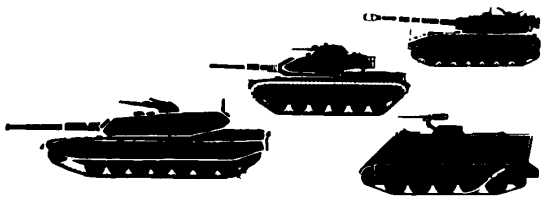
TECHNICAL MANUAL

OPERATORS, ORGANIZATIONAL,
DIRECT SUPPORT AND
GENERAL SUPPORT MAINTENANCE



BATTLEFIELD DAMAGE ASSESSMENT AND REPAIR

FOR

COMBAT VEHICLES

ITEM NSN
INSIDE FRONT COVER

HEADQUARTERS, DEPARTMENT OF THE ARMY

10 FEBRUARY 1984

This copy is a reprint which includes current pages from Change 1.

BDAR FIXES SHALL BE USED ONLY IN COMBAT AT THE DISCRETION OF THE COMMANDER AND SHALL BE REPAIRED BY STANDARD MAINTENANCE PROCEDURES AS SOON AS PRACTICABLE AFTER THE MISSION IS COMPLETED.

BDAR techniques in this manual pertain to the following end items:

M1 **Abrams Tank,** Combat Full Tracked, 105MM Gun (NSN 2350-01-061-2445)

M48/M60 Vehicle Series, Full Tracked:

M48A5	Tank, Combat, 105MM Gun	(NSN 2350-00-582-5595)
M48A5	Tank, Combat, 105MM Gun, Low Profile	(NSN 2350-01-059-1504)
M48A5	Armored Vehicle, Launcher, Bridge	(NSN 5420-01-076-6096)
M60A1	Tank, Combat, 105MM Gun	(NSN 2350-00-756-8497)
M60A1	Tank, Combat, (AOS) 105MM Gun	(NSN 2350-00-058-9487)
M60A1	Tank, Combat, (Rise), 105MM Gun	(NSN 2350-01-116-9765)
M60A1	Tank, Combat (Rise Passive), 105MM Gun	(NSN 2350-01-059-1503)
M60A1	Armored Vehicle, Launcher, Bridge	(NSN 5420-00-889-2020)
M247	Gun System, Air Defense, 40 MM Gun	(NSN 2350-01-089-1261)
M728	Combat Engineer Vehicle	(NSN 2350-00-795-1797)
M60A3	Tank, Combat, 105MM Gun	(NSN 2350-00-148-6548)

M109 Howitzer, Medium 155MM, Self Propelled:

M109	Howitzer	(NSN 2350-00-440-8811)
M109A1	Howitzer	(NSN 2350-00-485-9662)
M109A3	Howitzer	(NSN 2350-01-031-8851)

M113 Family of Vehicles, Self Propelled, Full Tracked:

M113A1	Carrier, Personnel Armored	(NSN 2350-00-968-6321)
M113A2	Carrier, Personnel Armored	(NSN 2350-01-068-4077)
M577A1	Carrier, Command Post, Light	(NSN 2350-00-056-6808)
M577A2	Carrier, Command Post, Light	(NSN 2350-00-068-4089)
M106A1	Carrier, Mortar, 107MM	(NSN 2350-00-076-9002)
M106A2	Carrier, Mortar, 107MM	(NSN 2350-01-069-6931)
M125A1	Carrier, Mortar, 81MM	(NSN 2350-01-071-0732)
M125A2	Carrier, Mortar, 81MM	(NSN 2350-01-068-4087)
M741	Chassis, AAA, 20MM	(NSN 2350-00-115-4418)
M741A1	Chassis, AAA, 20MM	(NSN 2350-01-099-8929)
M548	Carrier, Cargo, 6 Ton	(NSN 2350-00-078-4545)
M548A1	Carrier, Cargo, 6 Ton	(NSN 2350-01-096-9356)
M730	Carrier, Guided Missile	(NSN 1450-00-930-8749)
M730A1	Carrier, Guided Missile	(NSN 1450-00-121-2122)
M667	Carrier, Guided Missile Equipment	(NSN 1450-00-879-3380)
M901	Combat Vehicle, Anti Tank, ITV	(NSN 2350-01-045-1123)
XM806E1	Recovery Vehicle, Light Armored	(NSN 2350-00-808-6104)

Change
No. 1

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington D.C., *28 February 1992*

OPERATOR'S, UNIT, DIRECT SUPPORT AND
GENERAL SUPPORT MAINTENANCE

BATTLEFIELD DAMAGE ASSESSMENT AND REPAIR FOR COMBAT VEHICLES

(Item NAN Inside Front Cover)

TM 9-2350-276-BD, 10 February 1984 is changed as follows:

1. Remove old pages and insert new pages as indicated below.

2. New or changed material is indicated by a vertical bar in the margin of the page.

Remove Pages	Insert Pages
14-1 and 14-2	14-1 and 14-2
14-9 and 14-10	14-9 and 14-10

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

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Chief of Staff

Official:

MILTON H. HAMILTON
Administrative Assistant to the
Secretary of the Army
00051

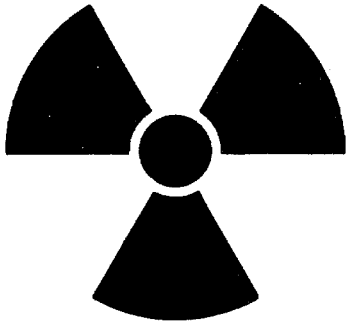
Distribution:

To be distributed in accordance with DA Form 12-37-E, Block 1688, Operator, Unit, Direct Support and General Support maintenance requirements for TM 9-2350-276-BD.

