IS IN "UNIT OFF" POSITION
722B
721B
720B
AC ON/OFF SWITCH
720C
FAN SWITCH
HEATER RUN-OFF-START SWITCH
START
RUN
HIGH
LOW
MED
COLD CONTROL
720D
436 AC
770 AC
771 AC
772 AC
799A AC
799B
799C AC
799G AC
799H AC
436D AC
437
437A CH
437 AC
LOW/MEDIUM RESISTOR
772A EH
771A EH
LO PRESSURE SWITCH
436A CH
436C CH
HI PRESSURE SWITCH
772B EH
771C EH
770A EH
770B EH
770D EH
799 D EH
436B CH
770C EH
770E EH
CONDENSER FANS
437C CH
437B CH
771B EH
772C EH
799E EH
799L CH
799K CH
799J CH
799F EH
EVAPORATOR FANS
799
770

AMBULANCE
(Evaporator Fans)
(M997 Only)
(Refer to Fig. 14.)

DIAGNOSTIC FLOWCHART

FROM 3, Page 2-580

4

KNOWN INFO

A/C CONTROL LEVER POSITION OK
FAN SWITCH POSITION OK
FUSE OK

POSSIBLE PROBLEMS

EVAPORATOR FANS

DISCONNECT LEADS 770 C AND 770 E AT EVAPORATOR FANS. IS THERE BATTERY VOLTAGE AT LEADS 770 C AND 770 E?

TEST OPTIONS

STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION

The presence of voltage would indicate a malfunction of evaporator fan or related components.

NO: GO TO 6, Page 2-584

YES: go to 5.

5

KNOWN INFO

A/C CONTROL LEVER POSITION OK
FAN SWITCH POSITION OK
FUSE OK

POSSIBLE PROBLEMS

EVAPORATOR FANS

DISCONNECT LEADS 799 E AND 799 F AT EVAPORATOR FANS. IS THERE CONTINUITY AT LEADS 799 E AND 799 F TO GROUND?

TEST OPTIONS

STE/ICE-R TEST 91, PAGE 2-752

REASON FOR QUESTION

No continuity would indicate damaged leads.

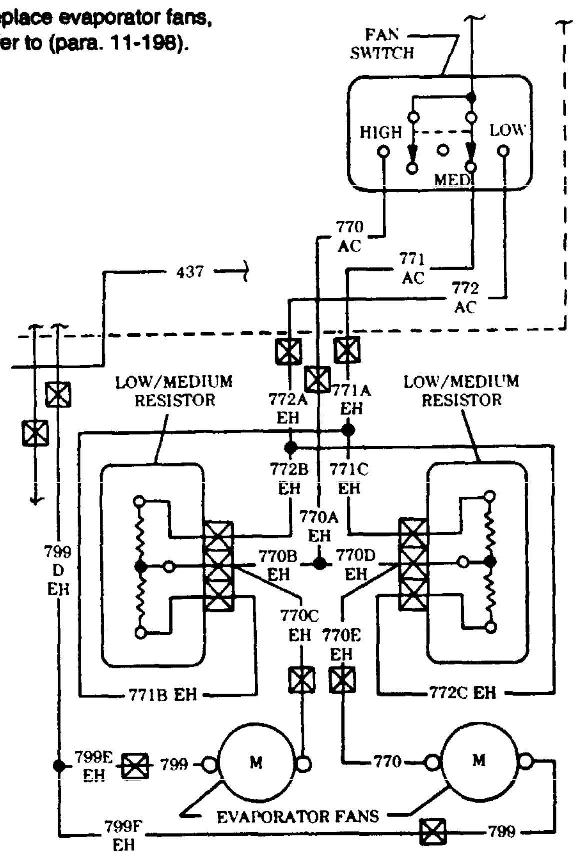
NO: GO TO 15, Page 2-592

YES: REPLACE EVAPORATOR FANS

REFERENCE INFORMATION **AMBULANCE**

0-45 DC VOLTS **STE/ICE-R TEST 89**
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

Replace evaporator fans, refer to (para. 11-198).



0-4500 OHMS **STE/ICE-R TEST 91**
1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

AMBULANCE
(Evaporator Fans)
(M997 Only)
(Refer to Fig. 14.)

DIAGNOSTIC FLOWCHART

FROM 4, Page 2-582

KNOWN INFO
PREVIOUSLY CORRECTED INFORMATION
POSSIBLE PROBLEMS
BATTERY CABLE 660 LEAD 660 C LEAD 721 LEAD 721 A DOOR SWITCH

6

PERFORM STEPS 4 AND 5 ON PAGE 2-564, THEN RETURN TO 7 BELOW.

KNOWN INFO
BATTERY OK CABLE 660 OK
POSSIBLE PROBLEMS
LEAD 660 C LEAD 721 LEAD 721 A DOOR SWITCH

7

IS THERE BATTERY VOLTAGE IN CONTROL BOX LEAD 660 C AT FUSE BLOCK?

TEST OPTIONS

STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION

No power would indicate a damaged lead.

NO → REPAIR LEAD 660 C

YES ↓

KNOWN INFO
BATTERY OK CABLE 660 OK LEAD 660 C OK
POSSIBLE PROBLEMS
LEAD 721 LEAD 721 A DOOR SWITCH

8

IS THERE BATTERY VOLTAGE IN CONTROL BOX AT TB TERMINAL 8?

TEST OPTIONS

STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION

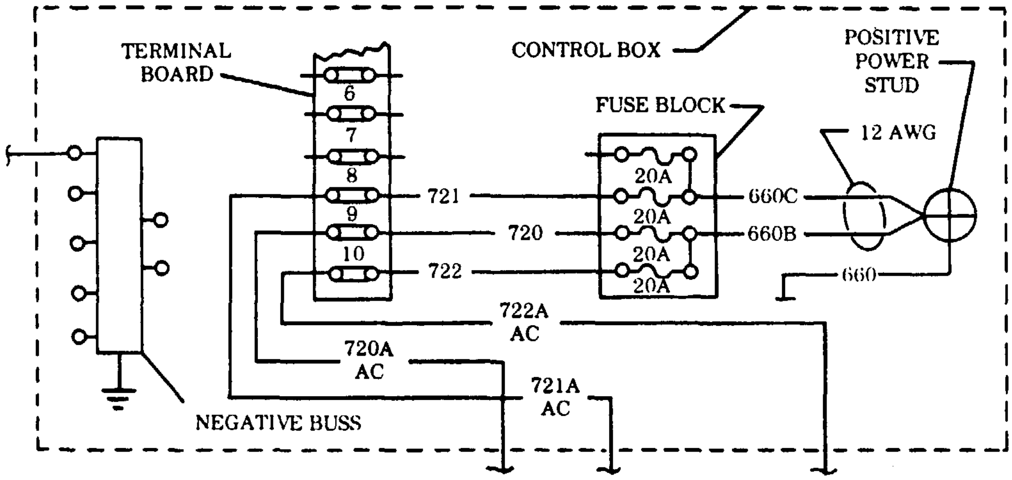
No power would indicate a damaged lead.

NO → REPLACE LEAD 721

YES ↓

GO TO 9, Page 2-586

REFERENCE INFORMATION **AMBULANCE**



Repair lead,
refer to (para. 4-85).

Repair lead connector,
refer to (para. 4-85).

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

AMBULANCE
(Evaporator Fans)
(M997 Only)
(Refer to Fig. 14.)

DIAGNOSTIC FLOWCHART

FROM 8, Page 2-584

KNOWN INFO

BATTERY OK
CABLE 660 OK
LEAD 660C OK
LEAD 721 OK

POSSIBLE PROBLEMS

LEAD 721 A
DOOR SWITCH

9

IS THERE BATTERY VOLTAGE IN ENVIRONMENTAL CONTROL BOX AT DOOR SWITCH?

TEST OPTIONS

STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION

No power would indicate a damaged lead.

NO → REPAIR LEAD 721 A

YES ↓

KNOWN INFO

BATTERY OK
CABLE 660 OK
LEAD 660 C OK
LEAD 721 OK
LEAD 721 A OK

POSSIBLE PROBLEMS

DOOR SWITCH

10

PLACE JUMPER WIRE BETWEEN LEAD 721 A AND LEAD 721 B AT DOOR SWITCH IN ENVIRONMENTAL CONTROL BOX. DO EVAPORATOR FANS OPERATE?

TEST OPTIONS

TRY IT

REASON FOR QUESTION

If evaporator fans operate, that would indicate a malfunction of the door switch.

NO → GO TO 11, Page 2-588

YES ↓

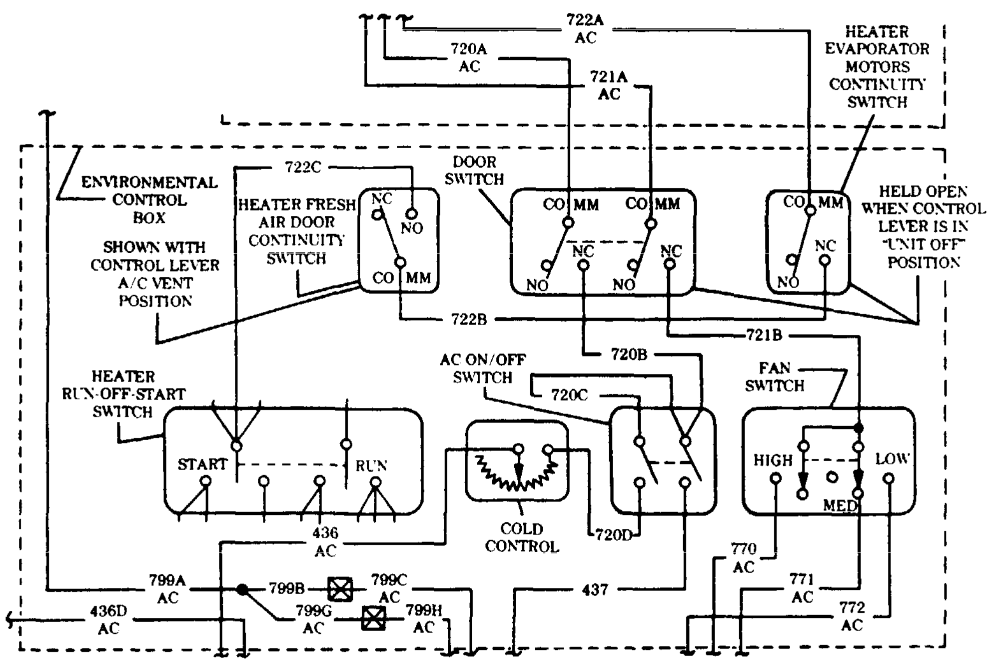
REPLACE DOOR SWITCH

Repair lead,
refer to (para. 4-85).

Repair lead connector,
refer to (para. 4-85).

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

Replace door switch,
refer to DS Maintenance.



AMBULANCE (Evaporator Fans) (M997 Only)

(Refer to Fig. 14.)

DIAGNOSTIC FLOWCHART

FROM 10, Page 2-586

11

KNOWN INFO
PREVIOUSLY CORRECTED INFORMATION

POSSIBLE PROBLEMS
LEAD 721 B
FAN SWITCH
LEAD 770
DAMAGED LEADS
DAMAGED COMPONENTS

IS THERE BATTERY VOLTAGE IN ENVIRONMENTAL CONTROL BOX AT LEAD 721 B AT FAN SWITCH?

TEST OPTIONS
STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION
No power would indicate a damaged lead.

NO → REPAIR LEAD 721 B

YES ↓

12

KNOWN INFO
LEAD 721 B OK

POSSIBLE PROBLEMS
FAN SWITCH
LEAD 770
DAMAGED LEADS
DAMAGED COMPONENTS

DISCONNECT FAN SWITCH LEAD 770 IN ENVIRONMENTAL CONTROL BOX FROM LEAD 770 A. IS THERE BATTERY VOLTAGE AT LEAD 770?

TEST OPTIONS
STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION
No power would indicate a malfunction of fan switch or a damaged lead.

NO → REPLACE FAN SWITCH AND/OR REPAIR LEAD 770

YES ↓

13

KNOWN INFO
LEAD 721 B OK
FAN SWITCH OK
LEAD 770 OK

POSSIBLE PROBLEMS
DAMAGED LEADS
DAMAGED COMPONENTS

DISCONNECT LEADS 770 C AND 770 E FROM EVAPORATOR FANS. IS THERE BATTERY VOLTAGE AT LEADS 770 C AND 770 E?

TEST OPTIONS
STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION
No power would indicate damage leads or resistors.

NO → REPAIR DAMAGED LEADS AND/OR REPLACE DAMAGED COMPONENTS

YES ↓

GO TO 14, Page 2-590

0-45 DC VOLTS
STE/ICE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.

2. Start Test 89, DC volts.

3. Displayed reading is in volts.

Repair lead, refer to (para. 4-85).

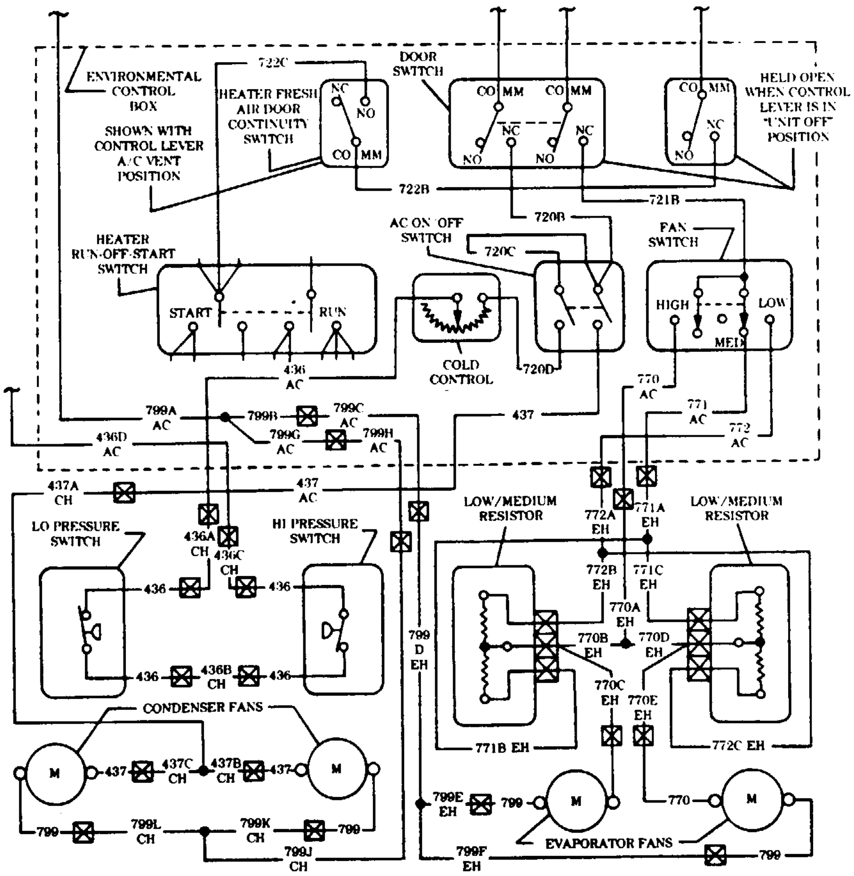
Replace fan switch, refer to (para. 4-127).

Repair lead, refer to (para. 4-85).

Repair lead connector, refer to (para. 4-85).

Repair lead, refer to (para. 4-85).

Repair lead connector, refer to (para. 4-85).



AMBULANCE
(Evaporator Fans)
(M997 Only)
(Refer to Fig. 14.)

DIAGNOSTIC FLOWCHART

KNOWN INFO

LEAD 721 B OK
FAN SWITCH OK
LEAD 770 OK
LEADS OK
COMPONENTS OK

POSSIBLE PROBLEMS

FROM 13,
Page 2-588

14

DO EVAPORATOR FANS OPERATE?

TEST OPTIONS

TRY IT

REASON FOR QUESTION

If evaporator fans do not operate, that would indicate possible problems of fans not being grounded properly.

NO

GO TO 5,
Page 2-582

YES

END TESTING

AMBULANCE
(Evaportor Fans)
(M997 Only)
(Refer to Fig. 14.)

DIAGNOSTIC FLOWCHART

FROM 5,
Page 2-582

KNOWN INFO

PREVIOUSLY
CORRECTED
INFORMATION

POSSIBLE PROBLEMS

LEAD 799 E
LEAD 799 F

15

REPAIR LEADS 799 E AND 799 F.
DO EVAPORATOR FANS
OPERATE?

TEST OPTIONS

1. STE/ICE-R TEST 91, PAGE 2-752
2. TRY IT

REASON FOR QUESTION

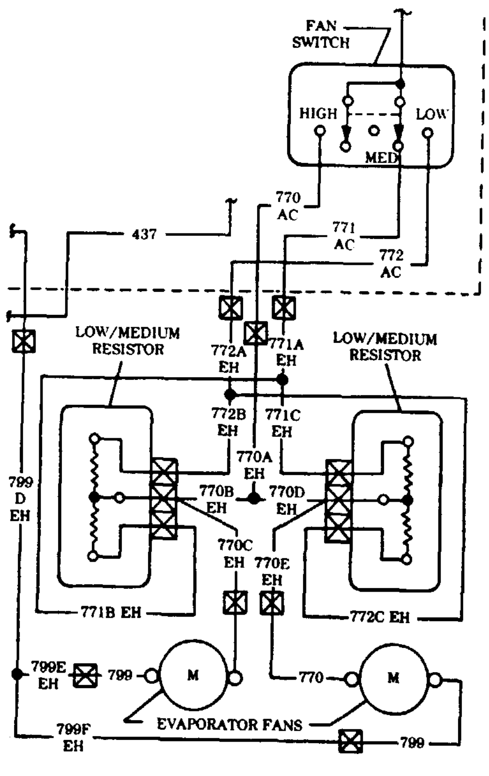
If properly grounded and evaporator fans are OK, the fans should operate.

NO: GO TO 16,
Page 2-594

YES: END OF TESTING

Repair lead, refer to (para. 4-85).
Repair lead connector, refer to (para. 4-85).

0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."



AMBULANCE
(Evaporator Fans)
(M997 Only)
(Refer to Fig. 14.)

DIAGNOSTIC FLOWCHART

FROM 15, Page 2-592

KNOWN INFO

PREVIOUSLY CORRECTED INFORMATION

POSSIBLE PROBLEMS

LEAD 799 D
LEAD 799 C
LEAD 799 B
LEAD 799 A
EVAPORATOR FANS

16

DISCONNECT LEAD 799 D FROM LEAD 799 C. IS THERE CONTINUITY BETWEEN:LEADS 799 E AND 799 D?
LEADS 799 F AND 799 D?

TEST OPTIONS

STE/ICE-R TEST 91, PAGE 2-752

REASON FOR QUESTION

No continuity would indicate damaged leads.

NO → REPAIR AND/OR REPLACE DAMAGED LEAD.

YES ↓

KNOWN INFO

LEAD 799 D OK

POSSIBLE PROBLEMS

LEAD 799 C
LEAD 799 B
LEAD 799 A
EVAPORATOR FANS

17

IS THERE CONTINUITY OF LEAD 799 C?

TEST OPTIONS

STE/ICE-R TEST 91, PAGE 2-752

REASON FOR QUESTION

No continuity would indicate a damaged lead.

NO → REPLACE LEAD 799 C

YES ↓

KNOWN INFO

LEAD 799 D OK
LEAD 799 C OK

POSSIBLE PROBLEMS

LEAD 799 B
LEAD 799 A
EVAPORATOR FANS

18

IS THERE CONTINUITY BETWEEN LEAD 799 B IN ENVIRONMENTAL CONTROL BOX AND GROUND IN CONTROL BOX?

TEST OPTIONS

STE/ICE-R TEST 91, PAGE 2-752

REASON FOR QUESTION

No continuity would indicate a damaged lead.

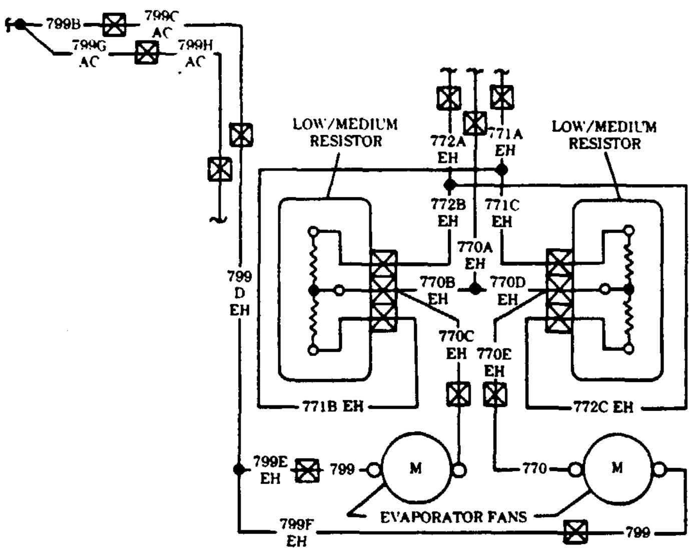
NO → REPAIR DAMAGED LEADS

YES ↓

GO TO 19, Page 2-596

Repair lead, refer to (para. 4-85).
Repair lead connector, refer to (para. 4-85).

0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less then 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."



Repair lead, refer to (para. 4-85).
Repair lead connector, refer to (para. 4-85).

AMBULANCE
(Evaporator Fans)
(M997 Only)
(Refer to Fig. 14.)

DIAGNOSTIC FLOWCHART

FROM 18, Page 2-594

KNOWN INFO

LEAD 799 D OK
LEAD 799 C OK
LEAD 799 B OK
LEAD 799 A OK

POSSIBLE PROBLEMS

EVAPORATOR FANS

19

DO EVAPORATOR FANS OPERATE?

TEST OPTIONS

TRY IT

REASON FOR QUESTION

If evaporator fans do not operate that would indicate a malfunction not handled at this level.

NO → REPLACE EVAPORATOR FANS OR NOTIFY DS MAINTENANCE

YES → END OF TESTING

Replace evaporator fans, refer to (para.11-198).

AMBULANCE
(Condenser Fans)
(M997 Only)
(Refer to Fig. 14.)

DIAGNOSTIC FLOWCHART

START

KNOWN INFO

NOTHING

POSSIBLE PROBLEMS

A/C CONTROL LEVER POSITION
A/C ON/OFF SWITCH POSITION
FUSE
COMPRESSOR CLUTCH
LEADS 437 B AND 437 C
LEAD 799 C
LEAD G LEAD H
LEADS 799 J, 799 K, AND 799 L
CONDENSOR FANS

1

IS AIR-CONDITIONING CONTROL LEVER IN PROPER POSITION?

TEST OPTIONS

VISUAL

REASON FOR QUESTION

Control lever must be in correct postion for fans to operate.

NO → PLACE CONTROL LEVER TO A/C NORMAL OR A/C MAX POSITION

YES ↓

KNOWN INFO

A/C CONTROL LEVER POSTION OK

POSSIBLE PROBLEMS

A/C ON/OFF SWITCH POSITION
FUSE
COMPRESSOR CLUTCH
LEADS 437 B AND 437 C
LEAD 799 G
LEAD 799 H
LEADS 799 J, 799 K, AND 799 L
CONDENSER FANS

2

IS A/C ON/OFF SWITCH IN PROPER POSITION?

TEST OPTIONS

VISUAL

REASON FOR QUESTION

Switch must be in correct position for fans to operate.

NO → PLACE A/C ON/OFF SWITCH TO ON POSTION

YES ↓

KNOWN INFO

A/C CONTROL LEVER POSITION OK
A/C ON/OFF SWITCH POSITION OK

POSSIBLE PROBLEMS

FUSE
COMPRESSOR CLUTCH
LEADS 437 B AND 437 C
LEAD 799 G
LEAD 799 H
LEADS 799 J, 799 K, AND 799 L
CONDENSER FANS

3

CHECK FUSE BLOCK ON CONTROL BOX COVER. IS FUSE OK?

TEST OPTIONS

VISUAL

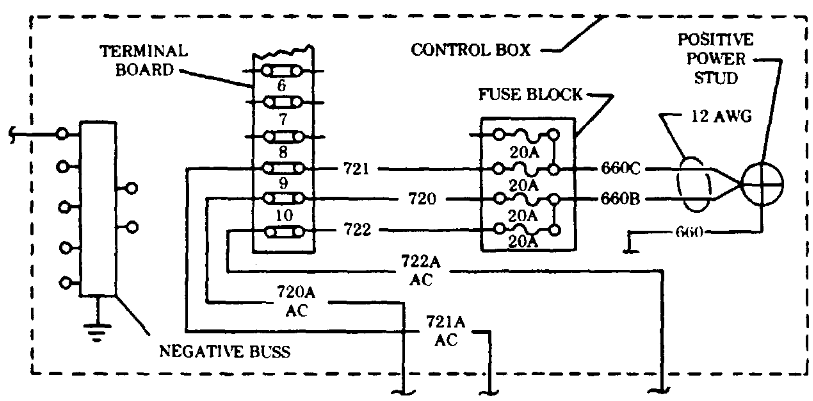
REASON FOR QUESTION

If fuse is blown, circuit to A/C is incomplete.

NO → REPLACE BLOWN FUSE

YES ↓

GO TO 4, Page 2-600


TERMINAL BOARD
CONTROL BOX
POSITIVE POWER STUD
FUSE BLOCK
12 AWG
6
7
8
9
10
721
720
722
20A
20A
20A
20A
660C
660B
660
722A AC
720A AC
721A AC
NEGATIVE BUSS

AMBULANCE
(Condenser Fans)
(M997 Only)
(Refer to Fig. 14.)

DIAGNOSTIC FLOWCHART

FROM 3, Page 2-598

KNOWN INFO
A/C CONTROL LEVER POSITION A/C ON/OFF SWITCH POSITION FUSE

POSSIBLE PROBLEMS
COMPRESSOR CLUTCH LEADS 437 B AND 437 C LEAD 799 G LEAD 799 H LEADS 799 J, 799 K, AND 799 L CONDENSER FANS

4

DOES COMPRESSOR CLUTCH ENGAGE?

TEST OPTIONS

TRY IT

REASON FOR QUESTION

Condenser fans are powered on same power source lines.

NO → PERFORM STEPS 3-23, PAGES 2-562 TO 2-578 AND RETURN TO 5 BELOW

YES ↓

KNOWN INFO
A/C CONTROL LEVER POSITION A/C ON/OFF SWITCH POSITION FUSE COMPRESSOR CLUTCH

POSSIBLE PROBLEMS
LEADS 437 B AND 437 C LEAD 799 G LEAD 799 H LEADS 799 J, 799 K, AND 799 L CONDENSER FANS

5

DISCONNECT LEAD 437 B AND 437 C FROM CONDENSER FANS. IS THERE BATTERY VOLTAGE AT LEAD 437 B, AND 437 C?

TEST OPTIONS

STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION

No power would indicate damaged leads.

NO → REPAIR DAMAGED LEADS OR REPLACE HARNESS 437 A, 437 B, 437 C

YES ↓

KNOWN INFO
A/C CONTROL LEVER POSITION A/C ON/OFF SWITCH POSITION FUSE COMPRESSOR CLUTCH LEADS 437 B AND 437 C

POSSIBLE PROBLEMS
LEAD 799 G LEAD 799 H LEADS 799 J, 799 K, AND 799 L CONDENSER FANS

6

IS THERE CONTINUITY BETWEEN LEAD 799 G IN ENVIRONMENTAL CONTROL BOX AND GROUND?

TEST OPTIONS

STE/ICE-R TEST 91, PAGE 2-752

REASON FOR QUESTION

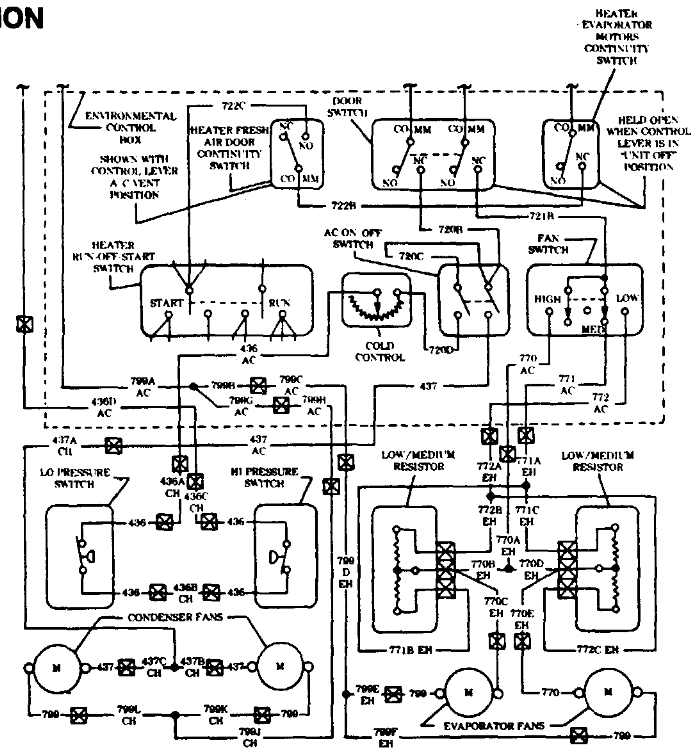
No continuity would indicate a damaged lead.

NO → REPAIR LEAD 799 G

YES ↓

GO TO 7, Page 2-602

REFERENCE INFORMATION **AMBULANCE**



Repair leads, refer to (para. 4-85).
Repair lead connectors, refer to (para. 4-85).

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

Repair lead, refer to (para. 4-85).
Repair lead connector, refer to (para. 4-85).

0-4500 OHMS STE/ICE -R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms STE/ICE displays "9.9.9.9."

AMBULANCE
(Condenser Fans)
(M997 Only)
(Refer to Fig.14.)

DIAGNOSTIC FLOWCHART

FROM 6, Page 2-600

KNOWN INFO

A/C CONTROL LEVER POSITION
A/C ON/OFF SWITCH POSITION
FUSE
COMPRESSOR CLUTCH
LEADS 437 B AND 437 C
LEAD 799 G

POSSIBLE PROBLEMS

LEAD 799 H
LEADS 799 J, 799 K, AND 799 L
CONDENSER FANS

7

IS THERE CONTINUITY BETWEEN LEAD 799 H AND GROUND?

TEST OPTIONS

STE/ICE TEST 91, PAGE 2-752

REASON FOR QUESTION

No power would indicate a damaged lead.

NO → REPLACE LEAD 799 H

YES ↓

KNOWN INFO

A/C CONTROL LEVER POSITION
A/C ON/OFF SWITCH POSITION
FUSE
COMPRESSOR CLUTCH
LEADS 437 B AND 437 C
LEAD 799 G
LEAD 799 H

POSSIBLE PROBLEMS

LEADS 799 J, 799 K, AND 799 L
CONDENSER FANS

8

DISCONNECT LEAD 799 K AND 799 L FROM CONDENSER FANS. IS THERE CONTINUITY BETWEEN:
LEADS 799 K AND 799 J?
LEADS 799 L AND 799 J?

TEST OPTIONS

1. STE/ICE-R TEST 91, PAGE 2-752
2. MULTIMETER

REASON FOR QUESTION

No continuity would indicate damaged leads.

NO → REPAIR DAMAED LEAD OR REPLACE HARNSS 799 J, 799 K, 799 L

YES ↓

KNOWN INFO

A/C CONTROL LEVER POSITION
A/C ON/OFF SWITCH POSITION
FUSE
COMPRESSOR CLUTCH
LEADS 437 B AND 437 C
LEAD 799 G
LEAD 799 H
LEADS 799 J, 799 K, AND 799 L

POSSIBLE PROBLEMS

CONDENSER FANS

9

DOES CONDENSER FANS OPERATE?

TEST OPTIONS

TRY IT

REASON FOR QUESTION

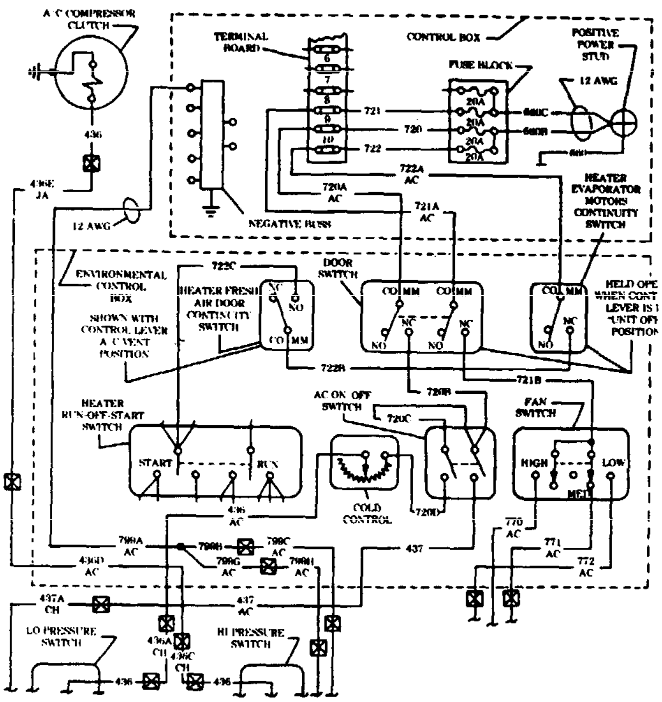
If condenser fans do not operate, that would indicate faulty fans or a malfunction not handled at this level.

NO → REPLACE CONDENSER FANS AND/OR NOTIFY DS MAINTENANCE

YES ↓

END OF TESTING

REFERENCE INFORMATION **AMBULANCE**

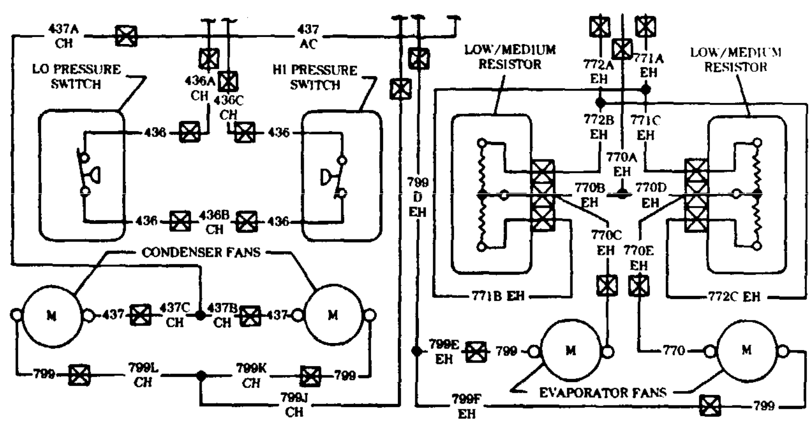


Repair leads, refer to (para. 4-85).
Repair lead connectors, refer to (para. 4-85).

0-4500 OHMS STE/ICE -R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms STE/ICE displays "9.9.9.9."

CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms. 2. Connect the RED and BLACK leads to the connections stated in the question. 3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

Replace condenser fans, refer to (para. 11-201).



AMBULANCE
(Condenser Fan)
(M997 Only)
(Refer to Fig. 14.)

DIAGNOSTIC FLOWCHART

START

1

KNOWN INFO
OTHER CONDENSER FAN OPERATES

POSSIBLE PROBLEMS
LEAD 437 LEAD 799 LEAD 437 B CONDENSER FAN

DISCONNECT CONDENSER FAN MOTOR LEAD. IS THERE CONTINUITY OF CONDENSER FAN MOTOR LEADS 437 AND 799?

TEST OPTIONS

STE/ICE-R TEST 91, PAGE 2-752

REASON FOR QUESTION

No continuity would indicate damaged leads.

NO → REPAIR DAMAGED LEAD

YES ↓

2

KNOWN INFO
LEAD 437 OK LEAD 799 OK OTHER CONDENSER FAN OPERATES

POSSIBLE PROBLEMS
LEAD 437 B CONDENSER FAN

IS THERE BATTERY VOLTAGE AT LEAD 437?

TEST OPTIONS

STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION

No power would indicate a damaged lead.

NO → REPAIR LEAD 437 B

YES ↓

REPLACE CONDENSER FAN

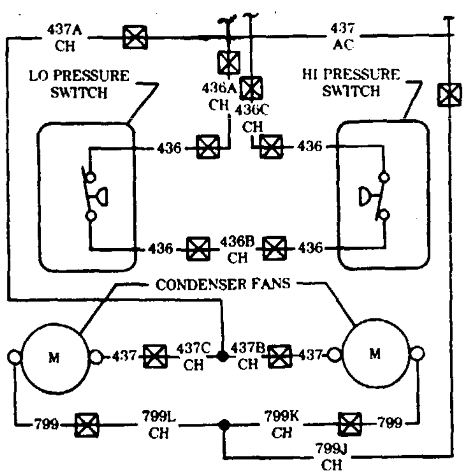
Repair leads, refer to (para. 4-85).
Repair lead connector, refer to (para. 4-85).

0-4500 OHMS STE/ICE -R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms STE/ICE displays "9.9.9.9."

Repair lead, (refer to 4-85).
Repair lead connector, refer to (para. 4-85).

Replace condenser fan, refer to (para. 11-201).

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.



AMBULANCE
(Blower Fan)
(M997 Only)
(Refer to Fig. 15.)

DIAGNOSTIC FLOWCHART

START

KNOWN INFO
NOTHING

POSSIBLE PROBLEMS
CONTROL LEVER POSITION FUSE LINKAGE BATTERY CABLE 660 LEAD 660 B LEAD 721 LEAD 721 A RELAY

1

IS VENT FAN CONTROL LEVER ON HEATER CONTROL PANEL PLACED TO ON POSITION?

TEST OPTIONS
VISUAL

REASON FOR QUESTION
Control lever must be in correct position for blower fan to operate.

NO → PLACE CONTROL LEVER TO ON POSITION

YES ↓

KNOWN INFO
CONTROL LEVER POSITION OK

POSSIBLE PROBLEMS
FUSE LINKAGE BATTERY CABLE 660 LEAD 660 B LEAD 721 LEAD 721 A RELAY

2

CHECK FUSE BLOCK IN CONTROL BOX. IS FUSE OK?

TEST OPTIONS
VISUAL

REASON FOR QUESTION
If fuse is blown, circuit is incomplete.

NO → REPLACE BLOWN FUSE

YES ↓

KNOWN INFO
CONTROL LEVER POSITION OK FUSE OK

POSSIBLE PROBLEMS
LINKAGE BATTERY CABLE 660 LEAD 660 B LEAD 721 LEAD 721 A RELAY

3

REMOVE HEATER COMPARTMENT PANEL. IS LINKAGE FROM BACK OF CONTROL PANEL TO FAN DUCT DOOR PROPERLY INSTALLED AND ADJUSTED?

TEST OPTIONS
VISUAL

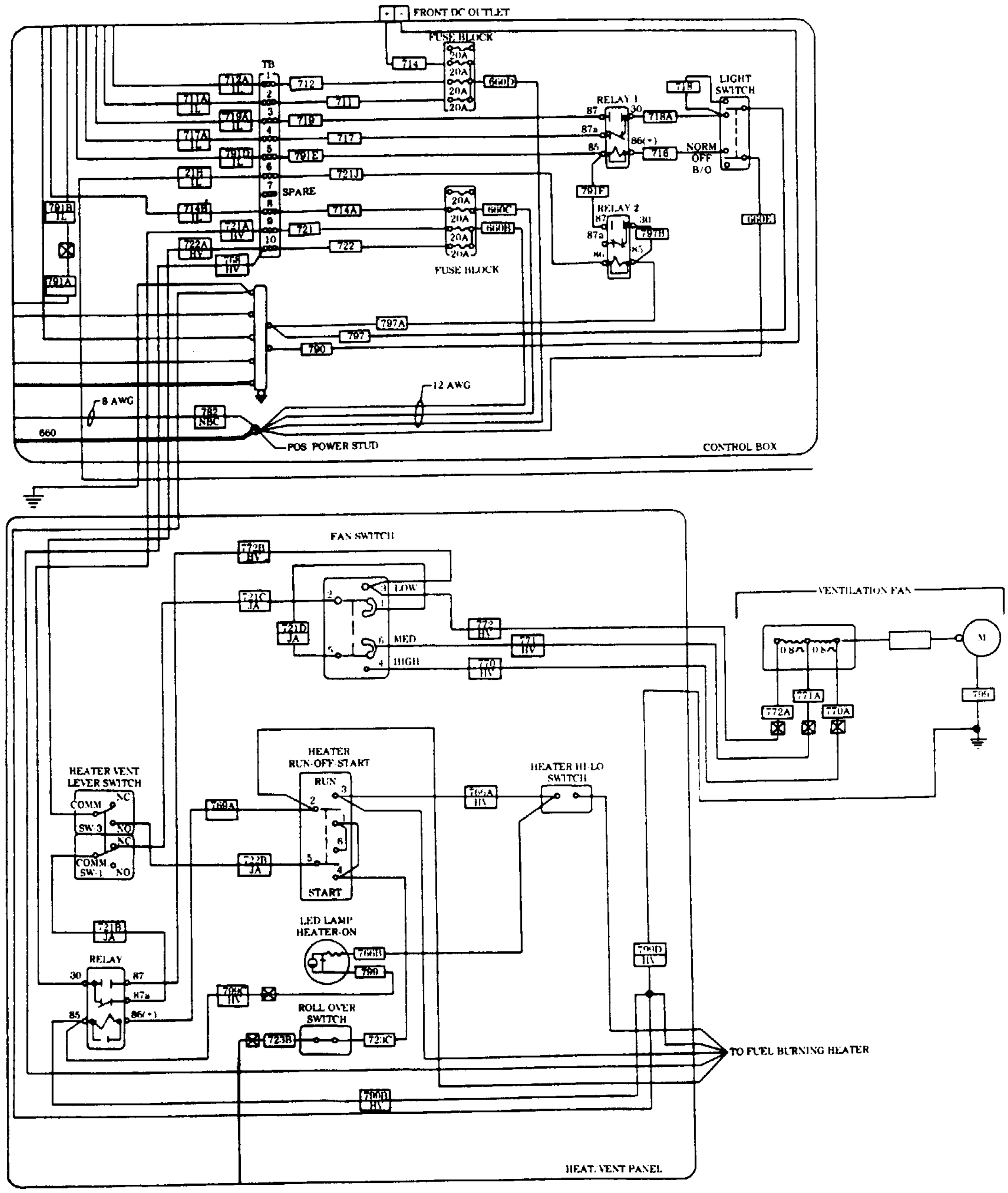
REASON FOR QUESTION
Fan duct door must be open to allow air circulation.

NO → REINSTALL OR ADJUST LINKAGE

YES ↓

GO TO 4, Page 2-608

REFERENCE INFORMATION **AMBULANCE**



Remove heater compartment panel, refer to (para. 11-214).

Installation/adjustment of fan duct door linkage, refer to (para. 11-211).

AMBULANCE
(Blower Fan)
(M997 Only)
(Refer to Fig. 15.)

DIAGNOSTIC FLOWCHART

FROM 3, Page 2-606

KNOWN INFO

CONTROL LEVER POSITION OK
FUSE OK
LINKAGE OK

POSSIBLE PROBLEMS

BATTERY
CABLE 660
LEAD 660 B
LEAD 721
LEAD 721 A
RELAY

4

IS BATTERY IN PROPER WORKING ORDER?

TEST OPTIONS

1. STE/ICE TEST 89, PAGE 2-750
2. MULTIMETER

REASON FOR QUESTION

Battery malfunction will cause any dependent circuit to malfunction.

NO → GO TO 1, Page 2-252

YES ↓

KNOWN INFO

CONTROL LEVER POSITION OK
FUSE OK
LINKAGE OK
BATTERY OK

POSSIBLE PROBLEMS

CABLE 660
LEAD 660 B
LEAD 721
LEAD 721 A
RELAY

5

IS THERE BATTERY VOLTAGE IN CONTROL BOX AT POWER STUD?

TEST OPTIONS

1. STE/ICE TEST 89, PAGE 2-750
2. MULTIMETER

REASON FOR QUESTION

No power at power stud would indicate a damaged cable form the power source.

NO → REPAIR CABLE 660

YES ↓

KNOWN INFO

CONTROL LEVER POSITION OK
FUSE OK
LINKAGE OK
BATTERY OK
CABLE 660 OK

POSSIBLE PROBLEMS

LEAD 660 B
LEAD 721
LEAD 721 A
RELAY

6

IS THERE BATTERY VOLTAGE IN CONTROL BOX LEAD 660 B AT FUSE BLOCK?

TEST OPTIONS

STE/ICE TEST 89, PAGE 2-750

REASON FOR QUESTION

No power would indicate a damagd lead.

NO → REPAIR LEAD 660 B

YES ↓

GO TO 7, Page 2-610

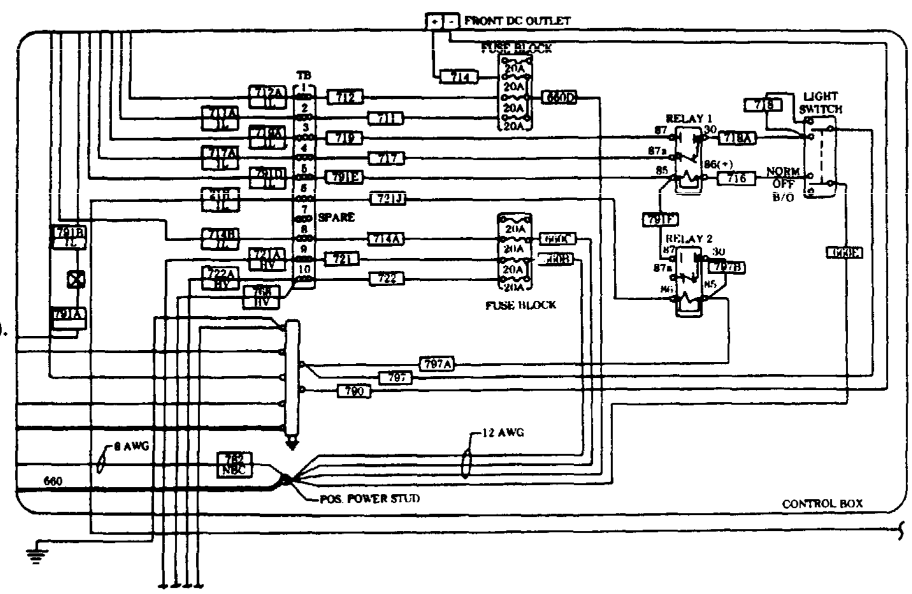
REFERENCE INFORMATION **AMBULANCE**

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.

Repair lead, refer to (para. 4-85).

Repair lead, refer to (para. 4-85).
Repair lead connector, refer to (para. 4-85).



AMBULANCE
(Blower Fan)
(M997 Only)
(Refer to Fig. 15.)

DIAGNOSTIC FLOWCHART

FROM 6, Page 2-608

7

KNOWN INFO
CONTROL LEVER POSITION OK
FUSE OK
LINKAGE OK
BATTERY OK
CABLE 660 OK
LEAD 660 B OK

POSSIBLE PROBLEMS
LEAD 721
LEAD 721 A
RELAY

IS THERE BATTERY VOLTAGE IN CONTROL BOX AT TB TERMINAL 9?

TEST OPTIONS
STE/ICE TEST 89, PAGE 2-750.

REASON FOR QUESTION
No power would indicate a damaged lead.

NO → REPLACE LEAD 721

YES ↓

8

KNOWN INFO
CONTROL LEVER POSITION OK
FUSE OK
LINKAGE OK
BATTERY OK
LEAD 660 OK
LEAD 660 B OK
LEAD 721 OK

POSSIBLE PROBLEMS
LEAD 721 A
RELAY

IS THERE BATTERY VOLTAGE AT TERMINAL 30 OF RELAY ON HEATER CONTROL PANEL?

TEST OPTIONS
1. STE/ICE TEST 89, PAGE 2-750.
2. MULTIMETER

REASON FOR QUESTION
No power would indicate a damaged lead.

NO → REPAIR LEAD 721 A

YES ↓

9

KNOWN INFO
CONTROL LEVER POSITION OK
FUSE OK
LINKAGE OK
BATTERY OK
CABLE 660 OK
LEAD 721 OK
LEAD 721 A OK

POSSIBLE PROBLEMS
RELAY

PLACE JUMPER WIRE FROM TERMINAL 30 TO TERMINAL 87 A OF RELAY. DOES BLOWER FAN OPERATE?

TEST OPTIONS
TRY IT

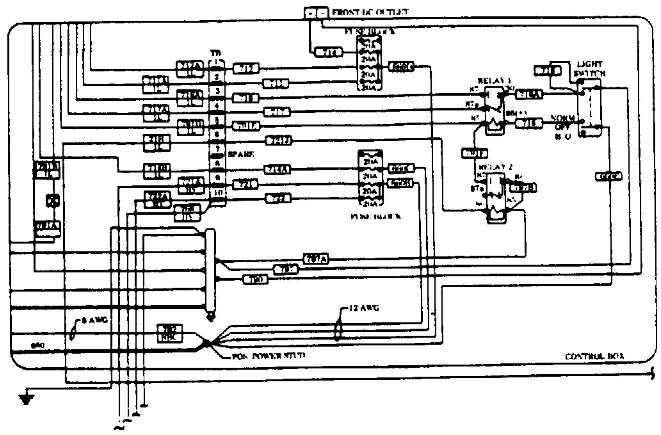
REASON FOR QUESTION
If blower fans operate then relay is malfunctioning.

NO → GO TO 10, Page 2-612

YES → REPLACE RELAY

REFERENCE INFORMATION

AMBULANCE

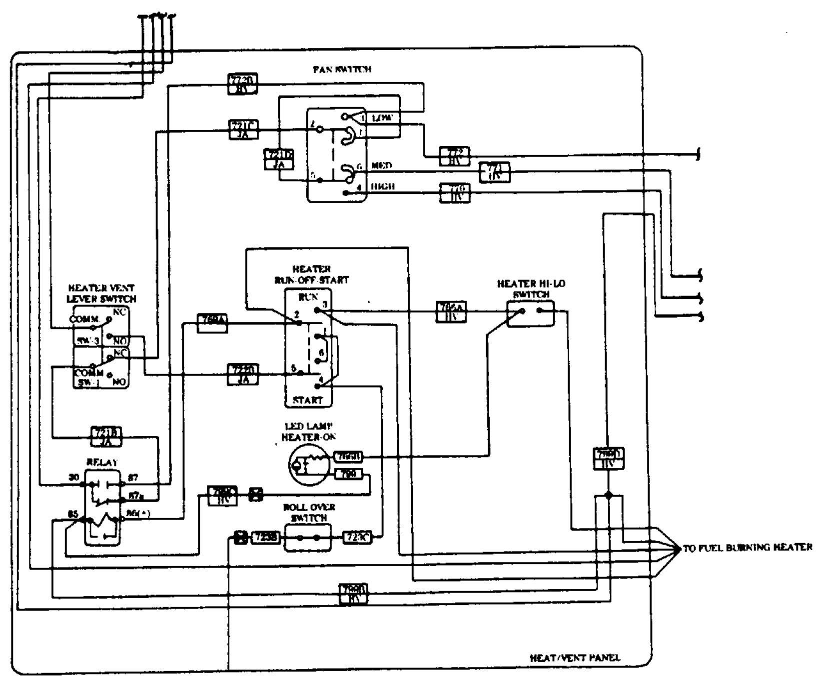


0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.

Repair lead, refer to (para. 4-85).
Repair lead connector, refer to (para. 4-85).

Replace relay, refer to (para. 4-120).



AMBULANCE
(Blower Fan)
(M997 Only)
(Refer to Fig. 15.)

DIAGNOSTIC FLOWCHART

FROM 9, Page 2-610

KNOWN INFO

PREVIOUSLY CORRECTED INFORMATION

POSSIBLE PROBLEMS

LEAD 721 B
LEAD 721 C
FAN SWITCH

10

IS THERE BATTERY VOLTAGE AT VENT LEVER SWITCH ON HEATER CONTROL PANEL?

TEST OPTIONS

STE/ICE TEST 89, PAGE 2-750

REASON FOR QUESTION

No power would indicate a damaged lead.

NO → REPLACE LEAD 721 B

YES ↓

KNOWN INFO

LEAD 721 B OK

POSSIBLE PROBLEMS

LEAD 721 A
FAN SWITCH

11

IS THERE BATTERY VOLTAGE AT FAN SWITCH TERMINAL 2 ON HEATER CONTROL PANEL?

TEST OPTIONS

STE/ICE TEST 89, PAGE 2-750

REASON FOR QUESTION

No power would indicate a damaged lead.

NO → REPLACE LEAD 721 C

YES ↓

KNOWN INFO

LEAD 721 B OK
LEAD 721 C OK

POSSIBLE PROBLEMS

FAN SWITCH

12

IS THERE CONTINUITY THROUGH FAN SWITCH AT ALL SPEED SETTINGS?

TEST OPTIONS

STE/ICE TEST 91, PAGE 2-752

REASON FOR QUESTION

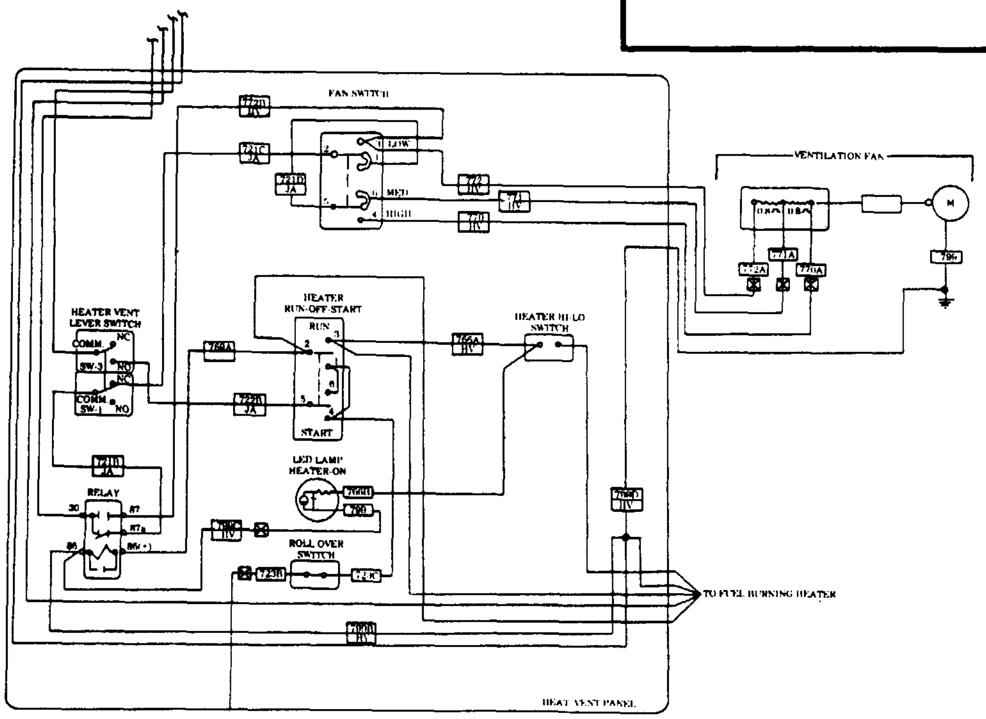
No continuity would indicate a damaged fan switch.