WARNING

THIS TECHNICAL MANUAL CONTAINS NONSTANDARD MAINTENANCE PROCEDURES. ALL NORMAL SAFETY PROCEDURES SHOULD BE OBSERVED WHEN THE TACTICAL SITUATION PERMITS. EXTRA CARE WILL BE TAKEN WHEN THE TACTICAL SITUATION REQUIRES PERFORMING MAINTENANCE WITH AMMUNITION UP-LOADED AND WHEN FUELS AND LUBRICANTS ARE SPILLED IN HULL AND TURRET.

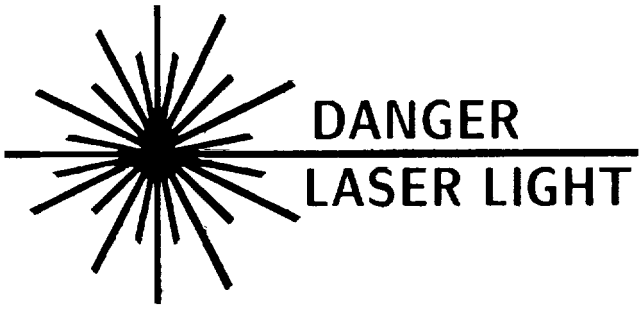
WARNING
RADIOACTIVE MATERIAL



HANDLE CAREFULLY

WARNING

The antireflective coating on all infrared optics contains thorium fluoride which is slightly radioactive. The only potential hazard involves ingestion (swallowing or inhaling) of this material. Dispose of broken lens, etc. in accordance with AR 385-11.

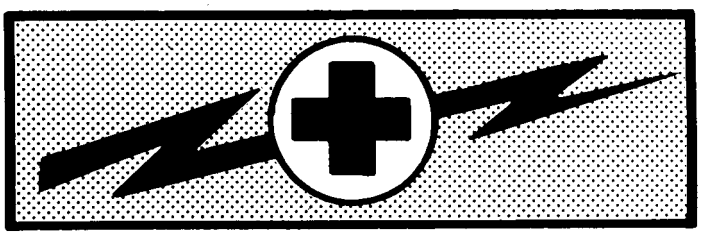


WARNING

You can be blinded if you look into a laser beam when you are not wearing laser safety goggles. Never aim the laser rangefinder (LRF) at personnel.

If laser beam reflects from a flat, mirror-like surface, it can blind you unless you are wearing laser safety goggles.

WARNING



HIGH VOLTAGE

High voltage is used in the operation of this equipment.

DEATH ON CONTACT

may result if personnel fail to observe safety precautions. Learn the areas containing high voltage in each piece of equipment. Be careful not to contact high voltage connections when installing or operating this equipment. Before working inside the equipment, turn power off and ground points of high potential before touching them.

For artificial respiration, refer to FM 21-11.

Technical Manual

HEADQUARTERS
DEPARTMENT OF THE ARMY

9-2350-276-BD

WASHINGTON, D.C., *10 February 1984*

OPERATOR'S, ORGANIZATIONAL DIRECT AND GENERAL SUPPORT MAINTENANCE

GENERAL BATTLEFIELD DAMAGE ASSESSMENT AND REPAIR for COMBAT VEHICLES

REPORTING OF ERRORS

You can help to improve this manual by calling attention to errors and by recommending improvements. Your letter, DA Form 2028 (Recommended Changes to Publications and Blank Forms) and/or DA Form 2028-2 (Recommended Changes to Equipment Technical Manuals), may be used. Copies of DA Form 2028-2 are attached in the back of the manual for your use. Please mail your recommended changes directly to Commander, US Army Tank-Automotive Command, ATTN: DRSTA-MB-BDAR, Warren, MI 48090. A reply will be furnished directly to you.