NO → REPLACE FAN SWITCH

YES ↓

GO TO 13, Page 2-614

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

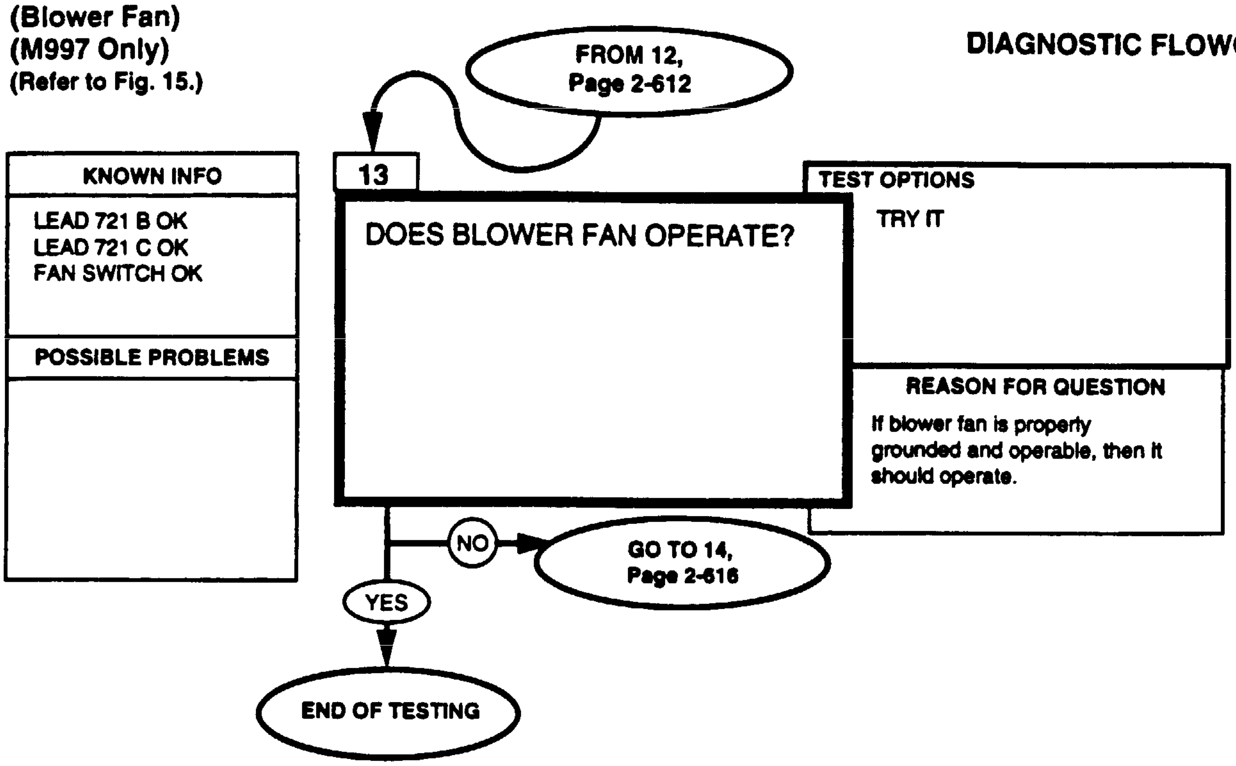


0-4500 OHMS STE/ICE -R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms STE/ICE displays "9.9.9.9."

Replace fan switch, refer to (para. 4-127).

AMBULANCE
(Blower Fan)
(M997 Only)
(Refer to Fig. 15.)

DIAGNOSTIC FLOWCHART



AMBULANCE
(Blower Fan)
(M997 Only)
(Refer to Fig.15.)

DIAGNOSTIC FLOWCHART

FROM 13, Page 2-614

14

KNOWN INFO	QUESTION	TEST OPTIONS / REASON FOR QUESTION
PREVIOISLY CORRECTED INFORMATION	IS THERE CONTINUITY OF LEAD 799 A TO GROUND?	TEST OPTIONS: STE/ICE-R TEST 91, PAGE 2-752
POSSIBLE PROBLEMS: LEAD 799 A, LEAD 799 D, BLOWER ASSEMBLY		REASON FOR QUESTION: No continuity would indicate a damaged lead.

NO → REPAIR LEAD 799 A

YES ↓

15

KNOWN INFO	QUESTION	TEST OPTIONS / REASON FOR QUESTION
LEAD 799 A OK	IS THERE CONTINUITY OF LEAD 799 D TO GROUND?	TEST OPTIONS: STE/ICE-R TEST 91, PAGE 2-752
POSSIBLE PROBLEMS: LEAD 799 D, BLOWER ASSEMBLY		REASON FOR QUESTION: No continuity would indicate a damaged lead.

NO → REPAIR LEAD 799 D

YES ↓

16

KNOWN INFO	QUESTION	TEST OPTIONS / REASON FOR QUESTION
LEAD 799 A OK, LEAD 799 D OK	DOES BLOWER FAN OPERATE?	TEST OPTIONS: TRY IT
POSSIBLE PROBLEMS: BLOWER ASSEMBLY		REASON FOR QUESTION: All connections and circuits are good and blower fan should operate.

NO → REPLACE BLOWER ASSEMBLY

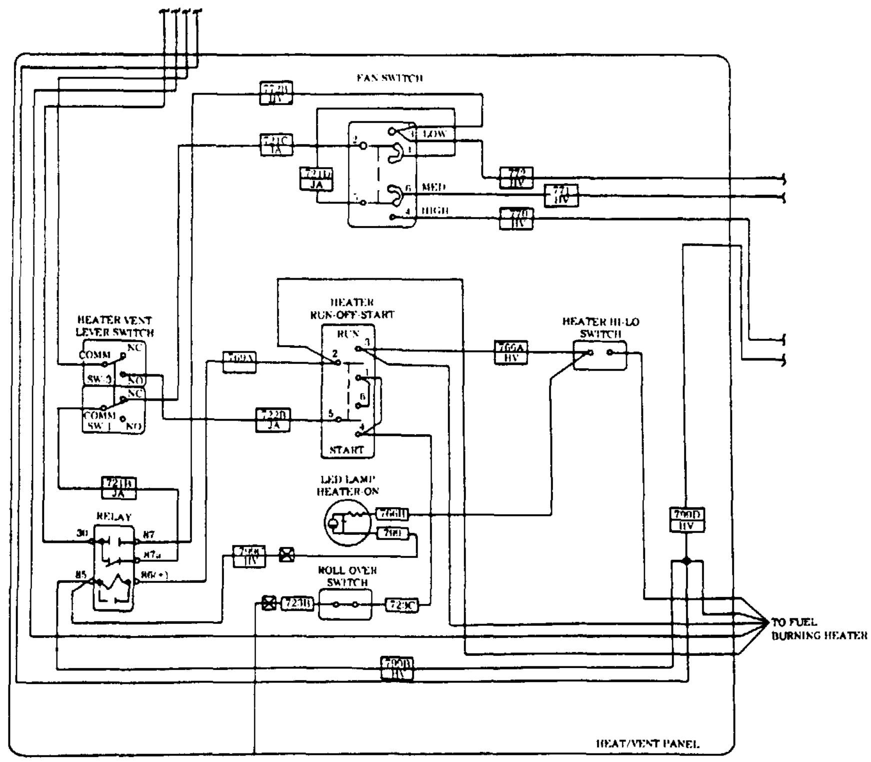
YES ↓

END OF TESTING

REFERENCE INFORMATION **AMBULANCE**

0-4500 OHMS STE/ICE -R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms STE/ICE displays "9.9.9.9."

Repair lead, refer to (para. 4-85).
Repair lead connector, refer to (para. 4-85).

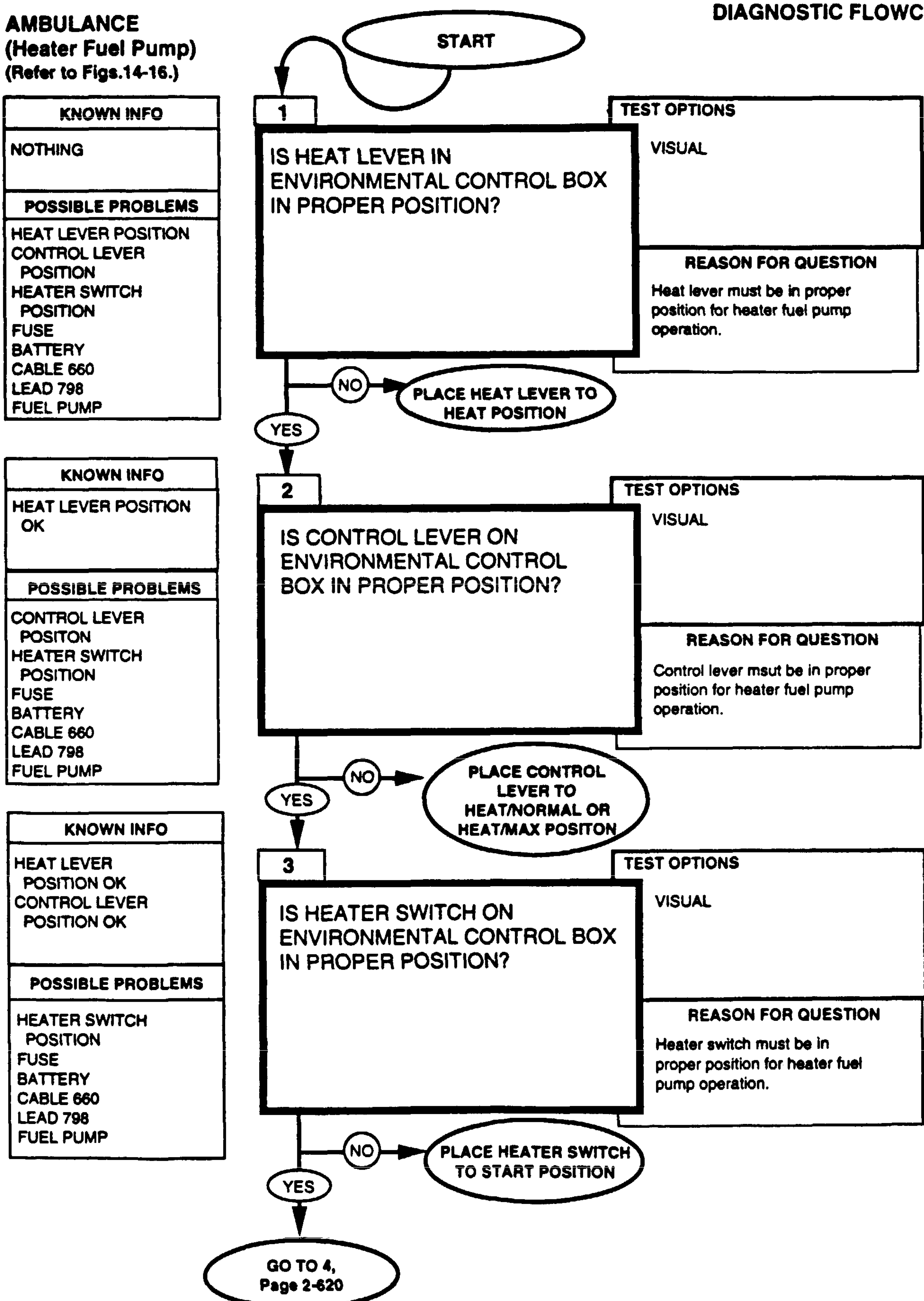


Repair lead, refer to (para. 4-85).

Replace blower assembly, refer to (para. 11-212).

DIAGNOSTIC FLOWCHART

AMBULANCE
(Heater Fuel Pump)
(Refer to Figs.14-16.)



AMBULANCE
(Heater Fuel Pump)
(Refer to Figs. 14-16.)

DIAGNOSTIC FLOWCHART

FROM 3,
Page 2-618

4

CHECK FUSE BLOCK ON CONTROL COVER. IS FUSE OK?

KNOWN INFO
HEAT LEVER POSITION OK CONTROL LEVER POSITION OK HEATER SWITCH POSITION OK
POSSIBLE PROBLEMS
FUSE BATTERY CABLE 660 LEAD 798 FUEL PUMP

TEST OPTIONS

VISUAL

REASON FOR QUESTION

If fuse is blown, circuit is incomplete.

NO → REPLACE BLOWN FUSE

YES ↓

5

IS BATTERY IN PROPER WORKING ORDER?

KNOWN INFO
HEAT LEVER POSITION OK CONTROL LEVER POSITION OK HEATER SWITCH POSITION OK
POSSIBLE PROBLEMS
BATTERY CABLE 660 LEAD 798 FUEL PUMP

TEST OPTIONS

1. STE/ICE-R TEST 89, PAGE 2-750
2. MULTIMETER

REASON FOR QUESTION

Battery malfunction will cause any dependent circuit to malfunction.

NO → GO TO 1, Page 2-252

YES ↓

6

IS THERE BATTERY VOLTAGE IN CONTROL BOX AT POWER STUD?

KNOWN INFO
HEAT LEVER POSITION OK CONTROL LEVER POSITION OK HEATER SWITCH POSITION OK FUSE OK BATTERY OK
POSSIBLE PROBLEMS
CABLE 660 LEAD 798 FUEL PUMP

TEST OPTIONS

1. STE/ICE-R TEST 89, PAGE 2-750
2. MULTIMETER

REASON FOR QUESTION

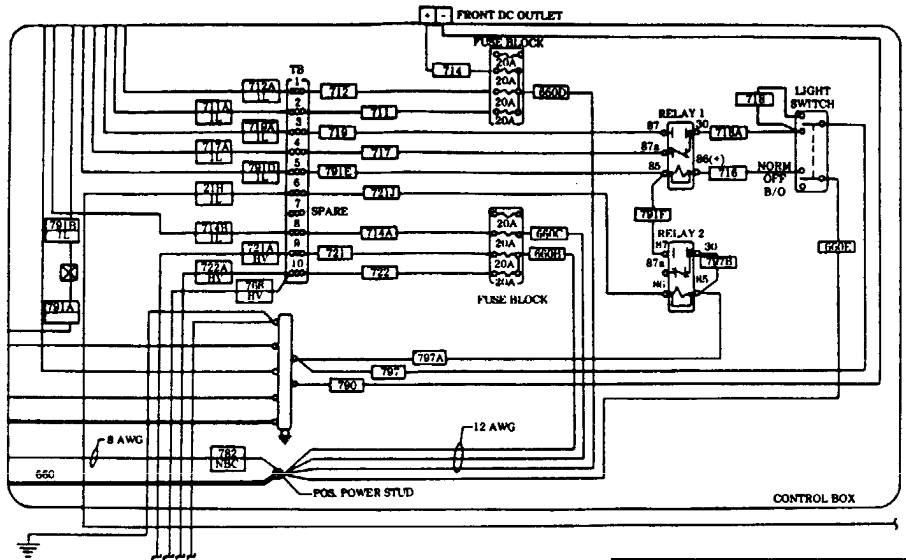
No power at power stud would indicate a damaged cable from the power source.

NO → REPAIR CABLE 660

YES ↓

GO TO 7,
Page 2-622

REFERENCE INFORMATION **AMBULANCE**



0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.

Repair lead, refer to (para. 4-85).

AMBULANCE
(Heater Fuel Pump)
(Refer to Figs.14-16.)

DIAGNOSTIC FLOWCHART

FROM 6, Page 2-620

KNOWN INFO

HEAT LEVER POSITION OK
CONTROL LEVER POSITION OK
HEATER SWITCH POSITION OK
FUSE OK
BATTERY OK
CABLE 660 OK

POSSIBLE PROBLEMS

LEAD 798
FUEL PUMP

7

DISCONNECT LEAD 723 A FROM FUEL PUMP LEAD. IS THERE BATTERY VOLTAGE AT LEAD 723 A?

TEST OPTIONS

STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION

No power would indicate a damaged lead.

NO → GO TO 9, Page 2-624

YES ↓

KNOWN INFO

HEAT LEVER POSITION OK
CONTROL LEVER POSITION OK
HEATER SWITCH POSITION OK
FUSE OK
BATTERY OK
CABLE 660 OK

POSSIBLE PROBLEMS

LEAD 798
FUEL PUMP

8

IS THERE CONTINUITY BETWEEN FUEL PUMP LEAD 798 AND GROUND?

TEST OPTIONS

STE/ICE-R TEST 91, PAGE 2-752

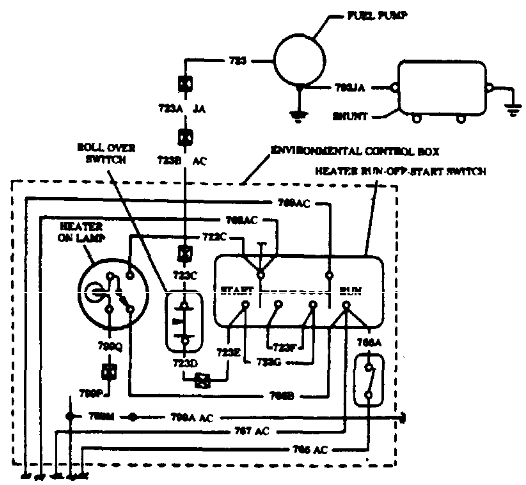
REASON FOR QUESTION

No continuity would indicated a damaged lead.

NO → REPAIR LEAD 798

YES → REPLACE FUEL PUMP

REFERENCE INFORMATION **AMBULANCE**



0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

Repair lead, refer to (para. 4-85).
Repair lead connector, refer to (para. 4-85).

Replace heater fuel pump, refer to (para. 11-194).

0-4500 OHMS STE/ICE -R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms STE/ICE displays "9.9.9.9."

AMBULANCE
(Heater Fuel Pump)
(Refer to Figs. 14-16.)

DIAGNOSTIC FLOWCHART

FROM 7, Page 2-622

KNOWN INFO

PREVIOUSLY CORRECTED INFORMATION

POSSIBLE PROBLEMS

LEAD 660 B LEAD 722
LEAD 722 A
HEATER CONTINUITY SWITCH
LEAD 722 B
HEATER FRESH AIR SWITCH
LEAD 722 C
HEATER SWITCH
LEAD 722 D
ROLLOVER SWITCH
LEAD 723 C LEAD 723 B
LEAD 723 A FUEL PUMP

9

IS THERE BATTERY VOLTAGE IN CONTROL BOX THROUGH LEAD 660 B AT FUSE BLOCK?

TEST OPTIONS

STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION

No power would indicate a damaged lead.

NO → REPAIR LEAD 660 B

YES ↓

KNOWN INFO

LEAD 660 B OK

POSSIBLE PROBLEMS

LEAD 722 LEAD 722 A
HEATER CONTINUITY SWITCH
LEAD 722 B
HEATER FRESH AIR SWITCH
LEAD 722 C
HEATER SWITCH
LEAD 722 D
ROLLOVER SWITCH
LEAD 723 C LEAD 723 B
LEAD 723 A FUEL PUMP

10

IS THERE BATTERY VOLTAGE IN CONTROL BOX AT TB TERMINAL 10?

TEST OPTIONS

STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION

No power would indicate a damaged lead.

NO → REPLACE LEAD 722

YES ↓

KNOWN INFO

LEAD 660 B OK
LEAD 722 OK

POSSIBLE PROBLEMS

LEAD 722 A
HEATER CONTINUITY SWITCH
LEAD 722 B
HEATER FRESH AIR SWITCH
LEAD 722 C
HEATER SWITCH
LEAD 722 D
ROLLOVER SWITCH
LEAD 723 C LEAD 723 B
LEAD 723 A FUEL PUMP

11

IS THERE BATTERY VOLTAGE IN ENVIRONMENTAL CONTROL BOX AT HEATER EVAPORATOR MOTORS CONTINUITY SWITCH?

TEST OPTIONS

STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION

No power would indicate a damaged lead.

NO → REPAIR LEAD 722 A

YES ↓

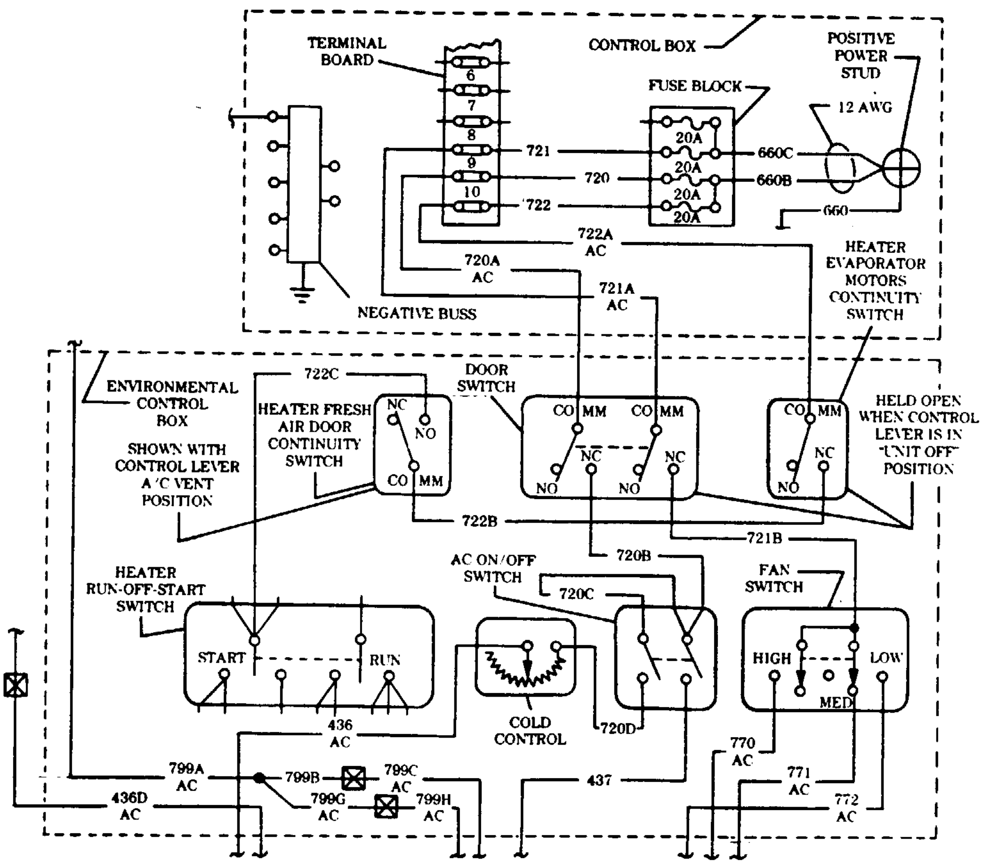
GO TO 12, Page 2-626

REFERENCE INFORMATION

AMBULANCE

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

Repair lead, refer to (para. 4-85).
Repair lead connector, refer to (para. 4-85).



Repair lead, refer to (para. 4-85).
Repair lead connector, refer to (para. 4-85).

AMBULANCE
(Heater Fuel Pump)
(Refer to Figs. 14-16.)

DIAGNOSTIC FLOWCHART

FROM 11, Page 2-624

12

KNOWN INFO
LEAD 660 B OK LEAD 722 OK LEAD 722 A OK
POSSIBLE PROBLEMS
HEATER CONTINUITY SWITCH LEAD 722 B HEATER FRESH AIR SWITCH LEAD 722 C HEATER SWITCH LEAD 723 D ROLLOVER SWITCH LEAD 723 C LEAD 723B LEAD 723 A FUEL PUMP

IS THERE BATTERY VOLTAGE IN ENVIRONMENTAL CONTROL BOX THROUGH HEATER EVAPORATOR MOTORS CONTINUITY SWITCH?

TEST OPTIONS

1. STE/ICE-R TEST 89, PAGE 2-750
2. MULTIMETER

REASON FOR QUESTION

No power would indicate a switch malfunction.

NO → REPLACE SWITCH

YES ↓

13

KNOWN INFO
LEAD 660 B OK LEAD 722 OK LEAD 722 A OK HEATER CONTINUITY SWITCH OK
POSSIBLE PROBLEMS
LEAD 722 B HEATER FRESH AIR SWITCH LEAD 722 C HEATER SWITCH LEAD 723 D ROLLOVER SWITCH LEAD 723 C LEAD 723 B LEAD 723 A FUEL PUMP

IS THERE BATTERY VOLTAGE IN ENVIRONMENTAL CONTROL BOX AT HEATER FRESH AIR DOOR CONTINUITY SWITCH?

TEST OPTIONS

STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION

No power would indicate a damaged lead.

NO → REPAIR LEAD 722 B

YES ↓

14

KNOWN INFO
LEAD 660 B OK LEAD 722 OK LEAD 722 A OK HEATER CONTINUITY SWITCH OK LEAD 722 B OK
POSSIBLE PROBLEMS
HEATER FRESH AIR SWITCH LEAD 722 C HEATER SWITCH LEAD 723 D ROLLOVER SWITCH LEAD 723 C LEAD 723 B LEAD 723 A FUEL PUMP

IS THERE BATTERY VOLTAGE IN ENVIRONMENTAL CONTROL BOX THROUGH HEATER FRESH AIR DOOR CONTINUITY SWITCH?

TEST OPTIONS

1. STE/ICE-R TEST 89, PAGE 2-750
2. MULTIMETER

REASON FOR QUESTION

No power at power stud would indicate a switch malfunction.

NO → REPLACE SWITCH

YES ↓

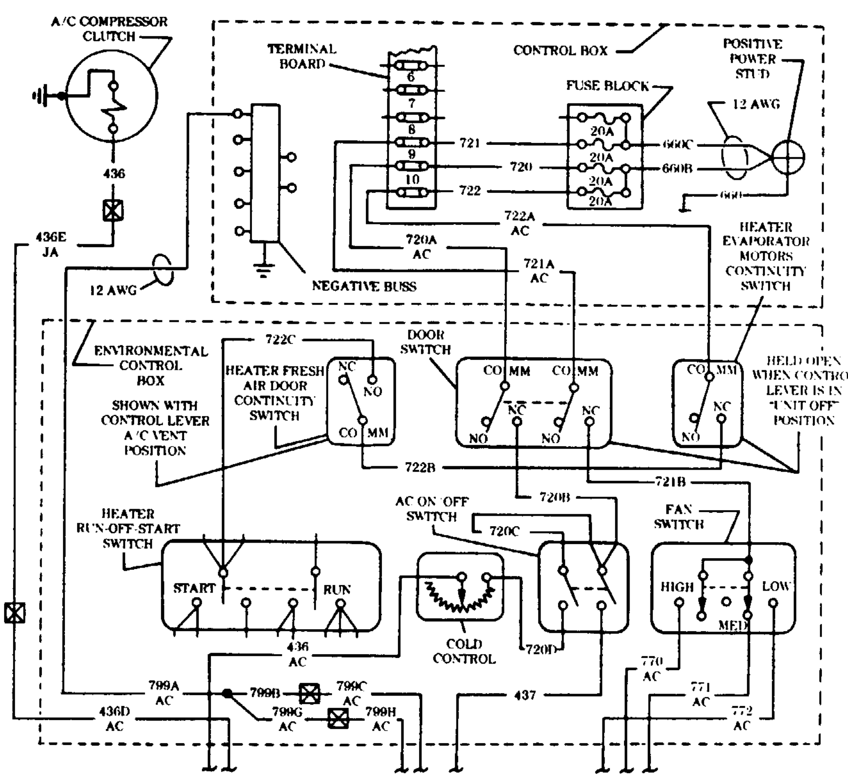
GO TO 15, Page 2-628

Replace Heater Evaporator Motors continuity switch, refer to DS Maintenance.

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.

Replace Heater Fresh Air Door continuity switch, refer to DS Maintenance.



AMBULANCE
(Heater Fuel Pump)
(Refer to Figs. 14-16.)

DIAGNOSTIC FLOWCHART

FROM 14, Page 2-626

KNOWN INFO
LEAD 660 B OK
LEAD 722 OK
LEAD 722 A OK
HEATER CONTINUITY SWITCH OK
LEAD 722 B OK
HEATER FRESH AIR SWITCH OK

POSSIBLE PROBLEMS
LEAD 722 C
HEATER SWITCH
LEAD 723 D
ROLLOVER SWITCH
LEAD 723 C
LEAD 723 B
LEAD 723 A
FUEL PUMP

15
IS THERE BATTERY VOLTAGE IN ENVIRONMENTAL CONTROL BOX AT HEATER SWITCH?

TEST OPTIONS
STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION
No power would indicate a damaged lead.

NO → REPAIR LEAD 722 C

YES ↓

KNOWN INFO
LEAD 660 B OK
LEAD 722 OK
LEAD 722 A OK
HEATER CONTINUITY SWITCH OK
HEATER FRESH AIR SWITCH OK
LEAD 722 C OK

POSSIBLE PROBLEMS
HEATER SWITCH
LEAD 723 D
ROLL OVER SWITCH
LEAD 723 C
LEAD 723 B
LEAD 723 A
FUEL PUMP

16
IS THERE BATTERY VOLTAGE IN ENVIRONMENTAL CONTROL BOX AT LEAD 723 E OF HEATER SWITCH?

TEST OPTIONS
1. STE/ICE-R TEST 89, PAGE 2-750
2. MULTIMETER

REASON FOR QUESTION
No power would indicate a damaged lead.

NO → REPLACE HEATER SWITCH

YES ↓

KNOWN INFO
LEAD 660 B OK
LEAD 722 OK
LEAD 722 A OK
HEATER CONTINUITY SWITCH OK
LEAD 722 B OK
HEATER FRESH AIR SWITCH OK
LEAD 722 C OK
HEATER SWITCH OK

POSSIBLE PROBLEMS
LEAD 723D
ROLLOVER SWITCH
LEAD 723 C
LEAD 723 B
LEAD 723 A
FUEL PUMP

17
IS THERE BATTERY VOLTAGE IN ENVIRONMENTAL CONTROL BOX AT ROLL OVER SWITCH?

TEST OPTIONS
STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION
No power would indicate a damaged lead.

NO → REPAIR LEAD 723 D

YES ↓

GO TO 18, Page 2-630

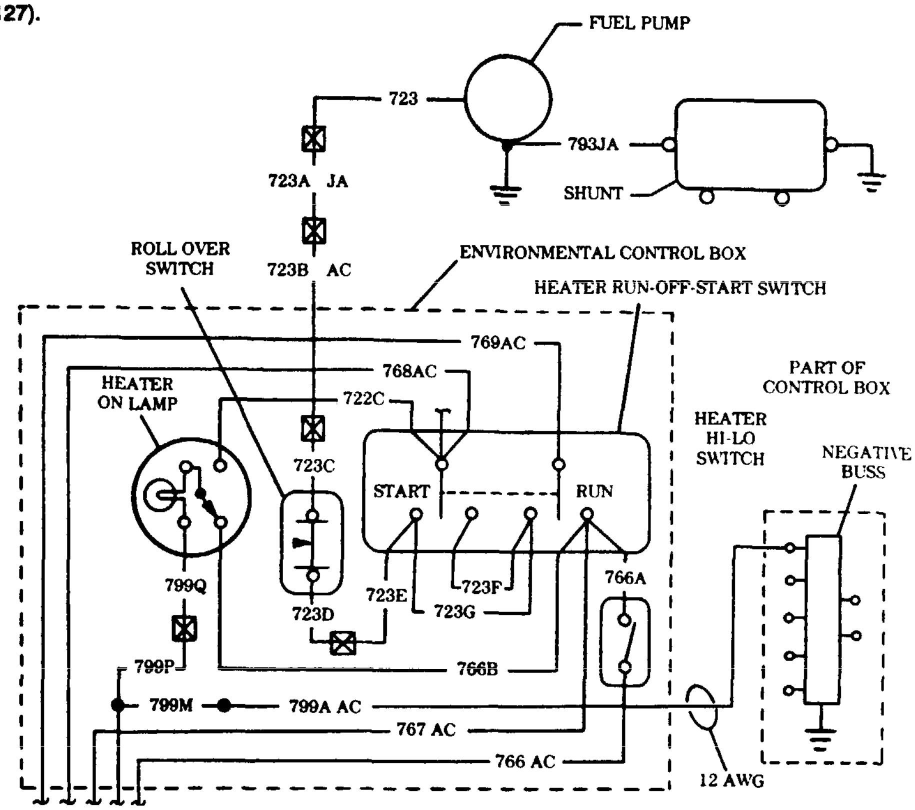
Repair lead, refer to (para. 4-85).

Replace Heater Switch, refer to (para. 4-126 or 4-127).

Repair lead, refer to (para. 4-85). Repair lead connector, refer to (para. 4-85).

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.



AMBULANCE
(Heater Fuel Pump)
(Refer to Figs. 14-16.)

DIAGNOSTIC FLOWCHART

FROM 17, Page 2-628

KNOWN INFO
LEAD 660 B OK
LEAD 722 OK
LEAD 722 A OK
HEATER CONTINUITY SWITCH OK
LEAD 722 B OK
HEATER FRESH AIR SWITCH OK
LEAD 722 C OK
HEATER SWITCH OK
LEAD 723 D OK

POSSIBLE PROBLEMS
ROLLOVER SWITCH
LEAD 723 C
LEAD 723 B
LEAD 723 A
FUEL PUMP

18

IS THERE BATTERY VOLTAGE IN ENVIRONMENTAL CONTROL BOX THROUGH ROLLOVER SWITCH?

TEST OPTIONS

1. STE/ICE-R TEST 89, PAGE 2-750
2. MULTIMETER

REASON FOR QUESTION

No power would indicate a switch malfunction.

NO → REPLACE ROLLOVER SWITCH

YES ↓

KNOWN INFO
LEAD 660 B OK
LEAD 722 OK
LEAD 722 A OK
HEATER CONTINUITY SWITCH OK
LEAD 722 B OK
HEATER FRESH AIR SWITCH OK
LEAD 722 C OK
HEATER SWITCH OK
LEAD 723 D OK
ROLLOVER SWITCH OK

POSSIBLE PROBLEMS
LEAD 723 C
LEAD 723 B
LEAD 723 A
FUEL PUMP

19

IS THERE BATTERY VOLTAGE IN ENVIRONMENTAL CONTROL BOX AT LEAD 723 C?

TEST OPTIONS

STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION

No power would indicate a damaged lead.

NO → REPAIR LEAD 723 C

YES ↓

KNOWN INFO
LEAD 660 B OK
LEAD 722 OK
LEAD 722 A OK
HEATER CONTINUITY SWITCH OK
LEAD 722 B OK
HEATER FRESH AIR SWITCH OK
LEAD 722 C OK
HEATER SWITCH OK
LEAD 723 D OK
ROLLOVER SWITCH OK
LEAD 723 C OK

POSSIBLE PROBLEMS
LEAD 723 B
LEAD 723 A
FUEL PUMP

20

IS THERE BATTERY VOLTAGE AT LEAD 723 B?

TEST OPTIONS

STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION

No power would indicate a damaged lead.

NO → REPAIR LEAD 723B

YES ↓

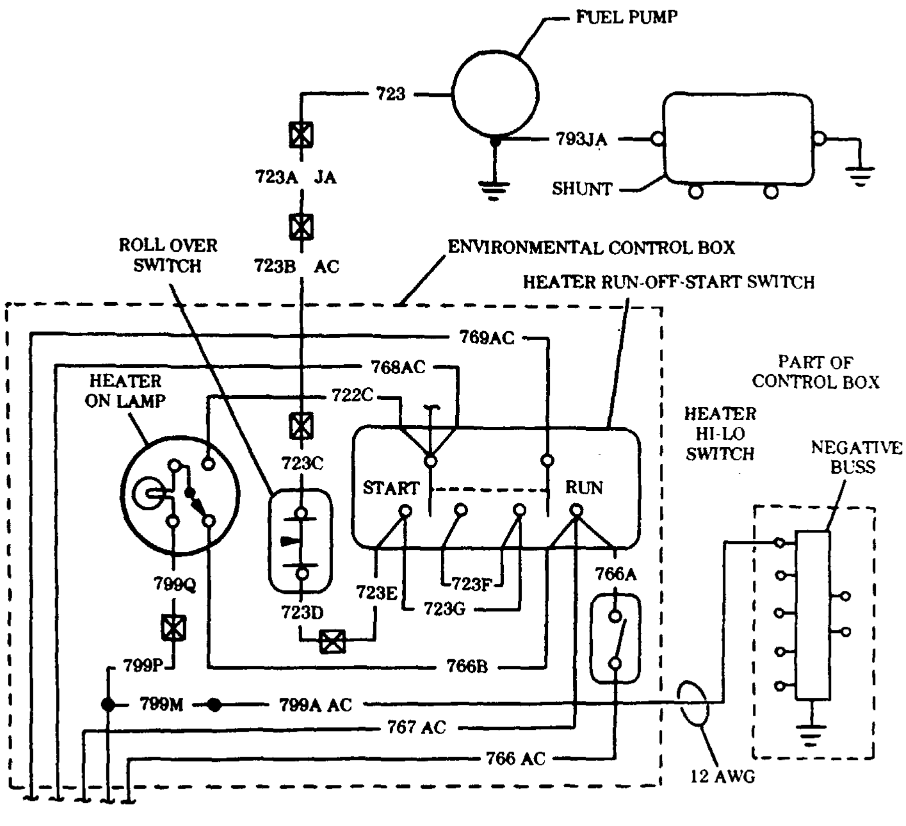
GO TO 21, Page 2-632

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.

Replace Rollover Switch,
refer to (para. 4-126 or 4-127).

Repair lead,
refer to (para. 4-85).
Repair lead connector,
refer to (para. 4-85).



AMBULANCE
(Heater Fuel Pump)
(Refer to Figs. 14-16.)

DIAGNOSTIC FLOWCHART

FROM 20, Page 2-630

KNOWN INFO
LEAD 660 B OK
LEAD 722 OK
LEAD 722 A OK
HEATER CONTINUITY SWITCH OK
LEAD 722 B OK
HEATER FRESH AIR SWITCH OK
LEAD 722 C OK
HEATER SWITCH OK
LEAD 723 D OK
ROLL OVER SWITCH OK
LEAD 723 C OK
LEAD 723 B OK

POSSIBLE PROBLEMS
LEAD 723 A
FUEL PUMP

21

IS THERE NOW BATTERY VOLTAGE AT LEAD 723 A?

TEST OPTIONS

STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION

No power would indicate a damaged lead.

NO → REPAIR LEAD 723 A

YES ↓

KNOWN INFO
LEAD 660 B OK
LEAD 722 OK
LEAD 722 A OK
HEATER CONTINUITY SWITCH OK
LEAD 722 B OK
HEATER FRESH AIR SWITCH OK
LEAD 722 C OK
HEATER SWITCH OK
LEAD 723 D OK
ROLL OVER SWITCH OK
LEAD 723 C OK
LEAD 723 B OK
LEAD 723 A OK

POSSIBLE PROBLEMS
FUEL PUMP

22

DOES HEATER FUEL PUMP OPERATE?

TEST OPTIONS

TRY IT

REASON FOR QUESTION

If heater fuel pump is inoperative at this point, a malfunction is the fuel pump.

NO → REPLACE HEATER FUEL PUMP

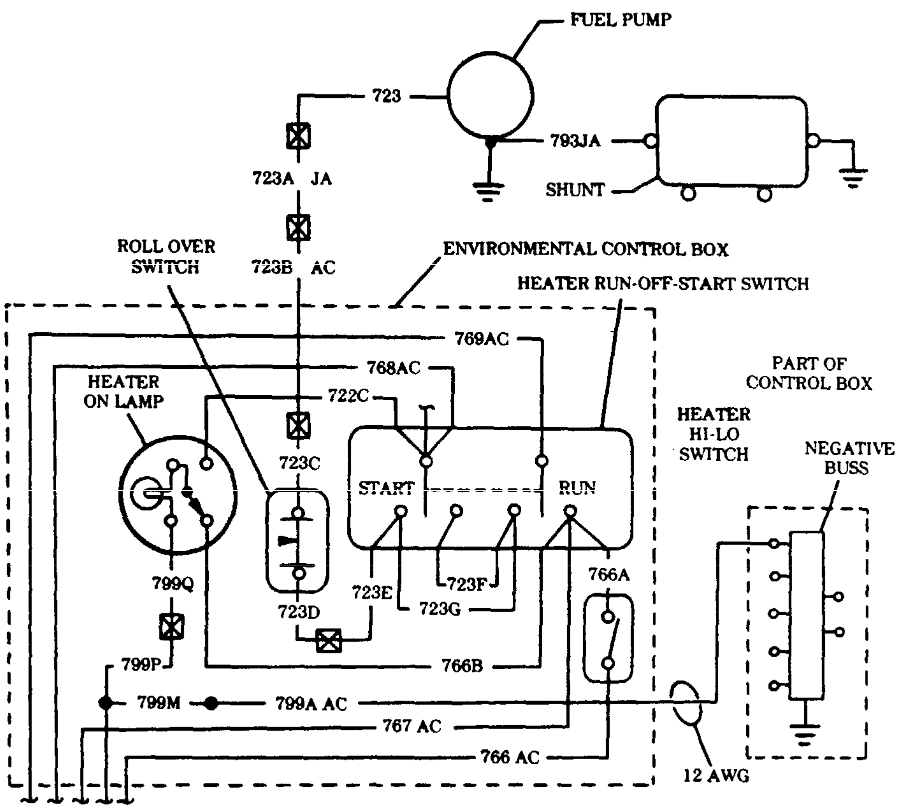
YES ↓

END OF TESTING

Repair lead,
refer to (para. 4-85).
Repair lead connector,
refer to (para. 4-85).

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

Replace Heater Fuel Pump,
refer to (para. 11-194).



AMBULANCE
(Heater On Lamp)
(Heater Operates)
(Refer to Figs. 15, 16.)

DIAGNOSTIC FLOWCHART

START

1

KNOWN INFO
NOTHING
POSSIBLE PROBLEMS
HEATER SWITCH POSITION LEAD 766 B LEAD 799 P HEATER ON LAMP

IS HEATER SWITCH ON ENVIRONMENTAL CONTROL BOX IN PROPER POSITION TO START HEATER?

TEST OPTIONS

VISUAL

REASON FOR QUESTION

Heater on lamp will not operate if heater is not on.

NO → PLACE HEATER SWITCH TO RUN POSITION UNTIL HEATER STARTS

YES ↓

2

KNOWN INFO
HEATER SWITCH POSITION OK
POSSIBLE PROBLEMS
LEAD 766 B LEAD 799 P HEATER ON LAMP

IS THERE BATTERY VOLTAGE IN ENVIRONMENTAL CONTROL BOX AT LEAD 766 B OF HEATER ON LAMP?

TEST OPTIONS

STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION

No power would indicate a damaged lead.

NO → REPAIR LEAD 766 B

YES ↓

3

KNOWN INFO
HEATER SWITCH POSITION OK LEAD 766 B OK
POSSIBLE PROBLEMS
LEAD 799 P HEATER ON LAMP

IS THERE CONTINUITY IN ENVIRONMENTAL CONTROL BOX BETWEEN LEAD 799 P AT HEATER ON LAMP AND GROUND?

TEST OPTIONS

STE/ICE-R TEST 91, PAGE 2-752

REASON FOR QUESTION

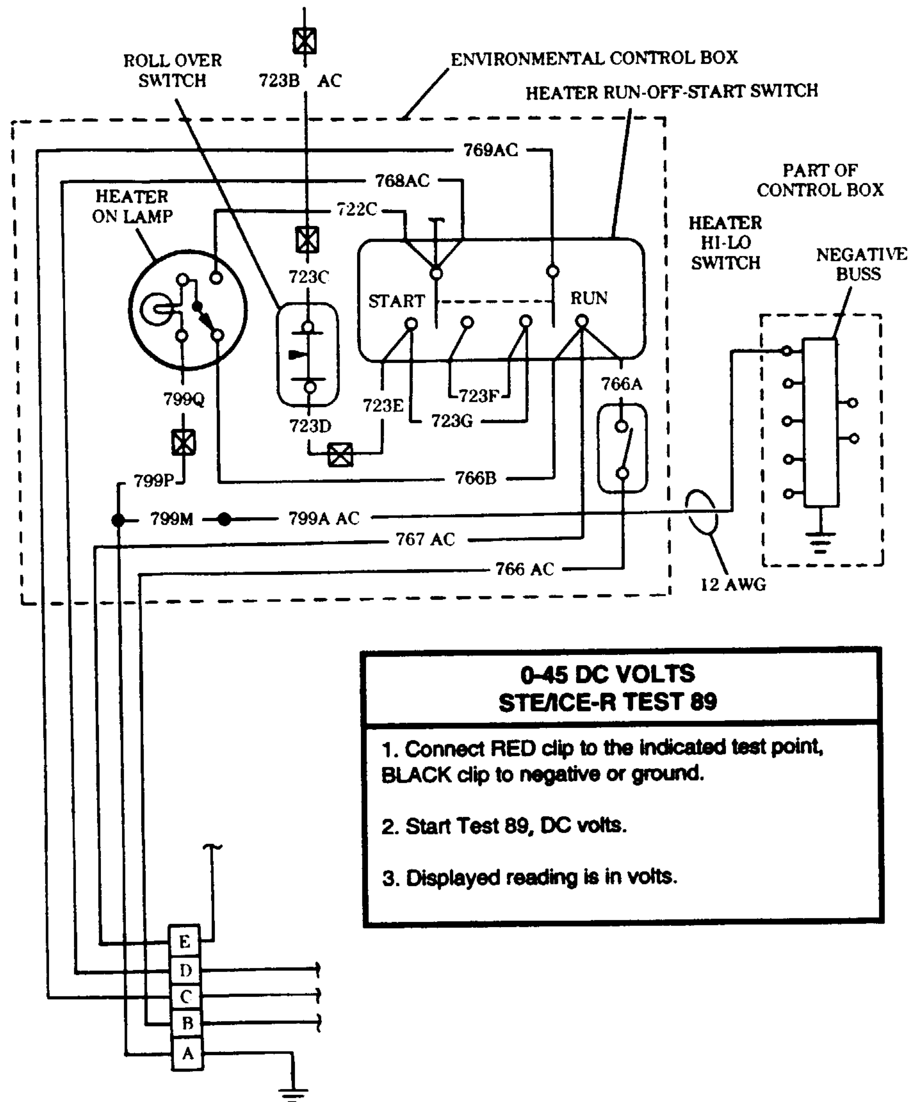
No continuity would indicate a damaged lead.

NO → REPAIR LEAD 799 P

YES ↓

REPLACE HEATER ON LAMP ASSEMBLY

REFERENCE INFORMATION **AMBULANCE**



0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

Repair lead, refer to (para. 4-85).

0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second. 2. Start test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

Repair lead, refer to (para. 4-85).
Repair lead connector, refer to (para. 4-85).
Replace Heater on Lamp, refer to (para. 4-126 or 4-127).

AMBULANCE
(Heater Output)
(Refer to Figs. 14-16.)

DIAGNOSTIC FLOWCHART

START

1

IS HEATER SWITCH ON ENVIRONMENTAL CONTROL BOX IN PROPER POSITION?

KNOWN INFO
NOTHING

POSSIBLE PROBLEMS
HEATER SWITCH POSITION
FUEL SWITCH POSITION
FUEL SHUTOFF VALVE POSITION
FUEL LINES
FUEL FILTER
LEAD 766 A
FUEL SWITCH

TEST OPTIONS
VISUAL

REASON FOR QUESTION
Heater switch must be in correct position for heater to operate.

NO → PLACE HEATER SWITCH TO RUN POSITION

YES ↓

2

IS FUEL SELECTION SWITCH ON ENVIRONMENTAL CONTROL BOX IN THE HI POSITION?

KNOWN INFO
HEATER SWITCH POSITION OK

POSSIBLE PROBLEMS
FUEL SWITCH POSITION
FUEL SWITCH VALVE POSITION
FUEL LINES
FUEL FILTER
LEAD 766 A
FUEL SWITCH

TEST OPTIONS
VISUAL

REASON FOR QUESTION
Selection switch must be in the correct position for desired heat output.

NO → REPLACE FUEL SWITCH IN HI POSITION

YES ↓

3

IS FUEL LINE SHUTOFF VALVE COMPLETELY OPEN AND ALL FUEL LINES FREE OF CRIMPS, KINKS, OR DAMAGE?

KNOWN INFO
HEATER SWITCH POSITION OK
FUEL SWITCH OK

POSSIBLE PROBLEMS
FUEL SWITCH VALVE POSITION
FUEL LINES
FUEL FILTER
LEAD 766 A
FUEL SWITCH

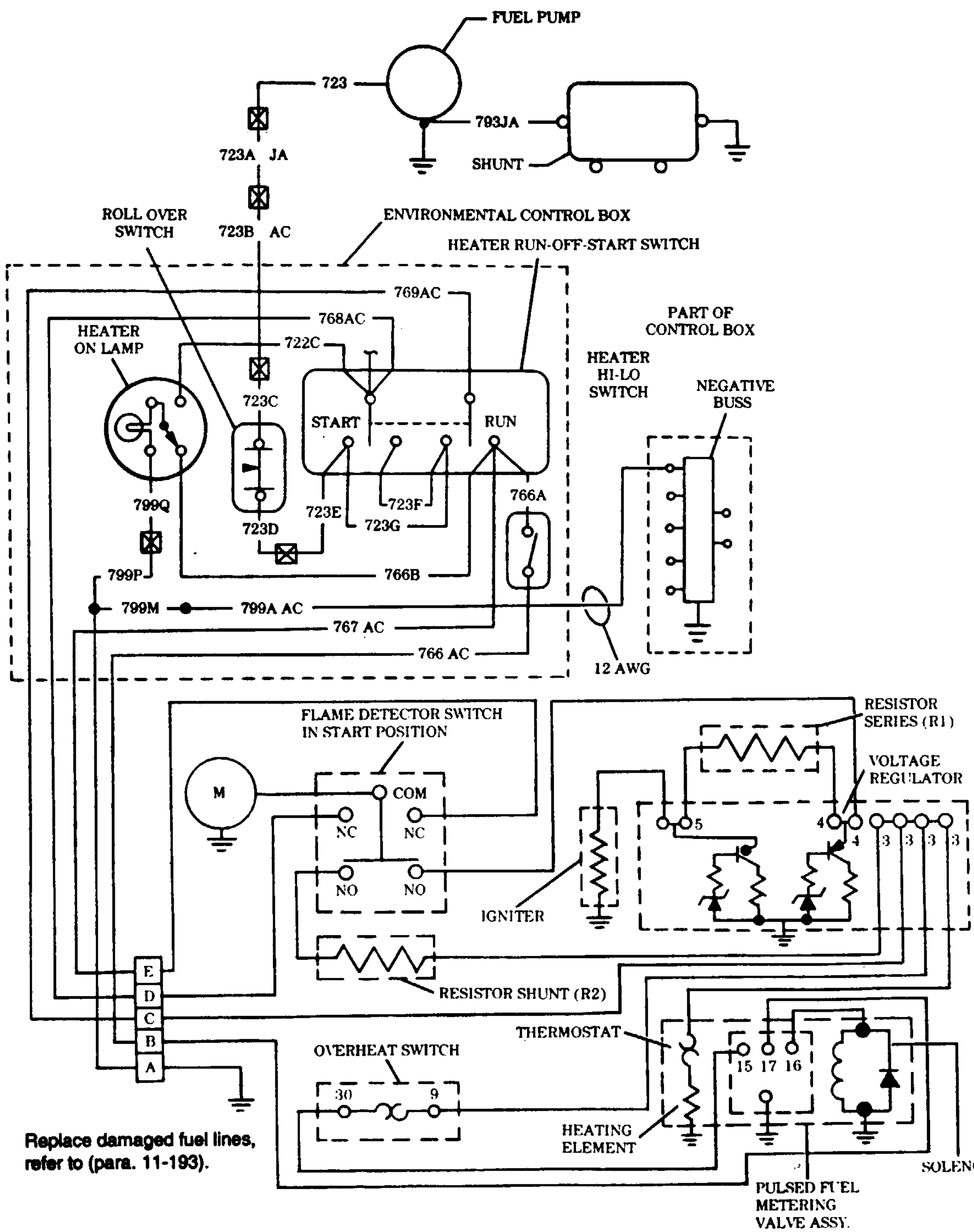
TEST OPTIONS
VISUAL

REASON FOR QUESTION
Proper amounts of fuel must be supplied for heater to operate correctly.

NO → OPEN SHUT OFF VALVE AND REPLACE ANY DAMAGED FUEL LINES

YES ↓

GO TO 4, Page 2-638



Replace damaged fuel lines, refer to (para. 11-193).

AMBULANCE
(Heater Output)
(Refer to Figs. 14-16.)

DIAGNOSTIC FLOWCHART

FROM 3, Page 2-636

4

KNOWN INFO	POSSIBLE PROBLEMS
HEATER SWITCH POSITION OK FUEL SWITCH POSITION OK FUEL SHUTOFF VALVE POSITION OK FUEL LINES OK	FUEL FILTER LEAD 766 A FUEL SWITCH

IS FUEL FILTER FREE OF RESTRICTIONS?

TEST OPTIONS: INSPECT

REASON FOR QUESTION: Proper amounts of fuel must be supplied unobstructed for heater to operate properly.

NO → SERVICE OR REPLACE FUEL FILTER

YES ↓

5

KNOWN INFO	POSSIBLE PROBLEMS
HEATER SWITCH POSITION OK FUEL SWITCH POSITION OK FUEL SHUTOFF VALVE POSITION OK FUEL LINES OK FUEL FILTER OK	LEAD 766 A FUEL SWITCH

IS THERE BATTERY VOLTAGE IN ENVIRONMENTAL CONTROL BOX AT LEAD 766 A TO HEATER HI-LO SWITCH?

TEST OPTIONS: STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION: No power would indicate a damaged lead.

NO → REPAIR LEAD 766 A

YES ↓

6

KNOWN INFO	POSSIBLE PROBLEMS
HEATER SWITCH POSITION OK FUEL SWITCH POSITION OK FUEL SHUTOFF VALVE POSITION OK FUEL LINES OK FUEL FILTER OK LEAD 766 A OK	FUEL SWITCH

PLACE JUMPER WIRE BETWEEN LEAD 766 A AND 766 AT HI-LO SWITCH. IS THERE HIGH OUTPUT OF HEAT?

TEST OPTIONS: TRY IT

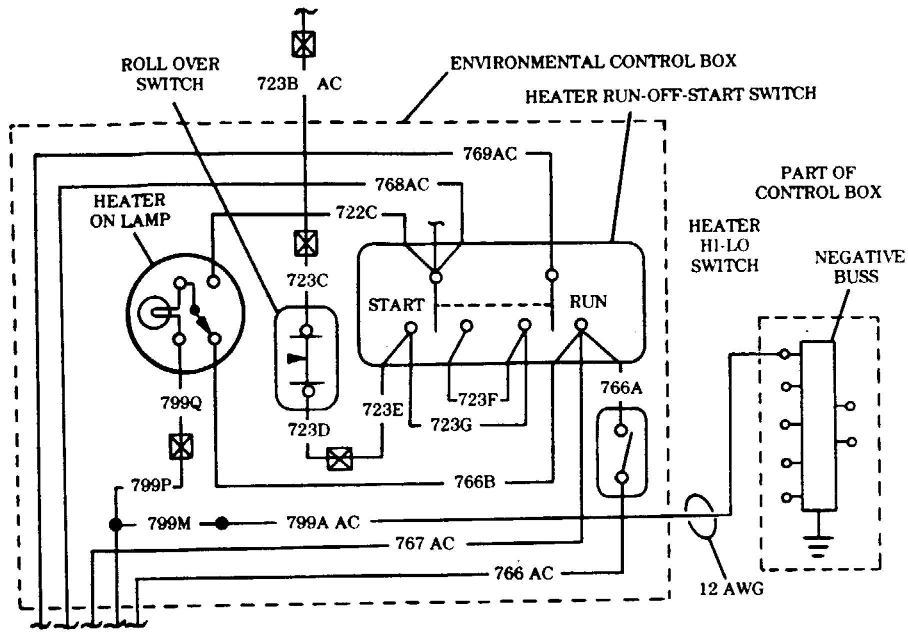
REASON FOR QUESTION: If high heat output occurs that would indicate a fuel switch malfunction.

NO → GO TO 7, Page 2-640

YES → REPLACE FUEL SWITCH

REFERENCE INFORMATION

AMBULANCE



Repair/replace fuel filter, refer to (para. 11-192).

Repair lead, refer to (para. 4-85).

0-45 DC VOLTS
STE/ICE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

Replace fuel switch, refer to (para. 4-127).

AMBULANCE
(Heater Output)
(Refer to Figs. 14-16.)

DIAGNOSTIC FLOWCHART

FROM 6,
Page 2-638

KNOWN INFO

PREVIOUSLY CORRECTED INFORMATION

POSSIBLE PROBLEMS

LEAD 766
HEATER ASSEMBLY

7

IS THERE BATTERY VOLTAGE OF LEAD 766 AT TERMINAL B OF FUEL COMBUSTION HEATER?

TEST OPTIONS

STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION

No power would indicate a damaged lead.

NO → REPAIR LEAD 766

YES ↓

KNOWN INFO

LEAD 766 OK

POSSIBLE PROBLEMS

HEATER ASSEMBLY

8

IS THERE HIGH OUTPUT OF HEAT?

TEST OPTIONS

TRY IT

REASON FOR QUESTION

Low heat output would indicate a heater assembly malfunction.

NO → REPLACE HEATER ASSEMBLY

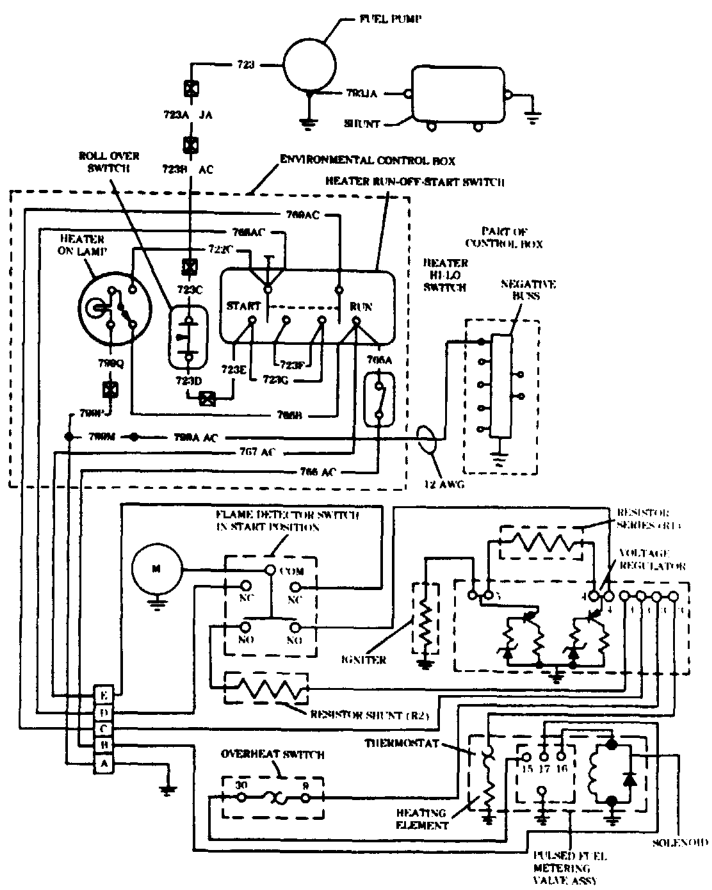
YES ↓

END OF TESTING

Repair lead, refer to (para. 4-85).
Repair lead connector,
refer to (para. 4-85).

0-45 DC VOLTS **STE/ICE-R TEST 89**
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

Replace heater assembly,
refer to (para. 11-190 or 11-209).



DIAGNOSTIC FLOWCHART

AMBULANCE
(Heater Starting)
(Refer to Figs. 14-16.)

START

1

KNOWN INFO

NOTHING

POSSIBLE PROBLEMS

HEATER ASSEMBLY
LEAD 723 D
ROLLOVER SWITCH
LEAD 723 B
LEAD 723 A
LEAD 798
FUEL PUMP
LEAD 768

WITH HEATER SWITCH ON ENVIRONMENTAL CONTROL BOX IN THE START POSITION IS HEATER ACTIVATED AT ALL?

TEST OPTIONS

TRY IT

REASON FOR QUESTION

To determine if any power is getting to heater switch on control box.

NO → GO TO 10, Page 2-648

YES ↓

2

KNOWN INFO

POSSIBLE PROBLEMS

HEATER ASSEMBLY
LEAD 723 D
ROLLOVER SWITCH
LEAD 723 B
LEAD 723 A
LEAD 798
FUEL PUMP
LEAD 768

IS THERE BATTERY VOLTAGE IN ENVIRONMENTAL CONTROL BOX AT ROLLOVER SWITCH?

TEST OPTIONS

STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION

No power would indicate a damaged lead.

NO → REPAIR LEAD 723 D

YES ↓

3

KNOWN INFO

LEAD 723 D OK

POSSIBLE PROBLEMS

HEATER ASSEMBLY
ROLL OVER SWITCH
LEAD 723 B
LEAD 723 A
LEAD 798
FUEL PUMP
LEAD 768

IS THERE BATTERY VOLTAGE IN ENVIRONMENTAL CONTROL BOX THROUGH ROLLOVER SWITCH?

TEST OPTIONS

1. STE/ICE-R TEST 89, PAGE 2-750
2. MULTIMETER

REASON FOR QUESTION

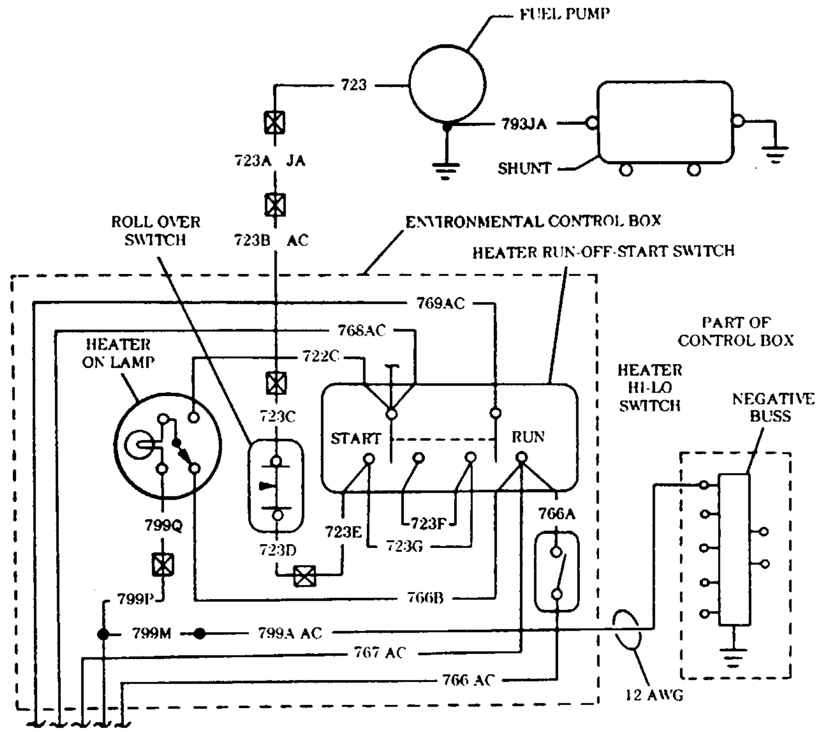
No power would indicate a switch malfunction.

NO → REPLACE ROLLOVER SWITCH

YES ↓

GO TO 4, Page 644

REFERENCE INFORMATION **AMBULANCE**



Repair lead, refer to (para. 4-85).
Repair lead connector,
refer to (para. 4-85).

Replace Rollover Switch,
refer to (para. 4-127).

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to volts scale of at least 40 volts. 2. Connect the RED lead to positive and the black lead to negative. 3. Be sure to read the correct scale.

AMBULANCE
(Heater Starting)
(Refer to Figs. 14-16.)

DIAGNOSTIC FLOWCHART

FROM 3, Page 2-642

4

KNOWN INFO
LEAD 723 D OK ROLLOVER SWITCH OK
POSSIBLE PROBLEMS
HEATER ASSEMBLY LEAD 723 B LEAD 723 A LEAD 798 FUEL PUMP LEAD 768

IS THERE BATTERY VOLTAGE AT LEAD 723 B?

TEST OPTIONS

STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION

No power would indicate a damaged lead.

NO → REPLACE LEAD 723 B

YES ↓

5

KNOWN INFO
LEAD 723 D OK ROLLOVER SWITCH OK LEAD 723 B OK
POSSIBLE PROBLEMS
HEATER ASSEMBLY LEAD 723 A LEAD 798 FUEL PUMP LEAD 768

DISCONNECT LEAD 723 A FROM FUEL PUMP LEAD. IS THERE BATTERY VOLTAGE AT LEAD 723 A?

TEST OPTIONS

STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION

No power would indicate a damaged lead.

NO → REPLACE LEAD 723 A

YES ↓

6

KNOWN INFO
LEAD 723 D OK ROLLOVER SWITCH OK LEAD 723 B OK LEAD 723 A OK
POSSIBLE PROBLEMS
HEATER ASSEMBLY LEAD 798 FUEL PUMP LEAD 768

IS THERE CONTINUITY BETWEEN FUEL PUMP LEAD 798 AND GROUND?

TEST OPTIONS

TRY IT

REASON FOR QUESTION

No continuity would indicate a damaged lead.

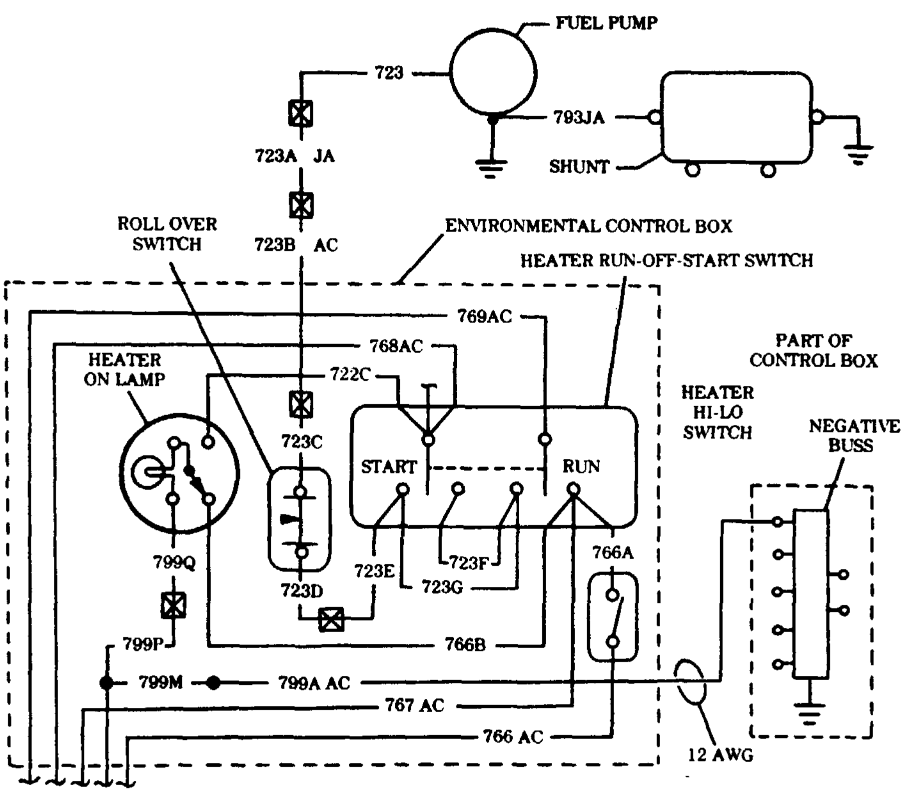
NO → REPAIR LEAD 798

YES ↓

GO TO 7, Page 2-646

Repair lead, refer to (para. 4-85).
Repair lead connector, refer to (para. 4-85).

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.



Repair lead, refer to (para. 4-85).
Repair lead connector, refer to (para. 4-85).

AMBULANCE
(Heater Starting)
(Refer to Figs. 14-16.)

DIAGNOSTIC FLOWCHART

FROM 6, Page 2-644

KNOWN INFO
LEAD 723 D OK
ROLLOVER SWITCH OK
LEAD 723 B OK
LEAD 723 A OK
LEAD 798 OK

POSSIBLE PROBLEMS
HEATER ASSEMBLY
FUEL PUMP
LEAD 768

7
DOES FUEL PUMP OPERATE PROPERLY ELECTRICALLY?

TEST OPTIONS
TRY IT

REASON FOR QUESTION
Faulty fuel pump could be due to a mechanical malfunction.

NO → REPLACE FUEL PUMP

YES ↓

KNOWN INFO
LEAD 723 D OK
ROLLOVER SWITCH OK
LEAD 723 B OK
LEAD 723 A OK
LEAD 798 OK

POSSIBLE PROBLEMS
HEATER ASSEMBLY
FUEL PUMP
LEAD 768

8
DOES FUEL PUMP OPERATE PROPERLY MECHANICALLY?

TEST OPTIONS
VISUAL

REASON FOR QUESTION
Faulty fuel pump could be due to an electrical malfunction.

NO → PERFORM STEPS 1 AND 2, Page 2-706 AND RETURN

YES ↓

KNOWN INFO
LEAD 723 D OK
ROLLOVER SWITCH OK
LEAD 723 B OK
LEAD 723 A OK
LEAD 798 OK
FUEL PUMP OK

POSSIBLE PROBLEMS
HEATER ASSEMBLY
LEAD 768

9
WITH HEATER SWITCH ON ENVIRONMENTAL CONTROL BOX IN THE RUN POSITION, IS THERE BATTERY VOLTAGE AT HEATER CONNECTOR PLUG PIN D?

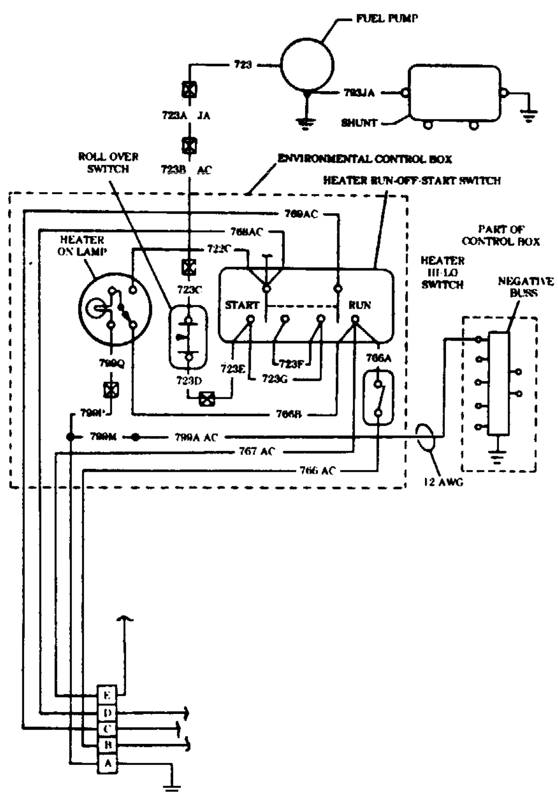
TEST OPTIONS
STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION
No power would indicate a damaged lead.

NO → REPAIR LEAD 768

YES → REPLACE HEATER ASSEMBLY

Replace fuel pump, refer to (para. 11-194).



Replace heater assembly, refer to (para. 11-190 or 11-209).

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

AMBULANCE
(Heater Starting)
(Refer to Figs. 14-16.)

DIAGNOSTIC FLOWCHART

FROM 1, Page 2-642

KNOWN INFO

POSSIBLE PROBLEMS

HEAT LEVER POSITION
CONTROL LEVER POSITION
FUSE
BATTERY
CABLE 660
LEAD 660 B
LEAD 722
LEAD 722 A
CONTINUITY SWITCHES
LEAD 722 B
LEAD 722 C
HEATER SWITCH
LEAD 769
LEAD 799 N
HEATER ASSEMBLY

10

IS HEAT LEVER IN ENVIRONMENTAL CONTROL BOX IN PROPER POSITION?

TEST OPTIONS

VISUAL

REASON FOR QUESTION

If heat lever is not in position, circuit is not closed.

NO → PLACE HEAT LEVER TO HEAT POSITION

YES ↓

KNOWN INFO

HEAT LEVER POSITION OK

POSSIBLE PROBLEMS

CONTROL LEVER POSITION OK
FUSE
BATTERY
CABLE 660
LEAD 660 B
LEAD 722
LEAD 722 A
CONTINUITY SWITCHES
LEAD 722 B
LEAD 722 C
HEATER SWITCH
LEAD 769
LEAD 799 N
HEATER ASSEMBLY

11

IS CONTROL LEVER ON ENVIRONMENTAL CONTROL BOX IN PROPER POSITION?

TEST OPTIONS

VISUAL

REASON FOR QUESTION

If control lever is not in position, circuit is not closed.

NO → PLACE CONTROL LEVER TO HEAT/NORMAL OR HEAT/MAX POSITION

YES ↓

KNOWN INFO

HEAT LEVER POSITION OK
CONTROL LEVER POSITION OK

POSSIBLE PROBLEMS

FUSE
BATTERY
CABLE 660
LEAD 660 B
LEAD 722
LEAD 722 A
CONTINUITY SWITCHES
LEAD 722 B
LEAD 722 C
HEATER SWITCH
LEAD 769
LEAD 799 N
HEATER ASSEMBLY

12

CHECK FUSE BLOCK ON CONTROL BOX COVER. IS FUSE OK?

TEST OPTIONS

VISUAL

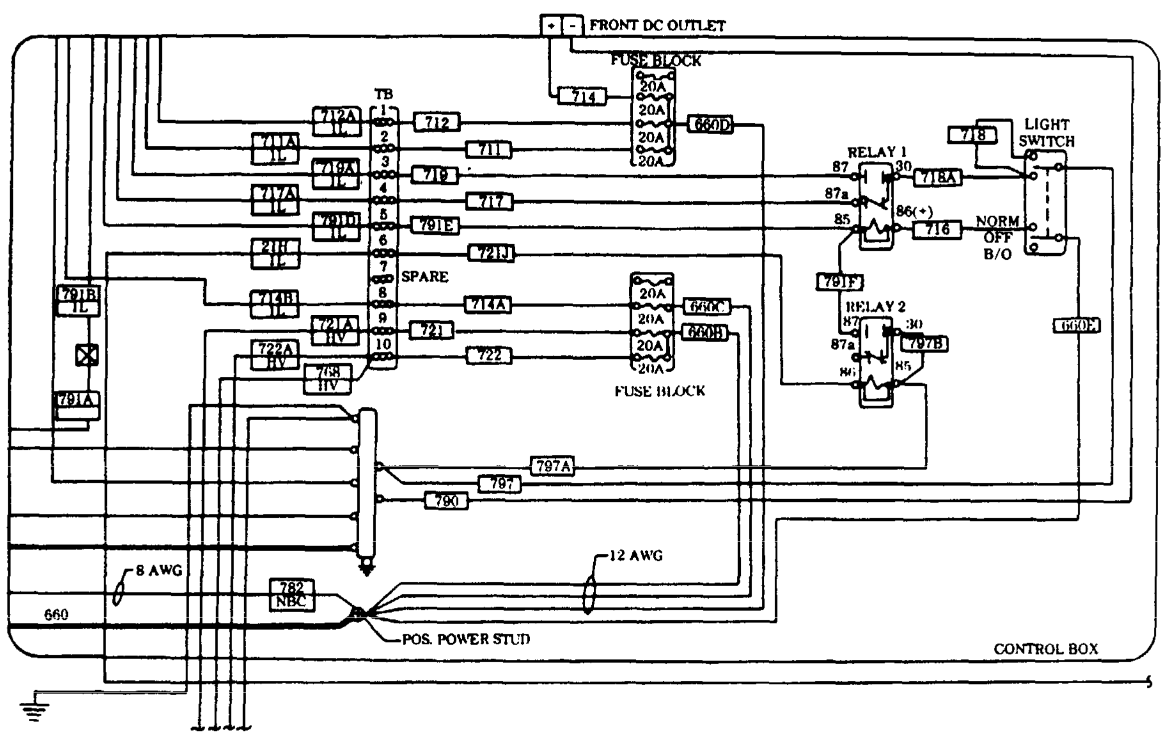
REASON FOR QUESTION

If fuse is blown, circuit is incomplete.

NO → REPLACE BLOWN FUSE

YES ↓

GO TO 13, Page 2-650


FRONT DC OUTLET
FUSE BLOCK
TB
SPARE
RELAY 1
RELAY 2
LIGHT SWITCH
NORM
OFF
B/O
FUSE BLOCK
8 AWG
12 AWG
POS. POWER STUD
CONTROL BOX
660

AMBULANCE
(Heater Starting)
(Refer to Figs. 14-16.)

DIAGNOSTIC FLOWCHART

FROM 12, Page 2-648

KNOWN INFO
HEAT LEVER POSITION OK
CONTROL LEVER POSITION OK
FUSE OK

POSSIBLE PROBLEMS
FUSE
BATTERY
CABLE 660
LEAD 660 B
LEAD 722
LEAD 722 A
CONTINUITY SWITCHES
LEAD 722 B LEAD 722 C
HEATER SWITCH
LEAD 769 LEAD 799 N
HEATER ASSEMBLY

13

IS BATTERY IN PROPER WORKING ORDER?

TEST OPTIONS

1. STE/ICE-R TEST 89, PAGE 2-750
2. MULTIMETER

REASON FOR QUESTION

Battery malfunction will cause any dependent circuit to malfunction.

NO → GO TO 1, Page 2-252

YES ↓

KNOWN INFO
HEAT LEVER POSITION OK
CONTROL LEVER POSITION OK
FUSE OK
BATTERY OK

POSSIBLE PROBLEMS
CABLE 660
LEAD 660 B
LEAD 722
LEAD 722 A
CONTINUITY SWITCHES
LEAD 722 B
LEAD 722 C
HEATER SWITCH
LEAD 769
LEAD 799 N
HEATER ASSEMBLY

14

IS THERE BATTERY VOLTAGE IN CONTROL BOX AT POWER STUD?

TEST OPTIONS

1. STE/ICE-R TEST 89, PAGE 2-750
2. MULTIMETER

REASON FOR QUESTION

No power at power stud would indicate a damaged cable from the power source.

NO → REPAIR CABLE 660

YES ↓

KNOWN INFO
HEAT LEVER POSITION OK
CONTROL LEVER POSITION OK
FUSE OK
BATTERY OK
CABLE 660 OK

POSSIBLE PROBLEMS
LEAD 660 B
LEAD 722
LEAD 722 A
CONTINUITY SWITCHES
LEAD 722 B
LEAD 722 C
HEATER SWITCH
LEAD 769
LEAD 799 N
HEATER ASSEMBLY

15

IS THERE BATTERY VOLTAGE IN CONTROL BOX THROUGH LEAD 660 B AT FUSE BLOCK?

TEST OPTIONS

STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION

No power would indicate a damaged lead.

NO → REPAIR LEAD 660 B

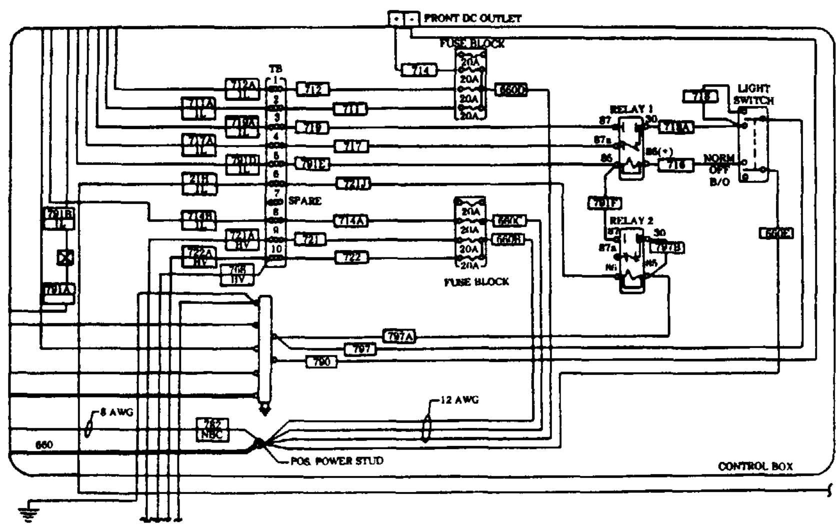
YES ↓

GO TO 16, Page 2-652

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.

Repair lead, refer to (para. 4-85).



Repair lead, refer to (para. 4-85).
Repair lead connector, refer to (para. 4-85).

AMBULANCE
(Heater Starting)
(Refer to Figs. 14-16.)

DIAGNOSTIC FLOWCHART

FROM 15, Page 2-650

KNOWN INFO
HEAT LEVER POSITION OK CONTROL LEVER POSITION OK FUSE OK BATTERY OK CABLE 660 OK LEAD 660 B OK
POSSIBLE PROBLEMS
LEAD 722 LEAD 722 A CONTINUITY SWITCHES LEAD 722 B LEAD 722 C HEATER SWITCH LEAD 769 LEAD 799 N HEATER ASSEMBLY

16

IS THERE BATTERY VOLTAGE IN CONTROL BOX AT TB TERMINAL 10?

TEST OPTIONS

STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION

No power would indicate a damage lead.

NO → REPAIR LEAD 722

YES ↓

KNOWN INFO
HEAT LEVER POSITION OK CONTROL LEVER POSITION OK FUSE OK BATTERY OK CABLE 660 OK LEAD 660 B OK LEAD 722 OK
POSSIBLE PROBLEMS
LEAD 722 A CONTINUITY SWITCHES LEAD 722 B LEAD 722 C HEATER SWITCH LEAD 769 LEAD 799 N HEATER ASSEMBLY

17

IS THERE BATTERY VOLTAGE IN ENVIRONMENTAL CONTROL BOX AT HEATER EVAPORATOR MOTORS CONTINUITY SWITCH?

TEST OPTIONS

STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION

No power would indicate a damaged lead.

NO → REPAIR LEAD 722 A

YES ↓

KNOWN INFO
HEAT LEVER POSITION OK CONTROL LEVER POSITION OK FUSE OK BATTERY OK CABLE 660 OK LEAD 660 B OK LEAD 722 OK LEAD 722 A OK
POSSIBLE PROBLEMS
CONTINUITY SWITCHES LEAD 722 B LEAD 722 C HEATER SWITCH LEAD 769 LEAD 799 N HEATER ASSEMBLY

18

IS THERE BATTERY VOLTAGE IN ENVIRONMENTAL CONTROL BOX THROUGH HEATER EVAPORATOR MOTORS CONTINUITY SWITCH?

TEST OPTIONS

1. STE/ICE-R TEST 89, PAGE 2-750
2. MULTIMETER

REASON FOR QUESTION

No power would indicate a switch malfunction.

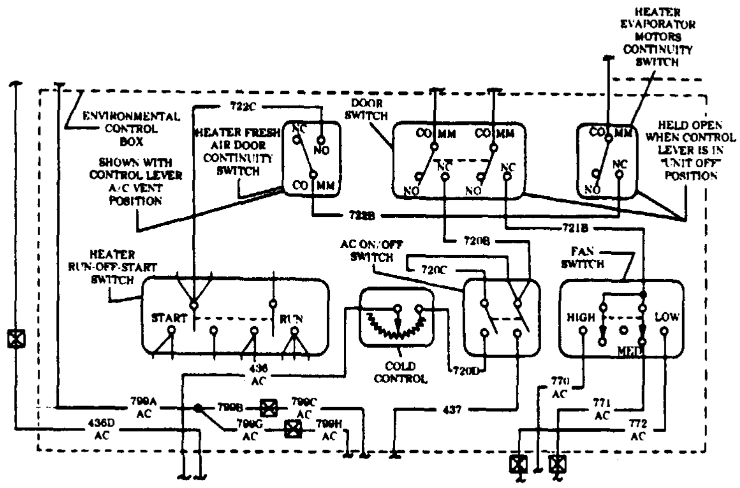
NO → REPLACE SWITCH

YES ↓

GO TO 19, Page 2-654

REFERENCE INFORMATION **AMBULANCE**

Repair lead, refer to (para. 4-85).
Repair lead connector, refer to (para. 4-85).



Replace Heater Evaporator
Motors continuity switch,
refer to DS Maintenance.

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to volts scale of at least 40 volts. 2. Connect the RED lead to positive and the black lead to negative. 3. Be sure to read the correct scale.

AMBULANCE
(Heater Starting)
(Refer to Figs. 14-16.)

DIAGNOSTIC FLOWCHART

FROM 18, Page 2-652

KNOWN INFO
HEAT LEVER POSITION OK CONTROL LEVER POSITION OK FUSE OK BATTERY OK CABLE 660 OK LEAD 660 B LEAD 722 OK LEAD 722 A OK
POSSIBLE PROBLEMS
CONTINUITY SWITCHES LEAD 722 B LEAD 722 C HEATER SWITCH LEAD 769 LEAD 799 N HEATER ASSEMBLY

19

IS THERE BATTERY VOLTAGE IN ENVIRONMENTAL CONTROL BOX AT HEATER FRESH AIR DOOR CONTINUITY SWITCH?

TEST OPTIONS

STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION

No power would indicate a damaged lead.

NO → REPAIR LEAD 722 B

YES ↓

KNOWN INFO
HEAT LEVER POSITION OK CONTROL LEVER POSITION OK FUSE OK BATTERY OK CABLE 660 OK LEAD 660 B OK LEAD 722 OK LEAD 722 A OK LEAD 722 B OK
POSSIBLE PROBLEMS
LEAD 722 C HEATER SWITCH LEAD 769 LEAD 799 N HEATER ASSEMBLY

20

IS THERE BATTERY VOLTAGE IN ENVIRONMENTAL CONTROL BOX THROUGH HEATER FRESH AIR DOOR CONTINUITY SWITCH?

TEST OPTIONS

1. STE/ICE-R TEST 89, PAGE 2-750
2. MULTIMETER

REASON FOR QUESTION

No power would indicate a switch malfunction.

NO → REPLACE SWITCH

YES ↓

KNOWN INFO
HEAT LEVER POSITION OK CONTROL LEVER POSITION OK FUSE OK BATTERY OK CABLE 660 OK LEAD 660 B OK LEAD 722 OK LEAD 722 A OK CONTINUITY SWITCHES OK LEAD 722 B OK
POSSIBLE PROBLEMS
LEAD 722 C HEATER SWITCH LEAD 769 LEAD 799 N HEATER ASSEMBLY

21

IS THERE BATTERY VOLTAGE IN ENVIRONMENTAL CONTROL BOX AT HEATER SWITCH?

TEST OPTIONS

STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION

No power would indicate a damaged lead.

NO → REPAIR LEAD 722 C

YES ↓

GO TO 22, Page 2-656

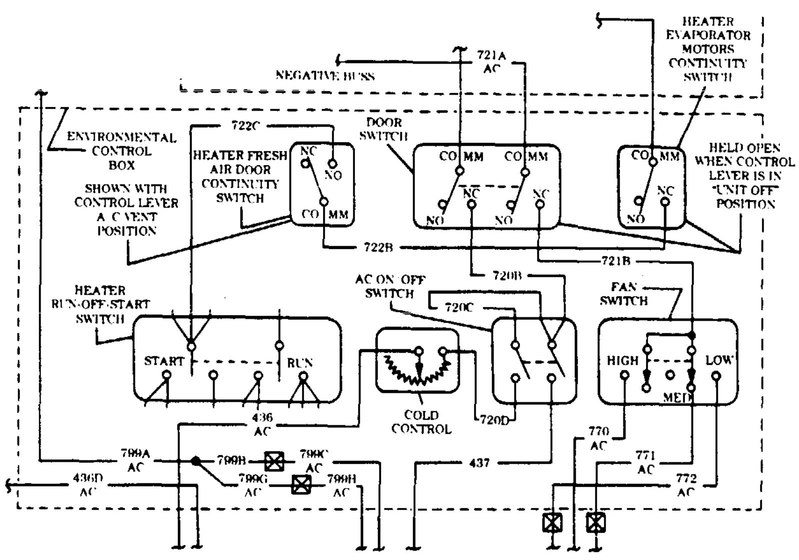
Repair lead, refer to (para. 4-85).

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to volts scale of at least 40 volts. 2. Connect the RED lead to positive and the black lead to negative. 3. Be sure to read the correct scale.

Replace heater fresh air door continuity switch, refer to DS Maintenance.

Repair lead, refer to (para. 4-85).



AMBULANCE
(Heater Starting)
(Refer to Figs. 14-16.)

DIAGNOSTIC FLOWCHART

FROM 21, Page 2-654

KNOWN INFO

HEAT LEVER POSITION OK
CONTROL LEVER POSITION OK
FUSE OK
BATTERY OK
CABLE 660 OK
LEAD 660 B OK
LEAD 772 OK
LEAD 772 A OK
CONTINUITY SWITCHES OK
LEAD 722 B OK
LEAD 722 C OK

POSSIBLE PROBLEMS

HEATER SWITCH
LEAD 769
LEAD 799 N
HEATER ASSEMBLY

22

IS THERE BATTERY VOLTAGE IN ENVIRONMENTAL CONTROL BOX AT LEAD 769 OF HEATER SWITCH?

TEST OPTIONS

1. STE/ICE-R TEST 89, PAGE 2-750
2. MULTIMETER

REASON FOR QUESTION

No power would indicate a switch malfunction.

NO → REPLACE HEATER SWITCH

YES ↓

KNOWN INFO

HEAT LEVER POSITION OK
CONTROL LEVER POSITION OK
FUSE OK
BATTERY OK
CABLE 660 OK
LEAD 660 B OK
LEAD 772 OK
LEAD 772 A OK
CONTINUITY SWITCHES OK
LEAD 722 B OK
LEAD 722 C OK
HEATER SWITCH OK

POSSIBLE PROBLEMS

LEAD 769
LEAD 769 N
HEATER ASSEMBLY

23

IS THERE BATTERY VOLTAGE AT HEATER CONNNECTOR PLUG PIN C?

TEST OPTIONS

STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION

No power would indicate a damaged lead.

NO → REPAIR LEAD 769

YES ↓

KNOWN INFO

HEAT LEVER POSITION OK
CONTROL LEVER POSITION OK
FUSE OK
BATTERY OK
CABLE 660 OK
LEAD 660 B OK
LEAD 722 OK
CONTINUITY SWITCHES OK
LEAD 722 B OK
LEAD 722 C OK
HEATER SWITCH OK
LEAD 769 OK

POSSIBLE PROBLEMS

LEAD 799 N
HEATER ASSEMBLY

24

IS THERE CONTINUITY OF LEAD 799 N IN ENVIRONMENTAL CONTROL BOX AT HEATER?

TEST OPTIONS

STE/ICE-R TEST 91, PAGE 2-752

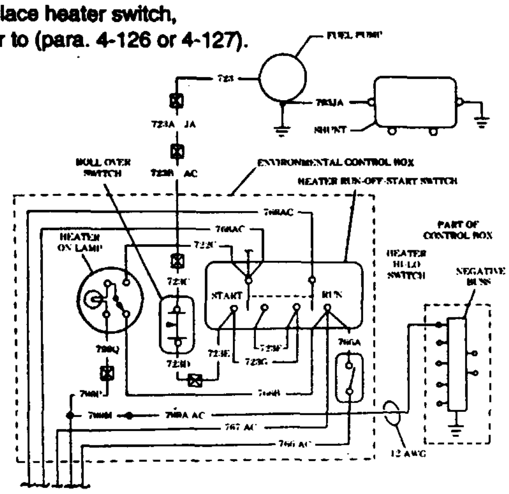
No continuity would indicate a damaged lead.

NO → REPAIR LEAD 799 N

YES ↓

GO TO 25, Pagr 2-658

Replace heater switch,
refer to (para. 4-126 or 4-127).



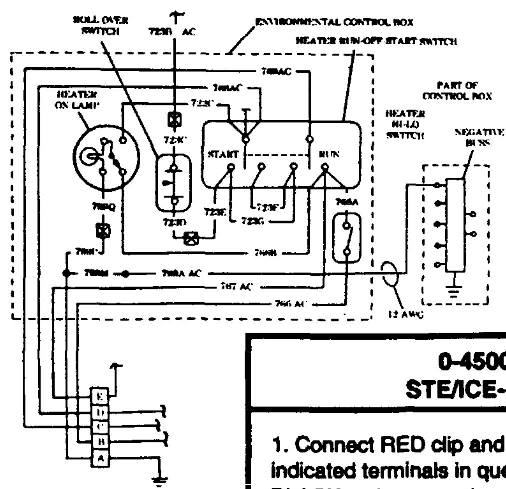
0-45 DC VOLTS
STE/ICE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

BATTERY VOLTAGE
MULTIMETER

1. Set the voltmeter to volts scale of at least 40 volts.
2. Connect the RED lead to positive and the black lead to negative.
3. Be sure to read the correct scale.

Repair lead, refer to (para. 4-85).
Repair lead connector, refer to (para. 4-85).



Repair lead, refer to (para. 4-85).
Repair lead connector, refer to (para. 4-85).

0-4500 OHMS
STE/ICE-R TEST 91

1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

AMBULANCE
(Heater Starting)
(Refer to Figs. 14-16.)

DIAGNOSTIC FLOWCHART

KNOWN INFO

HEAT LEVER POSITION OK
CONTROL LEVER POSITION OK
FUSE OK
BATTERY OK
CABLE 660 OK
LEAD 660 B OK
LEAD 772 OK
LEAD 722 A OK
CONTINUITY SWITCHES OK
LEAD 722 B OK
LEAD 722 C OK
HEATER SWITCH
LEAD 769 OK
LEAD 799 N OK

POSSIBLE PROBLEMS

HEATER ASSEMBLY

FROM 24, Page 2-656

25

WITH HEATER SWITCH ON ENVIRONMENTAL CONTROL BOX STILL IN THE "START" POSITION, IS HEATER NOW ACTIVATED AT ALL?

TEST OPTIONS

TRY IT

REASON FOR QUESTION

No activation at all would indicate a heater malfunction.

NO — REPLACE HEATER ASSEMBLY

YES — RETURN TO STEP 2, Page 2-642

Replace heater assembly,
refer to (paras.11-190 or 11-209).

AMBULANCE
(NBC Filter Blower)
(Refer to Fig. 17.)

DIAGNOSTIC FLOWCHART

START

1

KNOWN INFO
NOTHING

POSSIBLE PROBLEMS
NBC SWITCH POSITION
DAMAGED LEADS/ COMPONENTS
NBC FILTER BLOWER

IS NBC SWITCH ON NBC CONTROL PANEL IN PROPER POSITION?

TEST OPTIONS
VISUAL

REASON FOR QUESTION
If switch is open, no power is supplied to NBC filter blower.

NO → PLACE NBC SWITCH TO 'ON' POSITION

YES ↓

2

KNOWN INFO
NBC SWITCH POSITION OK

POSSIBLE PROBLEMS
DAMAGED LEADS/ COMPONENTS
NBC FILTER BLOWER

DISCONNECT LEAD 783 B FROM NBC FILTER BLOWER. IS THERE BATTERY VOLTAGE AT LEAD 783 B?

TEST OPTIONS
STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION
No power would indicate damaged leads and/or components.

NO → GO TO 4, Page 2-662

YES ↓

3

KNOWN INFO
NBC SWITCH POSITION OK

POSSIBLE PROBLEMS
DAMAGED LEADS/ COMPONENTS
NBC FILTER BLOWER

IS THERE CONTINUITY BETWEEN NBC FILTER BLOWER LEAD 796 B AND GROUND?

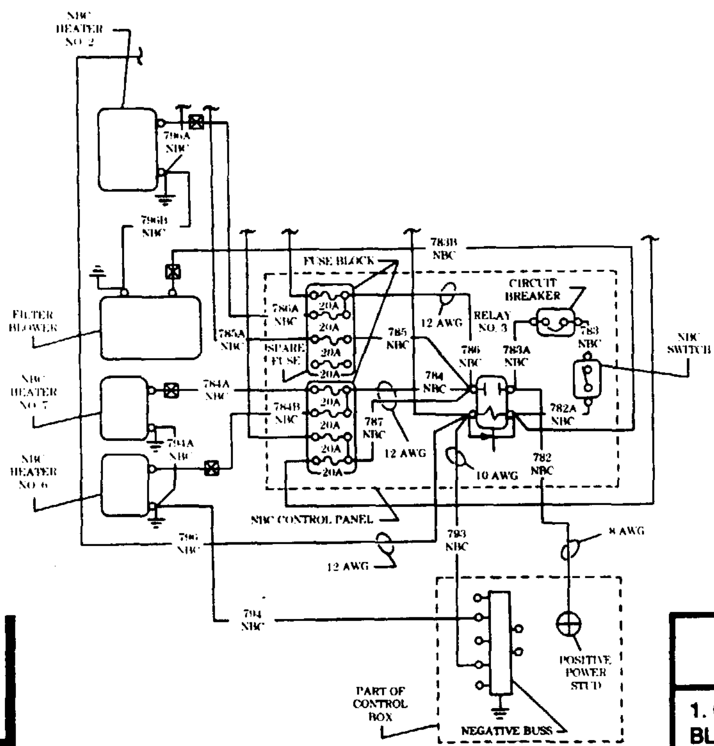
TEST OPTIONS
STE/ICE-R TEST 91, PAGE 2-752

REASON FOR QUESTION
No continuity would indicate damaged leads and/or components.

NO → GO TO 13, Page 2-668

YES ↓

REPLACE NBC FILTER BLOWER



0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

Replace NBC filter blower, refer to DS Maintenance.

0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

AMBULANCE
(NBC Filter Blower)
(Refer to Fig. 17.)

DIAGNOSTIC FLOWCHART

FROM 2,
Page 2-660

KNOWN INFO
PREVIOUSLY CORRECTED INFORMATION

POSSIBLE PROBLEMS
BATTERY
CABLE 660
LEAD 782
LEAD 782 A
CIRCUIT BREAKER
LEAD 783
NBC SWITCH
LEAD 783 A
LEAD 783 B

4

IS BATTERY IN PROPER WORKING ORDER?

TEST OPTIONS
1. STE/ICE-R TEST 89, PAGE 2-750
2. MULTIMETER

REASON FOR QUESTION
Battery malfunction will cause any dependent circuit to malfunction.

NO → GO TO 1, Page 2-252

YES ↓

KNOWN INFO
BATTERY OK

POSSIBLE PROBLEMS
CABLE 660
LEAD 782
LEAD 782 A
CIRCUIT BREAKER
LEAD 783
NBC SWITCH
LEAD 783 A
LEAD 783 B

5

IS THERE BATTERY VOLTAGE IN CONTROL BOX AT POWER STUD?

TEST OPTIONS
1. STE/ICE-R TEST 89, PAGE 2-750
2. MULTIMETER

REASON FOR QUESTION
No power at power stud would indicate a damaged cable from the power source.

NO → REPAIR CABLE 660

YES ↓

KNOWN INFO
BATTERY OK
CABLE 660 OK

POSSIBLE PROBLEMS
LEAD 782
LEAD 782 A
CIRCUIT BREAKER
LEAD 783
NBC SWITCH
LEAD 783 A
LEAD 783 B

6

IS THERE BATTERY VOLTAGE IN NBC CONTROL PANEL AT LEAD 782 OF RELAY 3?

TEST OPTIONS
STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION
No power would indicate a damaged lead.

NO → REPAIR LEAD 782

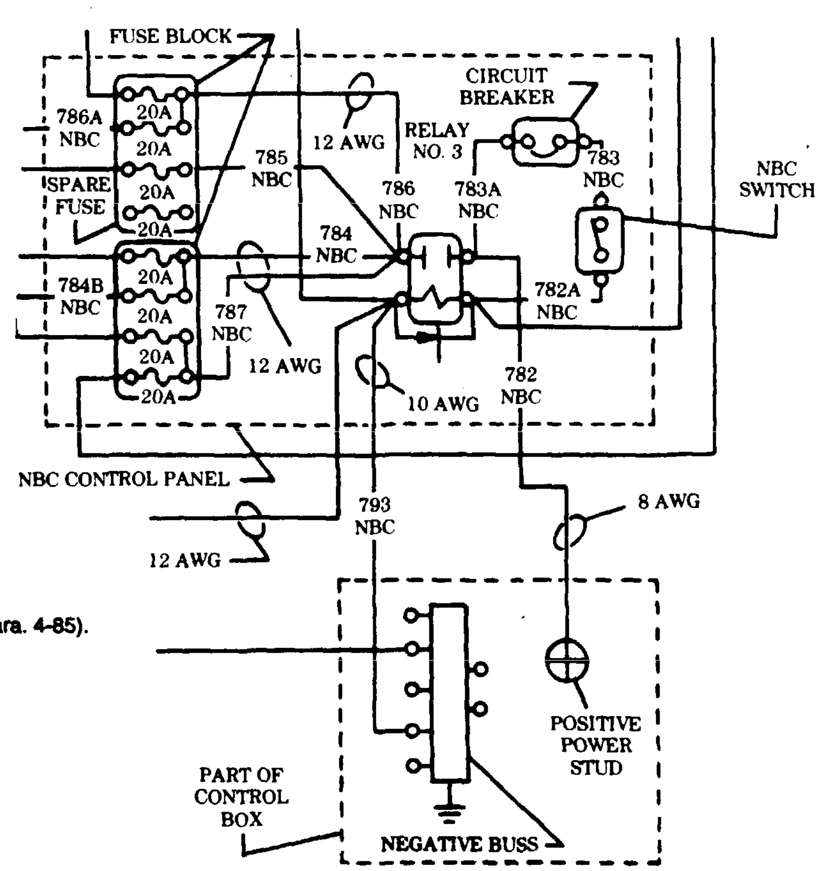
YES ↓

GO TO 7,
Page 2-664

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

Repair lead, refer to (para. 4-85).



Repair lead, refer to (para. 4-85).

Repair lead connector, refer to (para. 4-85).

AMBULANCE
(NBC Filter Blower)
(Refer to Fig. 17.)

DIAGNOSTIC FLOWCHART

FROM 6, Page 3-662

7

KNOWN INFO
BATTERY OK CABLE 660 OK LEAD 782 OK
POSSIBLE PROBLEMS
LEAD 782 A CIRCUIT BREAKER LEAD 783 NBC SWITCH LEAD 783 A LEAD 783 B

IS THERE BATTERY VOLTAGE IN NBC CONTROL PANEL AT CIRCUIT BREAKER?

TEST OPTIONS

STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION

No power would indicate a damaged lead.

NO → REPAIR LEAD 782 A

YES ↓

8

KNOWN INFO
BATTERY OK CABLE 660 OK LEAD 782 OK LEAD 782 A OK
POSSIBLE PROBLEMS
CIRCUIT BREAKER LEAD 783 NBC SWITCH LEAD 783 A LEAD 783 B

IS THERE BATTERY VOLTAGE IN NBC CONTROL PANEL THROUGH CIRCUIT BREAKER?

TEST OPTIONS

STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION

No power would indicate a damaged circuit breaker.

NO → REPLACE CIRCUIT BREAKER

YES ↓

9

KNOWN INFO
BATTERY OK CABLE 660 OK LEAD 782 OK LEAD 782 A OK CIRCUIT BREAKER OK
POSSIBLE PROBLEMS
LEAD 783 NBC SWITCH LEAD 783 A LEAD 783 B

IS THERE BATTERY VOLTAGE IN NBC CONTROL PANEL AT NBC SWITCH?

TEST OPTIONS

STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION

No power would indicate a damaged lead.

NO → REPLACE LEAD 783

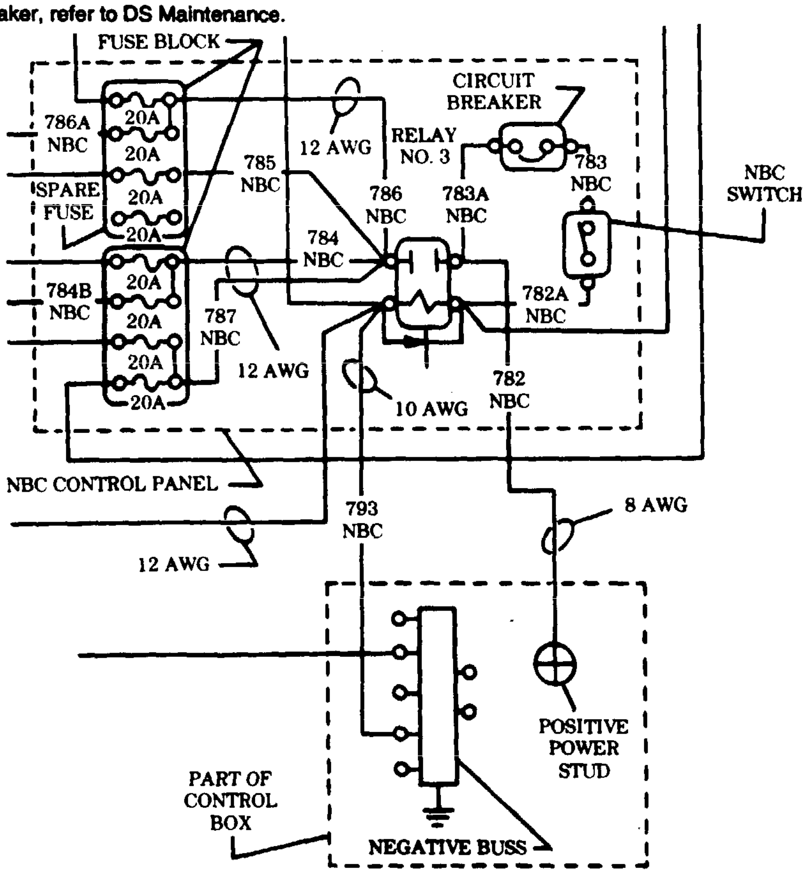
YES ↓

GO TO 10, Page 2-666

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

Repair lead, refer to (para. 4-85).

Replace circuit breaker, refer to DS Maintenance.



AMBULANCE
(NBC Filter Blower)
(Refer to Fig. 17.)

DIAGNOSTIC FLOWCHART

FROM 9, Page 2-664

10

IS THERE BATTERY VOLTAGE IN NBC CONTROL PANEL THROUGH NBC SWITCH?

KNOWN INFO
BATTERY OK CABLE 660 OK LEAD 782 OK LEAD 782 A OK CIRCUIT BREAKER OK LEAD 783 OK
POSSIBLE PROBLEMS
NBC SWITCH LEAD 783 A LEAD 783 B

TEST OPTIONS

STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION

No power would indicate a damaged switch.

NO → REPLACE NBC SWITCH

YES ↓

11

IS THERE BATTERY VOLTAGE IN NBC CONTROL PANEL AT LEAD 783 A OF RELAY 3?

KNOWN INFO
BATTERY OK CABLE 660 OK LEAD 782 OK LEAD 782 A OK CIRCUIT BREAKER OK LEAD 783 OK NBC SWITCH OK
POSSIBLE PROBLEMS
LEAD 783 A LEAD 783 B

TEST OPTIONS

STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION

No power would indicate a damaged lead.

NO → REPAIR LEAD 783 A

YES ↓

12

IS THERE BATTERY VOLTAGE AT LEAD 783 B OF NBC FILTER BLOWER?

KNOWN INFO
BATTERY OK CABLE 660 OK LEAD 782 OK LEAD 782 A OK CIRCUIT BREAKER OK LEAD 783 OK NBC SWITCH OK LEAD 783 A OK
POSSIBLE PROBLEMS
LEAD 783 B

TEST OPTIONS

STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION

No power would indicate a damaged lead.

NO → REPAIR LEAD 783 B

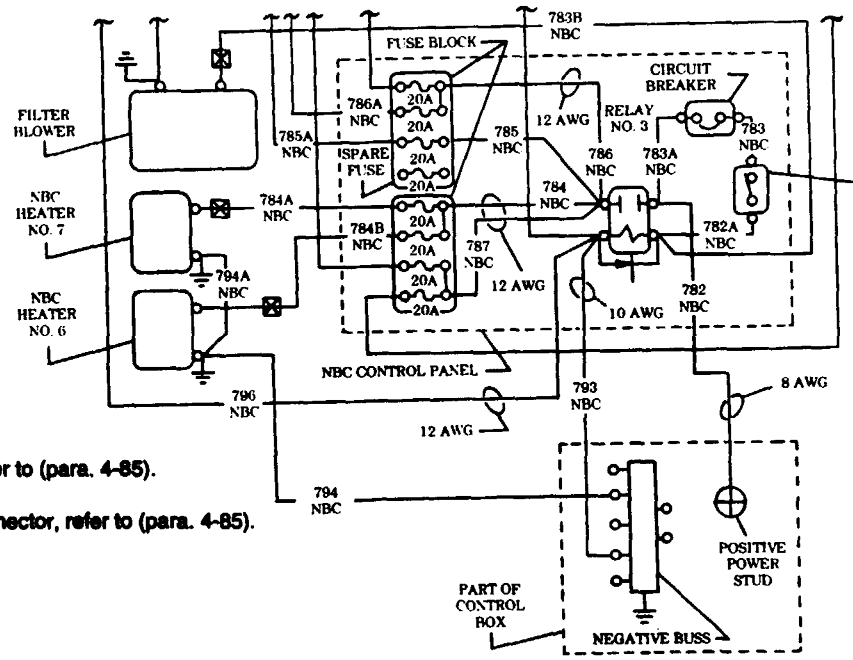
YES ↓

RETURN TO STEP 3, Page 2-660

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

Replace NBC switch, refer to DS Maintenance.

Repair lead, refer to (para. 4-85).



Repair lead, refer to (para. 4-85).

Repair lead connector, refer to (para. 4-85).

AMBULANCE
(NBC Filter Blower)
(Refer to Fig. 17.)

DIAGNOSTIC FLOWCHART

FROM 3, Page 2-660

KNOWN INFO

PREVIOUSLY CORRECTED INFORMATION

POSSIBLE PROBLEMS

LEAD 793
LEAD 796
LEAD 796 A
LEAD 796 B
NBC FILTER BLOWER

13

IS THERE CONTINUITY IN NBC CONTROL PANEL BETWEEN RELAY 3 AND GROUND?

TEST OPTIONS

STE/ICE-R TEST 91, PAGE 2-752

REASON FOR QUESTION

No continuity would indicate a damaged lead.

NO → **REPAIR LEAD 793**

YES ↓

KNOWN INFO

LEAD 793 OK

POSSIBLE PROBLEMS

LEAD 796
LEAD 796 A
LEAD 796 B
NBC FILTER BLOWER

14

IS THERE CONTINUITY OF LEAD 796?

TEST OPTIONS

STE/ICE-R TEST 91, PAGE 2-752

REASON FOR QUESTION

No continuity would indicate a damaged lead.

NO → **REPAIR LEAD 796**

YES ↓

KNOWN INFO

LEAD 793 OK
LEAD 796 OK

POSSIBLE PROBLEMS

LEAD 796 A
LEAD 796 B
NBC FILTER BLOWER

15

IS THERE CONTINUITY OF LEAD 796 A?

TEST OPTIONS

STE/ICE-R TEST 91, PAGE 2-752

REASON FOR QUESTION

No continuity would indicate a damaged lead.