CHAPTER 11. HYDRAULIC SYSTEMS

CHAPTER 12. ARMOR

CHAPTER 13. ARMAMENT AND FIRE CONTROL SYSTEMS

CHAPTER 14. COMMUNICATIONS SYSTEM

APPENDIX A

APPENDIX B

APPENDIX C

CHAPTER 1
INTRODUCTION

**BDAR FIXES SHALL BE USED ONLY IN COMBAT
AT THE DISCRETION OF THE COMMANDER
AND SHALL BE REPAIRED BY STANDARD MAINTENANCE PROCEDURES
AS SOON AS PRACTICABLE AFTER THE MISSION IS COMPLETED.**

SECTION I. General

1-1. Purpose.

a. This technical manual (TM) is for use by operators, organizational, and direct support/general support maintenance personnel. It provides procedures and guidelines for battlefield repairs on combat vehicles under the forward support maintenance concept during combat.

b. The purpose of Battlefield Damage Assessment and Repair (BDAR) is to rapidly return disabled combat vehicles to the operational commander by expediently fixing, by-passing, or jury-rigging components to restore the minimum essential systems required for the support of the specific combat mission or to enable the vehicle to selfrecover. These repairs may be temporary and may not restore full performance capability.

1-2. Scope.

a. This TM describes BDAR procedures of a general nature applicable to all combat vehicles. Expedient repairs applicable to systems or sub-systems of a specific combat vehicle are covered in system specific TM's.

b. Many expedient repair techniques helpful in preparing a vehicle for recovery are included in FM 20-22, Vehicle Recovery Operations. Details of such procedures are not duplicated in this TM, although certain quick fix battlefield operations which would, in some cases, prepare the vehicle for recovery or self-recovery will be described. Users of this manual should refer to FM 20-22 for further recovery-associated expedient repairs.

c. All possible types of combat damage and failure modes cannot be predicted nor are all effective field expedient repairs known. This TM provides guidelines for assessing and repairing battlefield failures of combat vehicles and is not intended to be a complete catalog of all possible emergency repairs. The repairs described here will serve as guidelines and will stimulate the experienced operator or mechanic to devise expedients as needed to rapidly repair equipment in a combat crisis.

1-3. Application.

a. The procedures in this manual are designed for battlefield environments and should be used in situations where standard maintenance procedures are impractical. These procedures are not meant to replace standard maintenance practices, but rather to supplement them strictly in a battlefield environment. Standard maintenance procedures will provide the most effective means of returning a damaged vehicle to ready status provided that adequate time, replacement parts, and necessary tools are available. BDAR procedures are only authorized for use in an emergency situation in a battlefield environment, and only at the direction of the commander.

b. BDAR techniques are not limited to simple restoration of minimum functional combat capability. If full functional capability can be restored expediently with a limited expenditure of time and assets, this should be done.

c. Some of the special techniques in this manual, if applied, may result in shortened life or damage to components of combat vehicles. The commander must decide whether the risk of having one less vehicle available for combat outweighs the risk of applying the potentially destructive expedient repair technique. Each technique gives appropriate warnings and cautions, and lists systems limitations caused by this action.

1-4. Definitions.

a. The term **"battlefield damage"** includes all incidents which occur on the battlefield and which prevent the vehicle from accomplishing its mission, such as combat damage, random failures, operator errors, accidents, and wear-out failures.

b. The term **"repair"** or **"fix"** in this manual includes any expedient action that returns a damaged part or assembly to a full or an acceptably degraded operating condition including:

(1) Short cuts in parts removal or installation.

(2) Installation of components from other vehicles that can be modified to fit or interchange with components on the vehicle.

(3) Repair using parts that serve a non-critical function elsewhere on the same vehicle for the purpose of restoring a critical function.

(4) Bypassing of non-critical components in order to restore basic functional capability.

(5) Expeditious cannibalization procedures.

(6) Fabrication of parts from kits or readily available materials.

(7) Jury-rigging.

(8) Use of substitute fuels, fluids or lubricants.

c. **"Damage Assessment"** is a procedure to rapidly determine what is damaged, whether it is repairable, what assets are required to make the repair, who can do the repair (i.e. crew, maintenance team (MT), or maintenance support team (MST), and where the repair should be made. The assessment procedure includes the following steps:

(1) Determine if the repair can be deferred, or if it must be done.

(2) Isolate the damaged areas and components.

(3) Determine which components must be fixed.

(4) Prescribe fixes.

(5) Determine if parts or components, materials, and tools are available.

(6) Estimate the manpower and skill required.

(7) Estimate the total time (clock-hours) required to make the repair.

(8) Establish the priority of the fixes.

(9) Decide where the fix shall be performed.

(10) Decide if recovery is necessary and to what location.

d. **A Maintenance Team** (MT) consists of organizational mechanics, who may be trained in assessing battle damage and field repair procedures. MT are called to out-of-action vehicles to supplement (or confirm) the crew's original damage assessment. MT assessment determines if field repairs will be conducted or if recovery is required. Depending on available time, the MT will assist the crew in restoring the vehicle to mission capability.

e. **A Maintenance Support Team** (MST) consists of direct support/general support mechanics and technical specialists, who are trained in assessing battle damage in addition to their specialty. The MST is called by the MT when vehicle damage exceeds MT assessment capability or organizational repair capability.

f. **The MT/MST assessor** is a senior member of the forward MT/MST. He is a systems mechanic/technician trained in BDAR techniques. He must know:

(1) The unit's mission and the commander's requirements.

(2) The maintenance capability of the unit, including the available skills, tools, repair parts, and materials.