NO → **REPAIR LEAD 796 A**

YES ↓

GO TO 16, Page 2-670

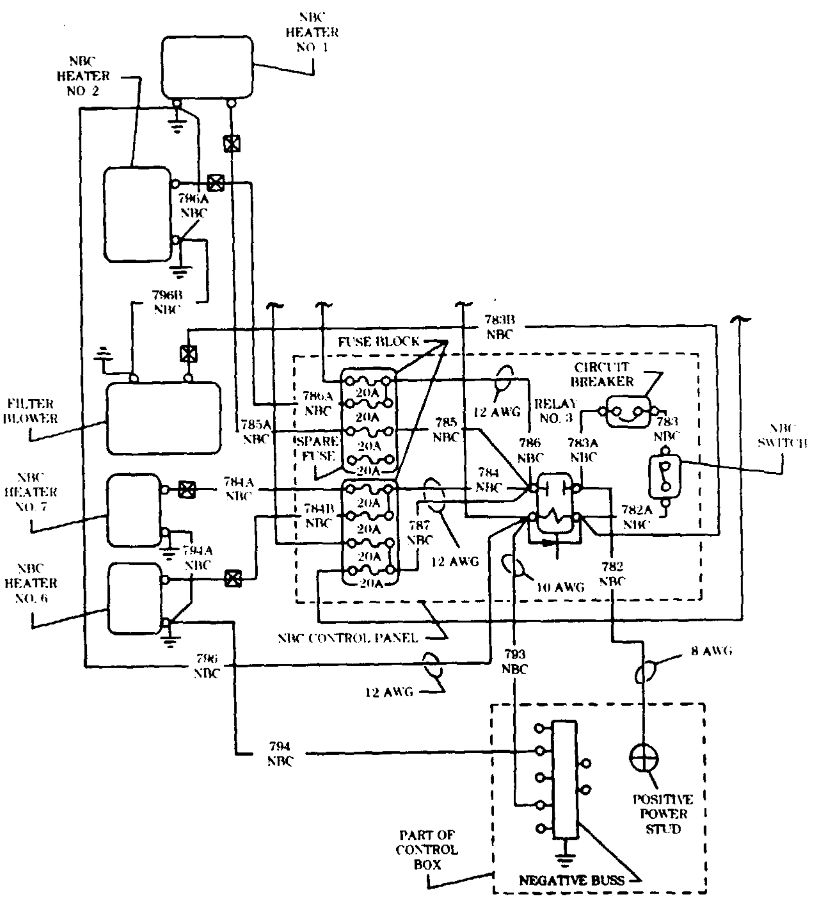
Repair lead, refer to (para. 4-85).

Repair lead connector, refer to (para. 4-85).

0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

Repair lead, refer to (para. 4-85).

Repair lead, refer to (para. 4-85).



AMBULANCE
(NBC Filter Blower)
(Refer to Fig. 17.)

DIAGNOSTIC FLOWCHART

FROM 15,
Page 2-668

KNOWN INFO

LEAD 793 OK
LEAD 796 OK
LEAD 796 A OK

POSSIBLE PROBLEMS

LEAD 796 B
NBC FILTER BLOWER

16

IS THERE CONTINUITY OF LEAD 796 B AT NBC FILTER BLOWER?

TEST OPTIONS

STE/ICE-R TEST 91, PAGE 2-752

REASON FOR QUESTION

No continuity would indicate a damaged lead.

NO → REPAIR LEAD 796 B

YES ↓

KNOWN INFO

LEAD 793 OK
LEAD 796 OK
LEAD 796 A OK
LEAD 796 B OK

POSSIBLE PROBLEMS

NBC FILTER BLOWER

17

DOES NBC FILTER BLOWER OPERATE?

TEST OPTIONS

TRY IT

REASON FOR QUESTION

If NBC filter blower does not operate, there is a malfunction of the unit.

NO → REPLACE NBC FILTER BLOWER

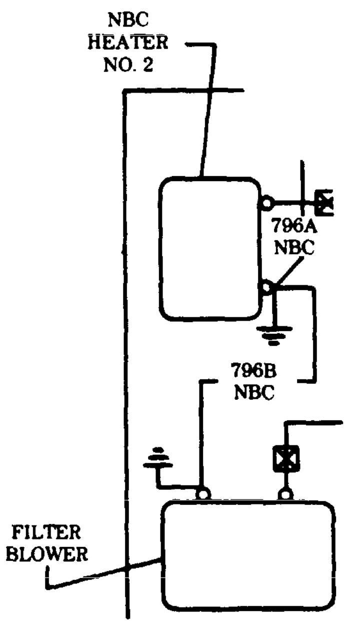
YES ↓

END OF TESTING

Repair lead, refer to (para. 4-85).

0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

Replace NBC filter blower, refer to DS Maintenance.



AMBULANCE
(NBC Heaters)
(Refer to Fig. 17.)

DIAGNOSTIC FLOWCHART

START

1

KNOWN INFO	POSSIBLE PROBLEMS
NOTHING	RELAY 3

IS NBC SWITCH ON NBC CONTROL PANEL IN PROPER POSITION?

TEST OPTIONS: VISUAL

REASON FOR QUESTION: If switch is open, no power is supplied to NBC heaters.

NO → PLACE NBC SWITCH TO 'ON' POSITION

YES ↓

2

KNOWN INFO	POSSIBLE PROBLEMS
	RELAY 3

DOES NBC FILTER BLOWER OPERATE?

TEST OPTIONS: TRY IT

REASON FOR QUESTION: If NBC filter blower operates, power is supplied to NBC control panel.

NO → GO TO 2, Page 2-660

YES ↓

3

KNOWN INFO	POSSIBLE PROBLEMS
	RELAY 3

PLACE JUMPER WIRE BETWEEN LEAD 782 AND LEADS 786, 785, 784, AND 787 AT RELAY 3 IN NBC CONTROL PANEL. DO NBC HEATERS OPERATE?

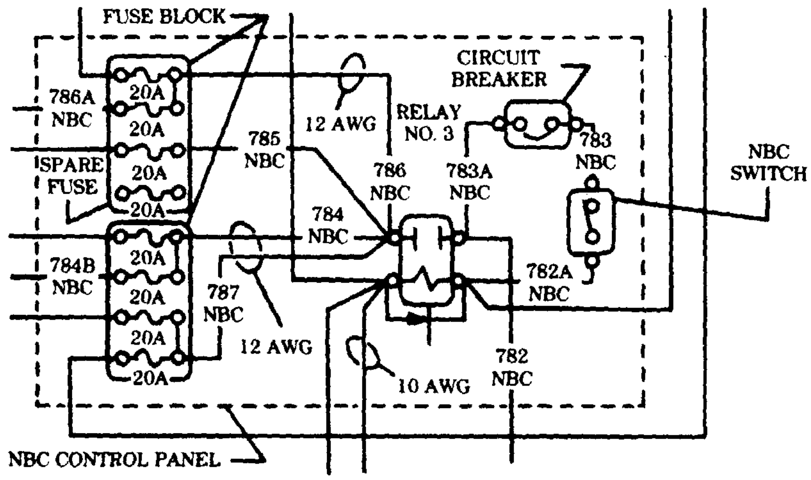
TEST OPTIONS: TRY IT

REASON FOR QUESTION: NBC heaters' operation would indicate a relay 3 malfunction.

NO → GO TO 4, Page 2-674

YES ↓

REPLACE RELAY 3


FUSE BLOCK
786A
NBC
20A
20A
20A
20A
SPARE
FUSE
20A
20A
20A
20A
784B
NBC
785
NBC
12 AWG
RELAY
NO. 3
CIRCUIT
BREAKER
783
NBC
NBC
SWITCH
786
NBC
783A
NBC
784
NBC
787
NBC
12 AWG
10 AWG
782A
NBC
782
NBC
NBC CONTROL PANEL

AMBULANCE
(NBC Heaters)
(Refer to Fig. 17.)

DIAGNOSTIC FLOWCHART

FROM 3, Page 2-672

4

CHECK BOTH FUSE BLOCKS IN NBC CONTROL PANEL. ARE ALL THE FUSES OK?

KNOWN INFO
PREVIOUSLY CORRECTED INFORMATION

POSSIBLE PROBLEMS
FUSES LEAD 786 LEAD 785 LEAD 784 LEAD 787 DAMAGED LEADS

TEST OPTIONS
VISUAL

REASON FOR QUESTION
If fuse is blown, individual circuits are incomplete.

NO → REPLACE BLOWN FUSES

YES ↓

5

IS THERE BATTERY VOLTAGE IN NBC CONTROL PANEL AT LEADS 786 AND 785 OF FIRST FUSE BLOCK?

KNOWN INFO
FUSES OK

POSSIBLE PROBLEMS
LEAD 786 LEAD 785 LEAD 784 LEAD 787 DAMAGED LEADS

TEST OPTIONS
STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION
No power would indicate damaged leads.

NO → REPLACE LEAD 786 AND/OR 785

YES ↓

6

IS THERE BATTERY VOLTAGE IN NBC CONTROL PANEL AT LEADS 784 AND 787 OF SECOND FUSE BLOCK?

KNOWN INFO
FUSES OK LEAD 786 OK LEAD 785 OK

POSSIBLE PROBLEMS
LEAD 784 LEAD 787 DAMAGED LEADS

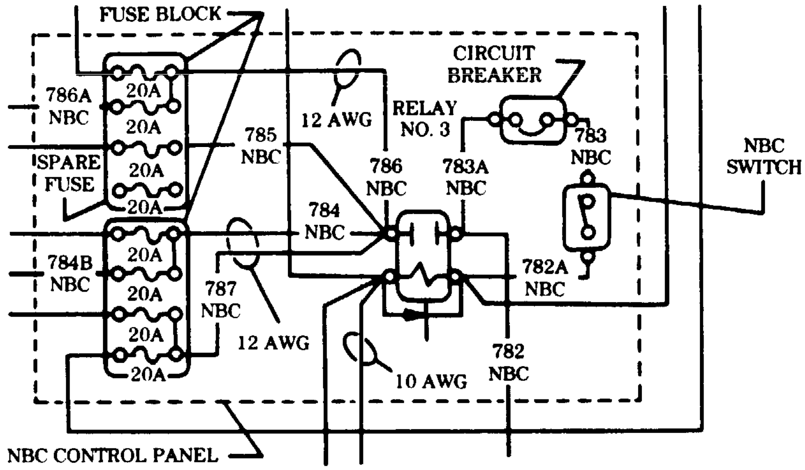
TEST OPTIONS
STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION
No power would indicate damaged leads.

NO → REPLACE LEAD 784 AND/OR 787

YES ↓

GO TO 7, Page 2-676



0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

AMBULANCE
(NBC Heaters)
(Refer to Fig. 17.)

DIAGNOSTIC FLOWCHART

FROM 6, Page 2-674

7

DISCONNECT: LEAD 785 A FROM NBC HEATER NO.1. LEAD 786 A FROM NBC HEATER NO. 2. LEAD 786 B FROM NBC HEATER NO. 3. LEAD 787 A FROM NBC HEATER NO. 4. LEAD 787 B FROM NBC HEATER NO. 5. 784 B FROM NBC HEATER NO. 6. 784 A FROM NBC HEATER NO. 7. IS THERE BATTERY VOLTAGE AT THESE LEADS?

KNOWN INFO
FUSES OK LEAD 786 OK LEAD 785 OK LEAD 784 OK LEAD 787 OK

POSSIBLE PROBLEMS
DAMAGED LEADS

TEST OPTIONS
STE/ICE-R TEST 89, PAGE 2-750

REASON FOR QUESTION
No power would indicate a damaged lead.

NO → REPAIR DAMAGED LEADS

YES ↓

8

DO NBC HEATERS OPERATE?

KNOWN INFO
FUSES OK LEAD 786 OK LEAD 785 OK LEAD 784 OK LEAD 787 OK LEADS OK

POSSIBLE PROBLEMS

TEST OPTIONS
TRY IT

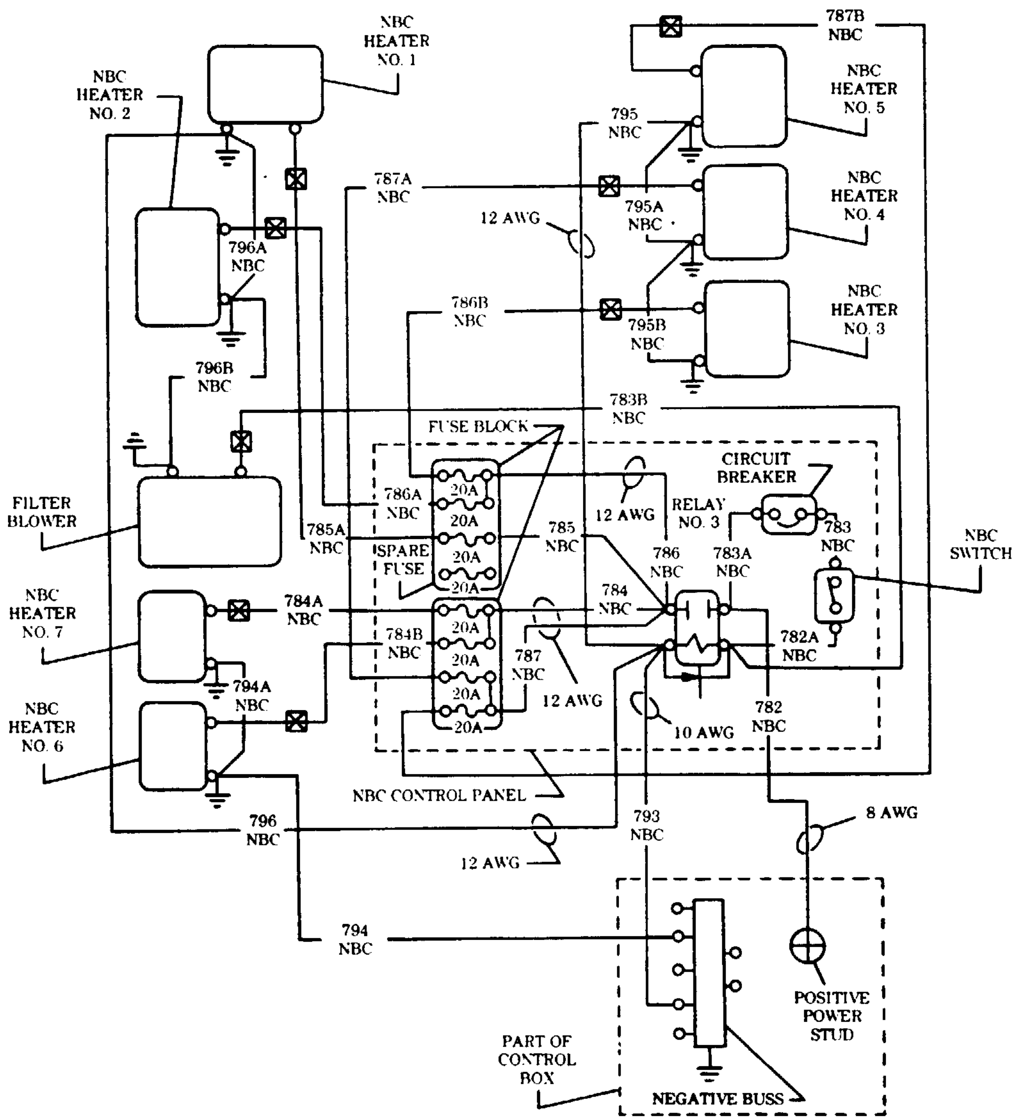
REASON FOR QUESTION
If NBC heaters do not operate, that would indicate a possible problem with ground wires.

NO → GO TO 9, Page 2-678

YES ↓

END OF TESTING

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.



AMBULANCE
(NBC Heaters)
(Refer to Fig. 17.)

DIAGNOSTIC FLOWCHART

FROM 8, Page 2-676

KNOWN INFO

PREVIOUSLY CORRECTED INFORMATION

POSSIBLE PROBLEMS

LEAD 795
LEAD 795 A
LEAD 795 B
LEAD 794
LEAD 794 A
NBC HEATERS

9

IS THERE CONTINUITY OF LEAD 795 AT NBC HEATER NO. 5 TO GROUND?

TEST OPTIONS

STE/ICE-R TEST 91, PAGE 2-752

REASON FOR QUESTION

No continuity would indicate a damaged lead.

NO: REPAIR LEAD 795

YES: go to 10.

KNOWN INFO

LEAD 795 OK

POSSIBLE PROBLEMS

LEAD 795 A
LEAD 795 B
LEAD 794
LEAD 794 A
NBC HEATERS

10

IS THERE CONTINUITY OF LEAD 795 A BETWEEN NBC HEATERS NO. 5 AND NO. 4?

TEST OPTIONS

STE/ICE-R TEST 91, PAGE 2-752

REASON FOR QUESTION

No continuity would indicate a damaged lead.

NO: REPAIR LEAD 795 A

YES: go to 11.

KNOWN INFO

LEAD 795 OK
LEAD 795 A OK

POSSIBLE PROBLEMS

LEAD 795 B
LEAD 794
LEAD 794 A
NBC HEATERS

11

IS THERE CONTINUITY OF LEAD 795 B BETWEEN NBC HEATERS NO. 4 AND NO. 3?

TEST OPTIONS

STE/ICE-R TEST 91, PAGE 2-752

REASON FOR QUESTION

No continuity would indicate a damaged lead.

NO: REPAIR LEAD 795 B

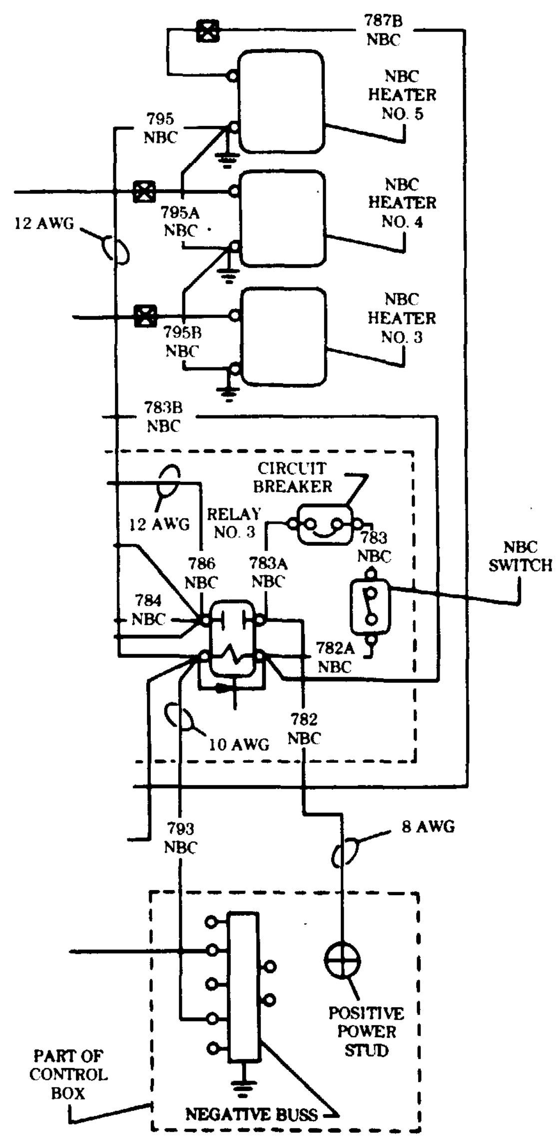
YES: GO TO 12, Page 2-680

0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

Repair lead, refer to (para. 4-85).

Repair lead, refer to (para. 4-85).

Repair lead, refer to (para. 4-85).



AMBULANCE
(NBC Heaters)
(Refer to Fig. 17.)

DIAGNOSTIC FLOWCHART

FROM 11, Page 2-678

12

IS THERE CONTINUITY OF LEAD 794 AT NBC HEATER NO. 6 TO GROUND?

KNOWN INFO
LEAD 795 OK
LEAD 795 A OK
LEAD 795 B OK

POSSIBLE PROBLEMS
LEAD 794
LEAD 794 A
NBC HEATERS

TEST OPTIONS
STE/ICE-R TEST 91, PAGE 2-752

REASON FOR QUESTION
No continuity would indicate a damaged lead.

NO → REPAIR LEAD 794

YES ↓

13

IS THERE CONTINUITY OF LEAD 794 A BETWEEN NBC HEATERS NO. 6 AND NO. 7?

KNOWN INFO
LEAD 795 OK
LEAD 795 A OK
LEAD 795 B OK
LEAD 794 OK

POSSIBLE PROBLEMS
LEAD 794 A
NBC HEATERS

TEST OPTIONS
STE/ICE-R TEST 91, PAGE 2-752

REASON FOR QUESTION
No continuity would indicate a damaged lead.

NO → REPAIR LEAD 794 A

YES ↓

14

DO NBC HEATERS OPERATE?

KNOWN INFO
LEAD 795 OK
LEAD 795 A OK
LEAD 795 B OK
LEAD 794 OK
LEAD 794 A OK

POSSIBLE PROBLEMS
NBC HEATERS

TEST OPTIONS
TRY IT

REASON FOR QUESTION
If NBC heaters do not operate, that would indicate heater malfunction.

NO → REPLACE NBC HEATERS

YES ↓

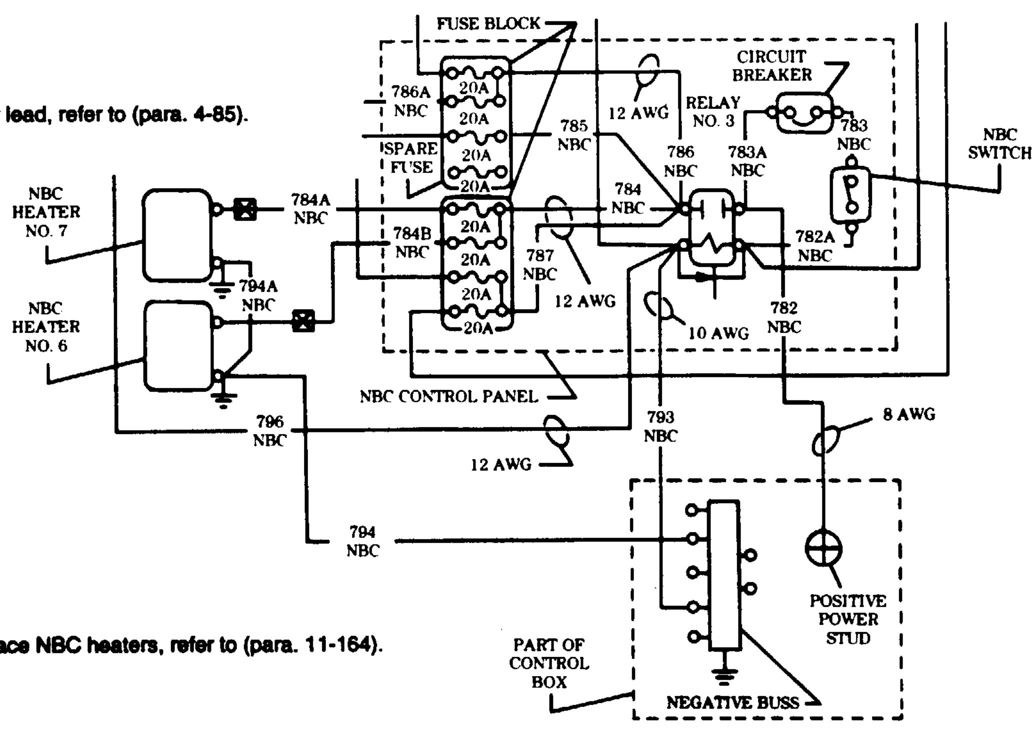
END OF TESTING

Repair lead, refer to (para. 4-85).

0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second.   2. Start Test 91, 0-4500 ohms.   3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

Repair lead, refer to (para. 4-85).

Replace NBC heaters, refer to (para. 11-164).



AMBULANCE
(NBC Heater)
(Refer to Fig. 17.)

DIAGNOSTIC FLOWCHART

START

1

KNOWN INFO	POSSIBLE PROBLEMS
NOTHING	FUSE POWER LEAD NBC HEATER GROUND LEAD

CHECK FUSE BLOCKS IN NBC CONTROL PANEL. IS NBC HEATER FUSE OK?

TEST OPTIONS	REASON FOR QUESTION
VISUAL	If fuse is blown, circuit is incomplete.

NO → REPLACE BLOWN FUSE

YES ↓

2

KNOWN INFO	POSSIBLE PROBLEMS
FUSE OK	POWER LEAD NBC HEATER GROUND LEAD

DISCONNECT NBC HEATER POWER LEAD. IS THERE BATTERY VOLTAGE AT LEAD?

TEST OPTIONS	REASON FOR QUESTION
STE/ICE-R TEST 89, PAGE 2-750	No power would indicate a damaged lead.

NO → REPAIR LEAD

YES ↓

3

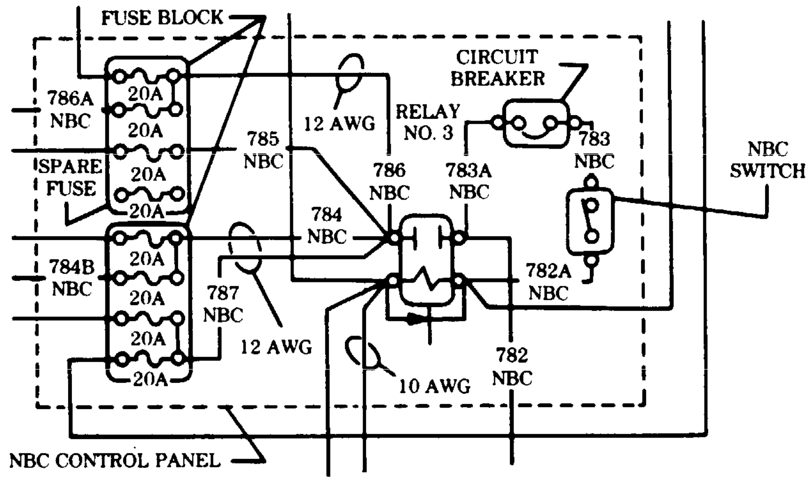
KNOWN INFO	POSSIBLE PROBLEMS
FUSE OK POWER LEAD OK	NBC HEATER GROUND LEAD

IS THERE CONTINUITY OF NBC HEATER GROUND LEAD?

TEST OPTIONS	REASON FOR QUESTION
STE/ICE-R TEST 91, PAGE 2-752	No continuity would indicate a damaged lead.

NO → REPAIR LEAD

YES → REPLACE NBC HEATER



Repair lead, refer to (para. 4-85).

Repair lead connector, refer to (para. 4-85).

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

Repair lead, refer to (para. 4-85).

Replace NBC heater, refer to (para. 11-164).

0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second. 2. Start Test 91, 0-4500 ohms. 3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

MALFUNCTION
TEST OR INSPECTION

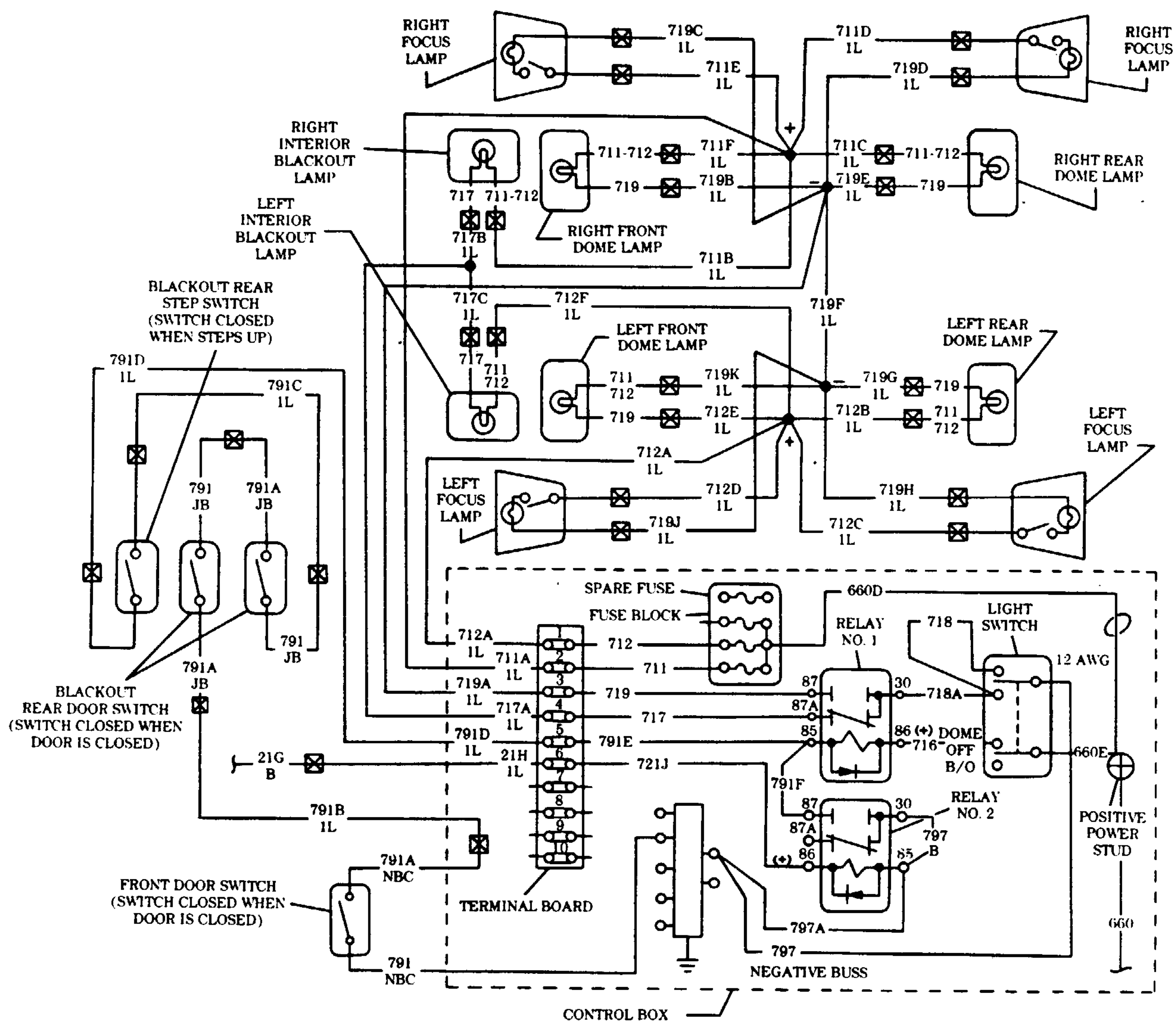


Figure 11. Lighting System

MALFUNCTION
TEST OR INSPECTION

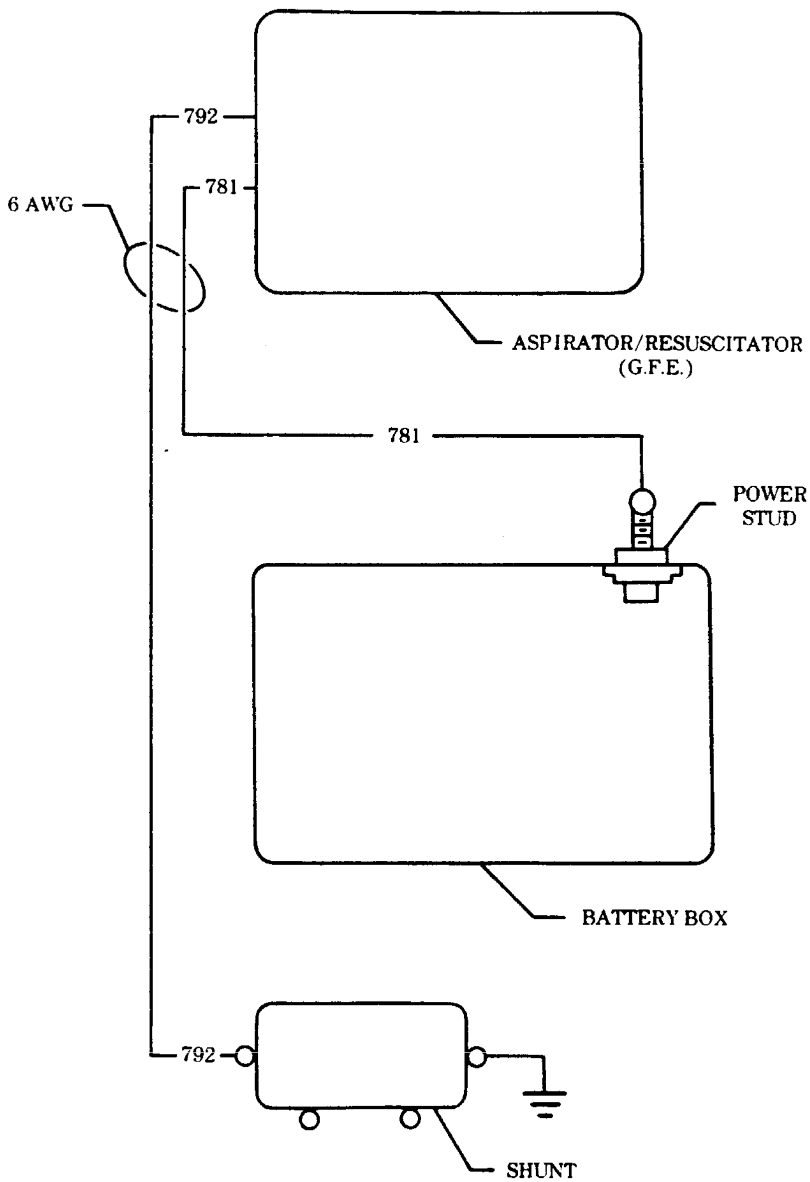


Figure 12. Aspirator System

MALFUNCTION TEST OR INSPECTION

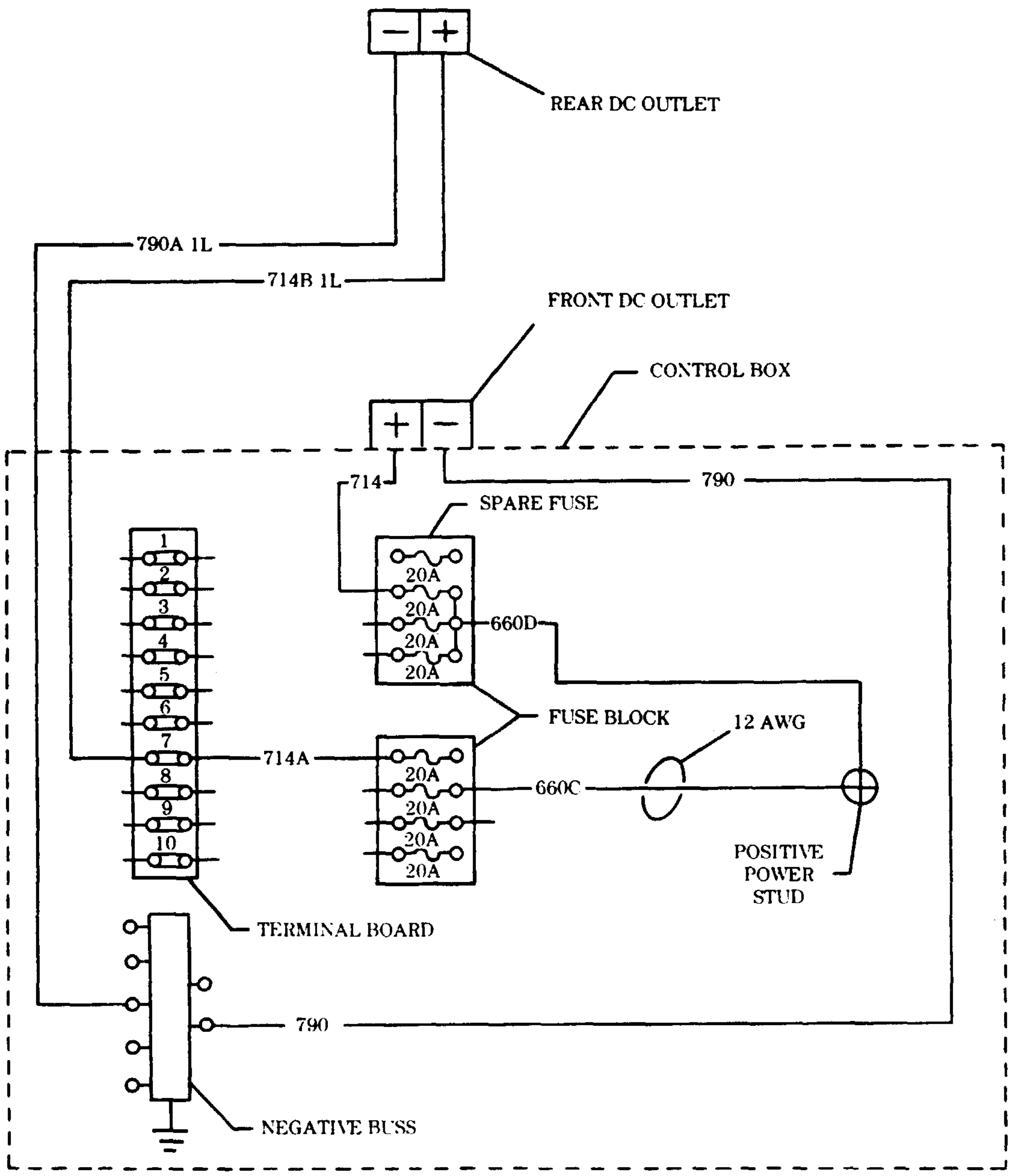


Figure 13. DC Voltage System

MALFUNCTION
TEST OR INSPECTION

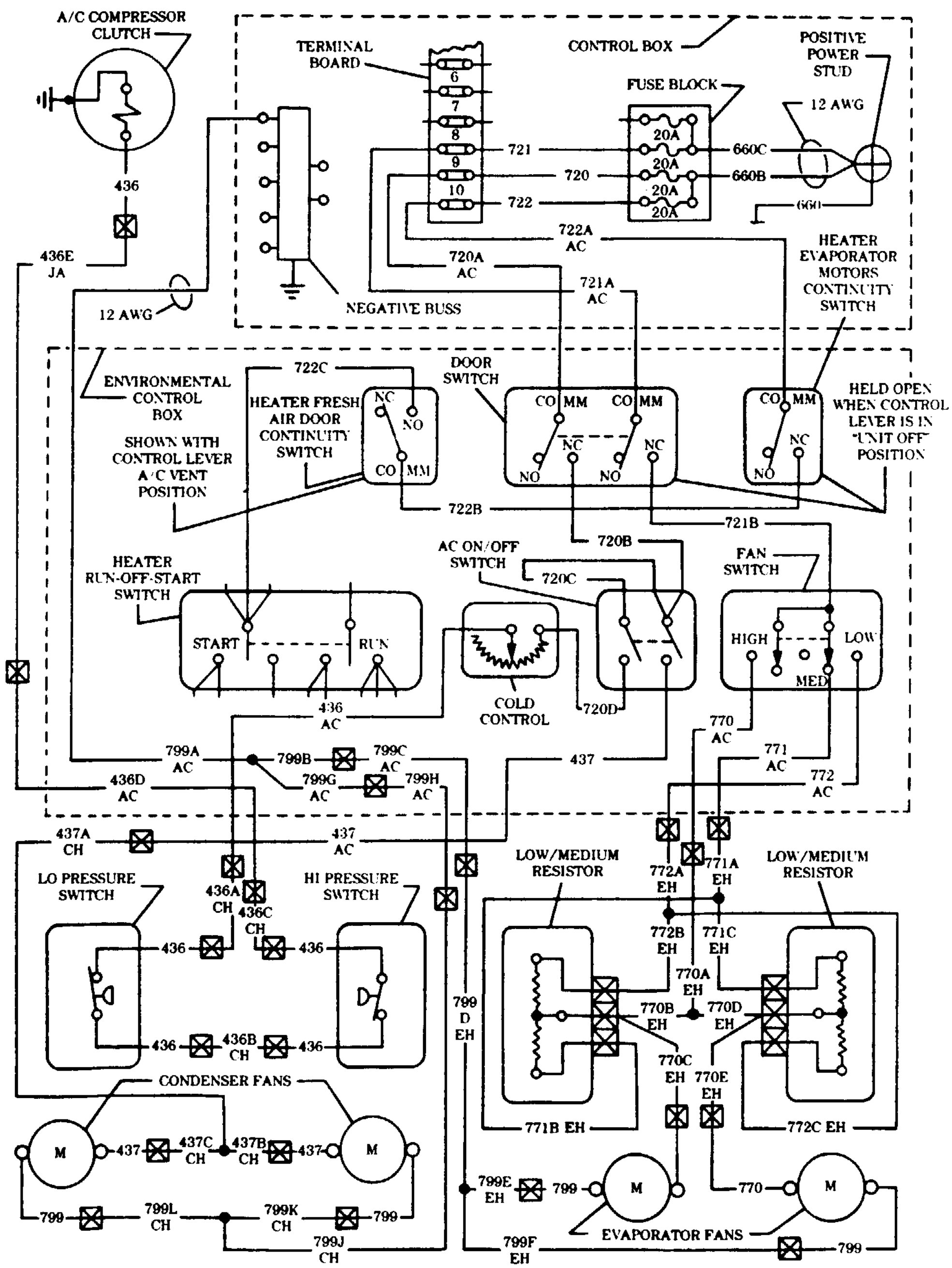


Figure 14. Air-Conditioning Control System

MALFUNCTION
TEST OR INSPECTION

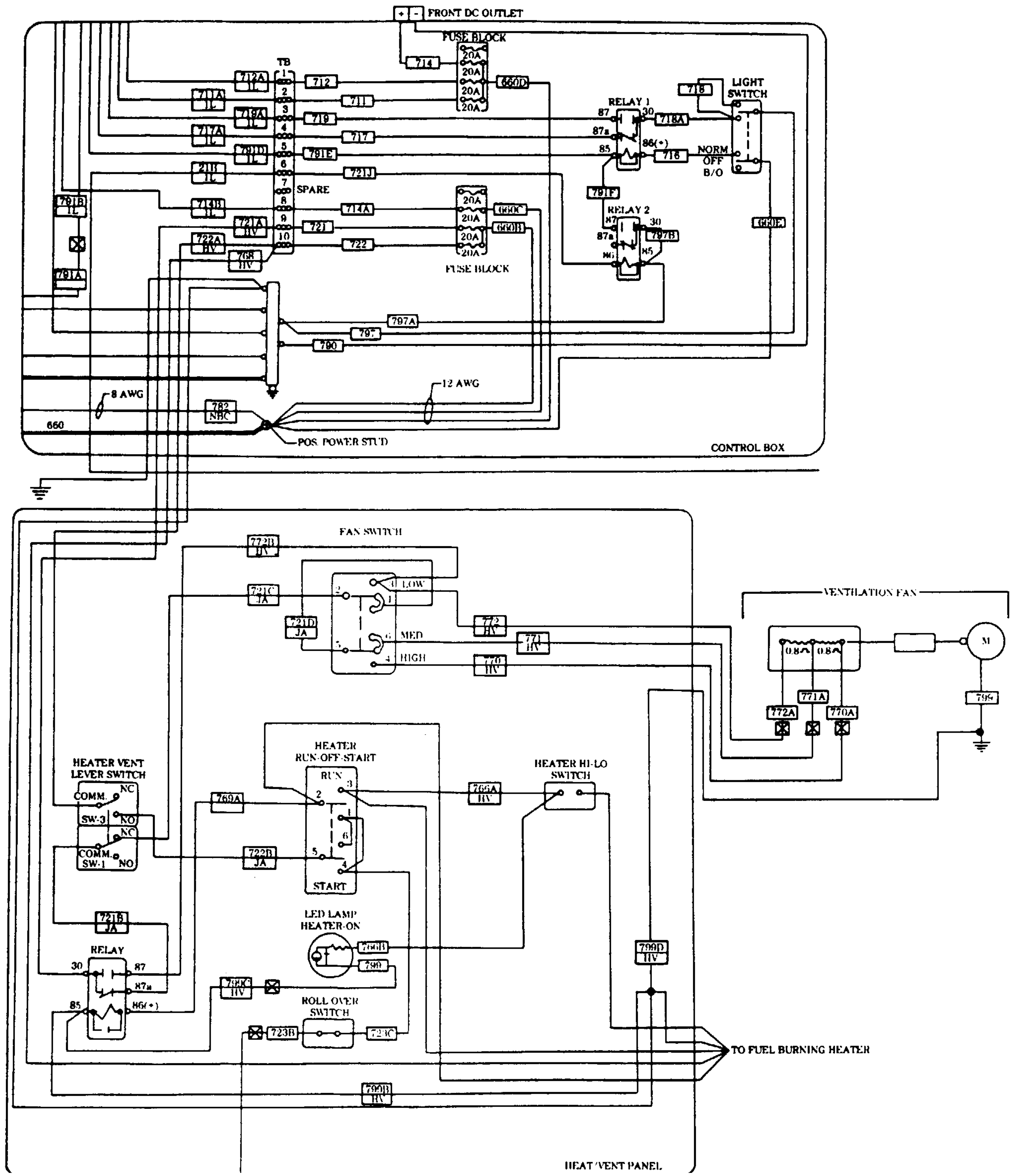


Figure 15. M996 and M996A1 Heater/Ventilation Control Box and Blower Fan

MALFUNCTION
TEST OR INSPECTION

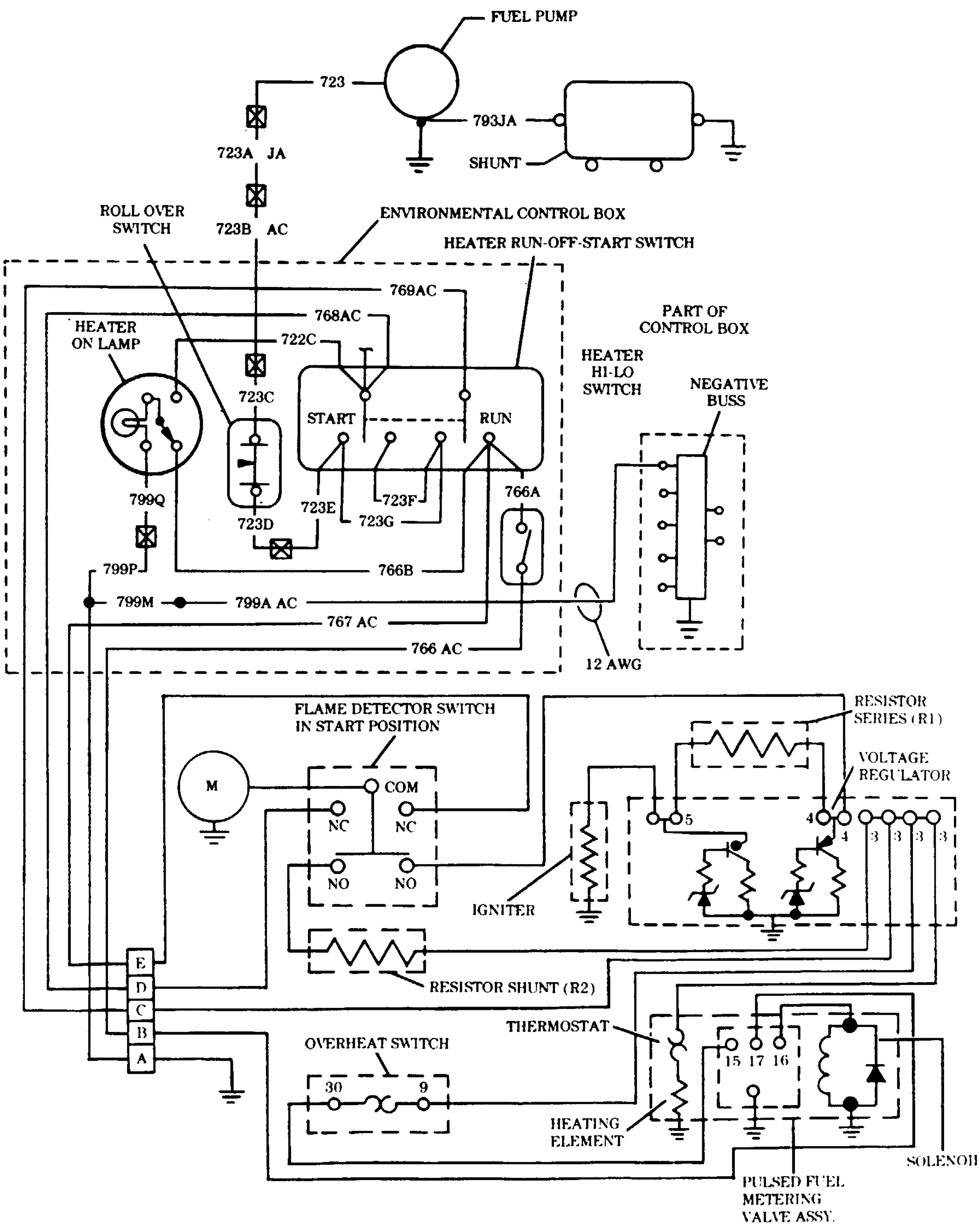


Figure 16. Heater Control System

MALFUNCTION
TEST OR INSPECTION

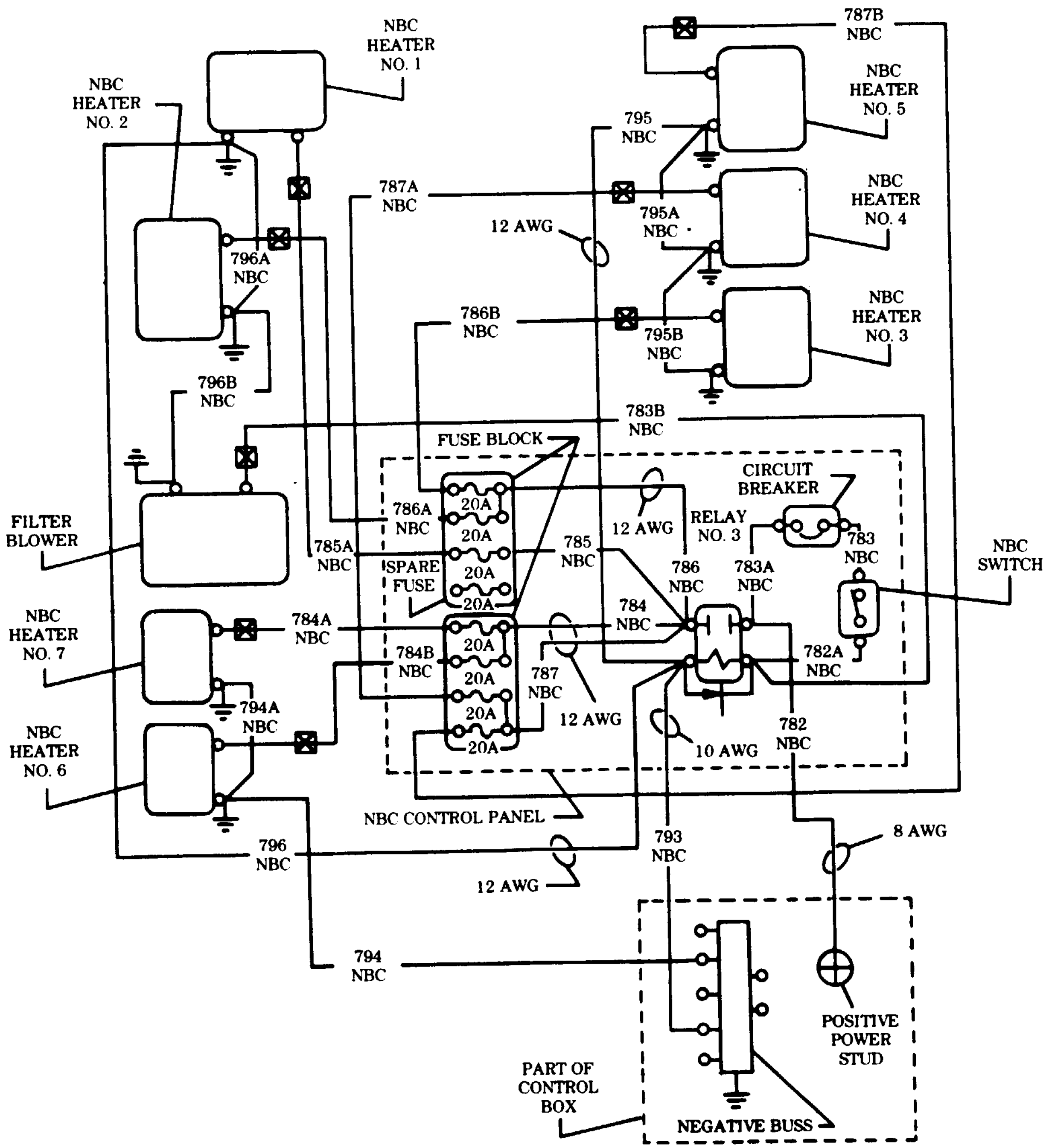


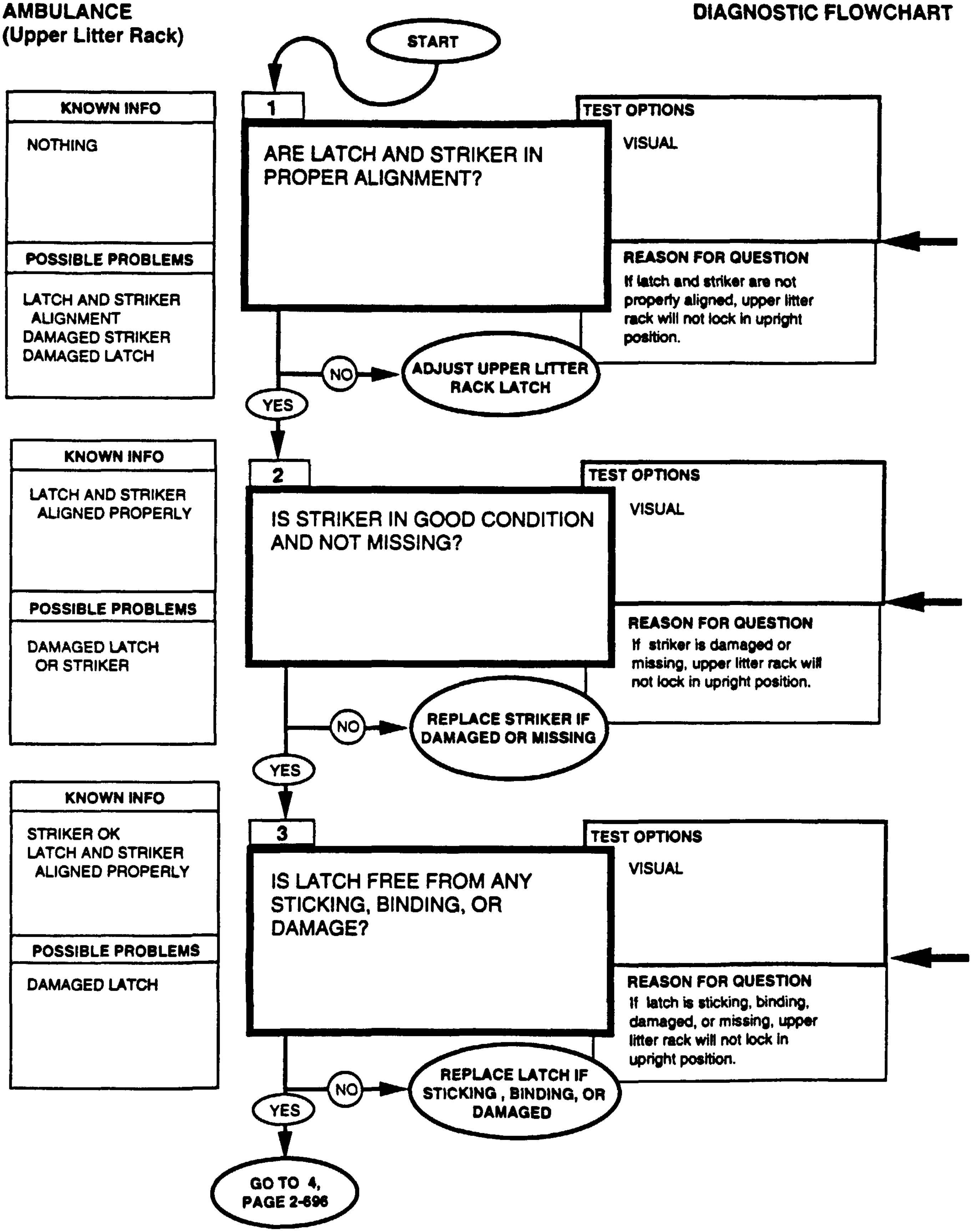
Figure 17. NBC Control System

2-40. AMBULANCE MECHANICAL SYSTEM TESTS

These ambulance system mechanical tests may be run anytime you think you have an ambulance mechanical problem or if you were sent here by another test chain. Just follow the path, answering the questions. Additional information and notes are given on the facing page when necessary.

AMBULANCE
(Upper Litter Rack)

DIAGNOSTIC FLOWCHART



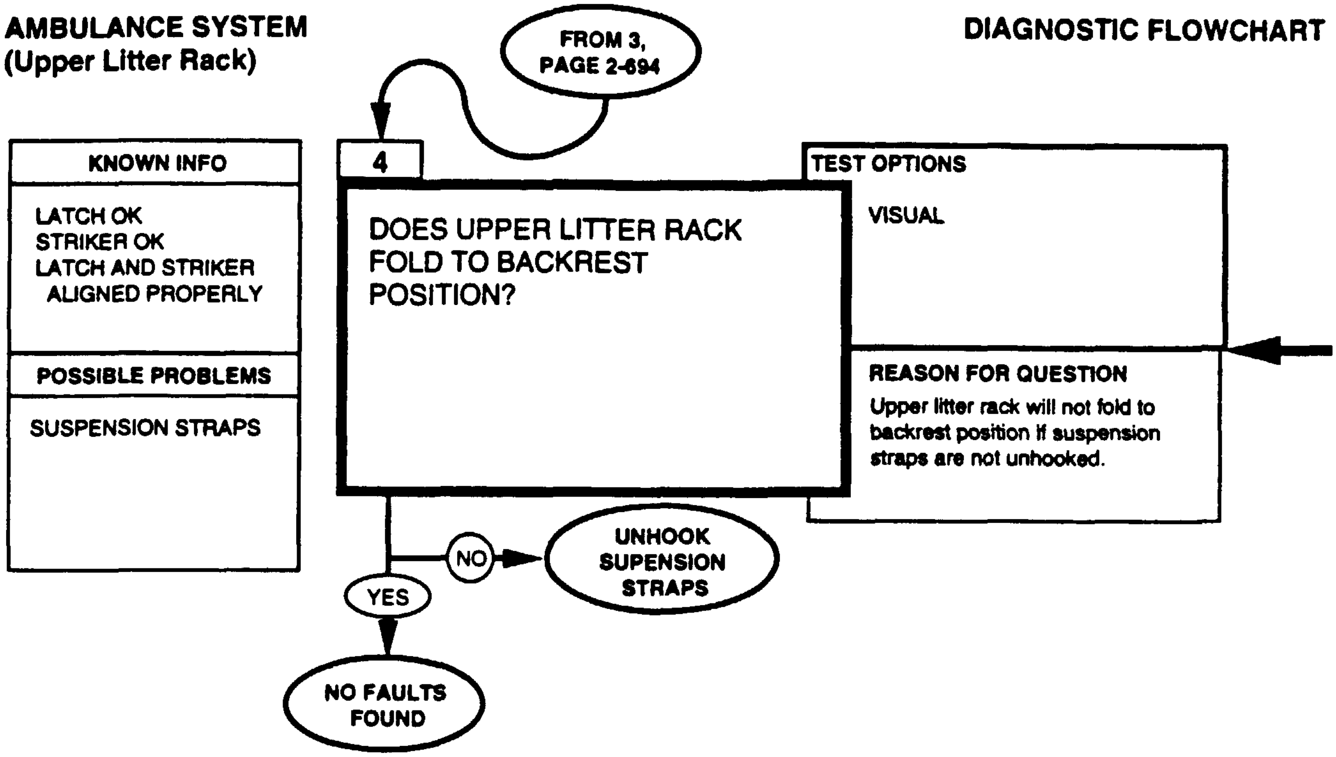
Adjust upper litter rack latch, refer to (para. 11-142).

Replace striker, refer to (para. 11-139).

Replace latch, refer to (para. 11-142).

AMBULANCE SYSTEM
(Upper Litter Rack)

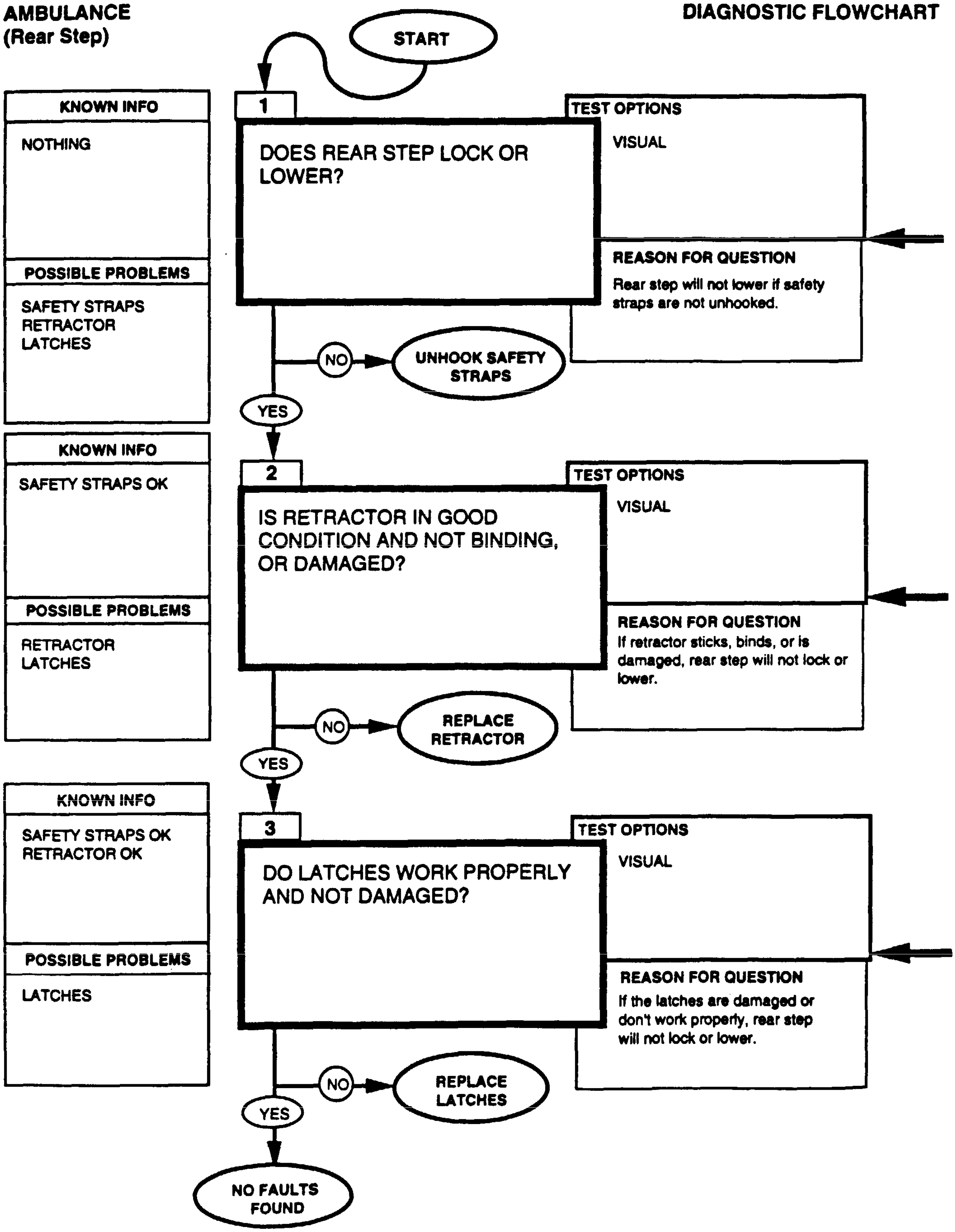
DIAGNOSTIC FLOWCHART



Unhook suspension straps, refer to (TM 9-2320-280-10).

AMBULANCE
(Rear Step)

DIAGNOSTIC FLOWCHART



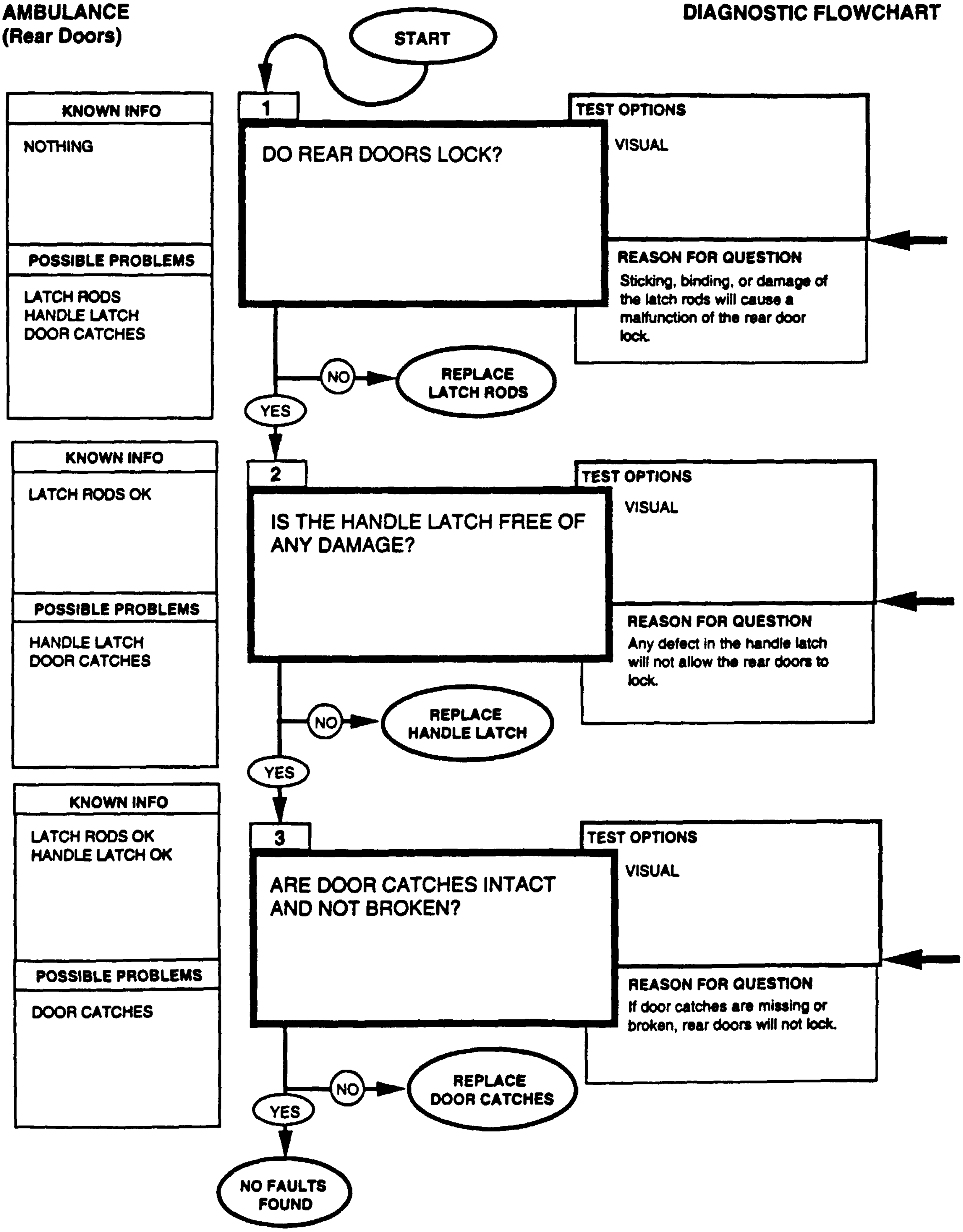
Unhook safety straps, refer to (TM 9-2320-280-10).

Replace retractor, refer to (para. 11-137).

Replace latches, refer to (para. 11-135).

AMBULANCE
(Rear Doors)

DIAGNOSTIC FLOWCHART



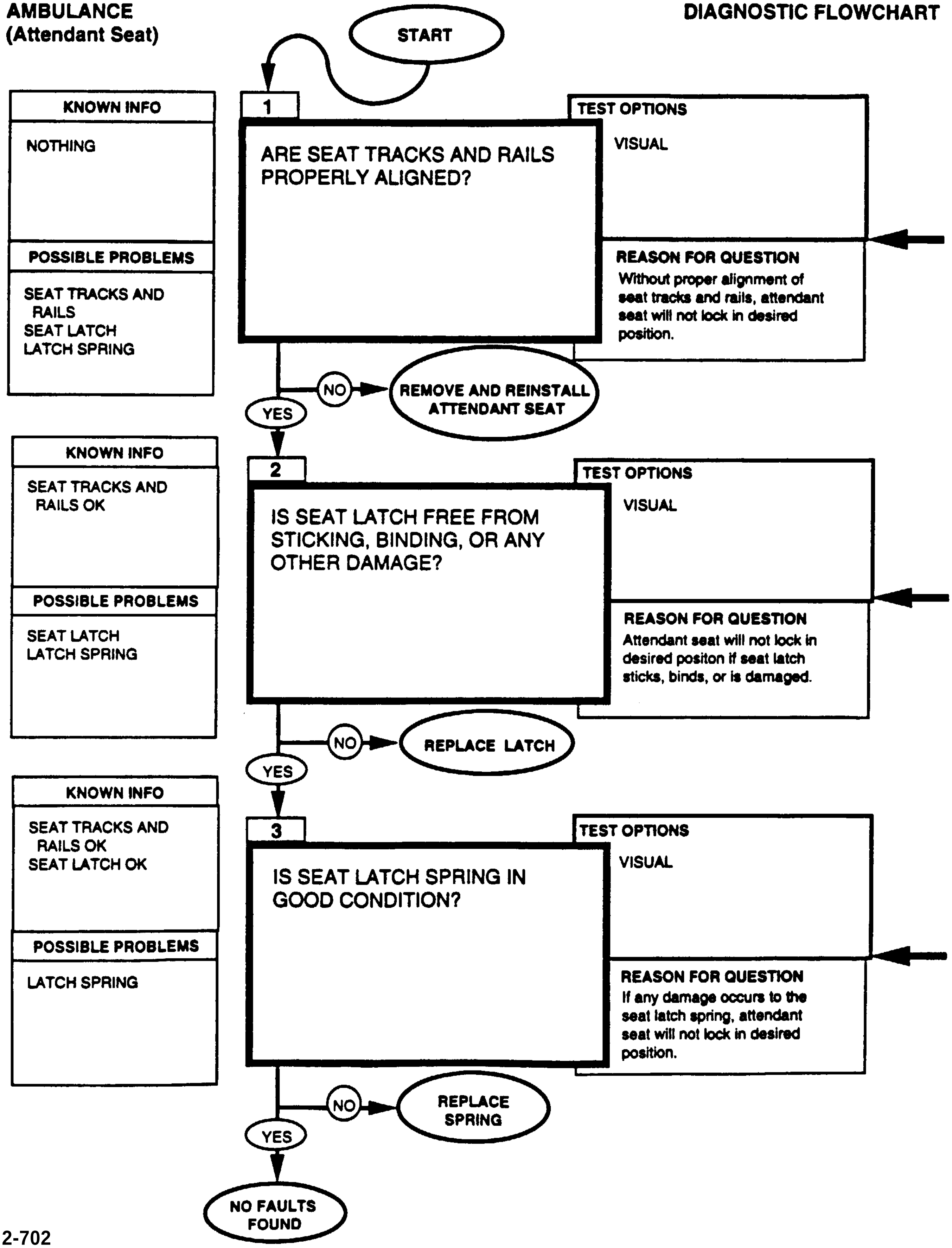
Replace latch rods, refer to (para. 11-128).

Replace handle latch, refer to (para. 11-128).

Replace door catches, refer to (para. 11-131).

AMBULANCE
(Attendant Seat)

DIAGNOSTIC FLOWCHART



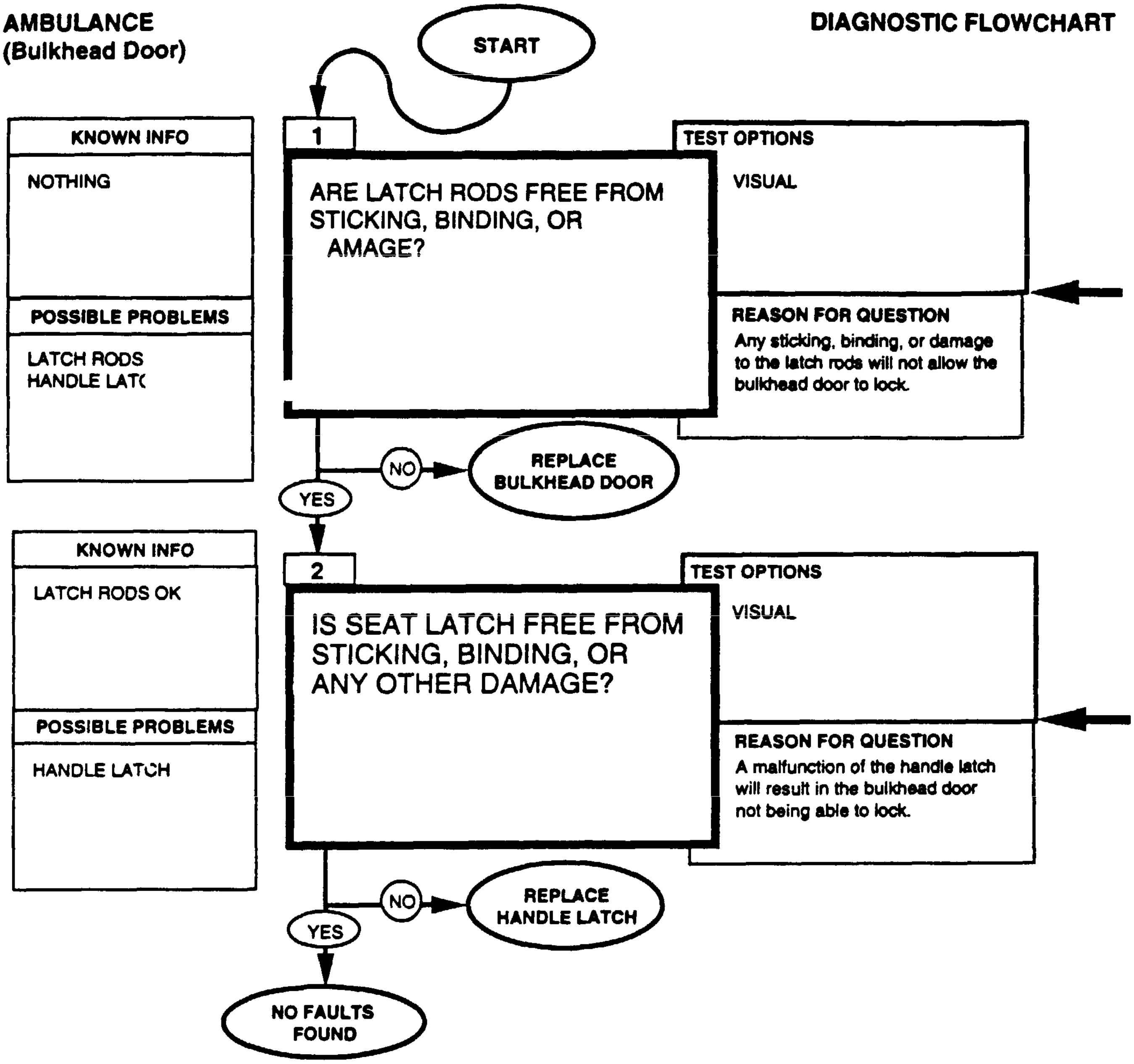
To ensure the proper alignment of attendant seat tracks and rails, remove and reinstall attendant seat making sure that tracks fully engage. Refer to (para. 11-157).

Replace latch, refer to (para. 11-157).

Replace spring, refer to (para. 11-157).

AMBULANCE
(Bulkhead Door)

DIAGNOSTIC FLOWCHART



Replace bulkhead door, refer to (para. 11-155).

Replace handle latch, refer to (para. 11-156).

AMBULANCE
(Heater)

DIAGNOSTIC FLOWCHART

START

KNOWN INFO
HEATER DOES NOT START OR SHUTS OFF
POSSIBLE PROBLEMS
ELECTRIC FUEL PUMP FUEL LINES HEATER FUEL FILTER HEATER EXHAUST PIPE AIR INTAKE DUCT DOOR

1

IS THE FUEL PUMP FREE FROM LEAKS OR ANY OTHER DEFECTS?

TEST OPTIONS
VISUAL

REASON FOR QUESTION
If the fuel pump is damaged or defective, the heater will either not start or shuts off after it starts.

NO → REPLACE FUEL PUMP

YES ↓

KNOWN INFO
FUEL PUMP OK
POSSIBLE PROBLEMS
FUEL LINES FUEL FILTER HEATER EXHAUST PIPE AIR INTAKE DUCT DOOR

2

ARE FUEL LINES WITHOUT ANY DAMAGE OR LEAKS?

TEST OPTIONS
VISUAL

REASON FOR QUESTION
Heater will not start or will shut off after starting if fuel lines are damaged or leaking.

NO → REPLACE FUEL LINES

YES ↓

KNOWN INFO
FUEL PUMP OK FUEL LINES OK
POSSIBLE PROBLEMS
FUEL FILTER HEATER EXHAUST PIPE AIR INTAKE DUCT DOOR

3

IS FUEL FILTER IN GOOD CONDITION AND WITHOUT RESTRICTIONS?

TEST OPTIONS
VISUAL

REASON FOR QUESTION
If there is any damage to the fuel filter or if it has restrictions, heater will not start or will shut off, after it starts.

NO → CLEAN OR REPLACE FUEL FILTER

YES ↓

GO TO 4, PAGE 2-708

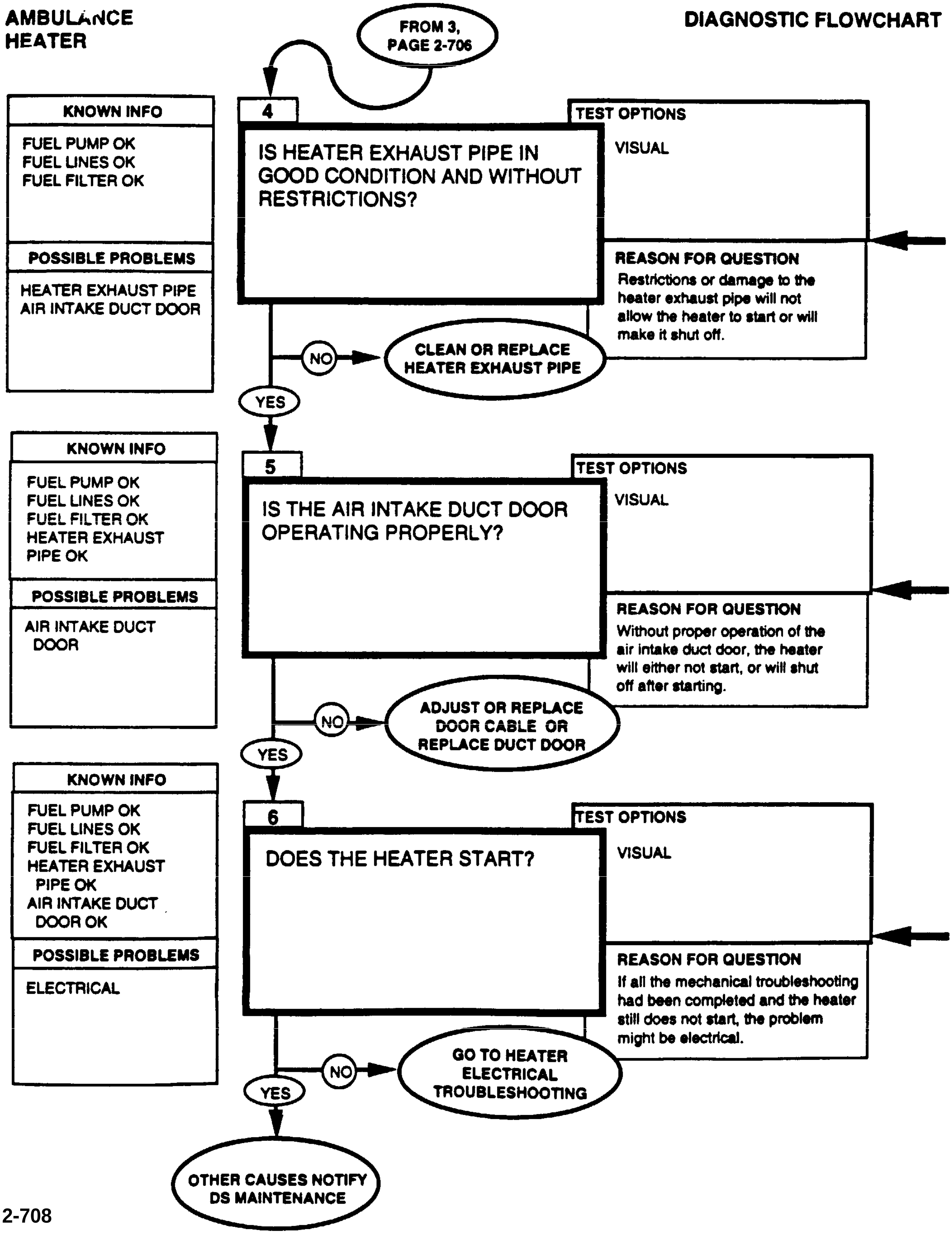
Replace fuel pump refer to (para. 11-194).

Replace fuel lines refer to (para. 11-193).

Clean or replae fuel filter refer to (para. 11-192).

AMBULANCE HEATER

DIAGNOSTIC FLOWCHART



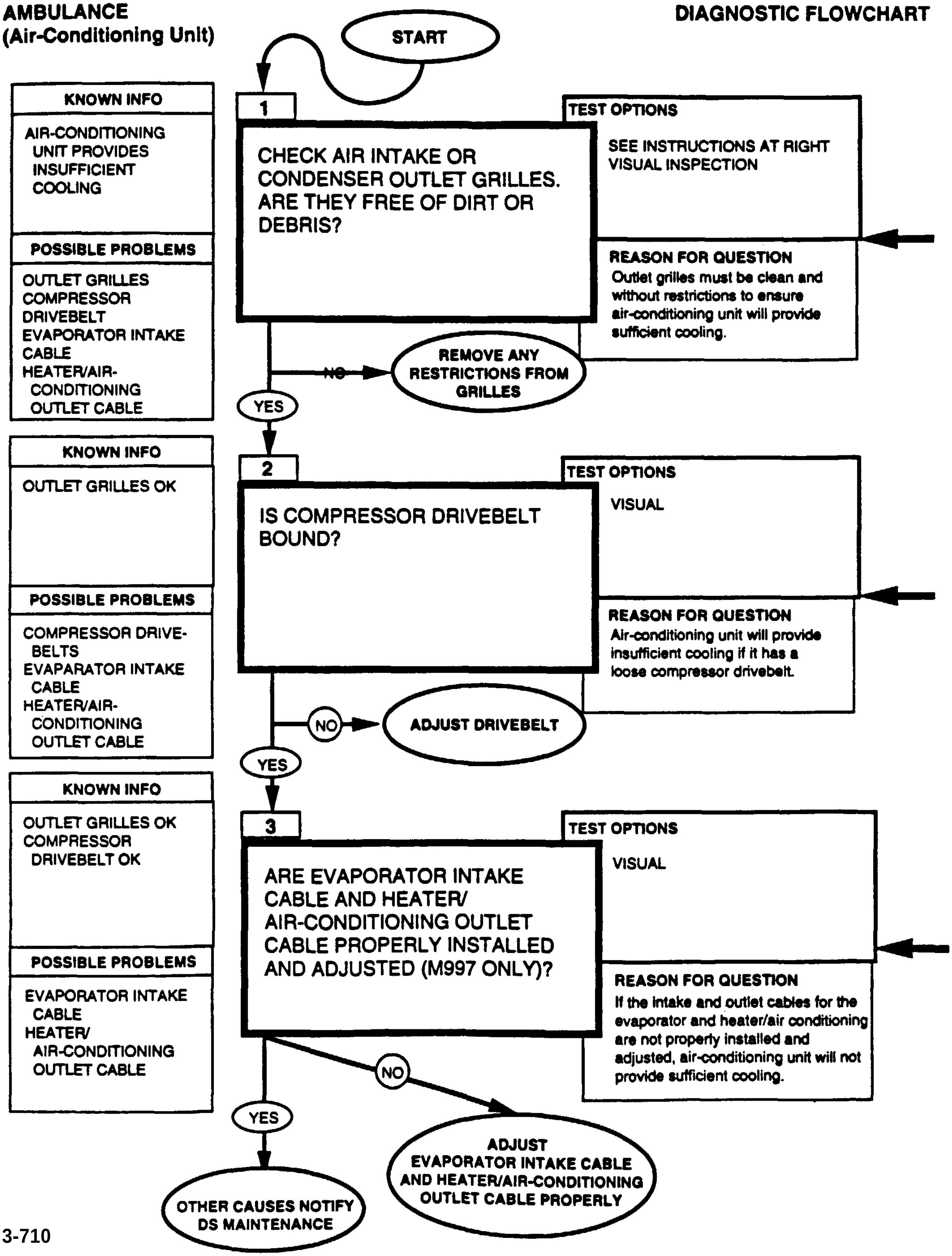
Clean or replace heater exhaust pipe, refer to (para. 11-189 or 11-207).

Adjust or replace door cable, refer to (para. 11-199). Replace duct door, refer to (para. 11-185).

At the completion of the mechanical troubleshooting steps, the heater should start. If not, there might be an electical problem. Refer to electrical troubleshooting section, para. 2-39 (heater electrical troubleshooting, page 2-636).

AMBULANCE
(Air-Conditioning Unit)

DIAGNOSTIC FLOWCHART



Turn on air-conditioning and set controls to maximum cooling and blower speed settings (TM 9-2320-280-10). Maintain engine speed at 1500 rpm with hand throttle. Verify rpm with STE/ICE equipment. Open ambulance body doors to allow flow of fresh air through vehicle. Run air-conditioner five minutes to allow temperature and pressure to stabilize. Check outlet ducts for cool air.

Adjust drivebelt, refer to (para. 11-202).

Properly adjust evaporator intake cable and heater/air-conditioning outlet cable, refer to (para. 11-199).

AMBULANCE
(NBC Door/Unit)

DIAGNOSTIC FLOWCHART

START

1

KNOWN INFO

NBC DOOR WILL NOT LOCK IN CLOSED OR OPEN POSITION (M997 ONLY)

POSSIBLE PROBLEMS

LATCH

CHECK LATCH FOR STICKING BINDING, OR DAMAGE. IS EVERYTHING OK WITH THE LATCH?

TEST OPTIONS

VISUAL

REASON FOR QUESTION

The latch is an integral part of the NBC door. If it is not functioning properly, NBC door will not lock in either closed or open position.

NO → REPAIR OR REPLACE LATCH

YES ↓

2

KNOWN INFO

NBC UNIT FAILS TO OPERATE
LATCH OK

POSSIBLE PROBLEMS

TUBING
FILTER

IS TUBING OK (NOT DAMAGED)?

TEST OPTIONS

VISUAL

REASON FOR QUESTION

Once there is damage to the tubing, NBC unit will not operate.

NO → REPLACE TUBING IF DAMAGED

YES ↓

3

KNOWN INFO

TUBING OK
LATCH OK

POSSIBLE PROBLEMS

FILTER

TAKE A GOOD LOOK AT THE FILTERS. ARE THEY FREE OF ANY RESTRICTIONS OR DAMAGES?

TEST OPTIONS

VISUAL

REASON FOR QUESTION

If the filter is damaged or restricted, NBC unit will not operate.

NO → REPLACE FILTER

YES ↓

NO FAULTS FOUND

REFERENCE INFORMATION

Repair or replace latch, refer to (para. 11-163).

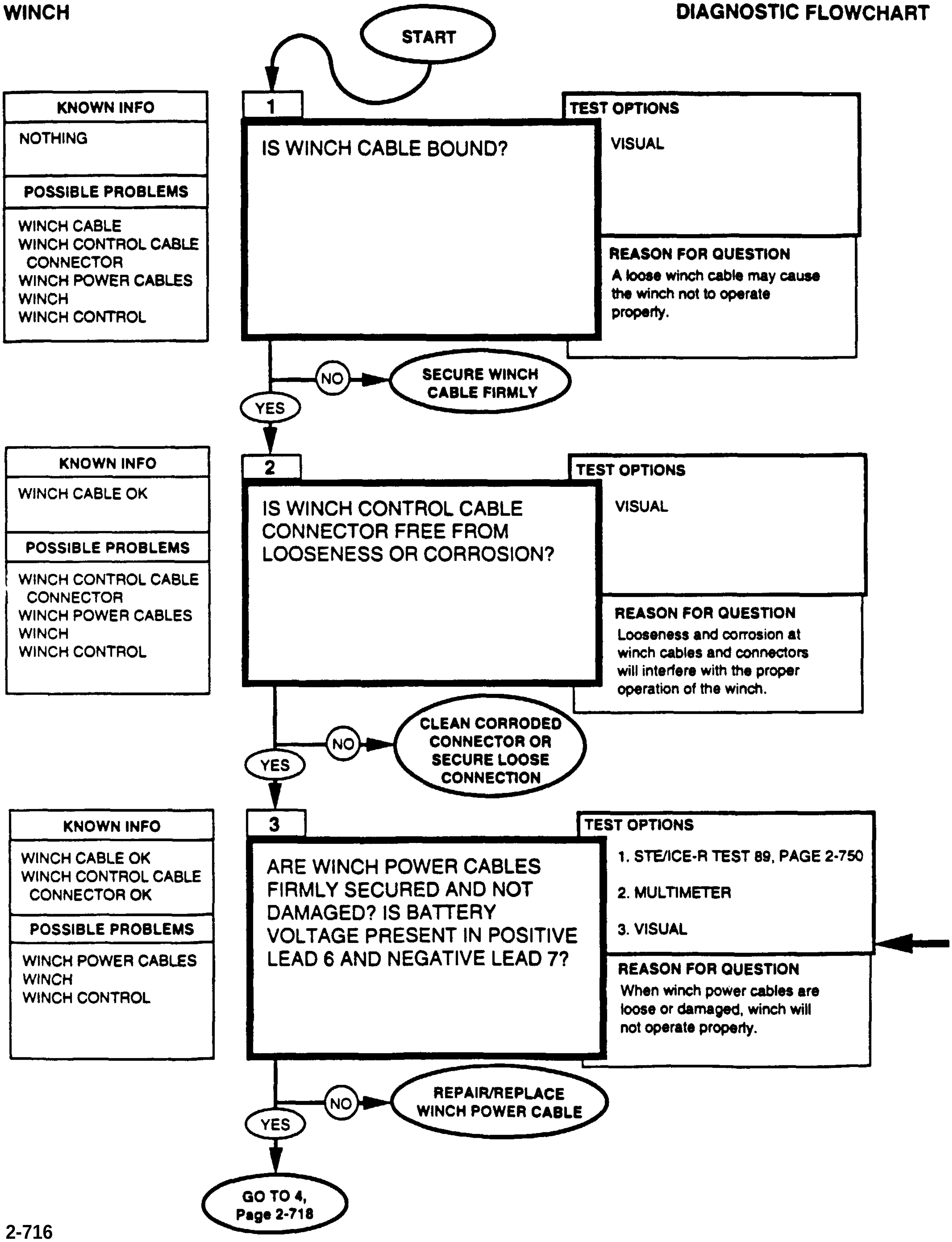
Replace tubing if damaged, refer to (para. 11-166).

Replace filter, refer to (para. 11-168).

2-41. WINCH SYSTEM TESTS

These winch system tests may be run anytime you think you have a winch problem or if you were sent here by another test chain, Just follow the path and answer the questions. Additional information and notes are given on the facing page when necessary.

WINCH DIAGNOSTIC FLOWCHART

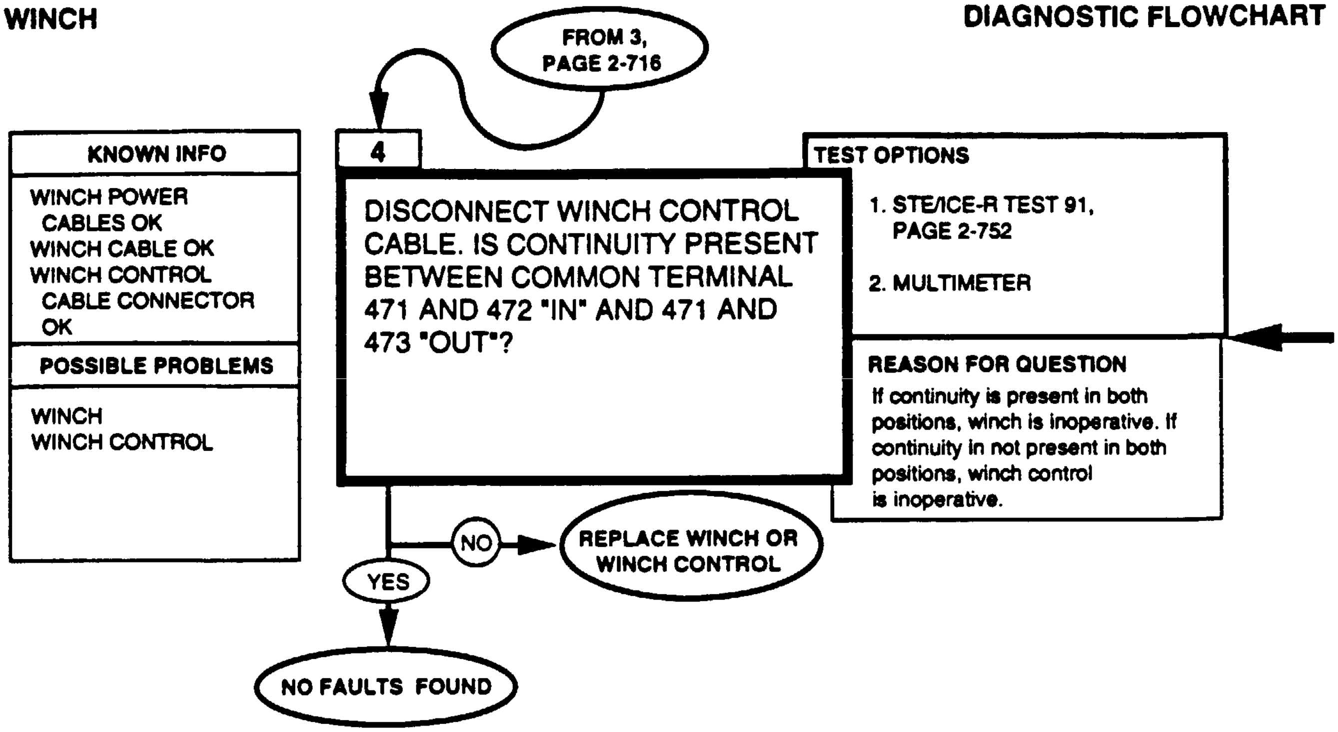


0-45 DC VOLTS STE/ICE-R TEST 89
1.Connect RED clip to the indicated test point, BLACK clip to negative or ground. 2. Start Test 89, DC volts. 3. Displayed reading is in volts.

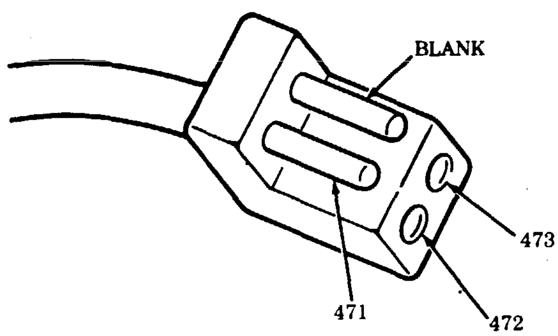
Repair/replace winch power cables, refer to (para. 10-107 or 10-108).

BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts. 2. Connect the RED lead to positive and the BLACK lead to negative. 3. Be sure to read the correct scale.

WINCH **DIAGNOSTIC FLOWCHART**



Replace winch or winch control, refer to (paras. 10-107, 10-108, or 10-109).



0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second.
2. Start test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays, "9.9.9.9."

CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

ARMAMENT/TOW CARRIERS

DIAGNOSTIC FLOWCHART

START

1

KNOWN INFO
NOTHING

POSSIBLE PROBLEMS
TURRET LOCK ASSEMBLY LOCKPIN BRAKE HANDLE

DOES WEAPON STATION ROTATE PROPERLY?

TEST OPTIONS
VISUAL

REASON FOR QUESTION
If the lockpin in the turret lock assemlby binds, sticks, is damaged, or out of alinement, weapon station will not rotate.

NO → REPLACE TURRET LOCK ASSEMBLY

YES ↓

2

KNOWN INFO
TURRET LOCK ASSEMBLY OK

POSSIBLE PROBLEMS
BRAKE HANDLE

IS BRAKE HANDLE IN PROPER POSITION?

TEST OPTIONS
VISUAL

REASON FOR QUESTION
Weapon station will not lock if brake handle is not in locked position.

NO → PLACE BRAKE HANDLE IN LOCKED POSITION

YES ↓

OTHER CAUSES, NOTIFY DS MAINTENANCE

Replace turret lock assembly, refer to (para. 11-56).

Place brake handle in locked position, refer to (TM 9-2320-280-10).

2-42. DCA TROUBLESHOOTING

These DCA tests can be run anytime you think there is a problem with the vehicle's DCA or its on board transducers. Do not use this paragraph to test the STE/ICE-R and its cables and transducers. Refer to TM 9-4910-571-12&P to test the STE/ICE-R. This paragraph will also supply instructions on how to use the STE/ICE-R in the TK mode to substitute for tests run through the DCA.

The HMMWV is equipped with three transducers - the pulse tachometer, the fuel pressure transducer, and the current shunt. A power test (12, 13) or RPM test (10) uses the pulse tachometer. The fuel pressure test (24) uses the pressure transducer. All of the starting circuit tests and battery tests done through the DCA use the shunt. Check to see that the wires are connected to the transducer for the test you're trying to run. There is a four wire connector for the fuel pressure transducer, a two wire connector for the pulse tachometer, and there are four wires connected to the shunt in addition to the battery cables.

The fold-out page FO-16 gives a cross reference between DCA tests and TK tests. Use this cross reference to find out how to substitute TK tests for DCA tests if you have a bad DCA. The Location of Parts page has a schematic of the HMMWV DCA.

DCA TROUBLESHOOTING **DIAGNOSTIC FLOWCHART**

START

KNOWN INFO
STE/ICE-R OK
CABLES OK
TK OK
RUNNING A DCA TEST

POSSIBLE PROBLEMS
DCA
TRANSDUCERS
VEHICLE SYSTEMS

1

WERE YOU RUNNING A FUEL PRESSURE, RPM, OR POWER TEST?

TEST OPTIONS
SEE NOTE TO RIGHT ABOUT THIS PARAGRAPH.

REASON FOR QUESTION
You need to know which transducer is causing the problem.

NO → GO TO A Page 2-728

YES ↓

KNOWN INFO
STE/ICE-R OK
W1 CABLE OK

POSSIBLE PROBLEMS
DCA
TRANSDUCERS
VEHICLE SYSTEMS

2

WERE YOU RUNNING STE/ICE-R TEST #24, FUEL PRESSURE?

TEST OPTIONS
N/A

REASON FOR QUESTION
You need to know which transducer is causing the problem.

NO → GO TO B Page 2-730

YES ↓

KNOWN INFO
STE/ICE-R OK
W1 CABLE OK
RUNNING TEST 24

POSSIBLE PROBLEMS
DCA
TRANSDUCERS
VEHICLE SYSTEMS

3

DISCONNECT CONNECTOR DIRECTLY BEFORE FUEL PRESSURE TRANSDUCER.
INSPECT FOR BENT PINS.
DOES EVERYTHING LOOK OK?

TEST OPTIONS
VISUAL INSPECTION

REASON FOR QUESTION
If the transducer pins are bent or broken you will get bad measurements.

NO → REPAIR OR REPLACE WIRING/ TRANSDUCER AS NEEDED

YES ↓

GO TO 4, Page 2-726

NOTE

The diagnostics in this chapter assume you have already run a test through the DCA. If you haven't run a test and are here to test the entire DCA, run tests 10 (RPM), 24 (Fuel Pressure) and 80 (BatteryCurrent) Make note of the results for later.

If you want to test the entire DCA harness, answer YES here and then return and answer NO when you've finished the test chain. Answer NO here to test the shunt.

Answer NO here to test the pulse tachometer.

Repair wiring or replace transducer, refer to (para 4-26).

DCA TROUBLESHOOTING — DIAGNOSTIC FLOWCHART

FROM 3, Page 2-724

KNOWN INFO

STE/ICE-R OK
W1 OK
RUNNING TEST 24
WIRING LOOKS OK

POSSIBLE PROBLEMS

TRANSDUCER
DCA
FUEL SYSTEM

4

REMOVE THE FUEL PRESSURE TRANSDUCER FROM THE TOP OF THE FUEL FILTER. USE THE STE/ICE-R IN THE TK MODE TO MEASURE THE FUEL PRESSURE WITH THE 25 PSI (RED) TRANSDUCER. IS THE FUEL PRESSURE OK?

TEST OPTIONS

STE/ICE-R TEST 49

REASON FOR QUESTION

This will tell if you have a fuel system problem or a DCA problem.

NO → VEHICLE PROBLEM. IF YOU CAME FROM ANOTHER PARAGRAPH, RETURN THERE AND FOLLOW THE PATH CORRESPONDING TO A FAILURE OF THE TEST YOU WERE RUNNING

YES ↓

KNOWN INFO

STE/ICE-R OK
W1 OK
RUNNING TEST 24
WIRING LOOKS OK
FUEL SYSTEM OK

POSSIBLE PROBLEMS

TRANSDUCER
DCA

5

DID TEST 24 GIVE A CORRECT RESULT?

TEST OPTIONS

N/A

REASON FOR QUESTION

If test 24 gave the same result as test 49, then everything is ok.

NO → SEE NOTE TO RIGHT

YES → NO FAULTS

The fuel pressure should always be greater than 3 psi. If you get about the same pressure with the 2 transducers, then you have a fuel system problem. Remove fuel pressure transducer, refer to (para 4-26). Make sure the STE/ICE-R is powered by a W5 cable.

STE/ICE-R TEST 49 0 TO 25 PSIG PRESSURE
1. CONNECT RED TRANSDUCER TO FUEL FILTER. 2. CONNECT TRANSDUCER TO A W4 CABLE. MAKE SURE THE SYSTEM UNDER TEST IS NOT PRESSURIZED. CONNECT OTHER END OF W4 TO J2 OR J3. PERFORM OFFSET TEST. 3. TURN ON SYSTEM AND READ PRESSURE.

You will have to decide if test 24 gave the wrong result. If test 24 gave a substantially different result than test 49, answer NO to this question.

NOTE

VEHICLE DCA FAULTY. Use the STE/ICE-R in the TK mode for the rest of your testing. See the chart on the foldout page for a way to run the rest of the DCA tests in the TK Mode. Have DS maintenance repair the DCA when you're finished.

DCA TROUBLESHOOTING **DIAGNOSTIC FLOWCHART**

A FROM 1, Page 2-724

A1

KNOWN INFO

STE/ICE-R OK
CABLES OK
TK OK
MEASURING THROUGH SHUNT OR ACROSS BATTERIES.

POSSIBLE PROBLEMS

SHUNT WIRING
BATTERY WIRING
VEHICLE SYSTEMS
DCA

SEE THE CHART ON THE FOLDOUT PAGE AND PERFORM THE TK MODE TEST FOR THE DCA TEST YOU WERE RUNNING. DOES THE VEHICLE PASS THE TEST?

TEST OPTIONS

TK MODE TEST THAT CORRESPONDS TO DCA TEST AS SHOWN ON THE FOLDOUT PAGE

REASON FOR QUESTION

If the TK test tells you that the vehicle is OK, then the problem is in the DCA. Otherwise, the vehicle itself has a fault.

NO

VEHICLE PROBLEM.
IF YOU CAME FROM ANOTHER PARAGRAPH, RETURN THERE AND FOLLOW THE PATH CORRESPONDING TO A FAILURE OF THE TEST YOU WERE RUNNING

YES

A2

KNOWN INFO

VEHICLE OK
STE/ICE-R OK
CABLES OK
TK OK

POSSIBLE PROBLEMS

SHUNT WIRING
BATTERY WIRING
DCA

DID THE ORIGINAL DCA TEST GIVE A CORRECT RESULT?

TEST OPTIONS

N/A

REASON FOR QUESTION

If you got a substantially different test result through the DCA, then you have a DCA problem.

NO

SEE NOTE TO RIGHT

YES

NO FAULTS

Make sure the STE/ICE-R is powered by a W5 cable.

If the TK mode test tells you that the vehicle has a fault, then return to the paragraph you came from. If the vehicle tests OK, continue here.

You will have to decide if the DCA test result is wrong. If the TK test gave a substantially different result than the DCA test, answer NO to this question.

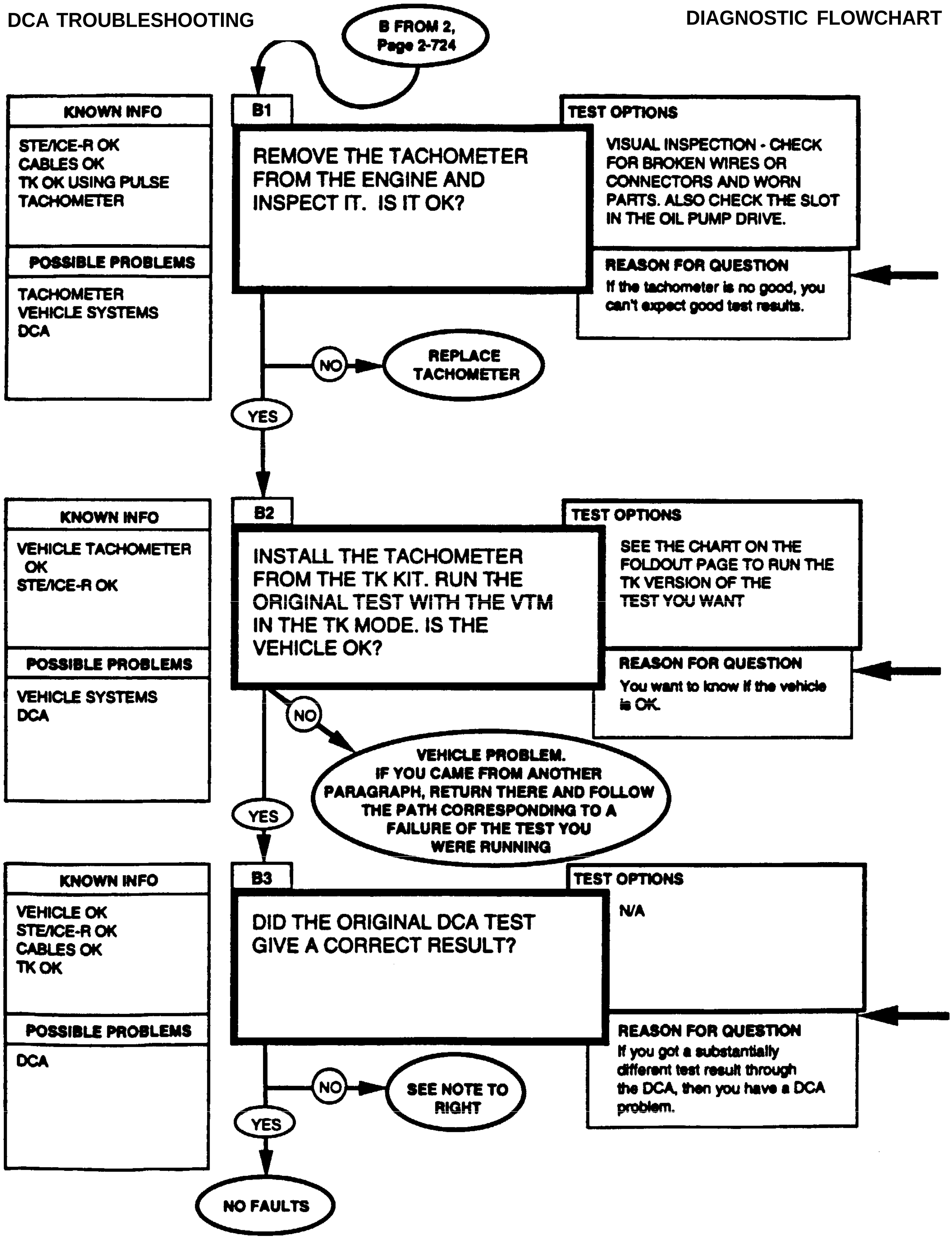
NOTE

VEHICLE DCA FAULTY. Use the STE/ICE-R in the TK mode for the rest of your testing. See the chart on the foldout page for a way to run the rest of the DCA tests in the TK Mode. Have DS maintenance repair the DCA when you're finished.

You can check the connections at the shunt and the power stud to see if they are OK. Look at the schematic for help.

DCA TROUBLESHOOTING

DIAGNOSTIC FLOWCHART



Remove tachometer, refer to (para 4-13). If you find the tachometer defective, replace it and return to where you came from and rerun the original DCA test. If it fails again return to this question and answer "YES".

Make sure the STE/ICE-R is powered by the W5 cable.

If you don't find any faults in the vehicle, the slot in the oil pump drive could be too worn to drive the tachometer. If you see this, notify DS maintenance.

You will have to decide if the DCA test result is wrong. If the TK test gave a substantially different result than the DCA test, answer "NO" to this question.

NOTE

Vehicle DCA faulty. Use the STE/ICE-R in the TK mode for the rest of your testing. See the chart on the foldout page for a way to run the rest of the DCA tests in the TK mode. Have DS maintenance repair the DCA when you're finished.

2-43. STE/ICE-R TEST PROCEDURES

This paragraph will be helpful when using the STE/ICE-R to answer diagnostic questions. Use this paragraph as a reference if you need additional information about a specific test. This paragraph contains information such as possible errors, test procedure, control codes, and additional notes as necessary. The following chart will help you find the test you need. The STE/ICE setup and internal checks (test no. G01, Page 2-763) must be perfomed prior to performing tests. A complete description and operation of the STE/ICE-R is found on Page 2-753. See TM 9-4910-571-12&P for additional information.

ENGINE RPM (Average) TEST #10

Description:

This procedure measures engine speed in the range 50 to 5000 RPM. At speeds below 50 RPM the VTM will display 0. At speeds above 5000 RPM the display may give a false reading. Test requires DCA hookup only.

Pre-Test Procedures

Run Confidence Test.

Typical Applications:

Check Engine Speed

Possible Error Messages

E014 Incorrect # of cylinders entered

Test Procedure:

1. Set TEST SELECT switches to 10
2. Press and release TEST button
3. Start engine
4. Observe displayed value (RPM).

POWER TEST (RPM/SEC) TEST #12

Description:

This procedure measures an engine's power producing potential in units of RFM/SEC. Test requires DCA hookup only.

Pre-Test Procedures:

Run Confidence Test. Warm up engine to operating temperature.

Typical Applications:

Check engine power in units of RPM/SEC.

Possible Error Messages:

E009 Engine not running at start of test.
E011 Throttle control operated incorrectly.
E012 Ignition adapter/pulse tachometer missing.
E014 Incorrect number of cylinder entries.
E033 Error in entry of power test constants

Test Procedure:

1. Start and idle engine
2. Set TEST SELECT switches to 10
3. Press and release TEST button
4. Observe displayed value (RPM) to adjust idle Speed if necessary.
5. Press down sharply on accelerator end observe displayed value (RPM) to adjust governor speed if necessary.
6. Set TEST SELECT switches to 12.
7. Press and release TEST button.
8. Wait for prompting message CIP to appear.
9. When CIP appears on display, press down sharply on engine accelerator end hold it to the floor. When VTM displays a number, release accelerator.
10. Observe displayed value (RFM/SEC).

NOTES

Engine idle speed must rechecked before performing power test. Idle spead must be within the range 625-675 RPM (6.2L and 6.5L) range to run test.
Engine governor no bad speed must be checked before performing power test. Governor no-load speed must be within the 3900-4100 RPM (6.2L) end 3600-3600 RPM (6.5L) range to run test.

POWER TEST (PERCENT) TEST #13

Description:

This procedure measures the percentage of engine's power producing potential as compared to a good engine. Test requires DCA hookup only.

Pm-lest Procedures:

Run Confidence Test. Warm up engine to operating temperature.