(3) How to detect contamination and effect decontamination of equipment.

(4) The unit's maintenance workload.

(5) The maintenance capability of all accessible rally and maintenance collection points.

g. The term **fully mission capable (FMC)** means that the vehicle can perform all its combat missions without endangering the life of the crew. To be FMC the vehicle must be complete and fully operable with no faults listed in the "Equipment is not ready /available if" column of the operator's Preventive Maintenance Checks and Services (PMCS).

h. The term **combat capable** means that the vehicle meets the minimum functional combat capability requirements. (See paragraph 1-10.)

i. The term **combat emergency capable** means that the vehicle meets the needs for specific tactical maneuver or firing missions; however, all systems are not functional. Also, additional damage due to the nature of an expedient repair may occur to the vehicle if it is used. The commander must decide if these limitations are acceptable for that specific emergency situation.

j. The term **self-recovery capable** means that the vehicle meets the needs for recovery under self-power. It could include hazardous equipment conditions such as partial brakes or limited steering.

k. The term **cannibalization** as used in this TM means any use of repair parts or components obtained from another combat vehicle either damaged or of lower priority to the immediate mission. In this TM, the term is used to include controlled exchange.

1-5. BDAR Recommendations and QDR/EIR.

a. Personnel originating new BDAR procedures should forward them directly to Commander, US Army Tank-Automotive Command, ATTN: DRSTA-,MB-BDAR, Warren, MI 48090. Personnel are encouraged to develop and report new BDAR ideas, techniques and procedures.

b. Equipment Improvement Recommendations (EIR) may be submitted by nyone who knows of an unsatisfactory condition with equipment design or use. You do not have to show a new design or list a better way to do a procedure, just tell why the design is unfavorable or why a procedure is hard. EIR may be submitted on SF 368, Quality Deficiency Report. Mail these directly to Commander, US Army Tank-Automotive Command, DRSTA-MC, Warren, MI 48090. A reply will be sent directly to you.

SECTION II. Battlefield Damage Assessment and Repair - Standards and Practices

1-6. BDAR Characteristics.

BDAR capability requires simplicity, speed, and effectiveness. Some BDAR procedures include repair techniques that violate standard peacetime maintenance practices. In a combat emergency situation, greater risks are necessary and acceptable..

1-7. Training.

The unit commander should insure that an adequate number of members of his organization, including supervisors, are trained in BDAR procedures applicable to his equipment. Each vehicle crewman should be trained to perform initial battle damage assessment for his crew position.

1-8. Waiver of Precautions.

Under combat conditions, BDAR may be performed on vehicles which are fueled and/or armed. Other similar precautions may be waived at the discretion of the commander. See paragraph 1-13e.

1-9. Environment.

BDAR may be required in a chemically toxic environment or under other adverse conditions with severe limitations in personnel, facilities, equipment, and materials. Performance of repair tasks may be necessary while wearing protective gear. Expedient decontamination procedures are described in FM 3-220.

1-10. Serviceability and Operability (Operating Characteristics).

As an example, the Minimum Functional Combat Capability (MFCC) criteria for tanks is given below. Refer to system specific TM's for each vehicle's specific MFCC.

NOTE

These criteria may be waived for recovery or if the tactical situation demands otherwise.

a. Armament and Fire Control

(1) Turret must traverse 360 degrees and elevate with no oscillations either manually or by power.

(2) Main gun must be capable of firing without damage to the recoil system.

(3) Must have an operational fire control device (primary or secondary).

b. Mobility.

(1) Must have operational track on both sides of the tank.

(2) May be missing roadwheels with the following stipulations:

(a) May not be missing more than a total of three individual roadwheels on each side.

(b) The first, second, and last roadwheel stations must each have complete sets of roadwheels.

(c) There must be a complete set of roadwheels between any two incomplete roadwheel stations.

(3) Drive train must be functional and must be capable of reverse, and at least one forward gear.

(4) Power train performance degradation cannot exceed that level which would cause the tank to be incapable of traveling 15 miles per hour on a level, unimproved road.

(5) Must be capable of normal braking/stopping from 15 mph and brakes must hold on a 30 percent slope.

(6) Vehicle steering system must be operational.

c. Communications. Must have intercom between tank commander and driver.

1-11. Permanent Repair.

Upon completion of the mission, or at the next practicable opportunity, the vehicle will be recovered or evacuated to the appropriate maintenance facility for permanent standard repair as required.

SECTION III. Battlefield Damage Assessment and Repair - Responsibilities and Tasks

1-12. General.

a. Battlefield damage assessment and repair procedures are applicable at all levels from crew through general support maintenance depending on the extent of the damage, the time available, the skills required, and the parts, components, tools, and materials available. Within these limits, each maintenance level will rapidly take whatever action is necessary and possible to restore the vehicle to the combat ready condition required for continuation of the mission.

b. Battlefield damage repair kits consisting of essential tools may be carried onboard each vehicle to enable the crew to rapidly fix the simplest and most common types of damage/failure. (See Appendix B, Special and Fabricated Tools.)