Typical Applications:

Check engine power

Possible Error Messages:

E009 Engine not running at start of test.
E011 Throttle control operated incorrectly.
E012 Ignition adapter/pulse tachometer missing.
E024 Test not valid for VID entered

Test Procedure:

1. Start and idle engine
2. Set TEST SELECT switches to 10
3. Press and release TEST button
4. Observe displayed value (RPM) to adjust idle speed if necessary.
5. Press down sharply on on engine accelerator and observe displayed value (RPM) to adjust governor speed if necessary.
6. Set TEST SELECT switches to 13.
7. Press and release TEST button.
8. Wait for prompting message CIP to appear.
9. When CIP appears on display, press down sharply on engine accelerator and hold it to the floor. When VTM displays OFF, release accelerator.
10. A number will be displayed after the engine has returned to idle speed. This number is the test result in units of percent of nominal rated power.

NOTES:

Engine idle speed must be checked before performing power test. Idle speed must be within the 625-675 RPM (6.2L and 6.5L) range to run test. Engine governor no load speed must be checked before performing power test. Governor no load speed must be within the 3600-3800 RPM (6.2L) and 3900-4100 RPM (6.5L) range to run test.

COMPRESSION UNBALANCE TEST #14 (6.2L ONLY)

Description:

This procedure compares the compression between the highest and lowest cylinders and displays the unbalance in percent. Test requires DCA hookup only.

Pre-Test Procedures:

Run Confidence Test. Warmup engine to operating temperature. Run first-peak series teats 72,73,74, 75.

Typical Applications:

Check compression unbalance of engine with VTM powered from battery of vehicle being tested.

Possible Error Messages:

E006 VTM doesn't detect battery Voltage.
E013 VTM cannot use date received.
E027 Error in entry of compression Unbalance constants.
E032 Vehicle's cranking speed is varying too much for a compression unbalance measurement.

Test Procedure:

1. Set up engine to prevent Starting by disconnecting wire 54A. Stop Engine. Shut off fuel before cranking. Crank engine without fuel for 5 seconds to dear fuel from cylinders.
2. Set TEST SELECT switches to 14.
3. Press and release TEST button.
4. Wait until GO appears on display before proceeding.
5. When GO appears, crank engine. Display will change to while engine is turning.
6. When OFF or E013 appears, stop cranking.
7. If OFF appears, wait for message to appear.
   (A) The number displayed will be the percent unbalance between the highest and lowest cylinders. A number above 25 is a failure.
   (B) If GO appears, repeat from step 2.
   (C) A FAIL message usually means compression is too far unbalanced to measure with STE/ICE.

NOTE

If E013 appears, test data cannot be analyzed because of weak batteries, or interrupted cranking during test. Correct problem and repeat from Step 2.

FUEL SUPPLY PRESSURE (psi) TEST # 24

Description:

This procedure measures the return pressure, in order to detect line blockage, leaks or insufficient restrictor back pressure. Test requires DCA hookup only.

Pre-Test Procedure-.

Run Confidence Test. Wait for 1 minute after turning engine off to run this test.

Typical Applications:

Fuel Supply Pressure

Control Functions:

01,02,03,04,06

Test Procedure:

1. Turn off vehicle.
2. Set TEST SELECT switch to 24.
3. Press and hold TEST button until CAL appears on display.
4. Release TEST button and wait for offset value to appear on display. If offset is within -15 to 15 proceed. If not, go to DCA Troubleshooting Procedure
5. Press and release TEST button.
6. Start engine
7. Observe displayed value.

Possible Error Messages:

E005 offset not performed.

PRESSURE (psi) 0 TO 1000 TEST #50

Description:

This procedure measures pressure, in the 0 to 1000 PSIG range. Teat requires the use of the TK adapters and transducers.

Pre-Test Procedures

Run Confidence Test.

Typical Applications:

Oil Pressure

Control Functions:

01,02,03,04,06

Test Procedure:

1. Attach connector P1 of cable W4 to J2 TK or J3 TK.
2. Install blue striped pressure transducer where pressure is to be measured. Attach connector P2 of cable W4 to transducer.
3. Set TEST SELECT switch to 50. Press and hold TEST button until CAL appears on display.
4. Release TEST button and wait for offset value to appear on display. If offset is within -150 to 150 proceed. If not, go to DCA Troubteshooting Procedure.
5. Energize system
6. Press and release TEST button.
7. Observe displayed value.

Possible Error Messages

E005 Offset not perfomed.
E002 Transducer not connected

BATTERY VOLTAGE TEST #67

Description:

This procedure measures battery voltage in the 9 to 32 range volts. The voltage is measured directly at the power source of the VTM, and maybe done with the vehicle operating or shut down. Test requires DCA hookup only.

Pre-Test Procedures:

Run Confidence Test.

Typical Applications:

Check Battery Voltage

Control Functions:

01,02,03,04,06

Test Procedure:

1. Set TEST SELECT switch to 67.
2. Press and release TEST button.
3. If .9.9.9.9 is displayed, voltage is not within the test range.
4. Observe displayed value (volts).

Possible Error Messages:

none

STARTER MOTOR VOLTAGE TEST #68

Description:

This procedure measures the voltage present at the starter motor positive terminal, in the 0-32 volts range. Test requires DCA hookup only.

Pm-Test Procedures:

Run Confidence Test.

Typical Applications:

Check Starter Motor Voltage

Control Functions:

01,02,03,04,06

Test Procedure:

1. Disconnect Fuel Solenoid wire 54A to prevent starting.
2. Set TEST SELECT switch to 68.
3. Press and release TEST button.
4. Crank the engine and observe the displayed Votage.

Possible Error Messages:

none

STARTER NEGATIVE CABLE VOLTAGE DROP TEST #69

Description:

This procedure measures the voltage drop on the starter path. A high voltage (>2V) indicates excessive ground path resistance. Test requires DCA hookup only.

Pre-Test Procedures:

Run Confidence Test.

Typical Applications:

Check Starter Negative Cable Voltage Drop.

Control Functions:

01,02,03,04,06

Test Procedure:

1. Disconnect Fuel Solenoid wire 54A to prevent starting.
2. Set TEST SELECT switch to 69.
3. Press and release TEST button.
4. Crank the engine and observe the displayed voltage.

Possible Error Messages:

None

STARTER SOLENOID VOLTS TEST #70

Description:

This procedure measures the voltage present at the starter solenoids positive terminal. Test requires DCA hookup only.

Pre-Test Procedures:

Run Confidence Test.

Typical Applications:

Check Starter Solenoid Volts.

Control Functions:

01,02,03,04,08

Test Procedure:

1. Discoonned Fuel Solenoid wire 54A toprevent starting.
2. Set TEST SELECT switch to 70.
3. Press and release TEST button.
4. Crank the engine and observe the displayed voltage.

Possible Error Messages:

None

STARTER CURRENT AVERAGE TEST #71

Description:

This procedure measures the average starter current in the 0 - 1000 amps range. Test requires DCA hookup only.

Pre-Test Procedureas

Run Confidence Test.

Typical Applications:

Check Starter Current.

Control Functions:

01,02,03,04,08

Test Procedure:

1. Disconnect fuel solenoid wire 54A to prevent startimg.
2. Set TEST SELECT switch to 71.
3. Press and hold TEST button until CAL appears on display.
4. Release TEST button and wait for offset value to appear on display. If offset is within -150 to 150, proceed. If not, go to DCA .Troubleshooting Procedure.
5. Press and release TEST button.
6. Crank engine.
7. Observe the displayed starter current.

Possible Error Messages

E005 Offset not performed.

CURRENT FIRST PEAK TEST #72

Description:

This procedure measures the overall condition of the complete starting system. Test requires DCA hookup only.

Pre-Test Procedures:

Run Confidence Test. Warm up engine to operating temperature. Turn off ail electrical accessories.

Typical Applications:

Check conditon of starting system on C1 engines with VTM trdngpowered from battery of vehicle tested.

Possible Error Messages:

E002 Transducer not connected.
E005 Offset not performed.
E008 VTM does not detect battery voltage.
E013 VTM cannot use data received.
E020 No first peak information was detected by the VTM.
E021 VTM cannot calculate result because current is over current probe's range.

Test Procedure:

1. **DiscABonnect fuel solenoid wire 54A to prevent** starting.
2. Make sure all vehicle accessories are off.
3. Set TEST SELECT switches to 72.
4. Press and hold TEST button until CAL appears on display.
5. Release TEST button and wait for offset value to appear on display. If offset is within the range -150 to 150, proceed. If not, go to DCA Troubteshooting Procedure.
6. Press and release TEST button.
7. When GO appears on display, crank engine for 2 seconds or until one of the following appears on the display OFF
   .9.9.9.9
   A number
   An error measage
8. Observe displayed value (amps).

NOTES:

If .9.9.9.9 is displayed, current first peak was too high and cannot be measured with VTM.

If E013 is displayed, then check battery connections and correct as necessary. Repeat Step 6. If E013 persists after 3 tests, VTM cannot perform test.

BATTERY INTERNAL RESISTANCE TEST #73

Description:

This procedure measures the internal battery resistance. Internal battery resistance is a measure of the state of the batteries. Test requires DCA hookup only.

Pre-Test Procedures:

Run Confidence Test. Turn off all electrical accessories.

Typical Applications:

Evaluate batteries on CI engines with VTM being powered from battery of vehicle tested.

Possible Error Messages:

E002 Transducer not connected
E005 Offset not performed
E008 VTM does not detect battery voltage
E013 VTM cannot use data received.
E020 No first peak information was detected by the VTM.
E021 VTM cannot calculate result because current is over current probe's range.

Test Procedure:

1. Disconnect fuel solenoid wire 54A from the injector pump to prevent starting.
2. Make sure all vehicle accessories are off.
3. Set TEST SELECT switches to 73.
4. Press and hold TEST button until CAL appears on display.
5. Release TEST button and waif for offset value to appear on display. If offset is within the -150 to 150 range, proceed. If not, go to DCA Troubleshooting Procedure
6. Press and release TEST button.
7. When GO appears on display, crank engine for 2 seconds or until one of the following appears on the display OFF
   .9.9.9.9
   A number
   An error message
8. Observe displayed value (milliohms). The limit is 25 milliohms per battery pair.
9. Test #75 is Battery Resistance Change. You can run that test after this one if you want to.

NOTES:

If .9.9.9.9 is displayed, battery internal resistance was too high and cannot be measured with VTM.

If E013 is displayed, then check battery connections and correct as necessary. Repeat Step 6. If E013 persists after 3 tests, VTM cannot perform test.

STARTER CIRCUIT RESISTANCE TEST #74

Description:

This procedure measures starter circuit resistance. Test requires DCA hookup only.

Pre-Test Procedures:

Run Confidence Test Warm up engine to operating temperature. Turn off all electrical accessories.

Typical Applications:

Check resistance of complete starting system in Cl engines with VTM powered from batteries of Vehicle being tested.

Possible Error Messages

E002 Transducer not connected.
E005 Offset not performed.
E003 VTM does not detect battery voltage.
E013 VTM cannot use data received.
E020 No first peak information was detected by the VTM.
E021 VTM cannot calculate result because current is over current probe's range.

Test Procedure:

1. Disconnect fuel Solenoid wire 54A to prevent starting.
2. Make sure all vehicle accessories are off.
3. Set TEST SELECT switches to 74.
4. Press and hold TEST button until CAL appears on display.
5. Release TEST button and waft for offset value to appear on display. If offset is within the range -150 to 150, proceed. If not, go to DCA Troubleshooting Procedure.
6. Press and release TEST button.
7. When GO appears on display, crank engine for 2 seconds or until one of the following appears on the display OFF
   .9.9.9.9
   A number
   An error message
8. Observe displayed value(milliohms).

NOTES

If .9.9.9.9 is displayed, the starter circuit resistance value was too high and cannot be measured with VTM.

If E013 is displayed, then check battery connections and correct as necessary. Repeat Step 6. If E013 persistes after 3 tests, VTM cannot perform test.

BATTERY RESISTANCE CHANGE TEST #75

Description:

This procedure measures the change of battery resistance. Test requires DCA hookup only.

Pre-Test Procedures:

Run Confidence Test. Warm up engine to operating temperature. Turn off all electrical accessories.

Typical Applications:

Evaluate batteries in Cl engines with VTM powered from batteries of vehicle being tested.

Possible Error Messages

E002 Transducer not connected.
E005 Offset not performed.
E006 VTM does not detect battery voltage.
E013 VTM cannot use data received.
E020 No first peak information was detected by the VTM.
E021 VTM cannot calculate result because current is over current probe's range.

Test Procedure:

1. Disconnect fuel solenoid wire 54A to prevent starting.
2. Make sure all vehicle accessories are off.
3. Set TEST SELECT switches to 75.
4. Press and hold TEST button until CAL appears on display.
5. Release TEST button and wait for offset value to appear on display. If offset is within the -150 to 150 range, proceed. If not, go to DCA Troubleshooting Procedure.
6. Press and release TEST button.
7. When GO appears on display, engage starter for 2 seconds or until one of the following appears on the display OFF
   .9.9.9.9
   A number
   An error message
8. Observe displayed value (milliohms/second). The limit is 50 milliohms per battery pair. A lower number is better than a higher one.

NOTES

If .9.9.9.9 is displayed, the battery resistance change value is beyond the range of the VTM and cannot be measured with the VTM.

If E013 is displayed, then check battery connections and correct as necessary. Repeat Step 6. If E013 persistes after 3 tests, VTM cannot perform test.

BATTERY CURRENT TEST #80

Description:

This procedure measures current to or from the battery. Test requires DCA hookup only.

Pre-Test Procedures:

Run Confidence Test.

Typical Applications:

Evaluate batteries in CI engines.

Control Functions

01,02,03,04

Teat Procedure:

1. set TEST SELECT switch to 80.
2. Press and hold TEST button until CAL appears on display.
3. Release TEST button and wait for offset value to appear on display. If offset is within -150 to 150, proceed. If not, go to DCA Troubleshooting Procedure.
4. Press and release TEST button.
5. Observe displayed value (amps).

Possible Error Messages:

E005 Offset not Performed.

DC VOLTAGE O TO 45 VOLTS TEST #89

Description:

This procedure measures voltage in the range of -45 to 45 volts. The VTM is used as a DC voltmeter with the decimal point in the correct position. This test must be done with the component being tested turned on. Test requires the use of the TK adapters and transducers

Pre-Test Procedures

Run Confidence Test.

Typical Applications:

- Fuel Solenoid
- Starter Solenoid
- Alternator Output
- Any DC Voltage measurement

Control Functions:

01,02,03,04,06

Test Procedure:

1. Connect test probe cable W2. Attach P1 to J4.
2. Connect the desired test leads to P2.
3. Set TEST SELECT switch to 89.
4. Short leads together. Press and hold TEST button until CAL appears on display.
5. Release TEST button and wait for offset value to appear on display.
6. If offset is within -6.8 to 6.8 proceed. If not, go to DCA Troubleshooting Procedure.
7. Press and release TEST button. Observe displayed value.

Possible Error Messages

E005 Offset not performed.

DC CURRENT 0 TO 1500 AMPS TEST #90

Description:

This procedure measures DC currant in the range of 0 to 1500 amps. The VTM is used as an ammeter with the decimal point in the right positiion. This test may be done with the vehicle/equipment operating. Test requires the use of the TK adapters and transducers.

Pre-Test Procedures

Run Confidence Test.

Typical Applications:

- Alterator output
- Average Starter Current
- Battery Current
- Any DC Current up to 1500 Amps

Control Functions:

01,02,03,04,06

Test Procedure:

1. Connect test probe cable W4.
2. Attach P1 to J2 or J3. Connect the Current Probe to P2.
3. Set TEST SELECT switch to 90.
4. Clamp probe to da-energized wire.
5. Press and hold TEST button until CAL appears on display.
6. Release TEST button and wait for offset value to appear on display. If offset is within 225 to -225 proceed. If not, go to DCA Troubleshooting Procedure.
7. Energize circuit. Press and release TEST button.
8. Observe displayed value. A negative reading indicates the probe is backwards. Reverse and repeat from step 4.

Possible Error Messages

E002 Offset not performed.
E005 Transducer not connected.

RESISTANCE AND CONTINUITY O TO 4500 OHMS TEST #91

Description:

This procedure measures resistance in the range of 0 to 4500 ohms. The VTM is used as an ohmmeter, and test results are always displayed with the decimal point in the right position. Additionally, any voltage present in the device being tested will adversely affect test results. Make sure the circuit or component being tested is shut off. Test requires the use of the TK adapters and transducers.

Pre-Test Procedures

Run Confidence Test.

Typical Applications:

- Continuity checks
- Resistance measurements
- Switch and relay functions

Control Functions:

01,02,03,04,06

Test Procedure:

1. Connect test probe cable W2. Attach P1 to J4.
2. Connect the desired test leads to P2.
3. Set TEST SELECT switch to 91.
4. Short leads together. Press and hold TEST button until CAL appears on display.
5. Release TEST button and wait for offset value to appear on display.
6. If offset is within -225 to 225 proceed. If no go to DCA Troubleshooting Procedure
7. Press and release TEST button. Observe displayed value.

Possible Error Messages

E005 Offset not Performed.
E022 External voltage detected while measuring resistance.

a. STE/ICE-R Description and Operation. The following describes the operation of the Simplified Teat Equipment/Internal Combustion Engines (STE/ICE-R) system and contains detailed operating procedures. It is used to test the serviceability of HMMWV vehicles and to perform primary fault detection and isolation. After the technician has identified a faulty part or subsystem, he is referred to a paragraph number for replacement or repair procedures for individual parts.

b. Description and Operation. STE/ICE-R is a testing system that performs tests and measurement on internal combustion engines. STE/ICE-R measures standard voltage, current, resistance, pressure, temperature, and speed. Special tests, such as compression balance tests end starter system evaluations, are performed by STE/ICE-R. Standard equipment functions including vacuum pressure gauge, compression gauge, low-current tester, and multimeter are features of the STE/ICE-R set. STE/ICE-R is portable and operates on either 12- or 24-volt vehicle batteries or equivalent power source. The STE/ICE-R system consists of a vehicle test meter (VTM), a transducer kit (TK), four electrical cables, a transit case, and technical publications.

c. Vehicle Test Meter.

1. General. The VTM provides a method for the technician to test vehicle electrical and mechanical components. Readings are either pass/fail indications or digital displays in units familiar to the technician (psi, rpm, volts, ohms, amps, etc.). The diagnostic connector assembly (DCA) is permanently mounted in the vehicle and provides accessibility to the most frequently needed test points. The use of the VTM through the DCA is referred to as DCA mode. The VTM interfaces with the vehicle directly with a transducer from the transducer kit (TK). The use of the VTM through the TK is referred to as TK mode. The DCA and the TK can be used at the same time This may be necessary when the diagnostic connector assembly has a missing transducer. If a transducer is missing, a no sensor indication (E002) is displayed when a measurement is made. If this happens, the TK mode can be used to make the measurement. The use of the VTM through the DCA and TK is referred to as the combined mode. Additional teats can be done that involve manually probing and/or connecting transduce to appropriate test points. Operating power for the VTM is drawn from the vehicle batteries or some equivalent battery source. Power is routed to the VTM through the DCA connected to the battery. The STE/ICE-R general purpose testing capabilities that maybe applied to the vehicle are: 0-1000 psi pressure, 0-45 volts dc and 0-40k ohms resistance. The following control functions can be performed in conjunction with the special tests: interleave (displays rpm with next test), display maximum value, and display minimum value, and display peak-to-peak value.

2. Controls and Indicators. The controls and readout display on the VTM are illustrated. The following paragraphs describe how the controls are used and how the display functions.

(a) Power Switch (PUSH ON/PULL OFF). The power switch controls DC power to the VTM. The VTM can operate from a 12-volt or 24-volt battery system. When the power switch is pushed in (PUSH ON), the VTM power is on. To shut the VTM off, pull out the power switch (PULL OFF). The power switch contains a 4-amp circuit breaker. The power switch will pop out automatically if something is wrong which causes the VTM to use more power than it should. If the switch pops out, check your hookup carefully and try again before returning the VTM to direct support maintenance.

(b) TEST SELECT Switches. The TEST SELECT switches are used to select the actual test to be performed. There are ten positions on each switch numbered 0 through 9. The number dialed into these switches is read by the VTM when you press the test button. Changing the TEST SELECT switch positions has no effect until the TEST button is pushed.

(c) TEST Button. Depressing and releasing the TEST button causes the test measurement to begin. Observe the measured value on the readout display. The reading will be in unite normally used for the particular vehicle measurement. These units are listed on the flip cards. The TEST button must be pressed and immediately released. Depressing and holding the TEST button down initiates an offset test. Offset tests are described in TM 9-4910-571-12&P.

(d) Readout Display. The readout display will show different types of readouts during testing up to a maximum of 4-characters (for example .8.8.8.8). The types of readouts are described in detail in paragraph 3 below and are summarized as follows:

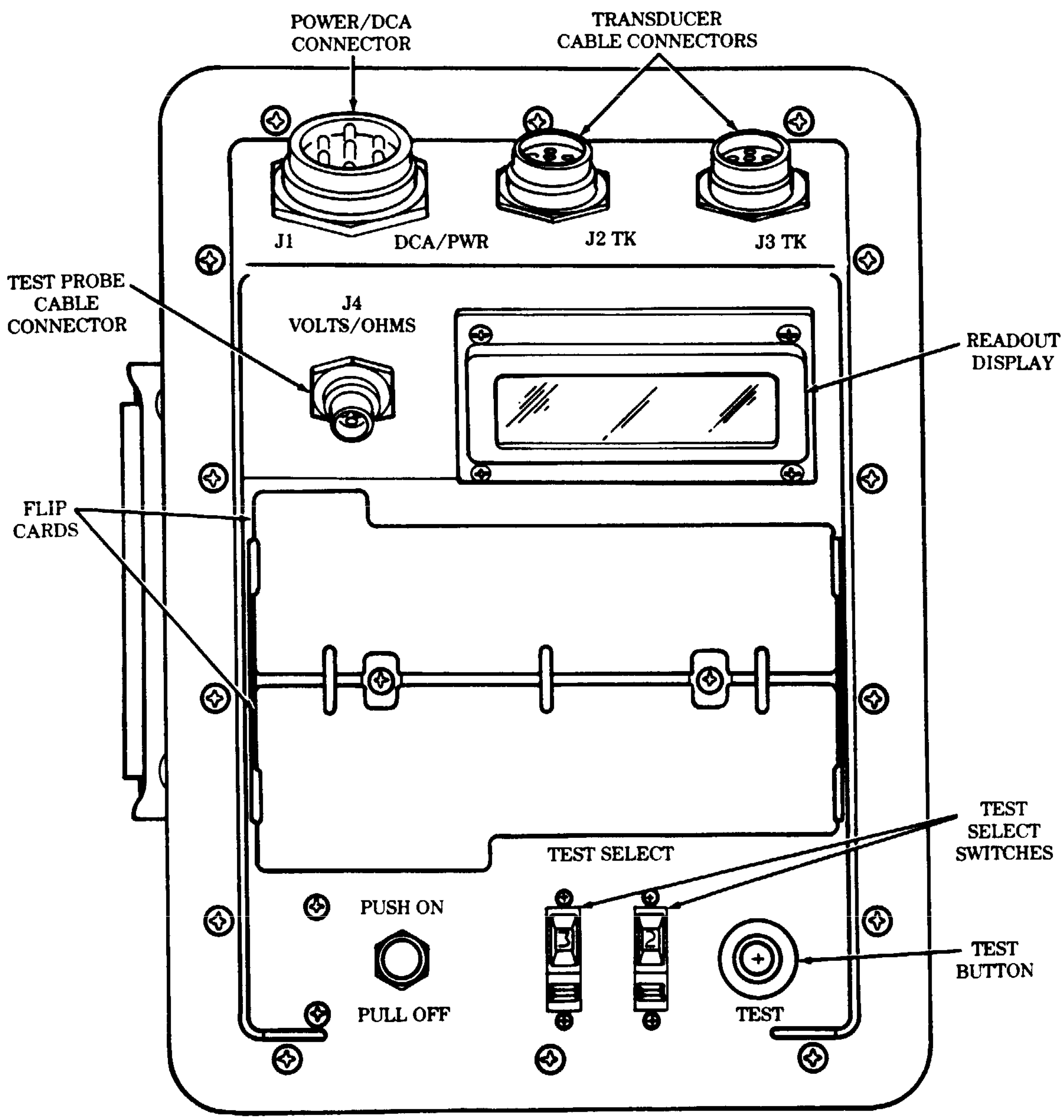
(1) Statue Readout. This type of readout keeps the technician informed of what is happening, such as power applied, failed test, etc.

(2) Numerical Readout. This type of readout is the measured value in units of the measurement being made. If you are measuring 0-45 volts dc, the number 24 on the display indicates 24 volts.

(3) Error Readout. This type of readout indicates that the wrong test number was selected, the transducer is not connected, or the VTM is faulty.

(e) Flip Cards. The flip cards list the 2-digit test number system for selecting the various tests. The cards also summarize the test and operating instructions contained herein.

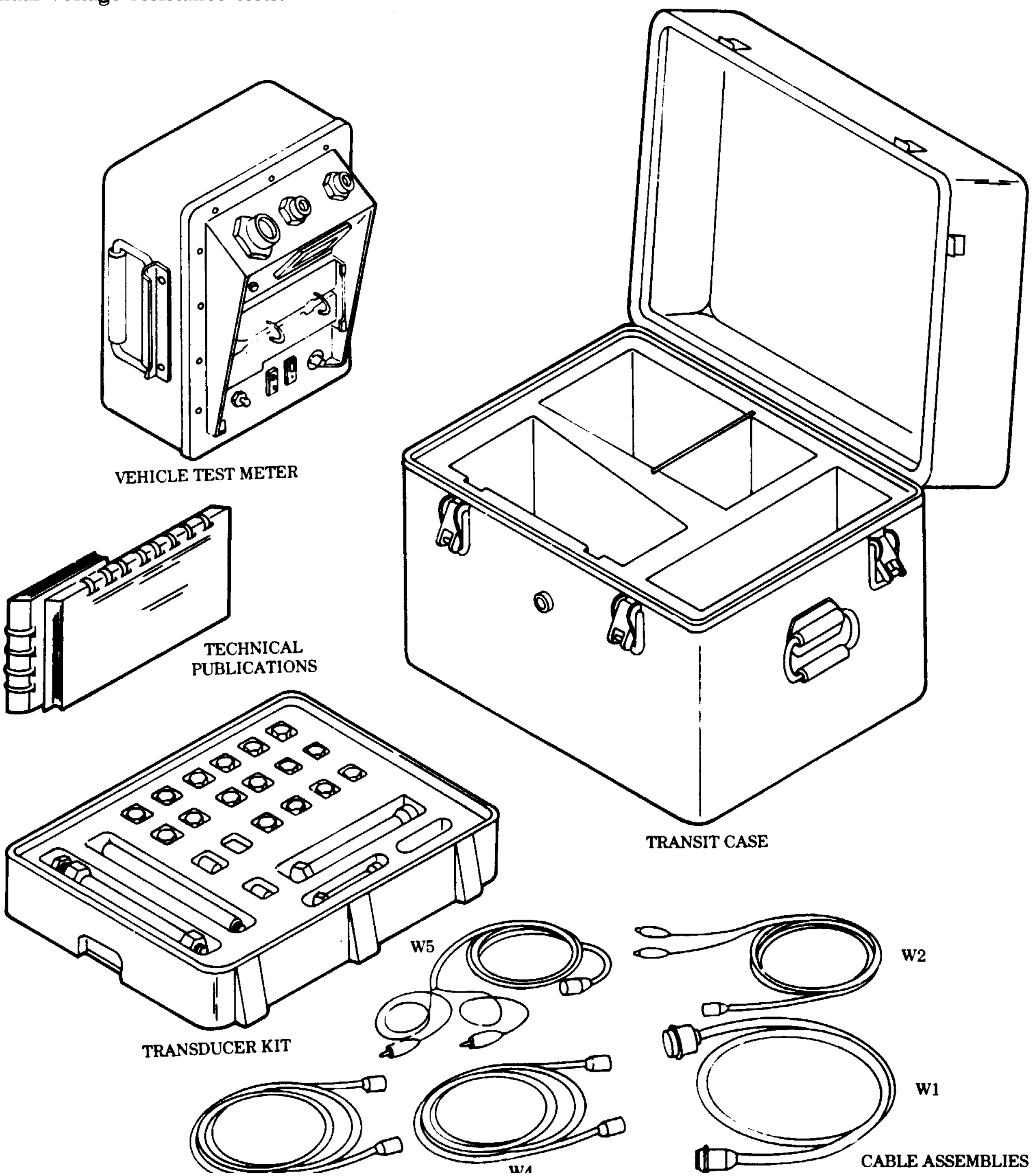
(f) Power/DCA Connector J1. Connector J1 connects the VTM to either a vehicle diagnostic connector using the DCA cable, or to the vehicle batteries using the power cable. Operating power and signals from the installed transducers are supplied to the VTM through the DCA cable.



VTM CONTROLS AND READOUT DISPLAY

(g) Transducer Cable Connectors J2, J3. Connector J2 or J3 connects the VTM to any transducer in the transducer kit. Operating power is supplied to the transducer and signals from the transducers are supplied to the VTM through the cable. Connectors J2 and J3 are identical and can be interchanged with each other or used in combination.

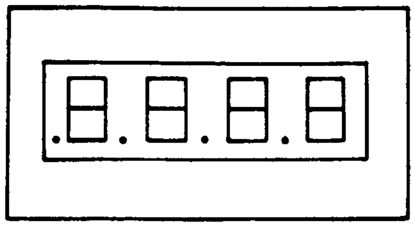
(h) Test Probe Cable Connector J4. Connector J4 connects test leads to the VTM when doing manual voltage resistance tests.



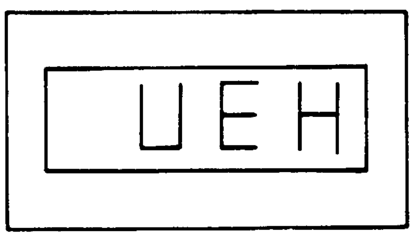
SIMPLIFIED TEST EQUIPMENT INTERNAL COMBUSTION ENGINE (STE/ICE) SYSTEM

3. Readouts. The following paragraphs describe the different types of readouts that can occur during testing.

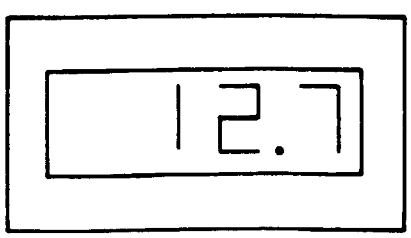
(a) Status Readout. A status readout keeps the technician informed of what is happening. For example, .8.8.8.8 is displayed each time the power switch is pushed on. It means that power is applied, and that all elements of the display are operative, it changes to --- 1.5 seconds later, indicating that the VTM is ready to be used for testing. The status readout displays are described in table 2-1.



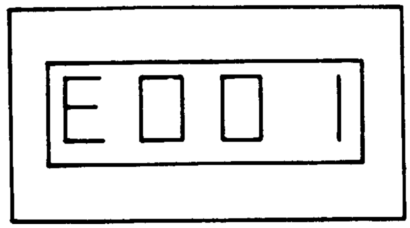
(b) Prompting Message. A prompting message is a technician action message. It is a signal for you to do something such as crank the engine. For example, UEH tells you to enter the vehicle type identification number into the VTM. After the technical action is performed, the test will automatically continue. Prompting messages are listed in table 2-2.



(c) Numerical Readout. A numerical readout is the measured value in units of the measurement being made. For example, if you are measuring 0-45 volts dc, 12.7 is volts dc. If you are measuring 0-25 psig pressure, 12.7 is psig. The units for each test are listed on the flip card. The numbers displayed in the VTM are always positive unless there is a minus shown to make them negative.



(d) Error Readout. E0001 is a typical error readout. There are 15 different readouts. All error readouts start with E. An error readout is a warning that you forgot to connect the transducer, selected a wrong test number, failed to start the engine, etc. All of the error messages mean you must correct the problem before continuing testing. Error readouts are listed in table 2-3. If the error message does not go away after corrective action, refer to TM 9-4910-571-12&P.



(e) Confidence Error Readouts. C004 is a typical error readout resulting from the detection of a faulty VTM during confidence test. For detailed information concerning confidence error readouts refer to TM 9-4910-571-12&P.

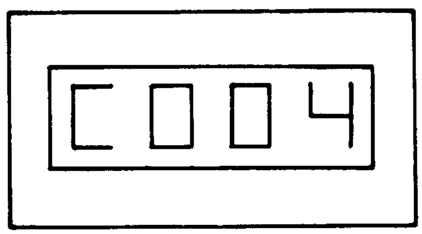


Table 2-1. Status Readouts.

VTM Readout	Interpretation
.8.8.8.8	A readout of .8.8.8.8 appears for 1 to 2 seconds each time the power is applied to the VTM. It means that there is power to the VTM, and that all elements of the readout display are operative.
----	A readout of ---- indicates the following
	(1) After power turn on it signifes that the VTM is ready for testing.
	(2) During a compression unbalance test it signifies testing is in progress.
.9.9.9.9	A readout of ..9.9.9.9 indicates that the VTM is reading a test value beyond the range of its measurement, capability. Either (1) the wrong test number is selected for the parameter being measured, or (2) there is a fault in the vehicle.
PASS FAIL	A PASS or FAIL readout is the result of a test that checks the condition of a component being measured. A PASS/FAIL readout means just that — the component either passes the test or fails the test.

Table 2-2. Prompting Messages

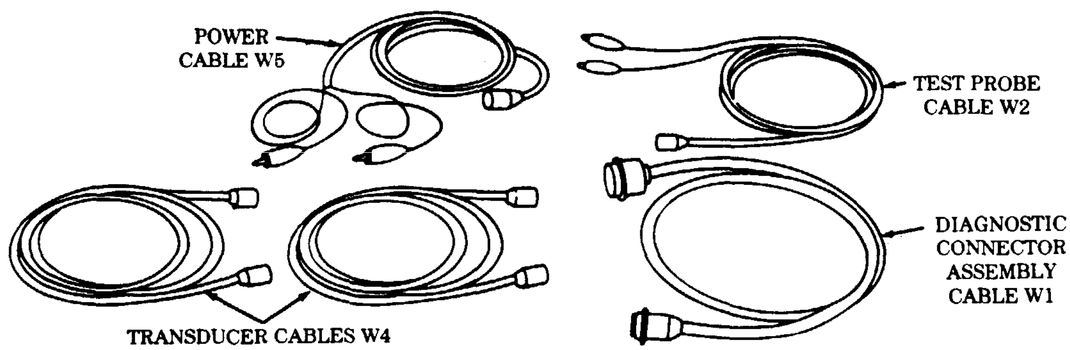
VTM Readout	Interpretation
UEH	Signal to ECT switches. Vehicle ID numbers are found under TEST DATA on the flip card, on the vehicle test cards.
Go	Signal to technician to crank engine in compression balance or first peak tests.
OFF	Signal to technician to stop cranking in compression balance test or to release the accelerator in the CI ower test.
CAL	Signal to the technician to release the TEST button during an offset test.
66	Numbers are used for prompting messages in several tests. In confidence test, a readout of 66 signals the technician to dial in 99. In test no. 12, the first numerical readout signals the technician to shut off fuel.

Table 2-3. Error Readouts

VTM Readout	Interpretation
E000	Occurs if you request the VTM for information it does not have. For example, if you request the vehicle ID and it has not been entered.
E001	Occurs in either the DCA or TK mode of operation. It indicates that a non-existent test number has been dialed into the TEST SELECT switches.
E002	Indicates that the required transducer is not connected.
E003	Indicates that a test number has been dialed which does not apply to the vehicle under test. It can only occur in the DCA mode.
E004	Indicates that a vehicle identification number or number of cylinders information has not been entered.
E005	Indicates that the transducer offset test was not performed.
E007	Indicates a conflict between the vehicle identification number (VID) dialed in the the number of cylinders dialed in. It may occur in response to either VID entry or number-of-cylinders entry.
E008	Indicates the VTM is not receiving the required voltage signal for the test selected. This error code is related only to starter and compression balance tests.
E009	Indicates that the engine was not running at the start of the test.
E010	Indicates that a wrong vehicle identification number was dialed into the VTM.
E01l	Indicates that throttle control was operated incorrectly during power test taking too much time to either accelerate or decelerate.
E013	Indicates bad data were taken for the test in progress. Repeat the test one (1) time.
E014	Indicates that a wrong number of cylinders was dialed into the VTM.
E018	Indicates that an engine RPM or AC frequency test was terminated automatically to protect the VTM. Termination is only after several minutes of no-signal operation. Most likely the VTM was left on the vehicle and the engine stalled.

d. Cable Assemblies.

1. General. The cable assemblies are shown below and are referred to by the cable number and by a name which describes how the cable is used. If necessary, the two transducer cables (W4) can be joined with the adapter supplied in the transducer kit to make one long cable.



CABLE ASSEMBLIES

2. Installation. When cables are connected, large key on the cable connector mates with a keyway on the transducer connector or the VTM connector for proper installation, If you experience any difficulty during testing and suspect that a cable is bad, refer to TM 9-4910-571-12&P for checking cable continuity.

e. Transducer Kit.

Table 2-4. Transducer Kit Components

ITEM NO.	TK NO.	PART NO.	QTY	ITEM
1	10	11669227	1	Hose and fitting assy (spark plug adapter)
2	11	12258878	1	Current probe
3	12	12258853-1	1	Pipe thread reducer, 3/4 MPT to 1/4 FPT
4	13	12258853-3	1	Pipe thread reducer, 1/2 MPT to 1/4 FPT
5	14	12258853-2	2	Pipe thread reducer, 3/8 MPT to 1/4 FPT
6	15	444620	1	Hex head plug, 1/4 MPT
7	16	5327970	1	Hex head plug, 1/8 MPT
8	17	12258876	1	Pressure transducer, 0-1000 psig
9	21	12258881	1	Snubber
10	20	3204X2	2	Adapter, 1/8 MPT to 1/4 FPT
11	19	3304X2	1	Coupling reducer, 1/8 FPT to 1/4 FPT
12	18	234X5	1	Male connector, 5/16 tube to 1/4 MPT
13	22	12258877	1	Pressure transducer, -30 in. Hg to 25 psig
14	23	444152	1	Street tee, 1/2 pipe thread
15	24	3750X4	1	Street tee, 1/4 pipe thread
16	25	547002	1	Street tee, 1/8 pipe thread
17	26	12258879-2	1	Street elbow, 1/4 pipe thread
18	27	12258879-1	1	Street elbow, 1/8 pipe thread
19	34	12258875	1	Pulse tachometer
20	32	12258880	1	Fuel line adapter
21	31	MS53099-2	1	Tachometer drive adapter
22	30	7540877	1	Ignition adapter
23	29	MS3119E14-19	1	Adapter (connector-to-connector)
24	28	12258762	1	Tee, inverted flare
25	33	8840543	1	Air chuck
26	35	11669236	1	Hose assembly, 1/8 MPT
27	36	12258852	1	Pipe nipple, 1/8 MPT

1. General. The transducer kit contains a pulse tachometer transducer, a pressure and a vacuum transducer and the necessary adapters (bushing, plugs, tees, etc.). Also included in the kit is a current probe for measuring current and a test probe cable for measuring voltage and resistance.

Not all fittings have part number markings. The legend will help to identify the items.

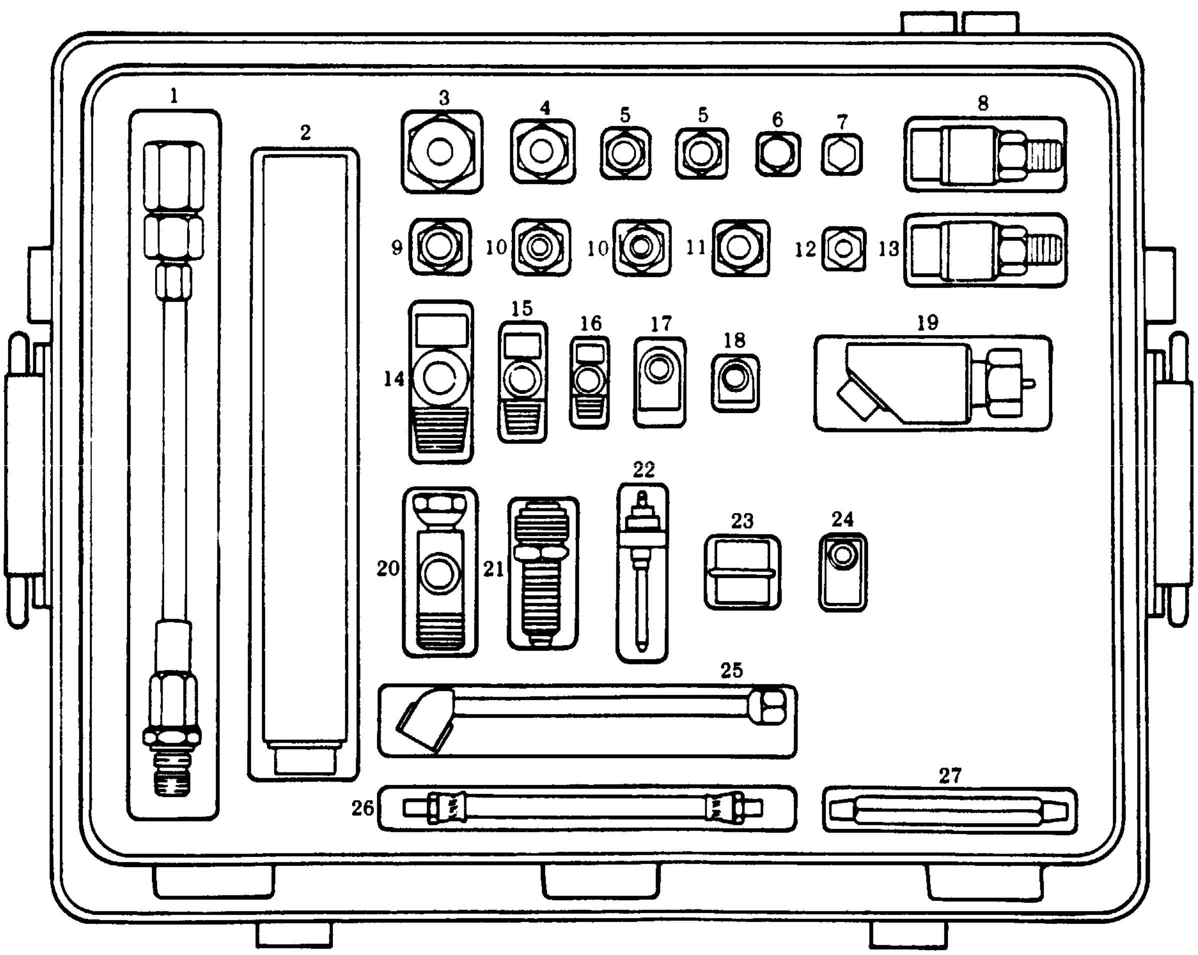
Before installing any transducer kit item on the vehicle, be sure to clean the mounting surfaces. This is particularly important if you are going to open fuel lines or tap into manifolds. Dirt particles entering the engine can cause damage to both the engine and the transducer kit item.

The transducers should kept clean, free of dirt and grease, and handled with reasonable care.

2. Pressure Transducer. The pressure transducers have a small breather hole on the side of the housing which should be kept unplugged. Do not use high pressure.

3. Pulse Tachometer. Make sure that the slotted hole in the engine tachometer drive shaft is clear and not hard packed before installing the pulse tachometer.

4. Threaded Adapters. Observe threaded fittings carefully to avoid engaging straight threads with pipe threads. Each measurement device (transducer) in the transducer kit has its own identification resistor. The VTM uses this identification resistor to check that the correct transducer is connected for the measurement being made. If the correct transducer is not connected, error code E002 will be displayed.



TRANSDUCER KIT

2-44. VEHICLE TESTING

a. General. To troubleshoot a vehicle problem, the technician can use the STE/ICE-R (vehicle test meter and transducers) and the vehicle test card.

b. Data Entry Tests. For information regarding Data Entry, Cylinder Entry, Vehicle ID Entry, and Data Display Tests, refer to TM 9-4910-571-12&P.

c. Offset Tests. The STE/ICE-R VTM performs a test by setting the TEST Select switches to the test number and pressing the TEST button. For some tests, an offset test is required before the test itself can be performed. This is done by selecting the number of the desired test and holding the TEST button down for several seconds.

The offset test nulls out characteristic differences in the VTM, test leads, and transducers. It zeros the meter. Once the offset is performed, the VTM automatically corrects for the offset before displaying measured values. The displayed offset value should be checked against limits on the vehicle test card. If the displayed value is outside these limits, either the transducer or the test cable is faulty and must be replaced. This is another form of self-test. The offset is performed when each transducer is connected. All tests requiring offset are identified by a star (*) on the flip cards and by OFFSET LIMITS on the vehicle test cards. The offset test is performed with the test probe cable or transducer connected to the VTM. Care should be taken to see that no stimulus is applied to the transducer. Test probe cable leads should be shorted together. To perform an offset test, dial the test number into the TEST SELECT switches. Press and hold the TEST button until the prompting message CAL appears on the display. A few seconds after release of the TEST button, a number will appear. This is the measured offset value associated with the test probe cable or transducer and cable.

d. Control Tests. These tests are used to change (or control) the way a vehicle test is displayed or the way it is run. There are five control tests:

01 Interleave (displays RPM with next test).

02 Display minimum value for next test.

03 Display maximum value for next test.

04 Display peak-to-peak value for next test.

06 Interleave.

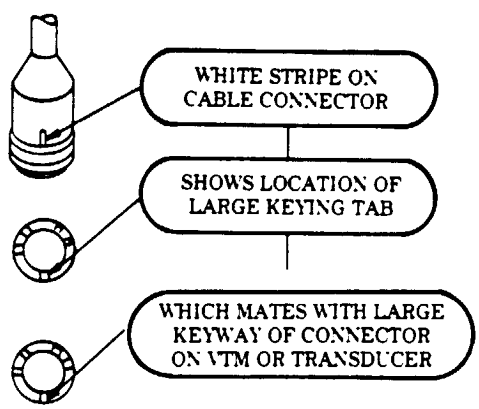
Control tests 01, 02, 03, 04, and 06 specify the action to be taken by the next test only. A subsequent test will reset the control.

1. Interleave (Test 01). This test alternately measures engine speed and a second parameter such as fuel pressure or alternator voltage. To initiate interleave, dial 01 into the TEST SELECT switches and press and release the TEST button. The prompting message CON will signal the technician to dial into the second test number and again press and release the TEST button.

2. Minimum Value (Test 02). This test displays the minimum value measured during a test. To initiate a minimum value display, dial 02 into the TEST SELECT switches and press and release the TEST button. The prompting message PASS will signal the technician to dial in the desired test number and again press and release the TEST button. The minimum value is displayed and updated whenever a lower minimum value is measured. Entering 02 and the test number again will reset the process and a new minimum value will be displayed.

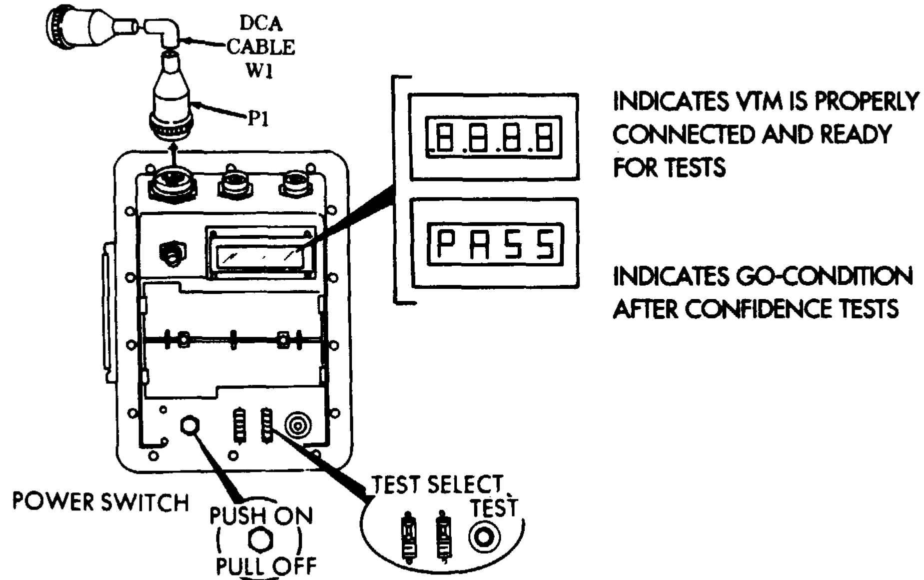
3. Maximum Value (Test 03). This test displays the maximum value measured during a test. To initiate a maximum value display, dial 03 into the TEST SELECT switches and press and release the TEST button. The prompting message PASS will signal the technician to dial in the desired test number and again press and release the TEST button. The maximum value is displayed and updated whenever a higher maximum value is measured. Entering 03 and the test number again will reset the process and a new maximum value will be displayed.

4. Peak-to-Peak Value (Test 04). This test displays the peak-to-peak value of 0-45 volts DC (89), 0-1500 amps DC (90), and battery volts (67). To start a peak-to-peak measurement, dial 04 into the TEST SELECT switches and press the TEST button. The prompting message PASS will signal the operator to dial in one of the three numbers (89, 90, 67) and again press the TEST button.



CONNECTOR KEY LOCATION

Table 2-1. STE/ICE-R GO-Chain Tests.



GO-CHAIN

NOTE

Perform all GO steps until a NO-GO condition exists, then perform the NO-GO step indicated.

G01 — **DCA MODE**

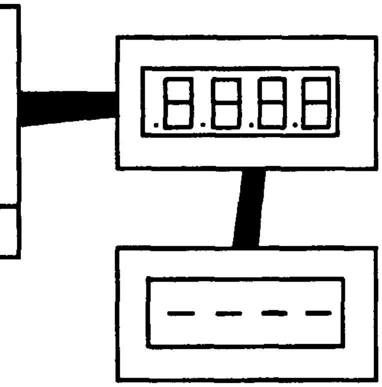
CAUTION

- Do not connect or disconnect the VTM while the vehicle is running.
- Connect DCA cable to the VTM before connecting to the diagnostic connector.

1 CONNECT VTM TO VEHICLE DIAGNOSTIC CONNECTOR:

- PULL OFF the VTM power switch.
- Connect DCA cable to the VTM.
- Connect DCA cable to the vehicle.
- PUSH ON the VTM power switch.
- Verify that the display indicated .8.8.8.8 for approximately 2 seconds and then changes to - - - -.

- Does the VTM display .8.8.8.8 and then change to - - - - ?



AFTER 2 SECONDS

YES
- Proceed to step 3.

3

NO
- Proceed to following page.

Table 2-1. STE/ICE-R GO-Chain Tests. (Cont'd)

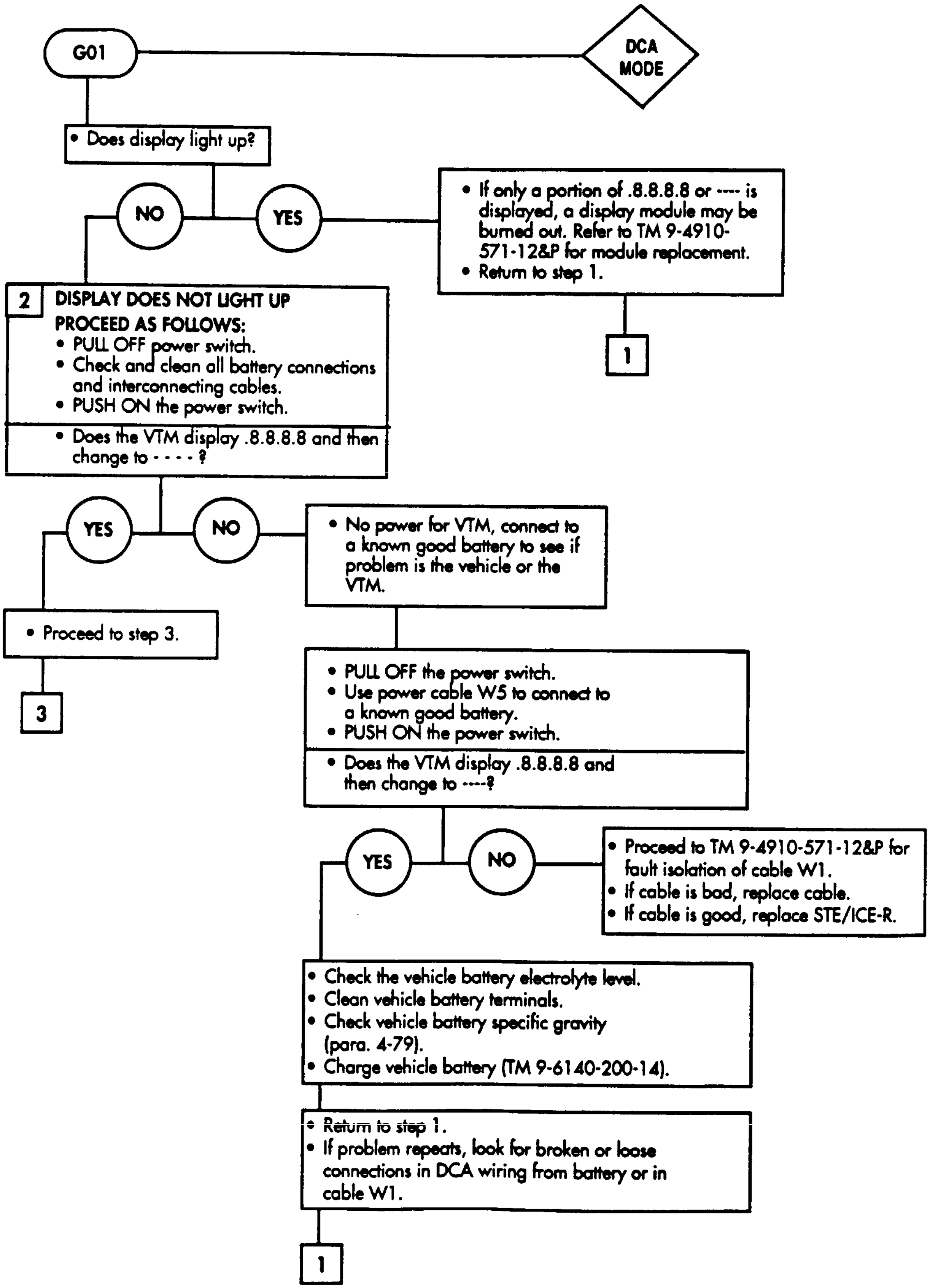


Table 2-1. STE/ICE-R GO-Chain Tests. (Cont'd)

G01

DCA MODE

3 **RUN CONFIDENCE TEST:**
- Dial 66 into TEST SELECT and press TEST.

- Does the VTM display and hold 0066?

YES — NO

- PULL OFF the power switch.
- PUSH ON the VTM power switch.
- Verify that the display indicates .8.8.8.8 for approximately 2 seconds and then change to ----.
- Re-dial 66 and press TEST.

- Does the VTM display and hold 0066?

YES — NO

- STE/ICE-R is bad. Replace.

- Dial 99 into TEST SELECT and press TEST.
- Look for this display.