1-13. Commander and Crew.

a. The crew of the damaged vehicle will make the first assessment immediately after damage has occurred. Crew members will provide the vehicle commander with an initial damage assessment which will include notice of system failure and all major vehicle systems visibly damaged, inoperative or impaired. If possible all systems will be checked at the same time by different crew members. If the failure is due to hostile fire, the report will include the location of impact and the manning status. Immediacy of the report is more important than how long it will take to get back into action. The initial report, therefore, may omit repair time estimates. The vehicle commander must make an initial out-of-action report to the platoon leader including these essentials:

(1) Vehicle damaged (out-of-action or impaired).

(2) Location of vehicle.

(3) Firepower status.

(4) Mobility status.

(5) Manning status.

(6) Current and anticipated enemy action.

b. If communication capability is damaged, the vehicle commander should approach the nearest friendly radio and make his report.

c. In the forward battle area it is imperative that the crew attempt to move the vehicle to a covered or concealed position to prevent additional combat damage. This is the first priority. If the vehicle is not capable of self movement, use any vehicle, including other combat vehicles to recover the vehicle or to get concealment. If this is

not possible, then the turret (if the vehicle is so equipped) should at least be turned in the direction of engaging fires in order to limit damage and possibly return fire.

d. Battlefield Damage Assessment/Repair Forms are provided in Chapter 2 to permit a systematic assessment by the crew. Assessment checks include looking at the damaged parts, determining what system they belong to, and deciding how they can be fixed or jury-rigged to permit immediate operation (full or partial).

e. A safety check should be made for any obvious hazards.

(1) Is there an ammunition round in the tube?

(2) Are any ammunition rounds critical due to shock, fire, or physical damage?

(3) Have any combustibles such as fuel, hydraulic fluid, or oil accumulated?

(4) Does wiring appear to be safe? Could arcing occur to stored ammo or leaking combustibles?

(5) Is the fire extinguishing system operational? If not, then one crew member should be stationed in the vehicle, either with a hand-fire extinguisher or prepared to manually operate the on-board fire extinguisher. A second crew member should be stationed outside the vehicle with the other fire extinguisher. He should also be prepared to manually actuate the engine compartment fire extinguisher.

f. A functional/operational test should be performed next on those systems which appear undamaged. For systems with a built-in self-test feature, this will be done. Only those systems found to be damaged or inoperative, shall be identified.

g. The vehicle commander shall report to the platoon leader the results of the crew's damage assessment, naming the major known causes of the vehicle's immobility and/or lack of fire power. If repair by crew is possible, he shall report a total estimated repair time and what functions may be restored.

h. The platoon leader will respond with directives and, if required, will call an MT to the location of the damaged vehicle for assistance. If possible, sufficient information will be provided to enable the MT to bring any needed repair parts or special tools.

i. The crew shall proceed to make any possible field expedient repairs to restore fire power, communications and/or vehicle mobility to the limit of their skills, materials, and tools available.

1-14. Organizational Maintenance and Maintenance Teams (MT).

a. The organizational maintenance team (MT) and assessor operate out of the company or battalion trains. The MT assessor performs his assessment and the

maintenance team completes repairs if possible at the damage site. If the site is within direct fire or under enemy observation, movement to a more secure site in defilade may be necessary. This is still considered "on-site".

b. If the vehicle has been left unattended in the forward battle area, the immediate area of the vehicle should be checked for mines and the vehicle should be checked for booby traps before starting the battle damage assessment. The MT should also make the safety checks listed in paragraph 1-13e.

c. The MT assessment will be more thorough than the crew's, using organizational maintenance support tools and equipment as needed. MT assessment includes:

(1) Reviewing the crew's out-of-action report, if available.

(2) Interviewing commander and crew if available.

(3) Visually inspecting damaged parts and systems.

(4) Performing a self-test.

(5) Making tests with organizational test equipment, if required.

(6) Performing additional vehicle operational tests, as necessary.

d. Using this information and following the steps of paragraph 1-4c, the MT will:

(1) Determine what must be repaired or replaced.

(2) Determine sequence and priority of repair actions.

(3) Estimate repair times for each repair task.

(4) Total the repair task times and determine if the repairs can be performed in the time available.

(5) Determine repair location and, if other than on-site, arrange for recovery of the vehicle to the repair site.

e. If all critical repairs can be made within the available time with the skills, materials, tools, and equipment at hand, the MT, assisted by the crew, will proceed with the on-site repair.

f. If the damage exceeds the repair capability of the MT, and time is available for an MST on-site fix, the MST shall be called.

g. If time for an MST on-site fix is not available, but the vehicle is repairable, the MT shall provide for recovery of the vehicle to a designated collection point.

h. If the vehicle is not repairable, the MT shall provide for one of the following:

(1) Recovery to a maintenance collection point for evacuation to the rear.

(2) On-site stripping (if approved by Commander, coordinated with support maintenance).

(3) Abandonment/destruction (if directed by commander).

i. Vehicle hulls, particularly tank hulls, should never be abandoned if recovery/evacuation is possible because hulls can almost always be rebuilt, no matter how badly damaged they are. If the vehicle is damaged catastrophically and evacuation is not possible, remove items in the following order:

(1) Needed spares on-site.

(2) Sensitive, high value, limited size items.

(3) Other needed spares or repair parts.

j. If the vehicle is contaminated, the MT shall mark the vehicle with contamination markers and arrange for recovery to a decontamination site.

1-15. Direct Support/General Support Maintenance Team.

a. The MST shall assist the MT as needed, using direct support maintenance tools and equipment. MST assessment and repair procedures are the same as those of the MT except at a higher maintenance level. If possible, the MT will tell the MST what tools and spare parts are needed to perform the repairs. While waiting for the MST to arrive, the crew, under the supervision of the MT, will open up the vehicle and make it ready for the MST to perform the BDAR when it arrives.

b. Damaged vehicles removed to designated repair sites shall be selected for repair by the MST in order of:

(1) Most essential to the completion of the mission.

(2) Can be repaired in the least amount of time.

1-16. Time Limits for Repairing Damage.

a. In combat, the time available for BDAR is limited. One of the factors to be considered in the selection of a repair site is the amount of time available at the site based on the tactical situation. Every assessment must include an estimate of total

elapsed time for all tasks required to restore the vehicle. The time available at the selected repair site must equal or exceed the estimated time required to accomplish all tasks associated with the BDAR.

b. Determining where BDAR will take place should be based on the guidelines in Table 1-1. These are general rules which must be adjusted by the commander based on his best estimate of how the most responsive maintenance support can be provided. He must consider the tactical situation, maintenance backlog, personnel, tools, TMDE, and repair parts available. The guidelines are based on a defensive scenario and can be extended when applied to the offense.

Table 1-1. Summary of BDAR Time Guidelines

LOCATION	ELEMENTS PERFORMING BDAR	TIME GUIDELINES
Breakdown Site	1. Operator/Crew 2. Battalion Maintenance Team (MT) 3. Maintenance Support Team (MST) from Forward Suppport Maintenance Company	2 Hours
Battalion Trains (OMCP)	1. Battalion Maintenance Platoon 2. Maintenance Support Team (MST) from Forward Support Maintenance Company 3. Maintenance Support Team (MST) from Maintenance Battalion.	6 Hours
Brigade Support Area	1. Forward Support Maintenance Co. 2. Maintenance Support Team (MST) from Maintenance Battalion 3. Maintenance Support Team (MST) from COSCOM	24 Hours
Division Suppport Area	1. Maintenance Battalion 2. Maintenance Support Team (MST) from COSCOM	36 Hours
Corps Support	1. COSCOM Maintenance Companies	96 Hours

1-17. Recording BDAR Repairs.

a. All components of a combat vehicle which are repaired using BDAR or other expedient techniques shall be marked with a tag, DD Form 1577, or similar conspicuous tag. It is not necessary to fill out the form. The purpose of marking an item which has been repaired using BDAR techniques is to quickly enable mechanics to recognize these parts when the vehicle is subsequently returned for authorized permanent repair.

b. Since it is impractical to attach tags to expediently repaired components located on the outside of the vehicle, the fix shall be noted on DD Form 1577 or similar tag, and the tags stored in the compartment normally reserved for the vehicle log book.

c. A tag should also be placed conspicuously in the vehicle commander's position when a BDAR procedure has resulted in a degraded operating capability. This tag should be marked "BDAR" and noted with its specific limitations or cautions.

d. When a component is cannibalized from a repairable vehicle, a tag should be attached in the space created by the missing part to alert downstream repair personnel quickly that the part has been removed.

e. When the vehicle is recovered/evacuated for permanent standard repair, and DA Forms 2404 and 2407 are used, the notation "BDAR" shall be added in the space provided for description of deficiencies.

f. DA PAM 738-750 provides for disposition of DA Form 2404 and copy number 3 of DA Form 2407. When "BDAR" is noted on these forms, they shall be mailed to: Combat Data Information Center, AFFDL/FES/CDIC, Wright Patterson AFB, Ohio 45433. The information on these forms will provide data for designing vehicles to be less susceptible to combat damage and easier to repair when damaged.

CHAPTER 2
ASSESSING BATTLEFIELD DAMAGE

**BDAR FIXES SHALL BE USED ONLY IN COMBAT
AT THE DISCRETION OF THE COMMANDER
AND SHALL BE REPAIRED BY STANDARD MAINTENANCE PROCEDURES
AS SOON AS PRACTICABLE AFTER THE MISSION IS COMPLETED.**

SECTION I. General

2-1. Scope

This chapter provides guidelines to use to assess battlefield damage. It directs you to an expedient repair procedure, or to the standard system TM if an expedient repair procedure for your problem doesn't exist.