1 — 0099

2 — BLANK

3 — .8.8.8.8

4 — BLANK

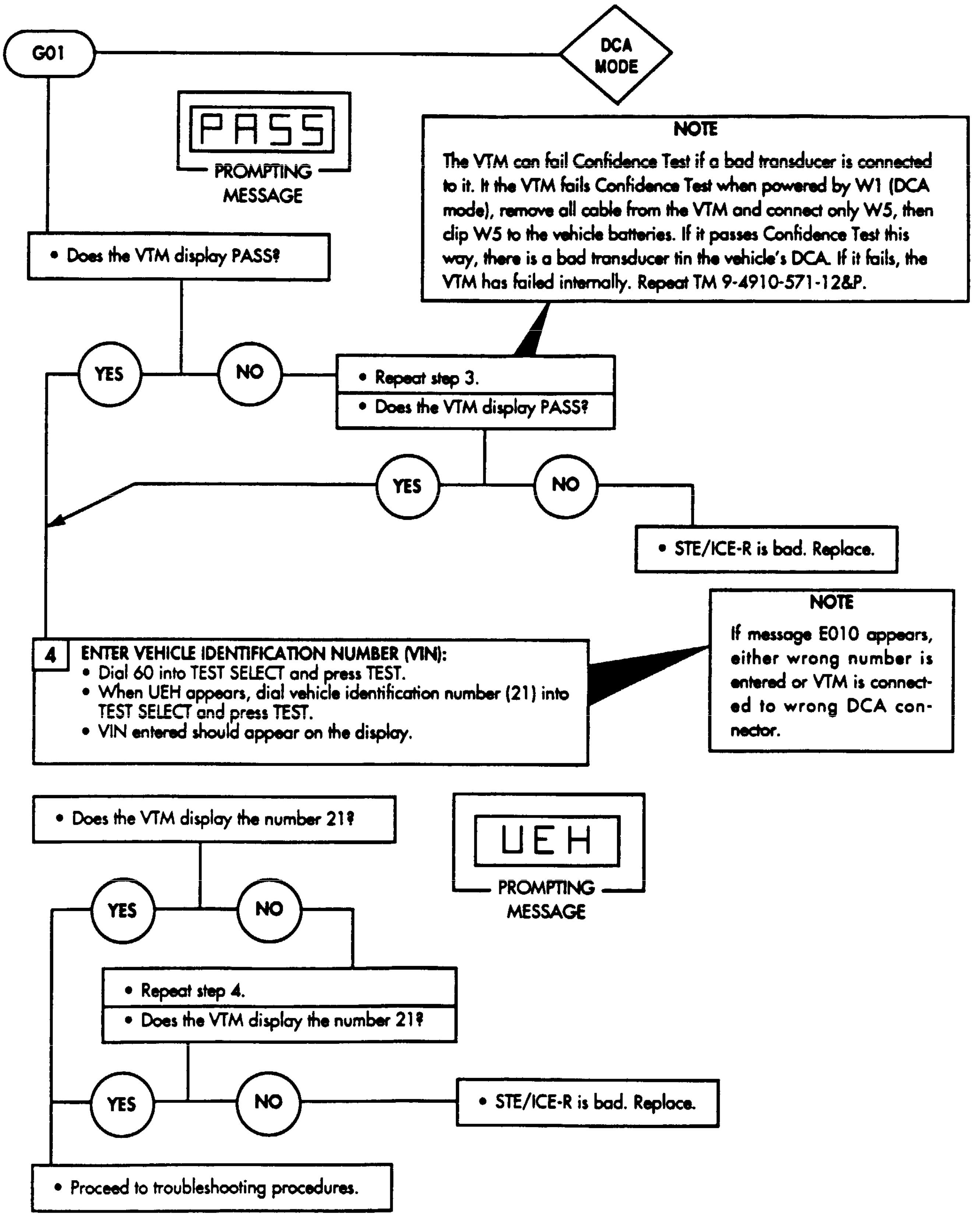
TEST NO.	TEST
66	CONFIDENCE TEST

NOTE

At this point in the test, several numbers will appear on the display. Wait for readout display of PASS.

- Proceed to following page.

Table 2-1. STE/ICE-R GO-Chain Tests. (Cont'd)



INDEX VOLUME 1

INDEX (Cont'd)

INDEX (Cont'd)

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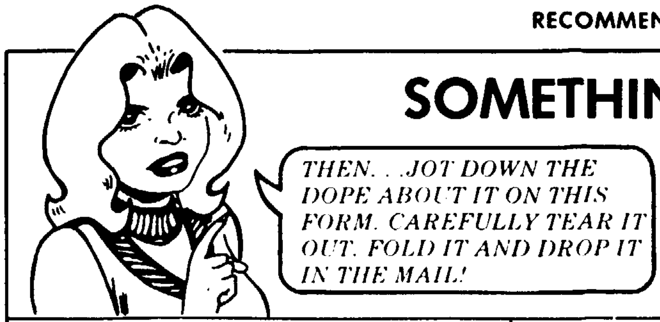

SOMETHING WRONG WITH THIS PUBLICATION?

FROM: (PRINT YOUR UNIT'S COMPLETE ADDRESS)

Your mailing address

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PUBLICATION NUMBER	PUBLICATION DATE	PUBLICATION TITLE
TM 9-2320-280-20-1	31 January 1996	UNIT MAINTENANCE

BE EXACT . .PIN-POINT WHERE IT IS

PAGE NO.	PARA-GRAPH	FIGURE NO.	TABLE NO.
11-220	11-142	—	—

IN THIS SPACE TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT:

Step 3 states that there are two screws securing strap assembly to right door.

There are actually four screws that secure the strap assembly to the right door.

Suggest changing the step to read:
"Remove four screws (39) securing strap assembly (40) to right door (28)."

SAMPLE

PRINTED NAME, GRADE OR TITLE, AND TELEPHONE NUMBERS

Your name, rank, and phone

SIGN HERE:

SP. John Doe

DA FORM 1 JUL 79 2028-2

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REVERSE OF DA FORM 2028-2

SAMPLE

FILL IN YOUR
UNIT'S ADDRESS

FOLD BACK

TEAR ALONG PERFORATED LINE

DEPARTMENT OF THE ARMY

COMMANDER
U.S. ARMY TANK-AUTOMOTIVE AND ARMAMENTS COMMAND
ATTN: AMSTA-IM-MMAA
WARREN, MI 48397-5000

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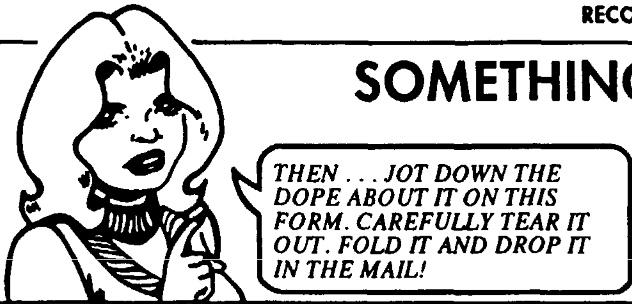

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FILL IN YOUR
UNIT'S ADDRESS

FOLD BACK

TEAR ALONG PERFORATED LINE

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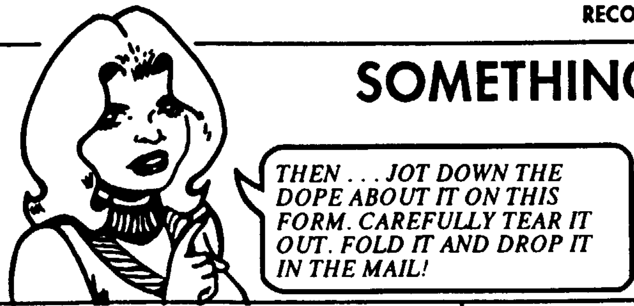

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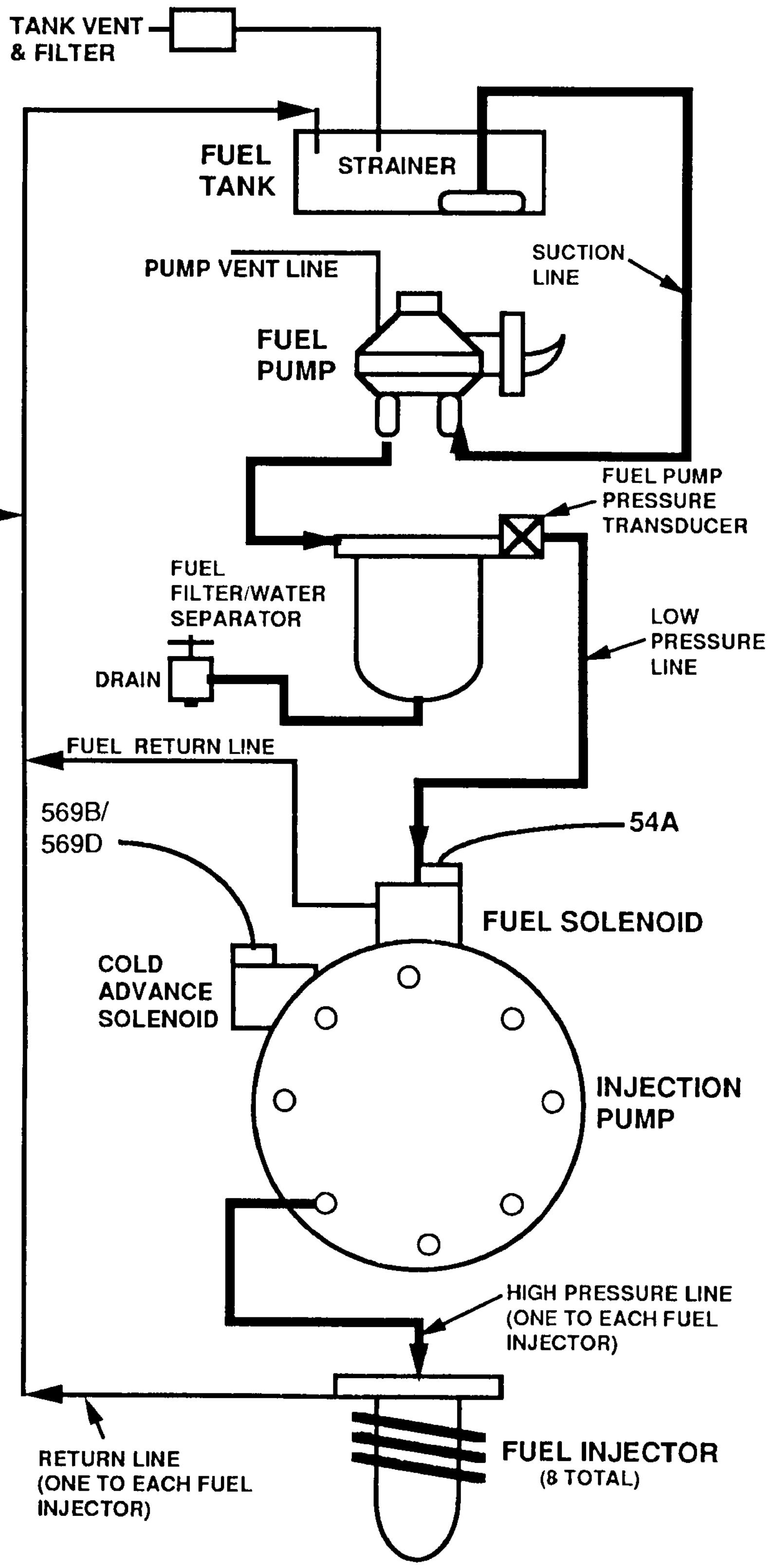
RETURN LINES

FUEL FILTER

COLD ADVANCE SOLENOID advances the injection timing while the engine is cold.



TANK VENT and FILTER allow air to enter and leave fuel tank while keeping contaminants out

FUEL TANK STRAINER prevents the larger particles of dirt and rust from being pulled into the fuel lines

FUEL PUMP pulls fuel from the tank and pumps it under low pressure to the injection pump

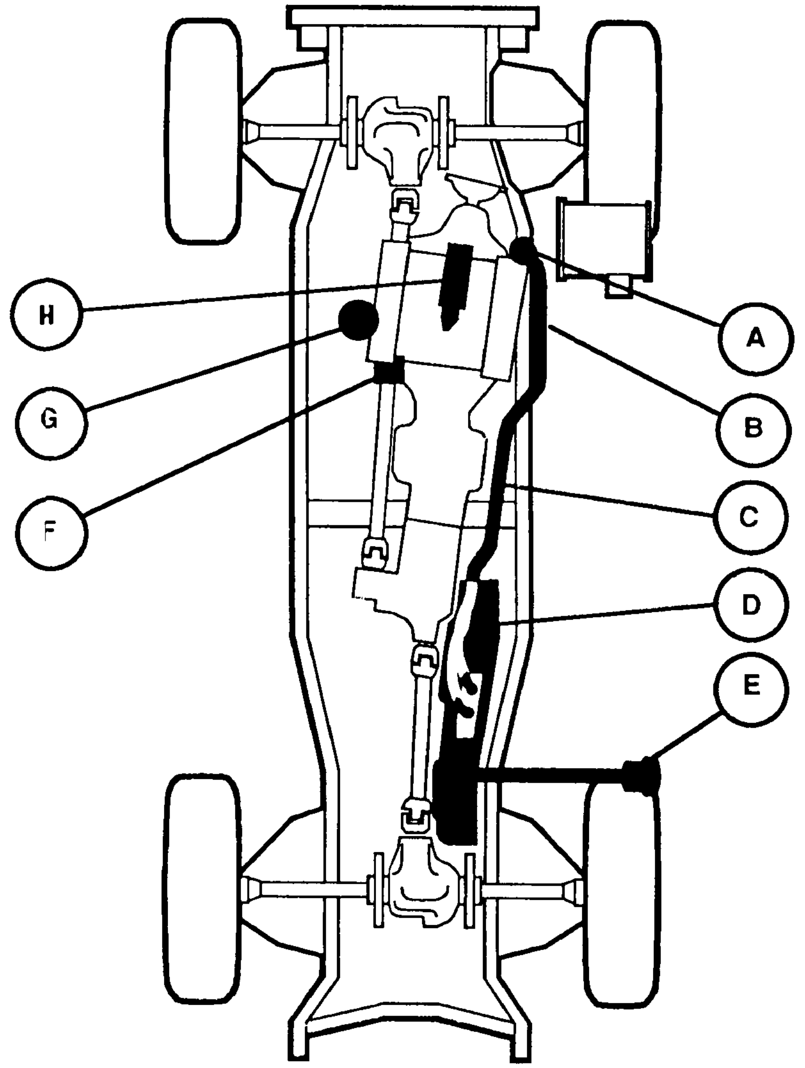
FUEL FILTER/WATER SEPARATOR filters fine particles and water from the fuel

FUEL SOLENOID opens to admit fuel to the injection pump for engine run and closes to stop fuel flow when shutting down engine

INJECTION PUMP delivers high pressure fuel to each injector in its proper turn

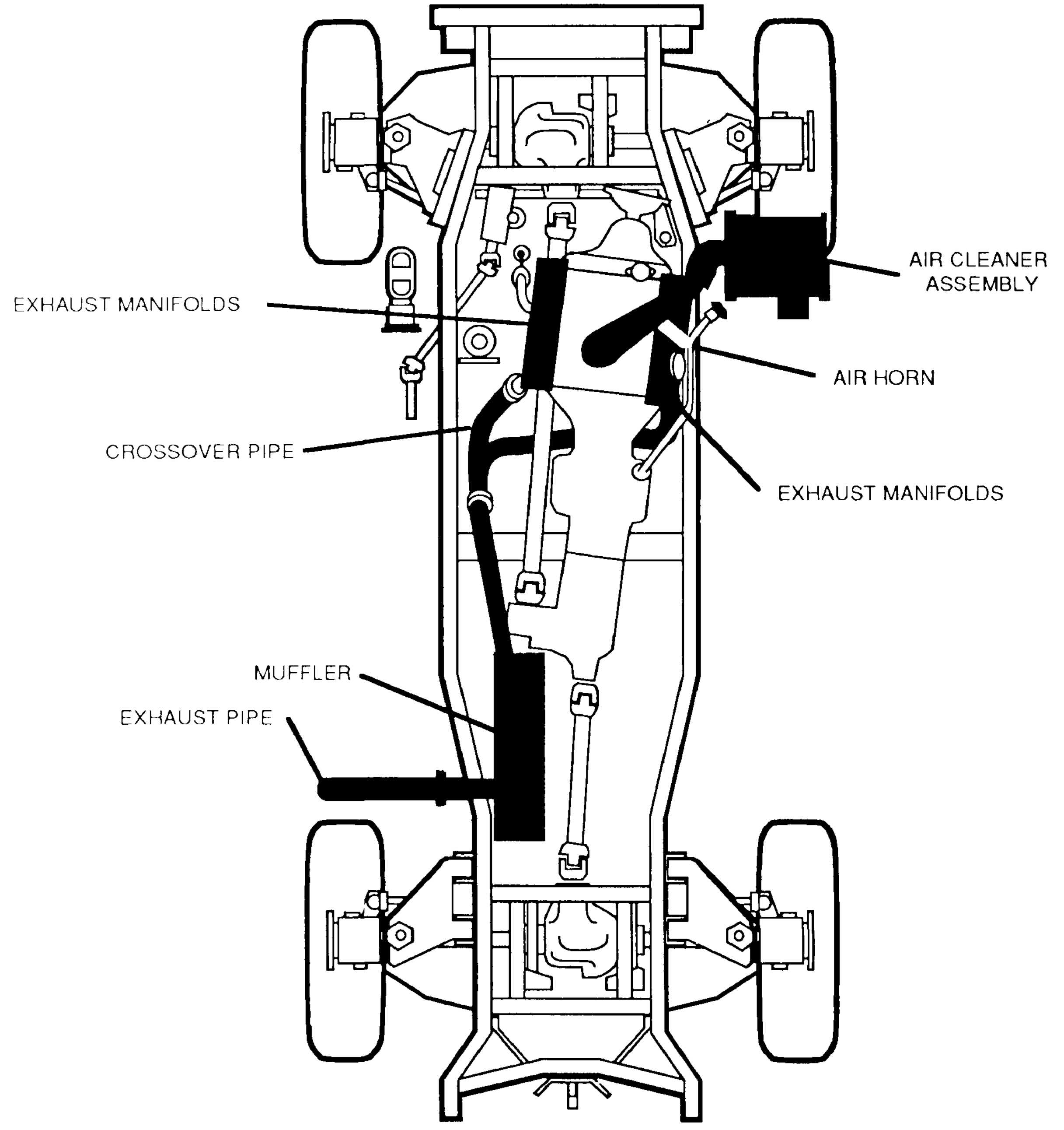
FUEL INJECTORS spray high pressure fuel into the cylinders at the proper time for combustion

A	FUEL LIFT PUMP	DRAWS FUEL FROM FUEL TANK THRU THE SUPPLY LINE AND PUMPS IT TO THE FUEL FILTER
B	FUEL RETURN LINE	DIRECTS UNUSED FUEL FROM THE INJECTION PUMP BACK TO THE FUEL TANK
C	FUEL SUPPLY LINE	DIRECTS FUEL FROM FUEL TANK TO THE SYSTEM
D	FUEL TANK	STORES 25 GALLONS OF DIESEL FUEL
E	FUEL FILLER CAP	LOCATED AT RIGHT REAR SIDE OF VEHICLE, THE CAP IS REMOVED TO PERMIT FUEL TANK SERVICING
F	FUEL INJECTORS	RECEIVE METERED FUEL FROM THE INJECTION PUMP AND SPRAYS FUEL INTO THE COMBUSTION CHAMBER
G	FUEL FILTER/ WATER SEPARATOR	FILTERS WATER AND SEDIMENT FROM FUEL BEFORE FUEL ENTERS THE INJECTION PUMP
H	INJECTION PUMP	DIRECTS METERED AND PRESSURIZED FUEL TO THE EIGHT INJECTOR NOZZLES. IT IS MOUNTED ON TOP OF THE ENGINE UNDER THE INTAKE MANIFOLD

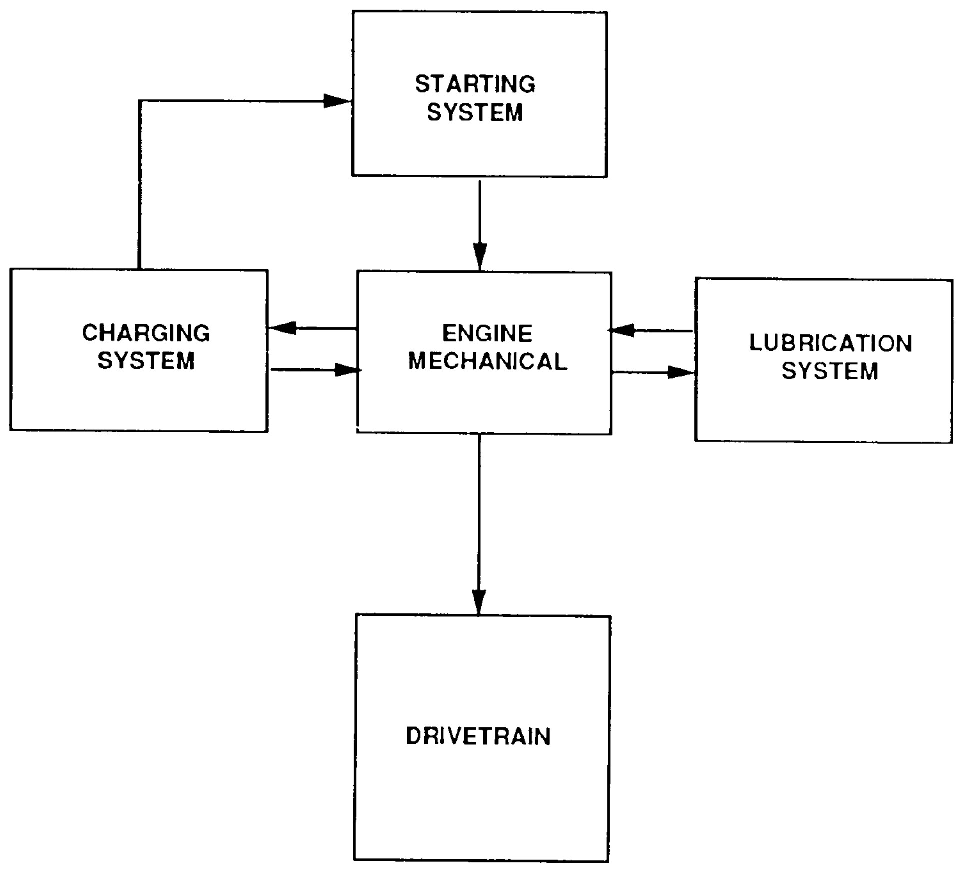


FO-1 Fuel System Functional Flow and Locations of Parts Diagrams

NOT APPLICABLE TO THIS SYSTEM

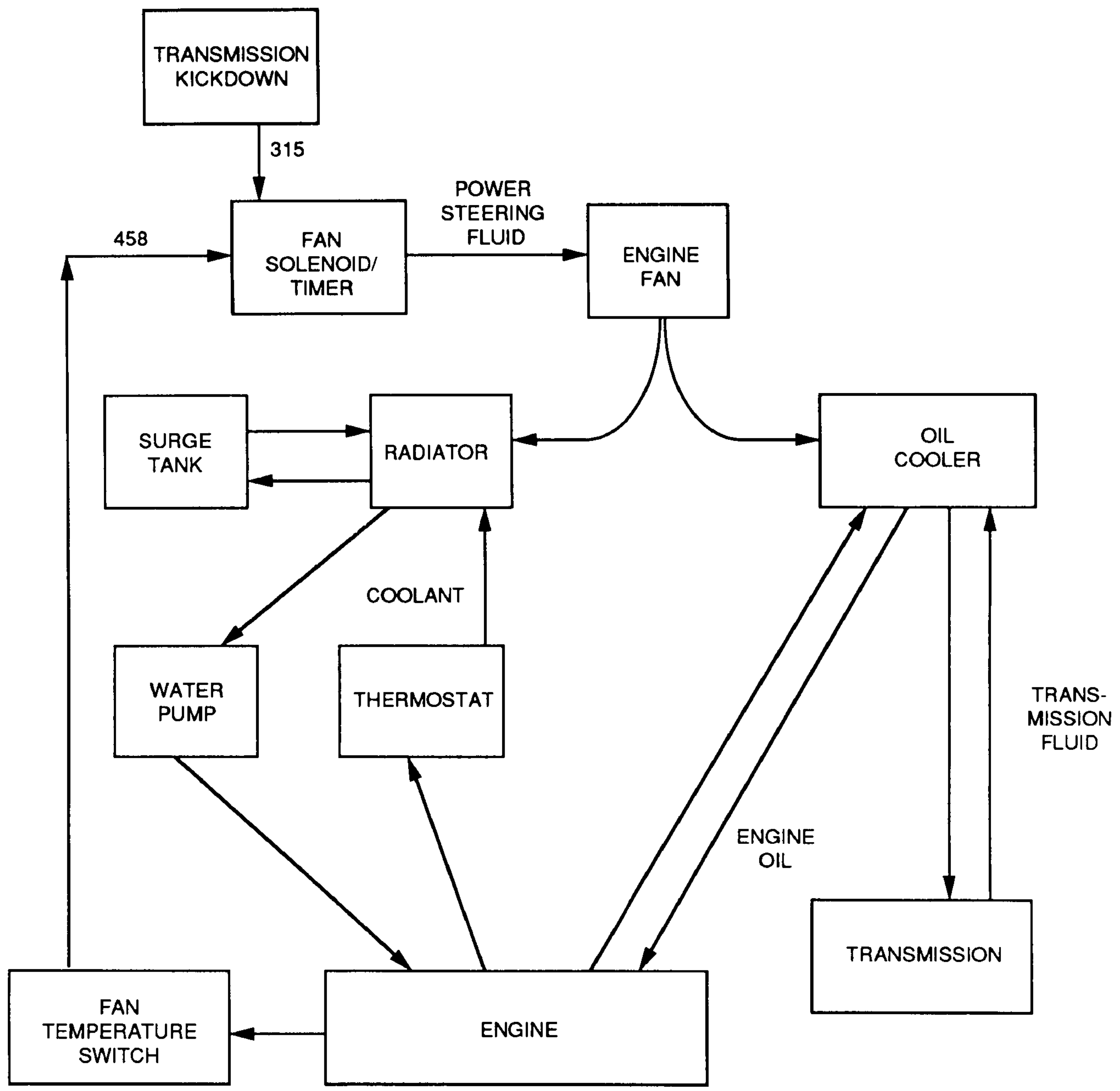


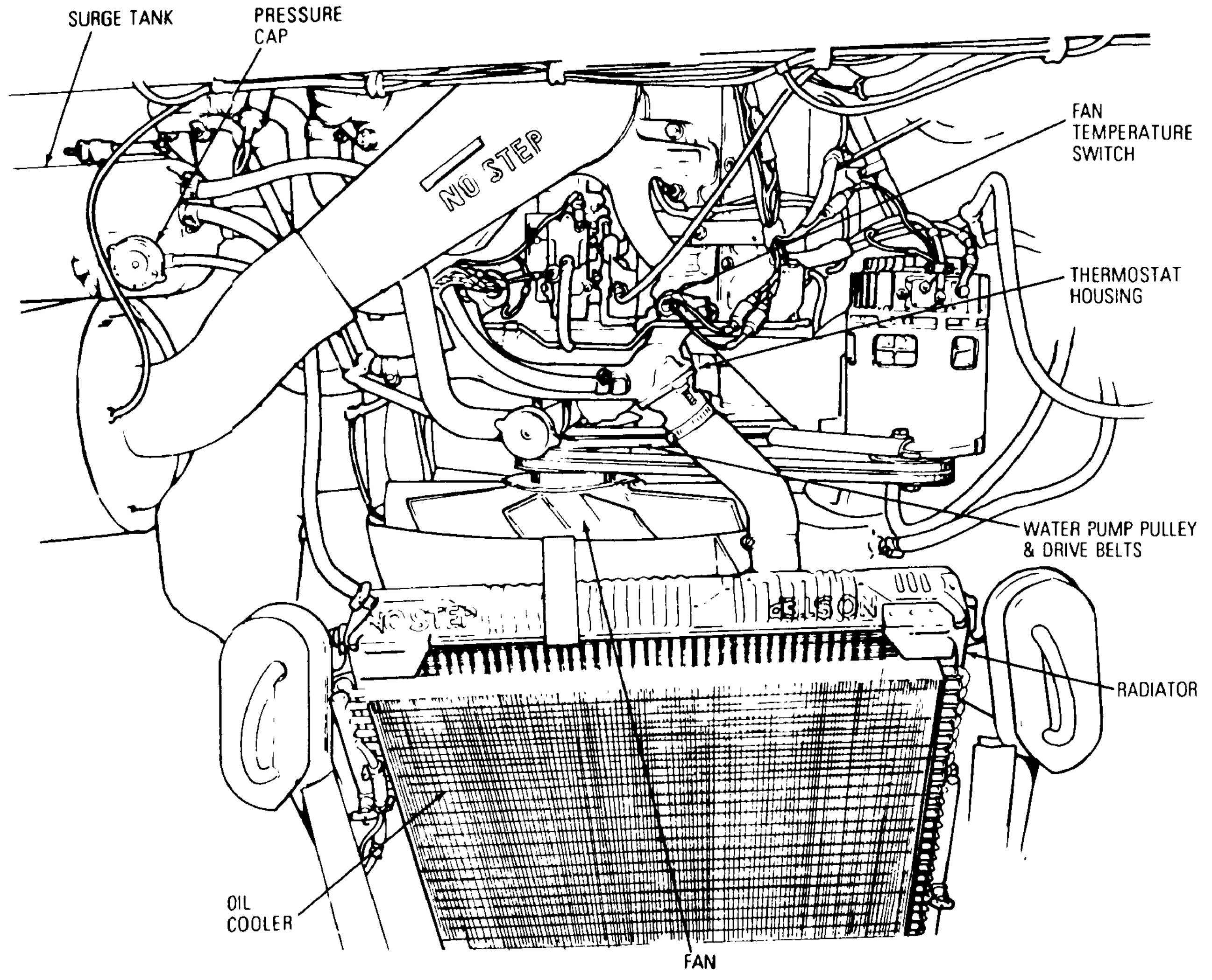
FO-2 Intake Air/Exhaust Functional Flow and Location of Parts Diagrams



NOT APPLICABLE TO THIS SYSTEM

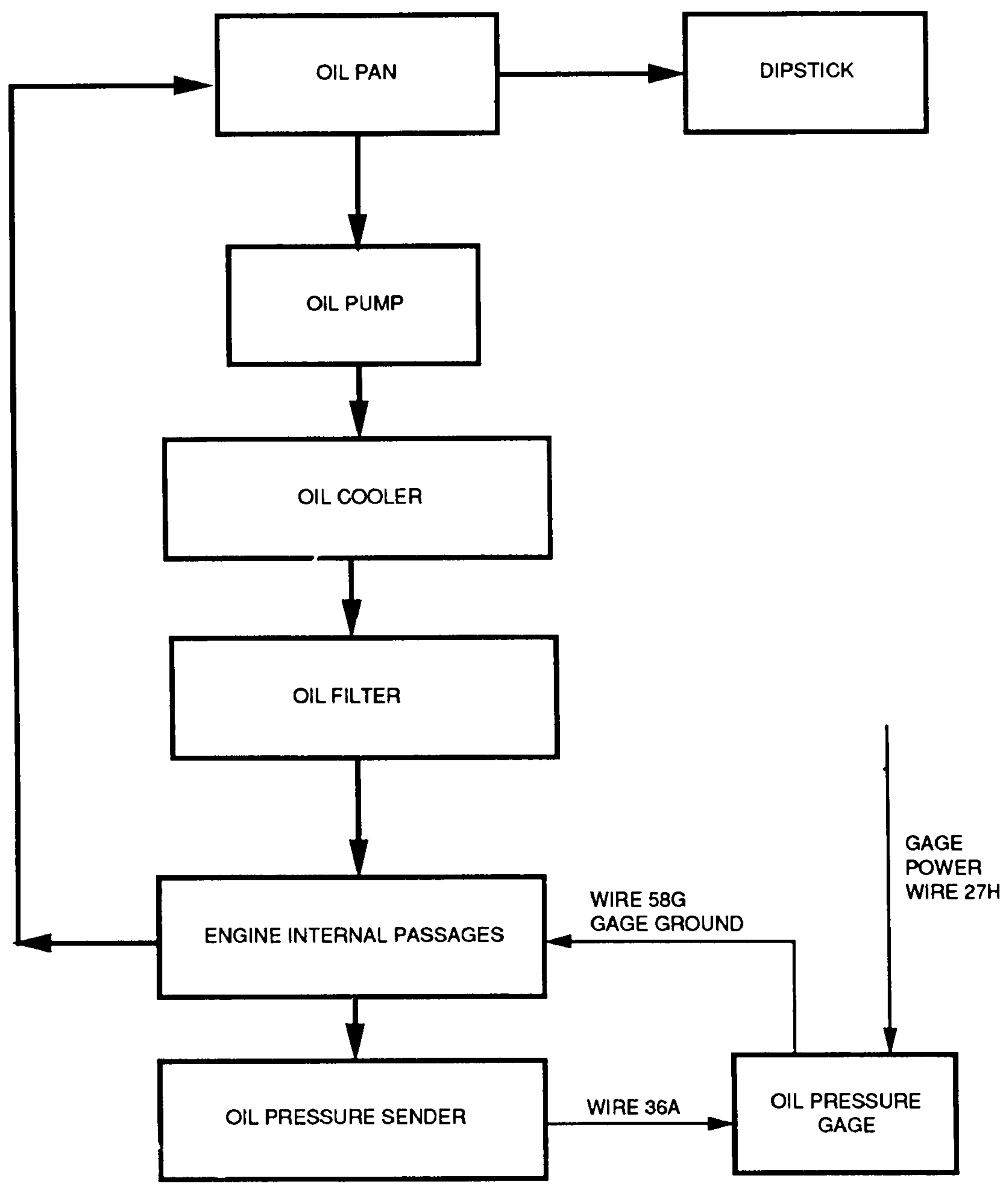
FO-3 Compression/Mechanical Function Flow and Location of Parts Diagrams

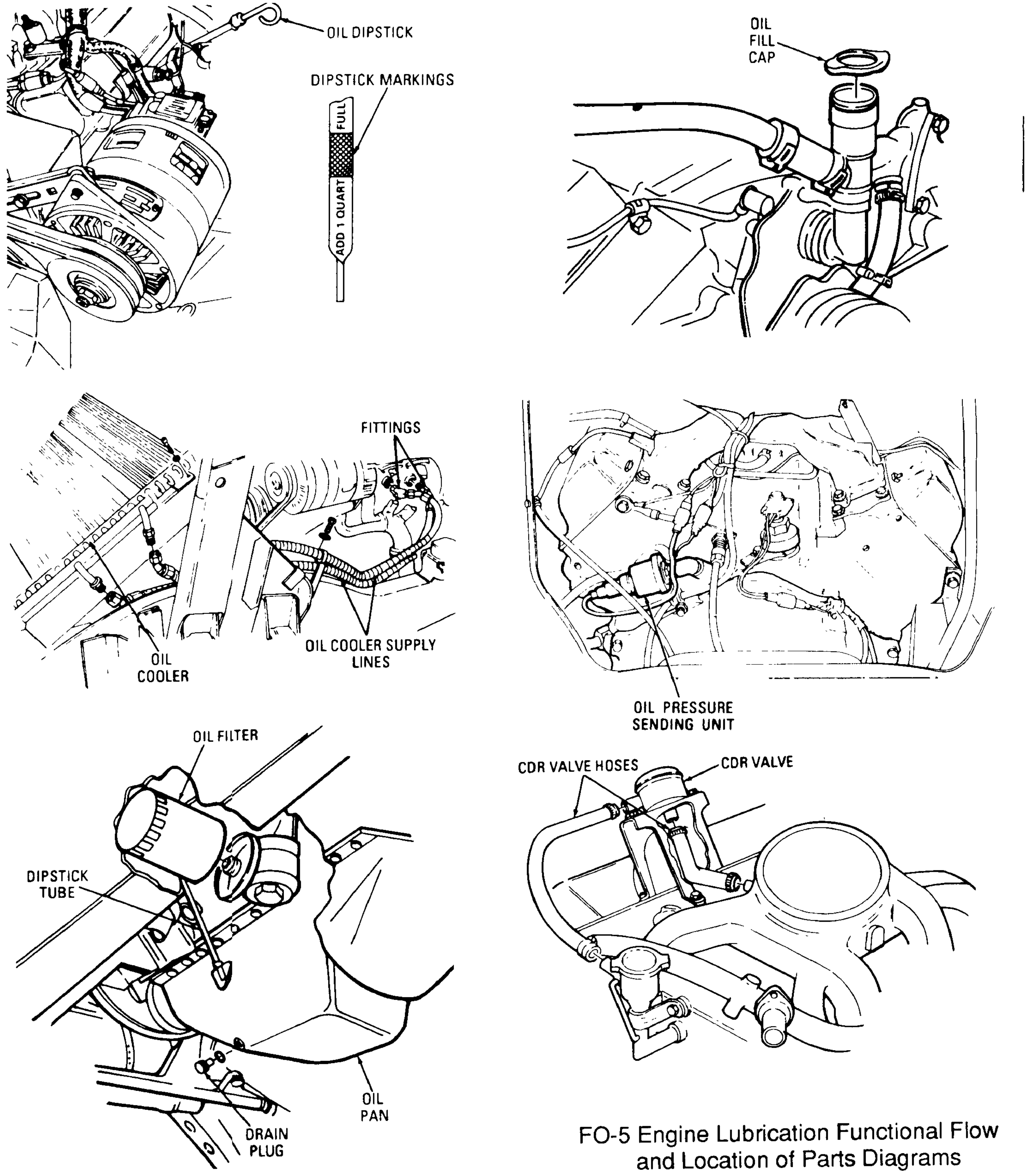




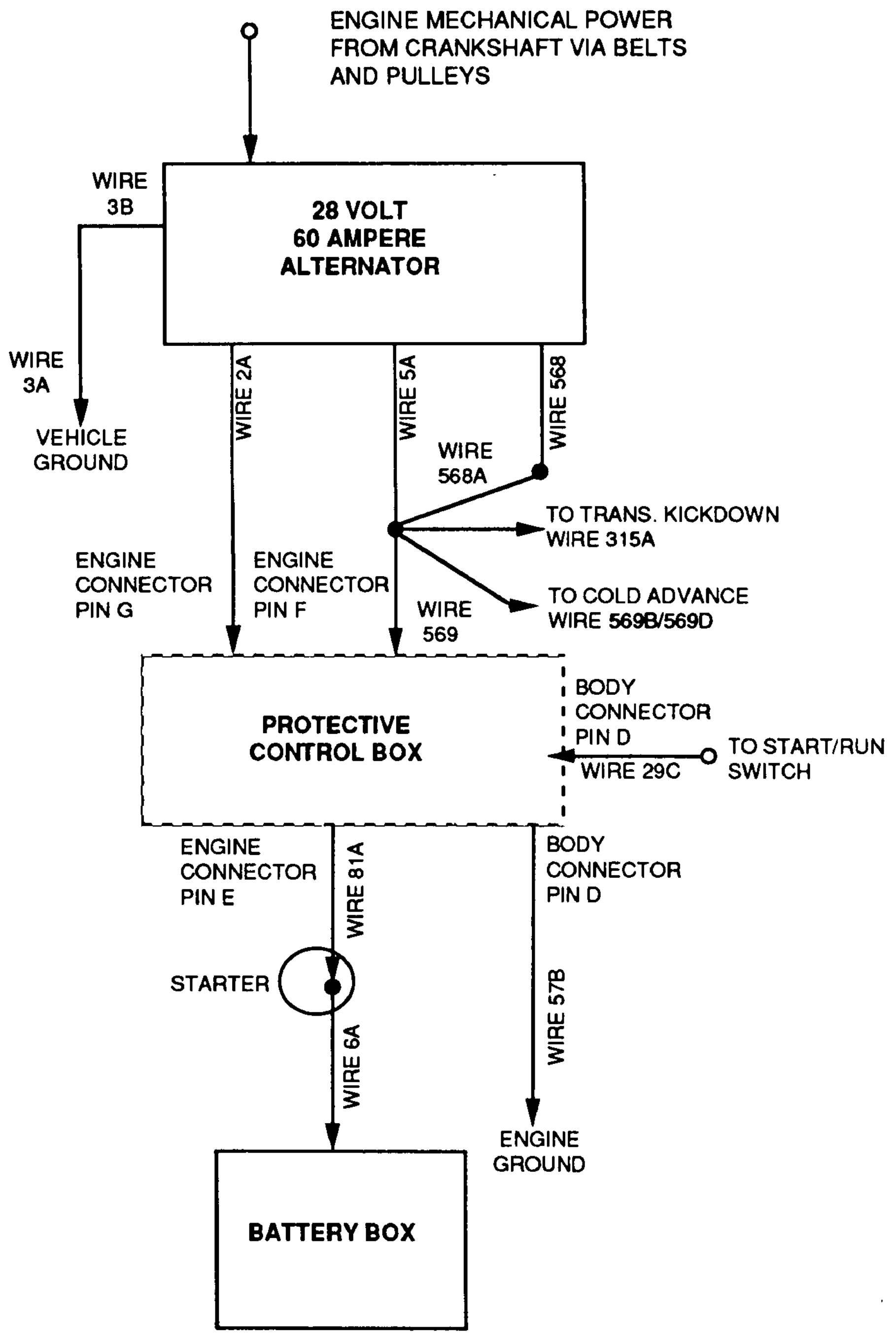
FO-4 Cooling Functional Flow and LOcation of Parts Diagrams

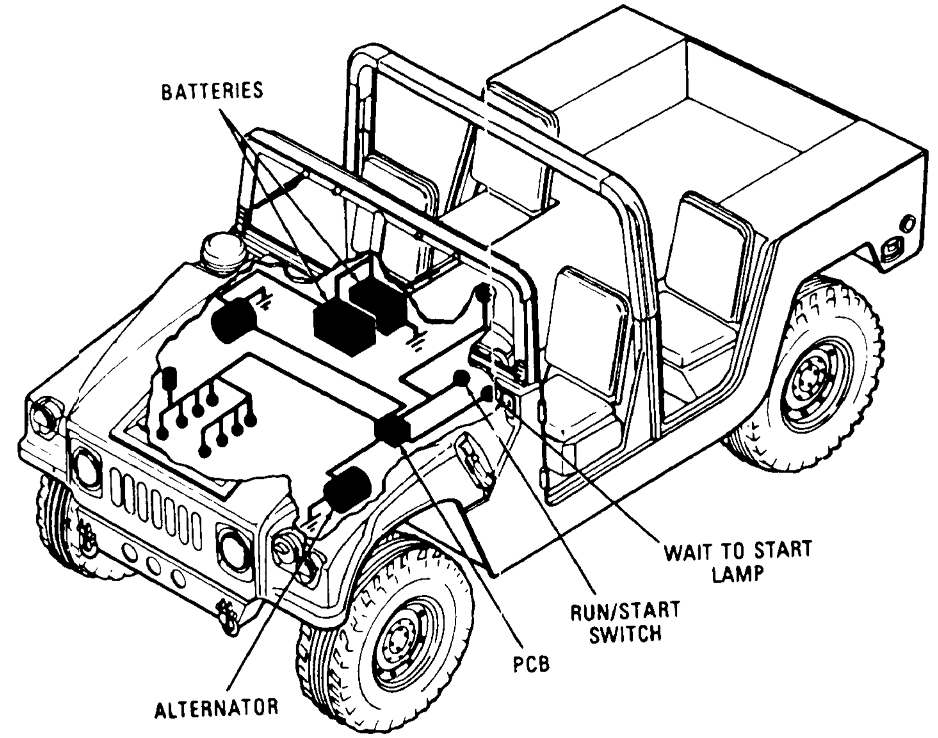
NOTE: HEAVIER LINES INDICATE OIL FLOW AND LIGHTER LINES ARE WIRES



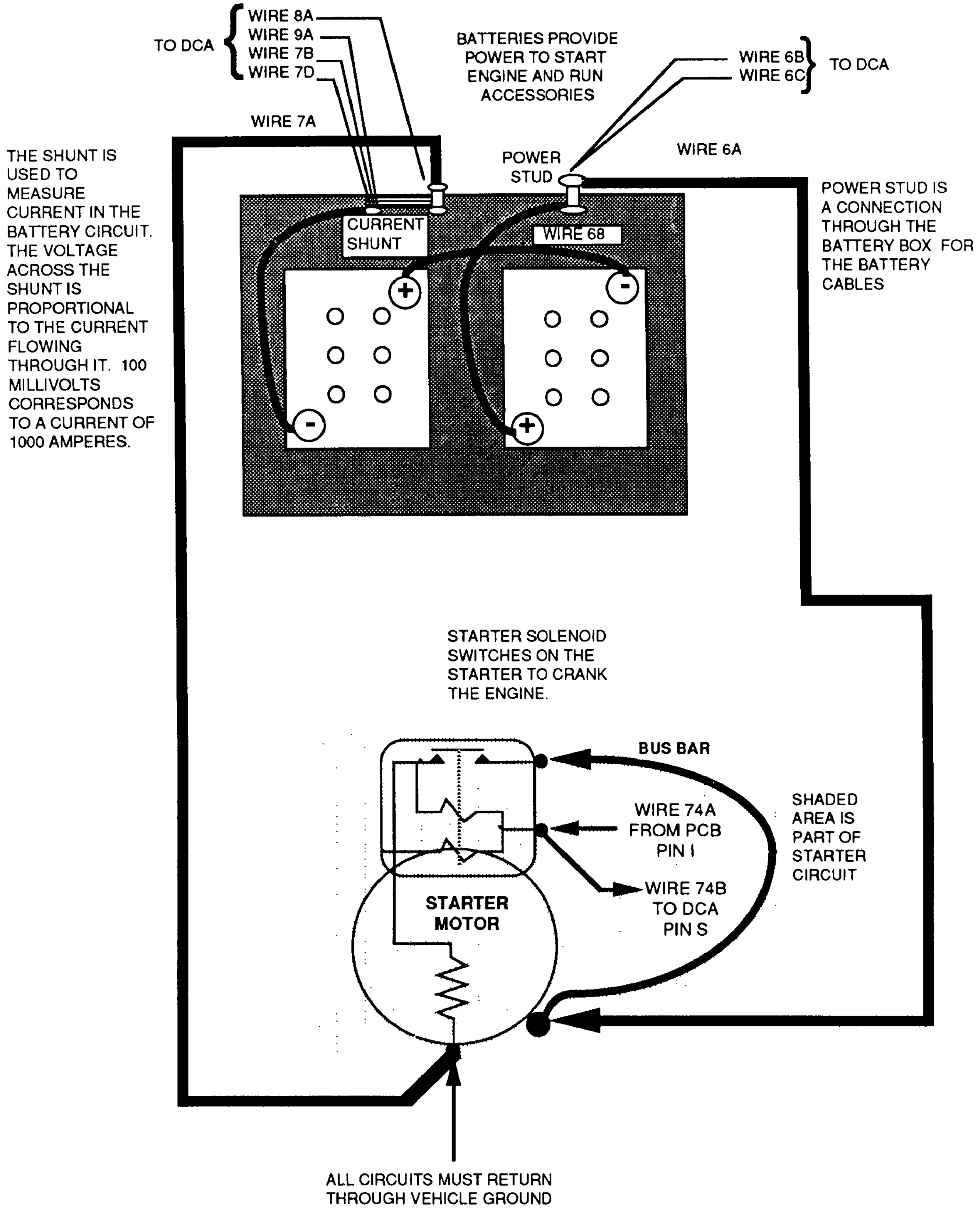


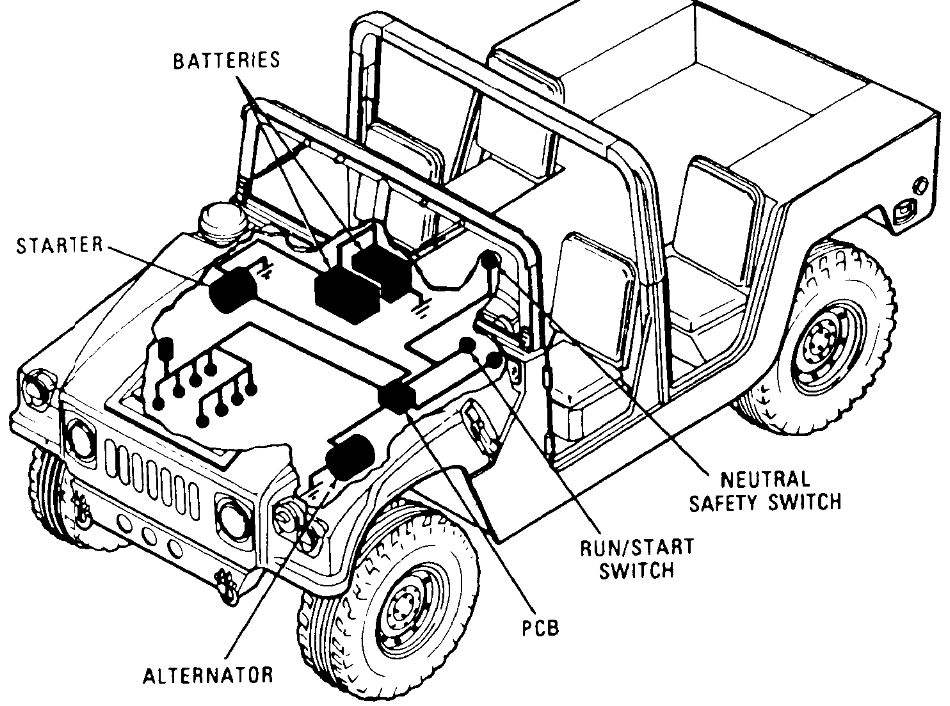
FO-5 Engine Lubrication Functional Flow and Location of Parts Diagrams





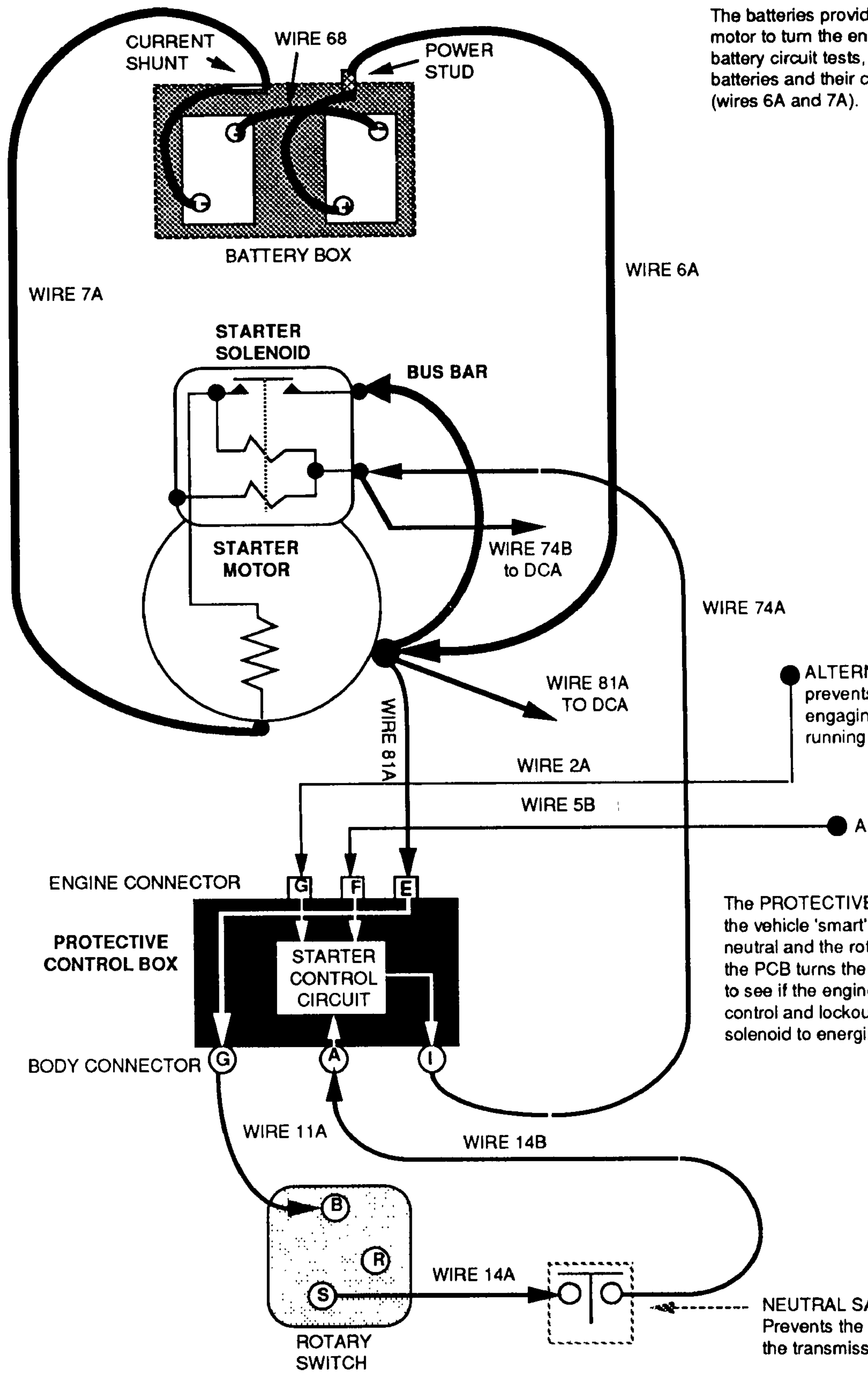
FO-6 Alternator Functional Flow and Location of Parts Diagrams



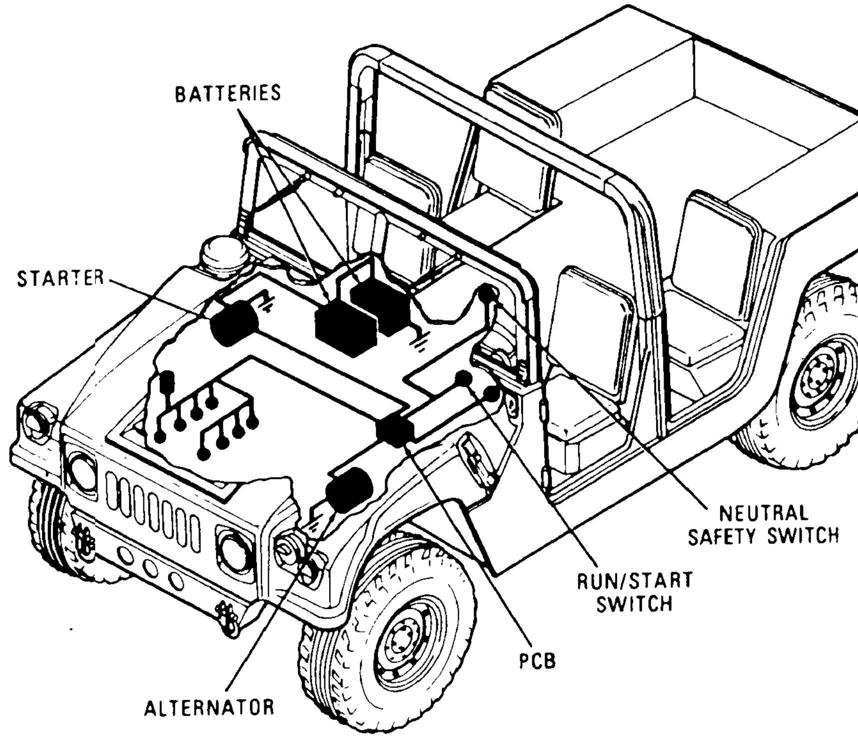


FO-7 Battery Functional Flow and Location of Parts Diagrams

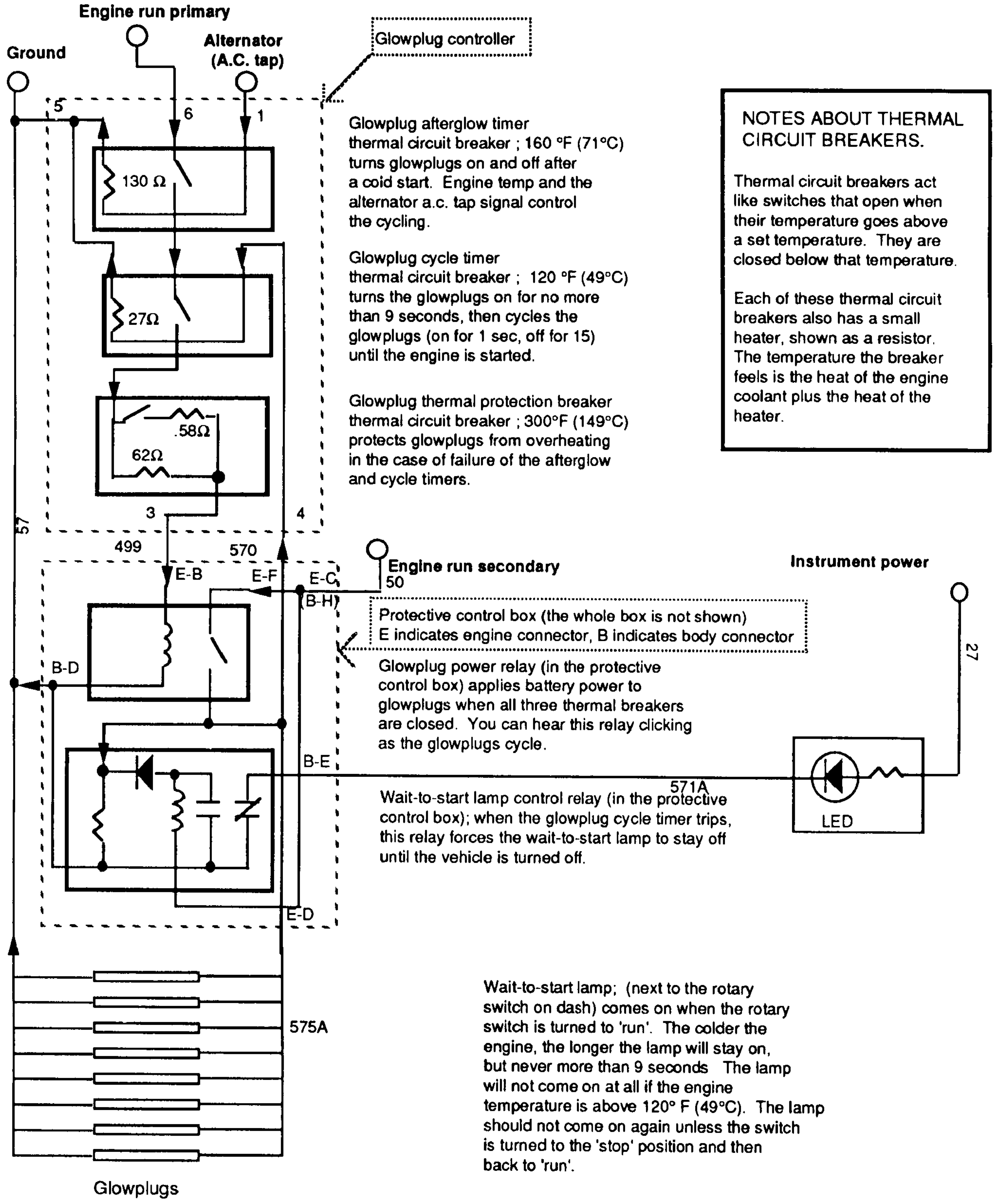
The batteries provide power for the starter motor to turn the engine so it can start. The battery circuit tests, p. 13-1, check out the batteries and their connections to the starter (wires 6A and 7A).