2-2. General

Use this TM in conjunction with the operator's technical manual (TM) and Lubrication Order (LO). This chapter explains how to use this manual to assess and fix battlefield damage that prevent moving, shooting, and/or communicating. This chapter contains the general fault assessment tables, general troubleshooting and maintenance instructions including combat damage report forms. General fault assessment tables, specific fault assessment tables, and detailed assessment procedures are used to locate the damage; and an expedient repair procedure tells how to fix the damage. An index of the expedient repair procedures is located in each chapter. If you don't know or aren't sure of exactly what your problem is, you should use the assessment tables and procedures to find the fault.

2-3. Application

Use the following steps to find and fix battlefield damages:

a. Do the Preventive Maintenance Checks and Services (PMCS) in the TM and LO. At the same time look for obvious damage to the vehicle.

b. If applicable, do the troubleshooting/repair recommended in the TM.

c. If you find the problem, determine its effect on the operation (mobility, firepower, or communication) of the vehicle.

d. If you can't fix the problem using the PMCS's and procedures in the TM and LO, use the assessment table 2-1 to assess and fix the problem.

e. If the problem does not affect vehicle operation, the commander will decide whether to attempt to fix the problem or continue with the mission.

f. If the damage does affect vehicle operation, do one of the following:

(1) Replace the bad part/assembly with a good one (from supply or other source or vehicle).

(2) Replace the bad part/assembly with a substitute, if one exists.

(3) Use the expedient repair procedures in this manual to repair the damage.

g. After repairing the damaged system, replace all lost fluids and/or lubricants. If the ones specified by LO or TM are not available, refer to Appendix C for a possible substitute.

SECTION II. Assessing Battlefield Damage

2-4. General.

a. This section provides an overall damage assessment procedure to evaluate the mobility, communications and firepower functions of individual vehicles.

b. The assessment procedures are designed to assure that all necessary aspects of a combat vehicle capability are evaluated during the assessment process. The procedures refer you to:

(1) procedures in this manual if a "quick-fix" is possible,

(2) the standard TM if the best repair is covered in the system TM, or

(3) a higher maintenance level if access to devices or materials to do the quick-fix are available only at those levels.

c. Each procedure:

(1) contains general information about the problem,

(2) lists materials and/or tools required other than those commonly available to the crew, MT, and MST (If the listed items are not available, improvise. Anything that will do the job is acceptable.),

(3) lists the estimated number of soldiers needed and the estimated time required to complete the repair,

(4) states the operational limitations caused by the repair action before experiencing further damage/degradation to the vehicle,

(5) provides other expedient options you can use depending on the availability of personnel, materials, tools, and/or time (This does not include standard maintenance procedures or recovery).

d. Following each assessment procedure is an index of the procedures contained in that chapter. If you know exactly what your problem is, you can use the index to find the proper expedient repair procedure.

e. Additional data is contained in the Appendices.

(1) Appendix A lists alternate sources of supply to include foreign ownership of US combat vehicles and expendable supplies which are recommended for use to implement various BDAR repairs.

(2) Appendix B lists special or fabricated tools used in performing BDAR repairs.

(3) Appendix C lists substitutes for the petroleum, oil, and lubricants (POL).

2-1. Assessment Process.

a. The assessment procedures are structured using the logic process shown in figure 2-1 below.