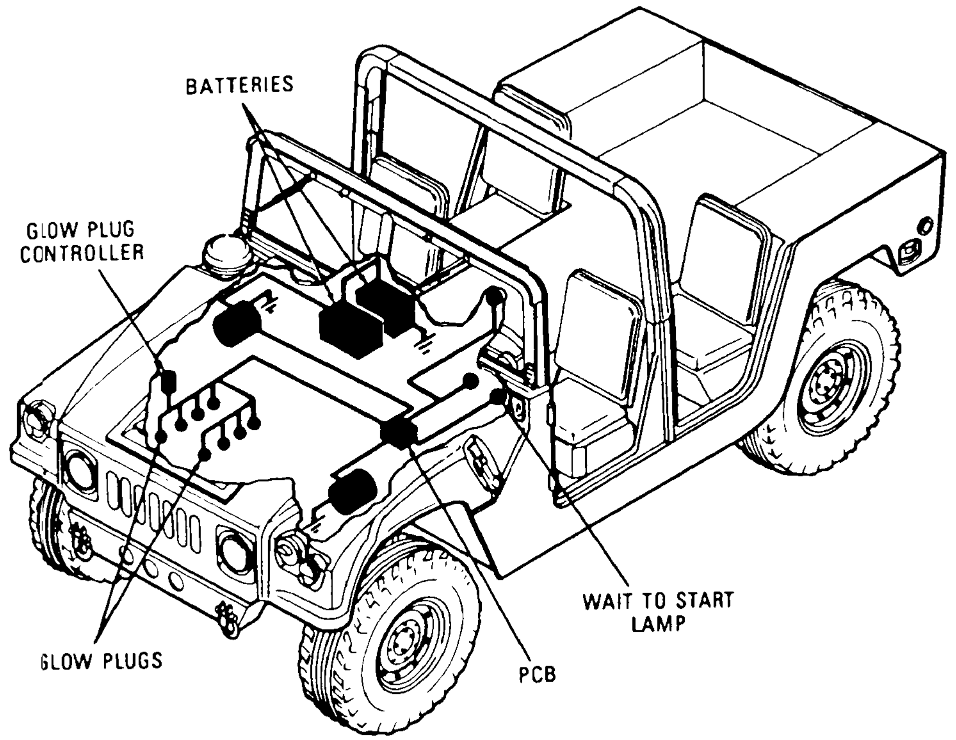


The PROTECTIVE CONTROL BOX makes the vehicle 'smart' With the transmission in neutral and the rotary switch turned to start, the PCB turns the dash lamps on and checks to see if the engine is running. The starter control and lockout circuit will not allow the solenoid to energize if the engine is running.

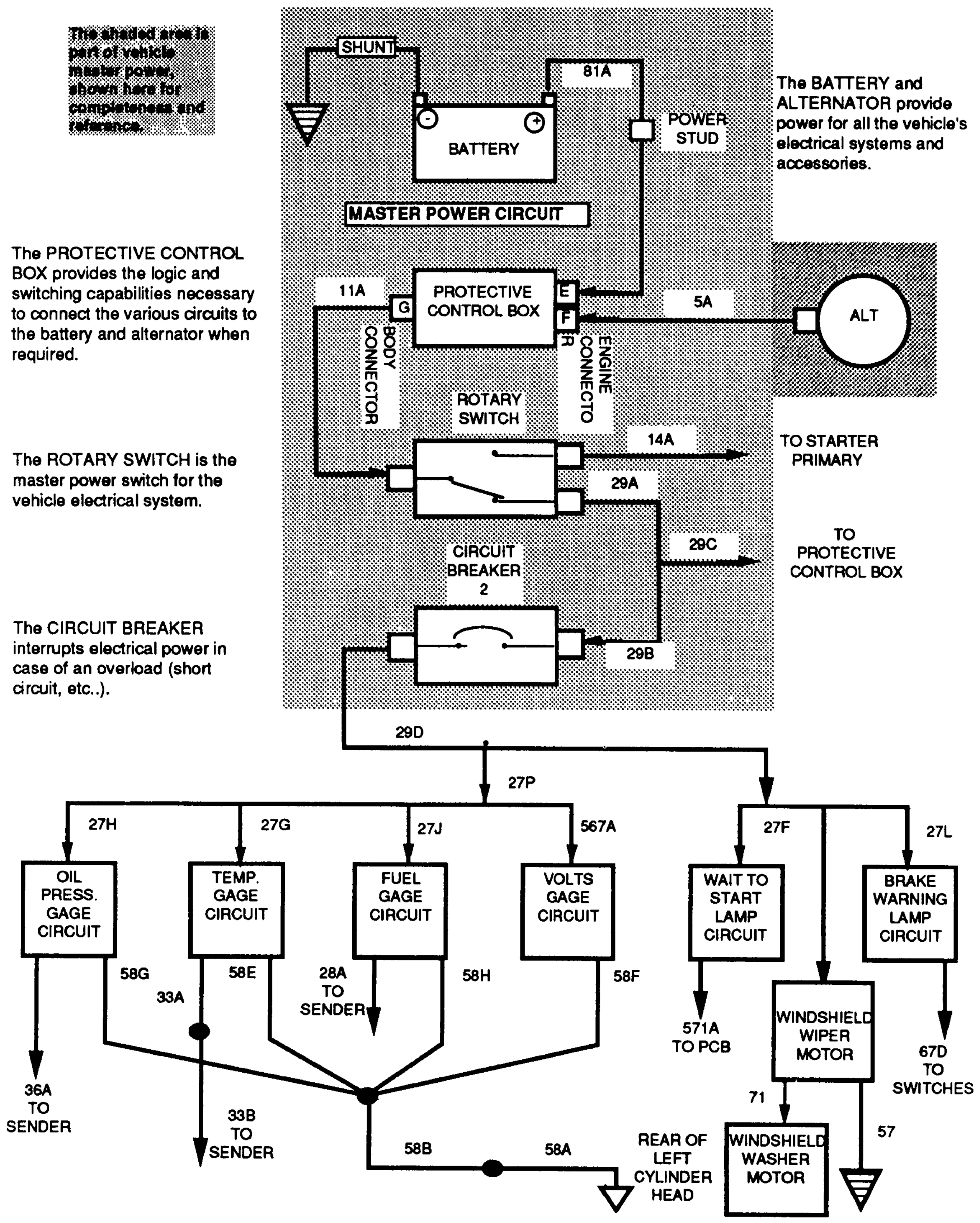


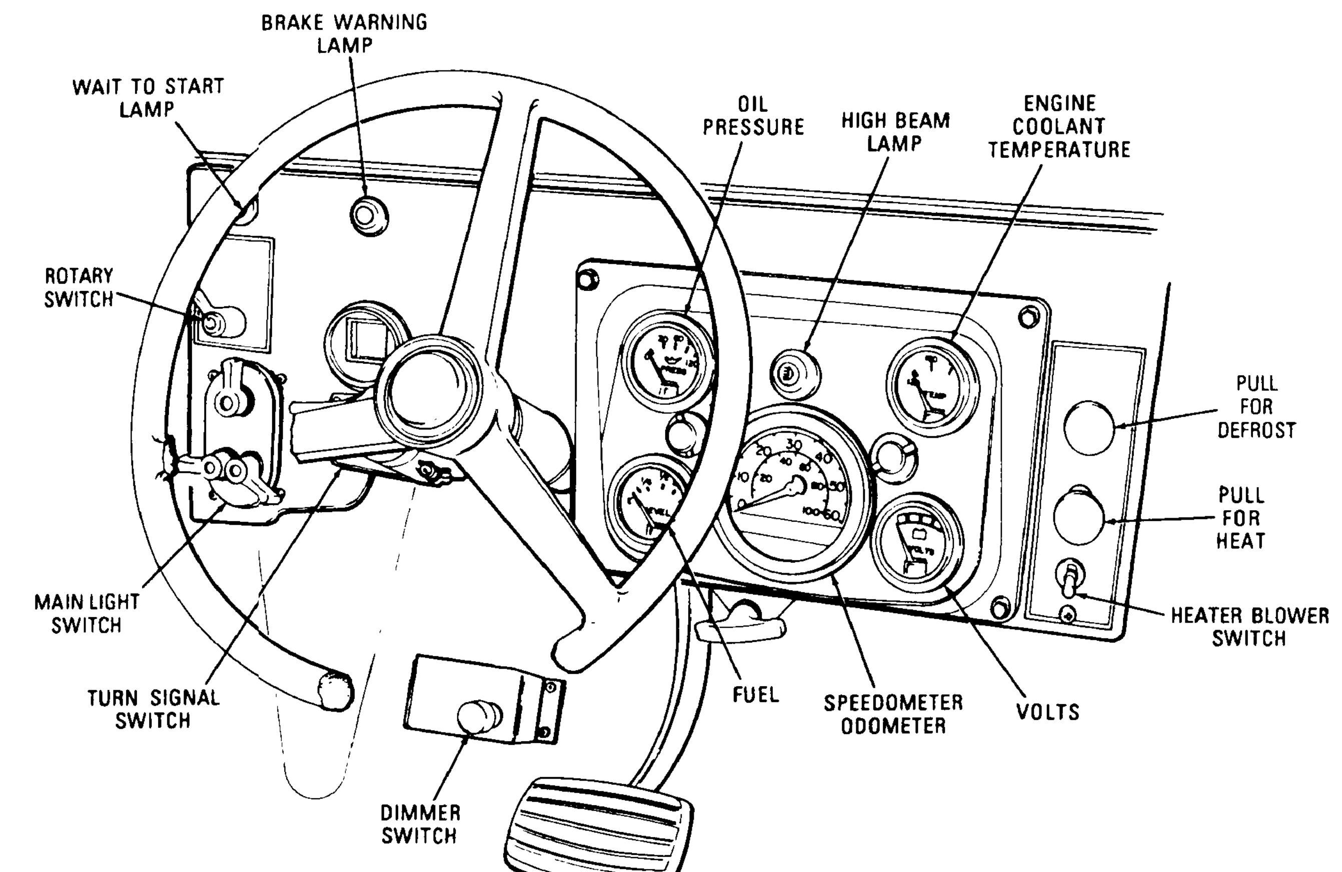
FO-8 Starter Circuit Functional Flow and Location of Parts Diagrams



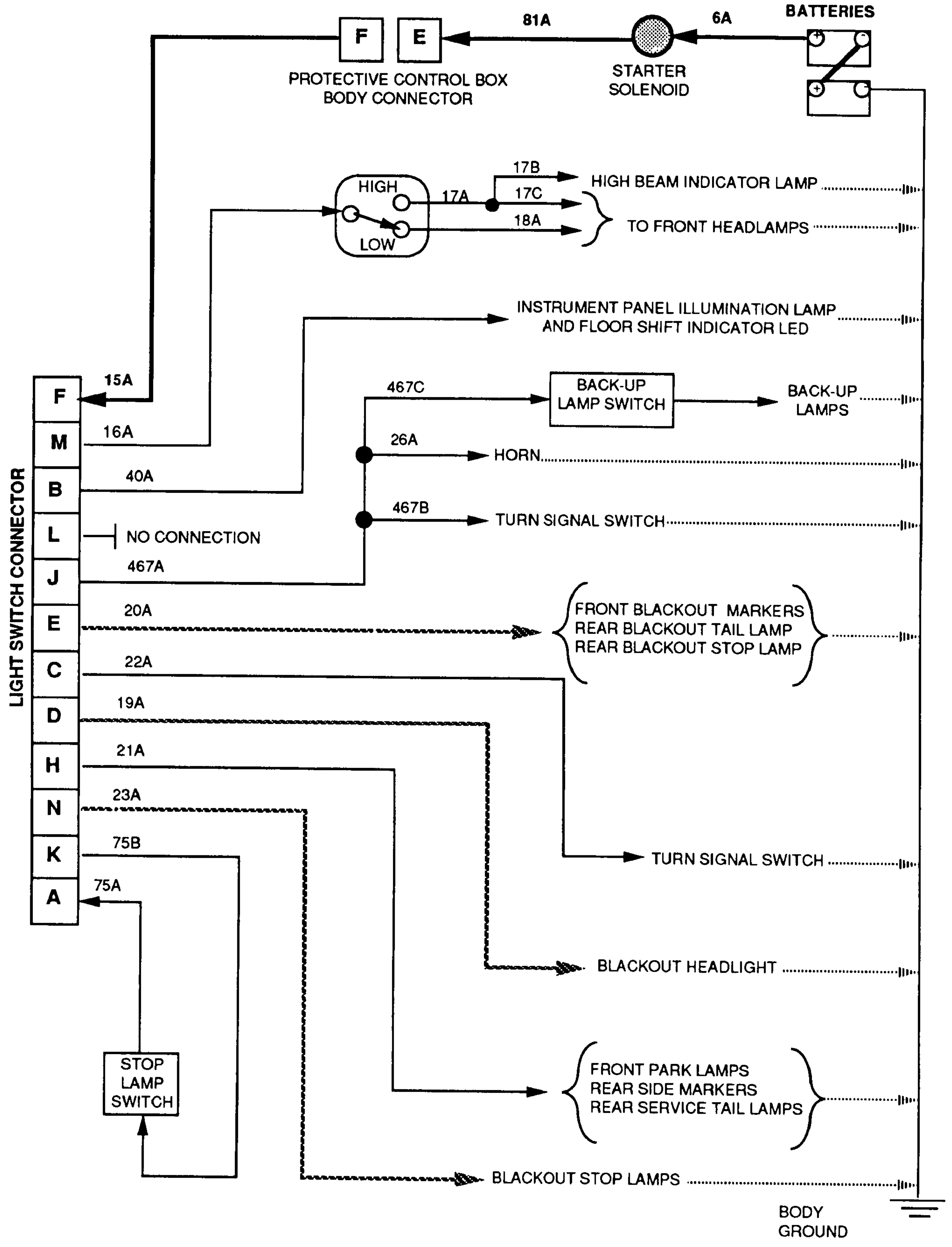


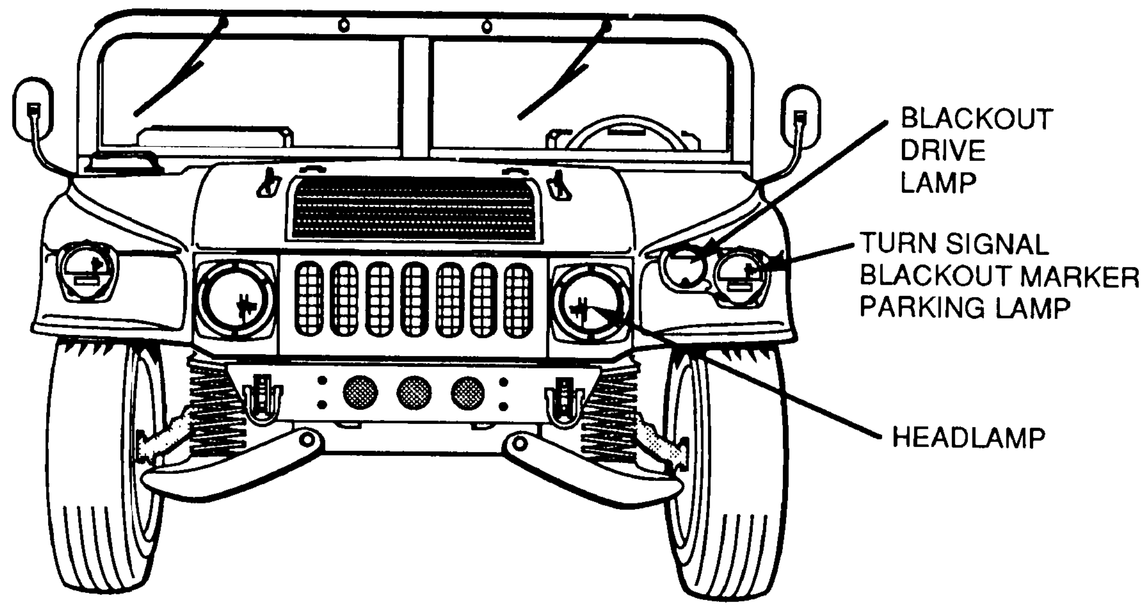
FO-9 Glowplugs Functional Flow and Location of Parts Diagrams



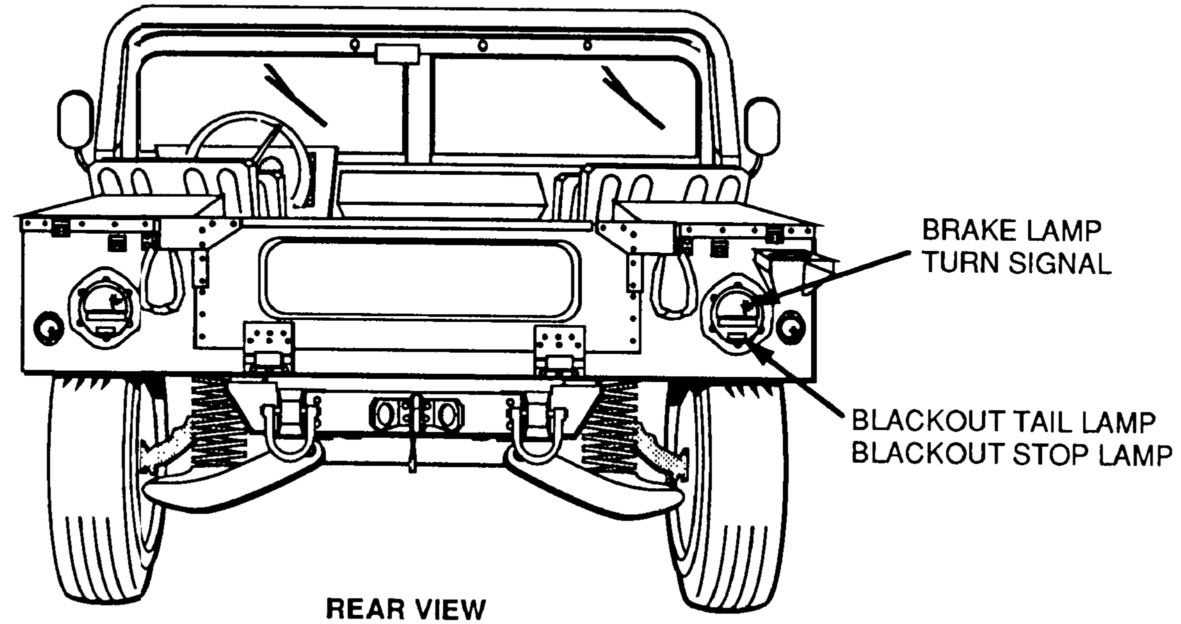


FO-10 Instruments Functional Flow and Location of Parts Diagrams



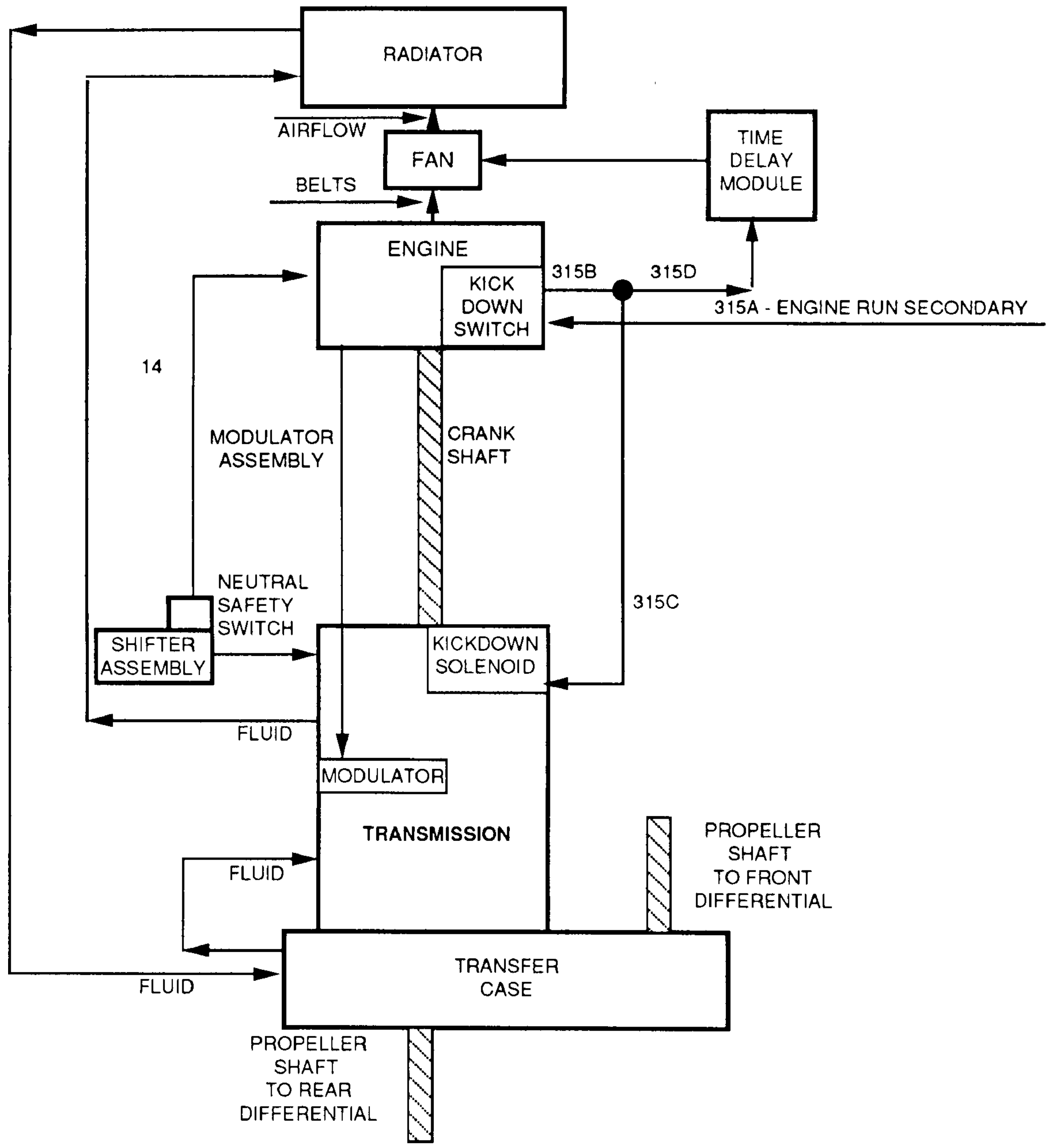


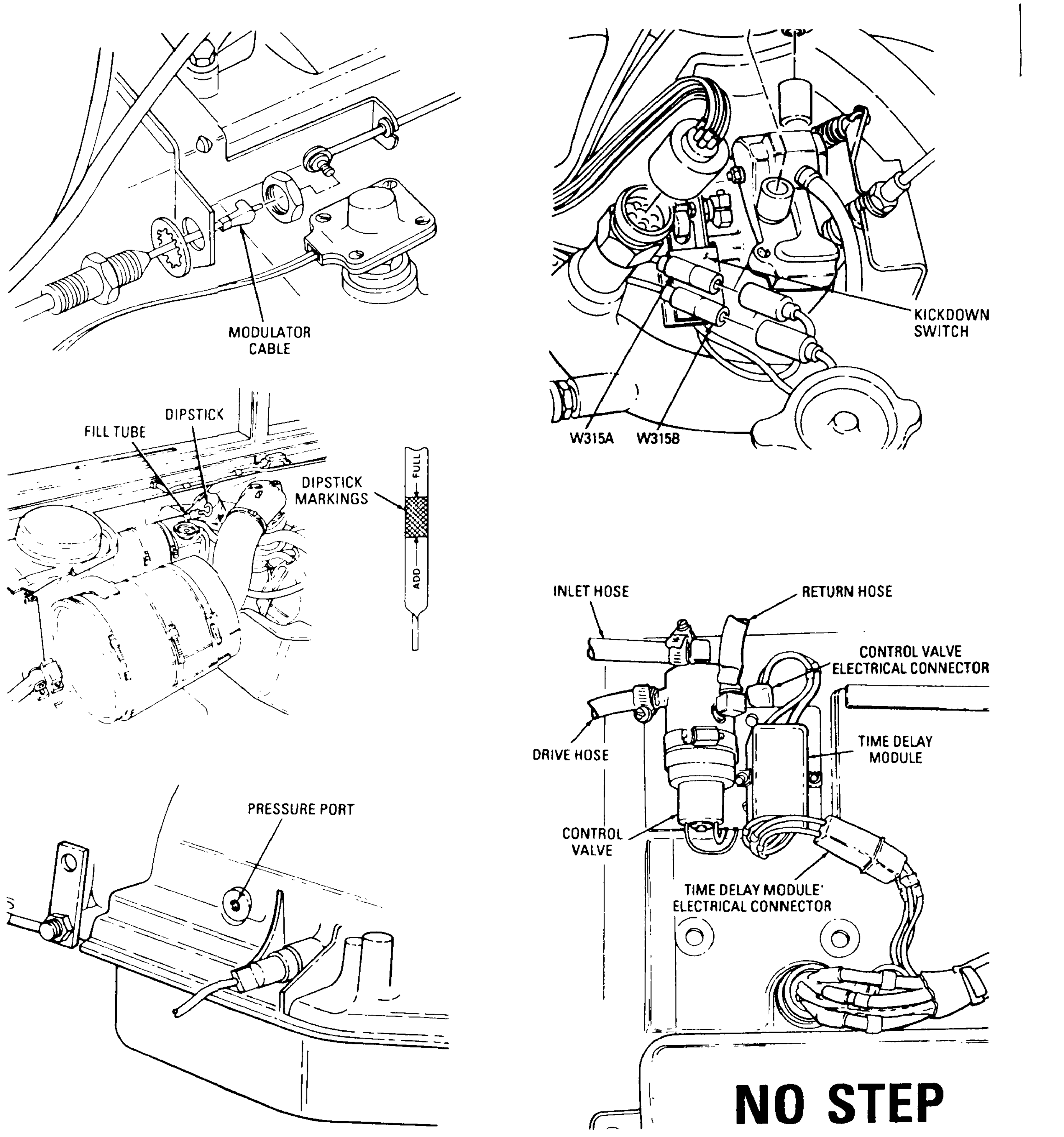
FRONT VIEW



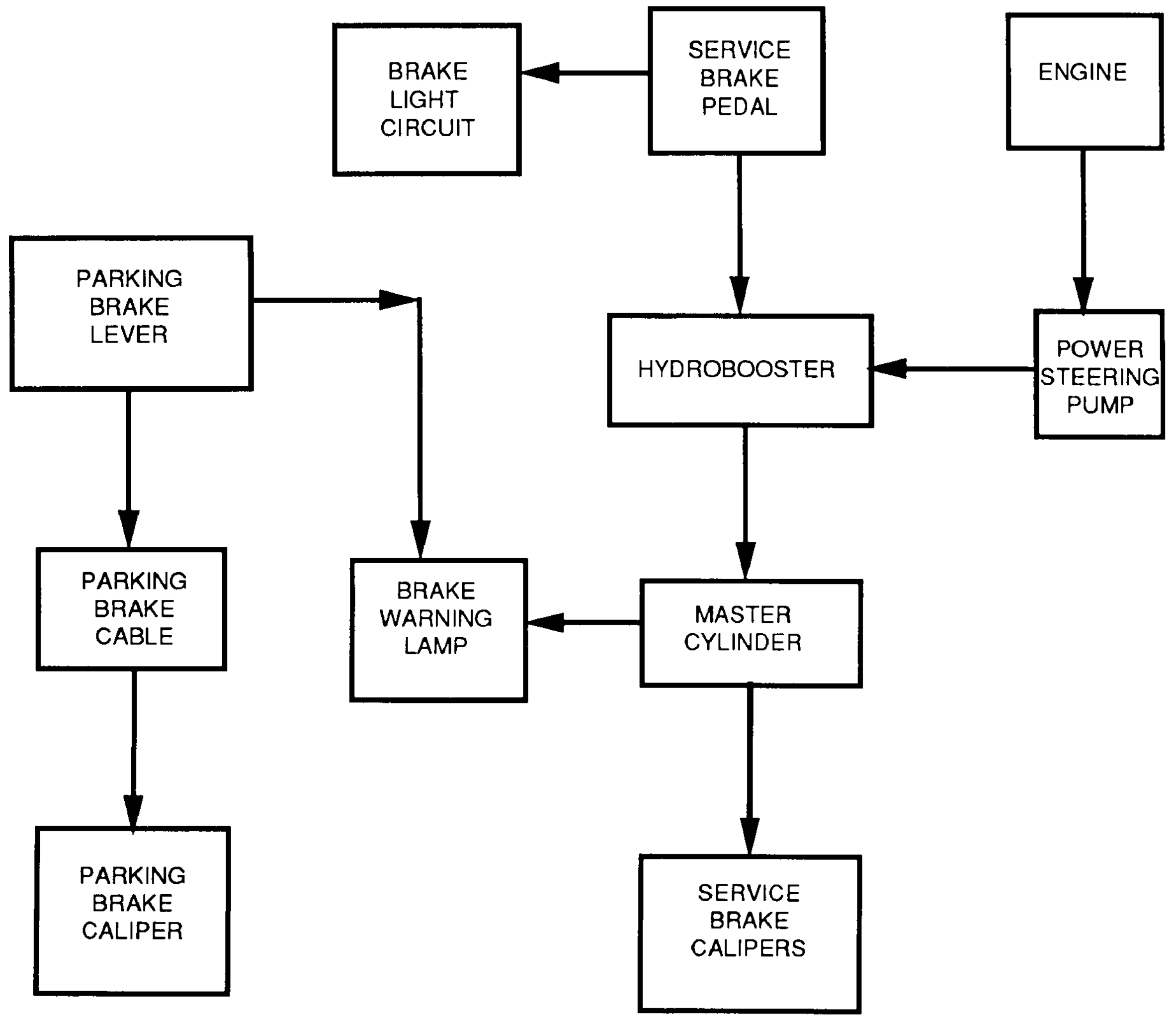
REAR VIEW

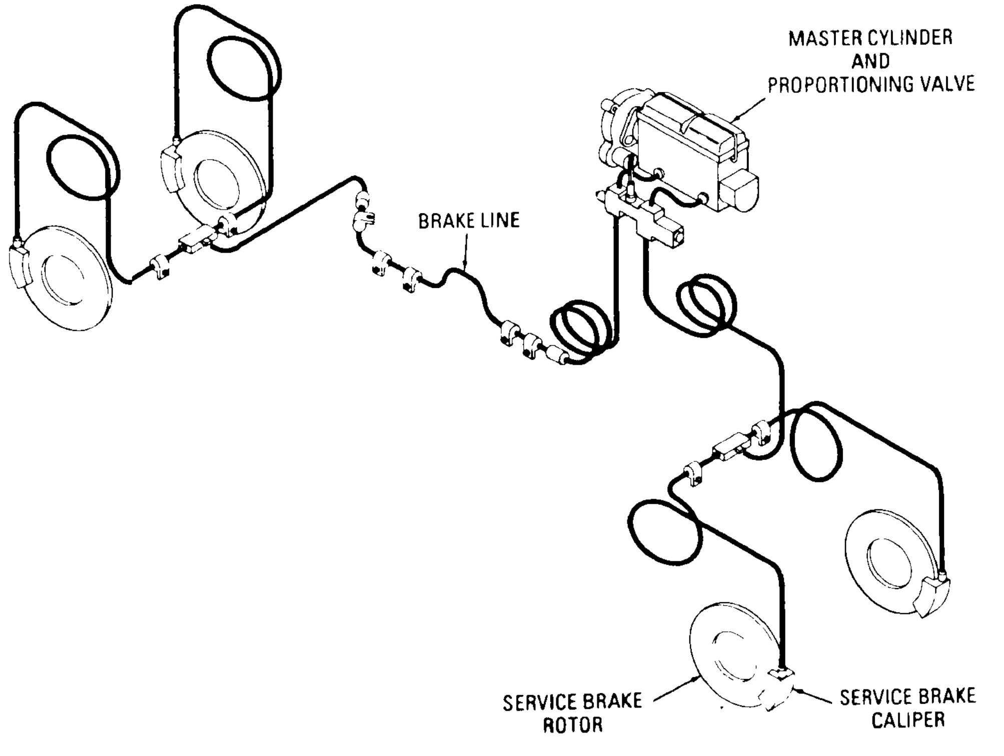
FO-11 Lights Functional Flow
and Location of Parts Diagrams



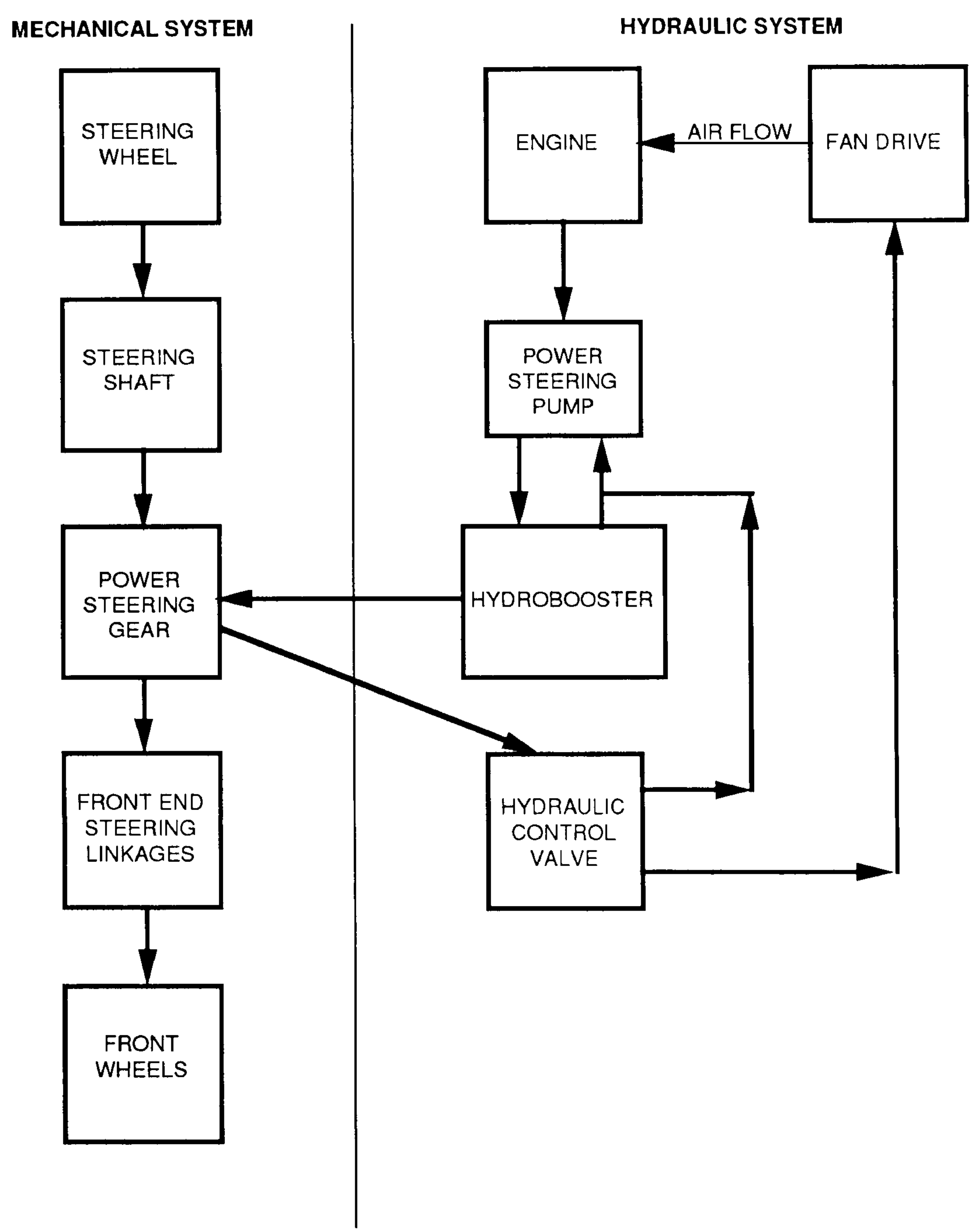


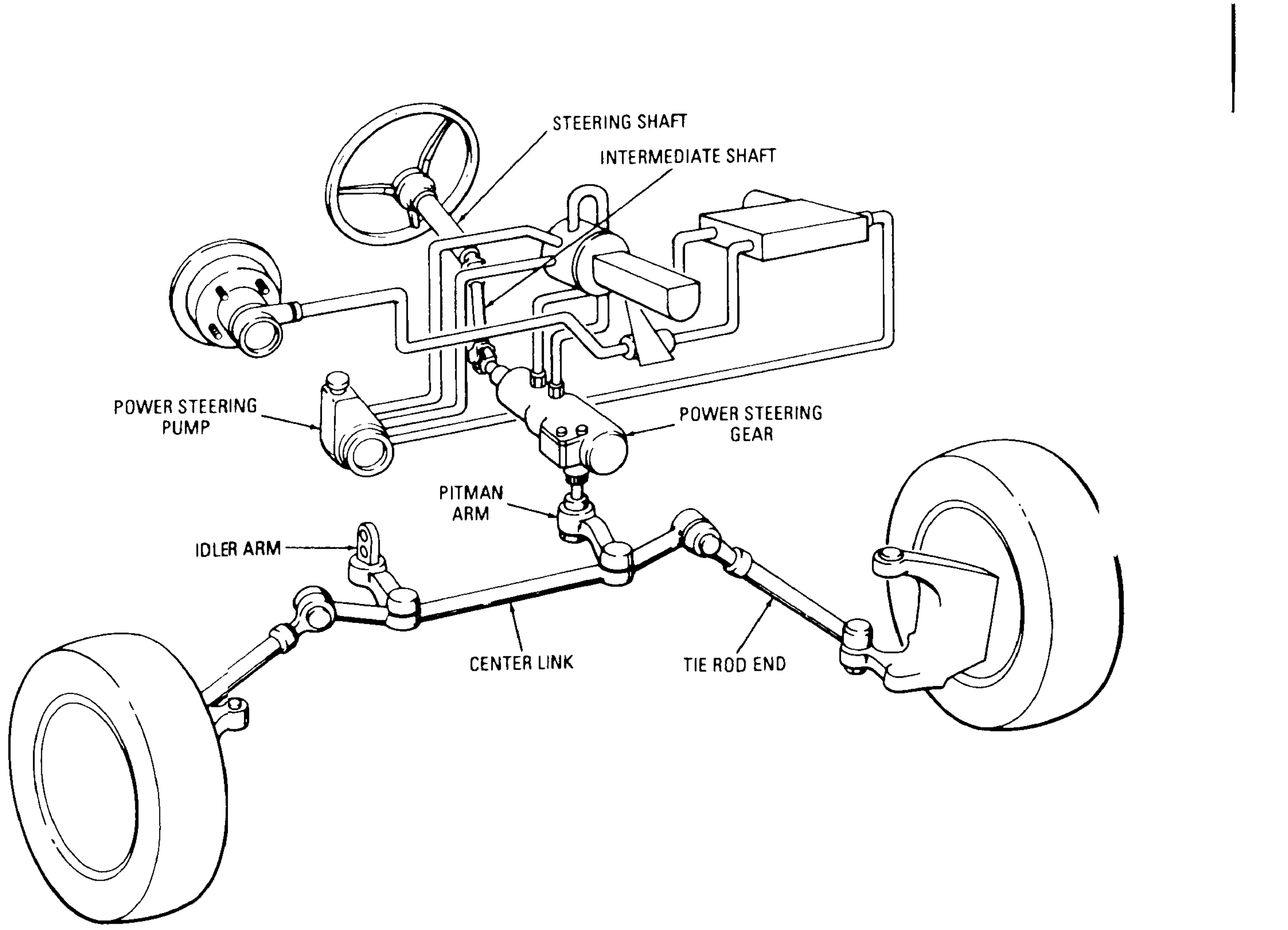
FO-12 Transmission Functional Flow and Location of Parts Diagrams



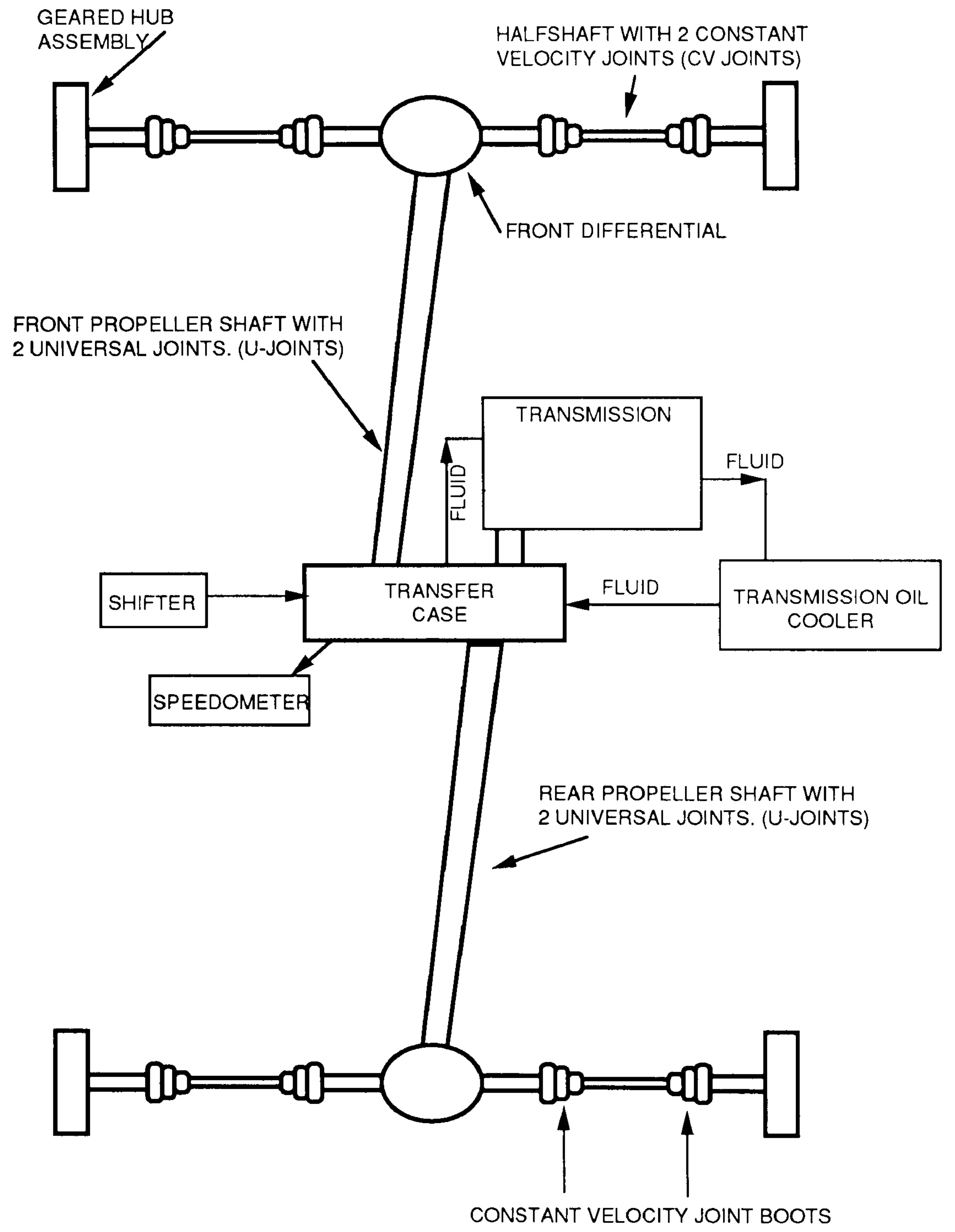


FO-13 Brakes Functional Flow
and Location of Parts Diagrams



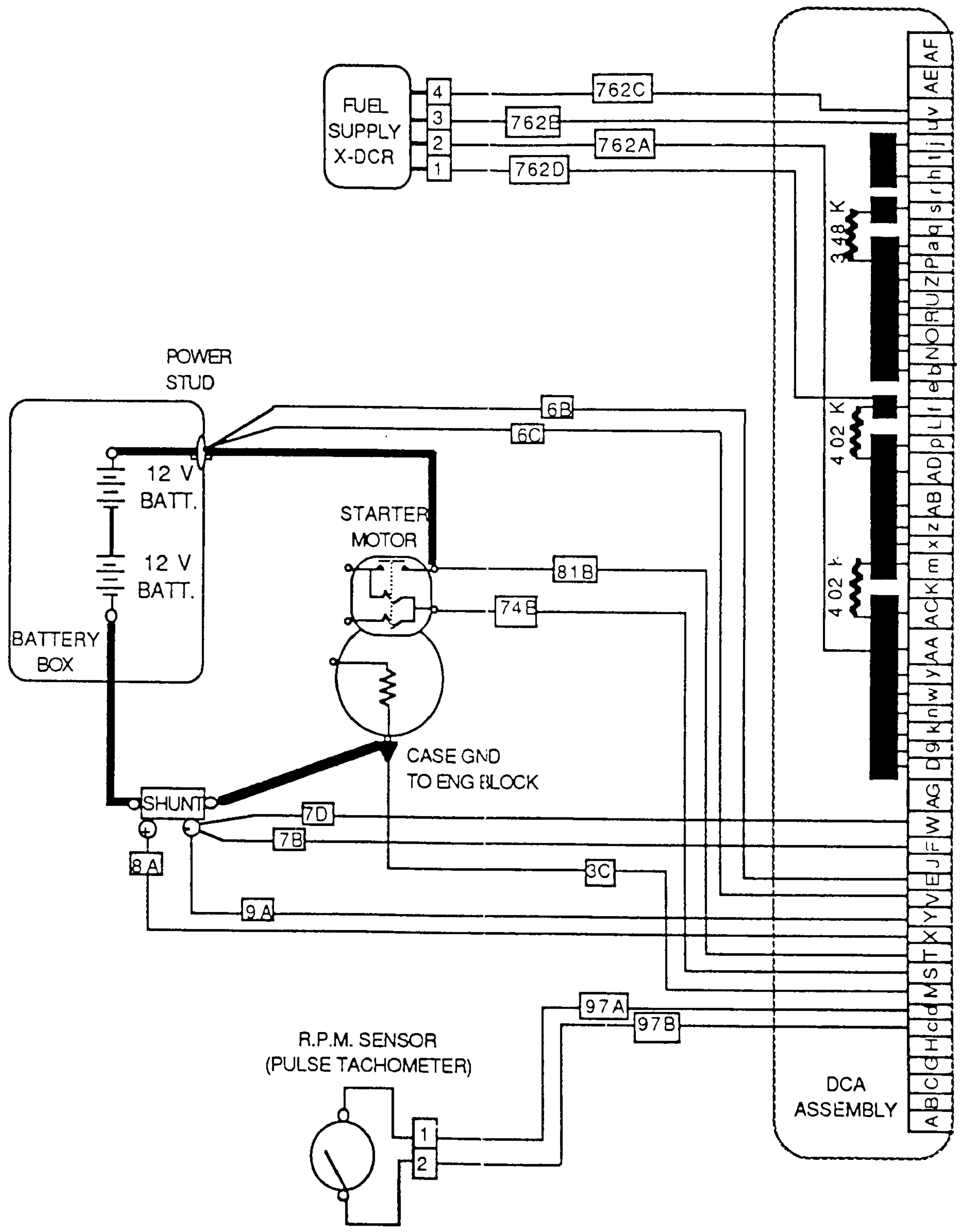


FO-14 Steering Functional Flow
and Location of Parts Diagrams



NOT APPLICABLE TO THIS SYSTEM

FO-15 Drive Train Functional Flow and Location of Parts Diagrams



DCA TO TK CROSS REFERENCE

This table assumes that the VTM is powered by the W5 cable. For additional information on any of these tests, see Chapter 23 or TM 9-4910-571-12&P. Tests 72,73,74, and 75 are known as a first peak series, and data for all four of these tests is taken simultaneously.

DCA TEST	PARAMETER	USE TK ITEM	TEST NO.	MEASUREMENT POINTS
10	RPM	34-PULSE TACH. WITH A W4 CABLE	10	PUT IN PLACE OF VEHICLE TACH.
12	POWER (RPM/SEC)	34-PULSE TACH. WITH A W4 CABLE	12	PUT IN PLACE OF VEHICLE TACH.
13	POWER (PERCENT)	34-PULSE TACH. WITH A W4 CABLE	13	PUT IN PLACE OF VEHICLE TACH.
14	COMPRESSION UNBALANCE	NONE REQUIRED	14	VTM TAKES DATA THROUGH W5 (POWER) CABLE
24	FUEL PRESSURE	22-RED PRESSURE TRANSDUCER	49	INSTALL IN PLACE OF VEHICLE FUEL PRESSURE TRANSDUCER.
67	BATTERY VOLTAGE	NONE REQUIRED	67	VTM TAKES DATA THROUGH W5 (POWER) CABLE
68	STARTER MOTOR VOLTS	W2 CABLE	89	ATTACH RED CLIP TO STARTER POSITIVE TERMINAL (WIRE 6A),BLACK TO BATTERY SIDE OF SHUNT
69	STARTER NEG. CABLE DROP	W2 CABLE	89	ATTACH RED CLIP TO STARTER GROUND TERMINAL (WIRE 7A),BLACK TO BATTERY SIDE OF SHUNT
70	STARTER SOL. VOLTS	W2 CABLE	89	ATTACH RED CLIP TO STARTER SOLENOID TERMINAL (WIRE 74A),BLACK T0 STARTER GROUND TERMINAL
71	STARTER CURRENT	11- CURRENT PROBE	90	PUT PROBE AROUND NEGATIVE BATTERY CABLE BETWEEN THE SHUNT AND THE BATTERY PACK.
72	CURRENT FIRST PEAK	11- CURRENT PROBE	72	PUT PROBE AROUND NEGATIVE BATTERY CABLE BETWEEN THE SHUNT AND THE BATTERY PACK.
73	BATTERY RESISTANCE	11- CURRENT PROBE	73	PUT PROBE AROUND NEGATIVE BATTERY CABLE BETWEEN THE SHUNT AND THE BATTERY PACK.
74	STARTER CIRCUIT RESISTANCE	11- CURRENT PROBE	74	PUT PROBE AROUND NEGATIVE BATTERY CABLE BETWEEN THE SHUNT AND THE BATTERY PACK.
75	BATTERY RESISTANCE CHANGE	11- CURRENT PROBE	75	PUT PROBE AROUND NEGATIVE BATTERY CABLE BETWEEN THE SHUNT AND THE BATTERY PACK.
80	BATTERY CURRENT	11- CURRENT PROBE	90	PUT PROBE AROUND NEGATIVE BATTERY CABLE BETWEEN THE SHUNT AND THE BATTERY PACK.

FO-16 DCA Functional Flow and Location of Parts Diagrams

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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 = 1,000 Millimeters = 39.37 Inches
1 Kilometer = 1,000 Meters = 0.621 Miles

WEIGHTS
1 Gram = 0.001 Kilograms = 1,000 Milligrams = 0.035 Ounces
1 Kilogram = 1,000 Grams = 2.2 Lb
1 Metric Ton = 1,000 Kilograms = 1 Megagram = 1.1 Short Tons

LIQUID MEASURE
1 Milliliter = 0.001 Liters = 0.0338 Fluid Ounces
1 Liter = 1,000 Milliliters = 33.82 Fluid Ounces

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

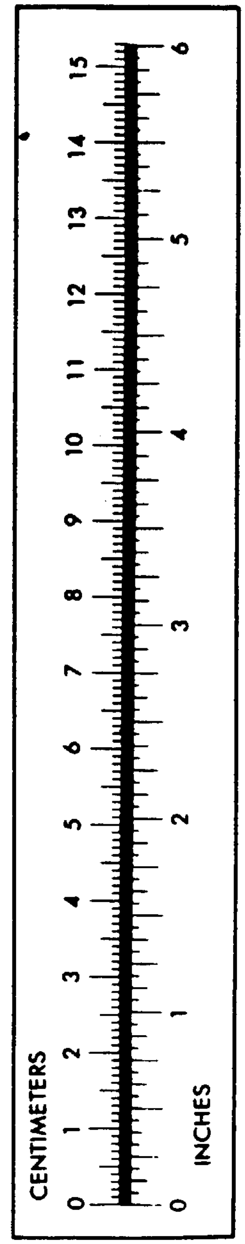
CUBIC MEASURE
1 Cu Centimeter = 1,000 Cu Millimeters = 0.06 Cu Inches
1 Cu Meter = 1,000,000 Cu Centimeters = 35.31 Cu Feet

TEMPERATURE
5/9 (°F -32) = °C
212° Fahrenheit is equivalent to 100° Celsius
90° Fahrenheit is equivalent to 32.2° Cesius
32° Fahrenheit is equivalent to 0° Celsius
9/5 C° +32 = F°

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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