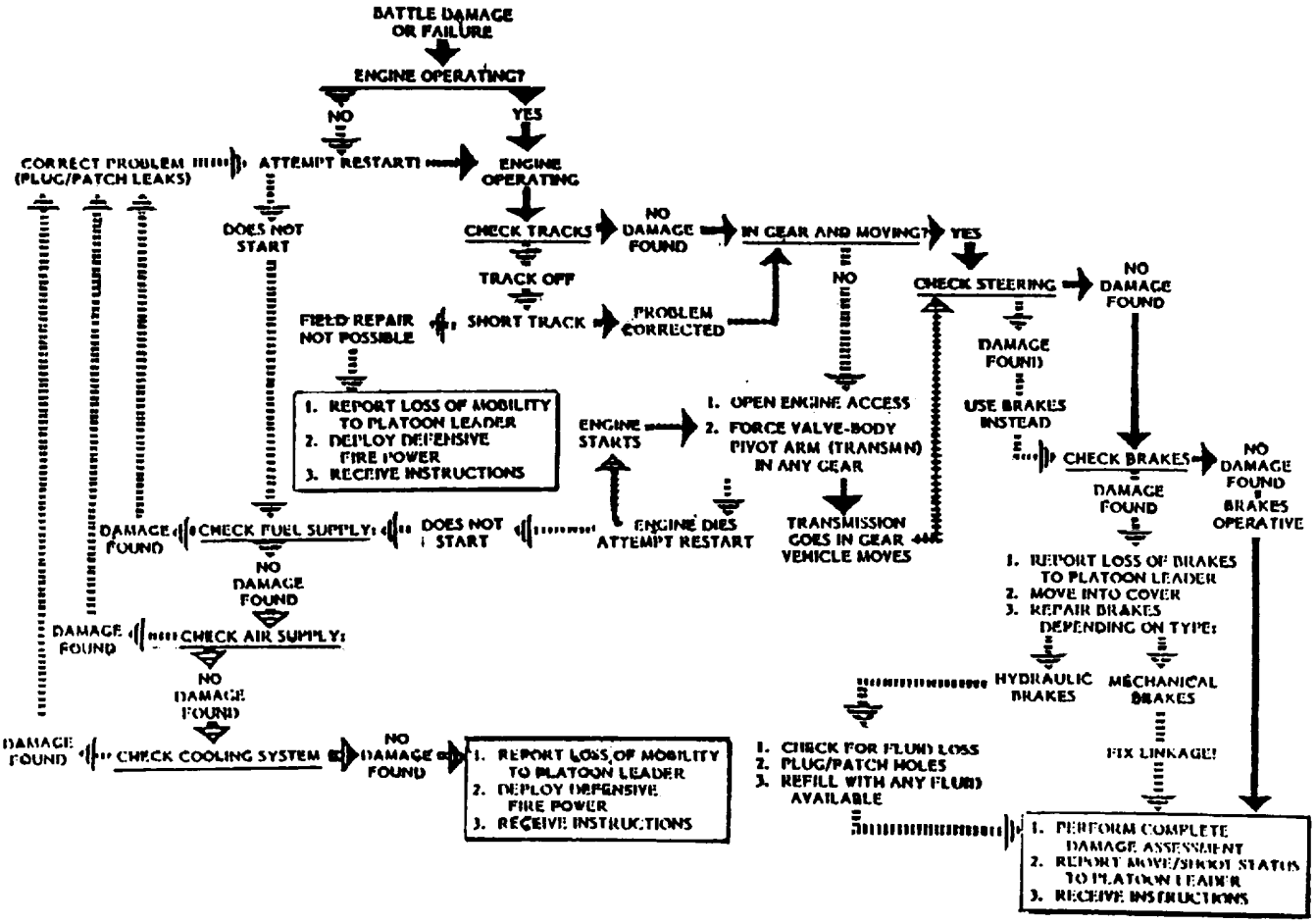


Figure 2-1. Battlefield Damage Assessment Process.

b. All assessment procedures follow the sequence:

(1) visually inspect (repair, if necessary),

(2) functionally test (repair, if necessary) and,

(3) assess the performance.

The field fixes will enable the crew to continue operations in some cases, but will usually be most useful to the MT/MST for scheduling and accomplishing fix-forward repairs and assessing combat capabilities for reporting to commanders.

c. There are three kinds of assessments performed on damaged equipment.

(1) The first assessment is extent and kind of damage and how it affects vehicle operation and capabilities.

(2) The second is whether the damage needs to be repaired and,

(3) The third is assessment of where and how to repair the damage.

d. Assessments of damage may be made in turn by operator/crew, MT, and MST assessors.

(1) Extent and kind of damage is readily assessable.

(2) Whether or not to repair the damage may be readily assessable. However, whether to attempt repair and when and how to repair the damage may be judgment calls. No procedure can take all possible situations into account. Assessment of whether the damage needs to be repaired will be made jointly by the MT and vehicle commander as they evaluate the vehicle for further operation or recovery.

(3) Assessment of where and how to repair the damage will be made by the MT usually with some suggestions by crew/operator. MST's may redirect or change MT's decisions.

2-6. Overall Vehicle Assessment Procedure.

a. This procedure can be used by the crew, but it will be of more use to an MT or MST assessor working to "quick-fix" vehicles for a mission or self-recovery. The procedure provides for assessing the kind of damage and determining:

(1) the effect of the damage and if it needs to be fixed,

(2) if the damage can be fixed using BDAR or if only regular maintenance

operations can fix it, and

(3) how long it will take to fix it.

b. This is accomplished by structuring this manual in rank order, from the vehicle three-function overview down to the specific. Each major function (shoot, move, communicate) and each subsystem that makes up a part of providing that function, has a stand-alone assessment procedure to make it easier to quantify each significant problem encountered in battlefield damaged equipment.

c. As an example, presume an M60 is down with a bad fuel pump. Fuel pumps are essential for even the lowest level of "limp-home" self recovery. The overall vehicle assessment table, as part of its power pack evaluation, tells the reader to visually and functionally check the pack. If it doesn't work, the assessor can then visually and functionally check the pack subsystems if time permits. The assessor would visually and functionally check the fuel subsystem and discover that the pump was inoperative. The fuel subsystem assessment table directs the reader to a specific page where BDAR suggestions for alternate fuel supply systems can be considered for use.

d. At any point on each of the assessment levels, the assessor can abort the procedure and direct recovery, evacuation or other actions if the tactical situation dictates.

e. Refer to Table 2-1, Vehicle/System Assessment to begin the assessment process.

Table 2-1. Vehicle/System Assessment.

ITEM/ACTION	FAULT ISOLATION	BDAR REFERENCE

NOTE

Items checked in this procedure must work to provide minimum functional combat capability. Even if all systems work the vehicle may be unsafe and may not satisfy normal required operating capabilities or may not receive mission-essential maintenance.

A. MOBILITY ASSESSMENT.

1. VISUALLY INSPECT

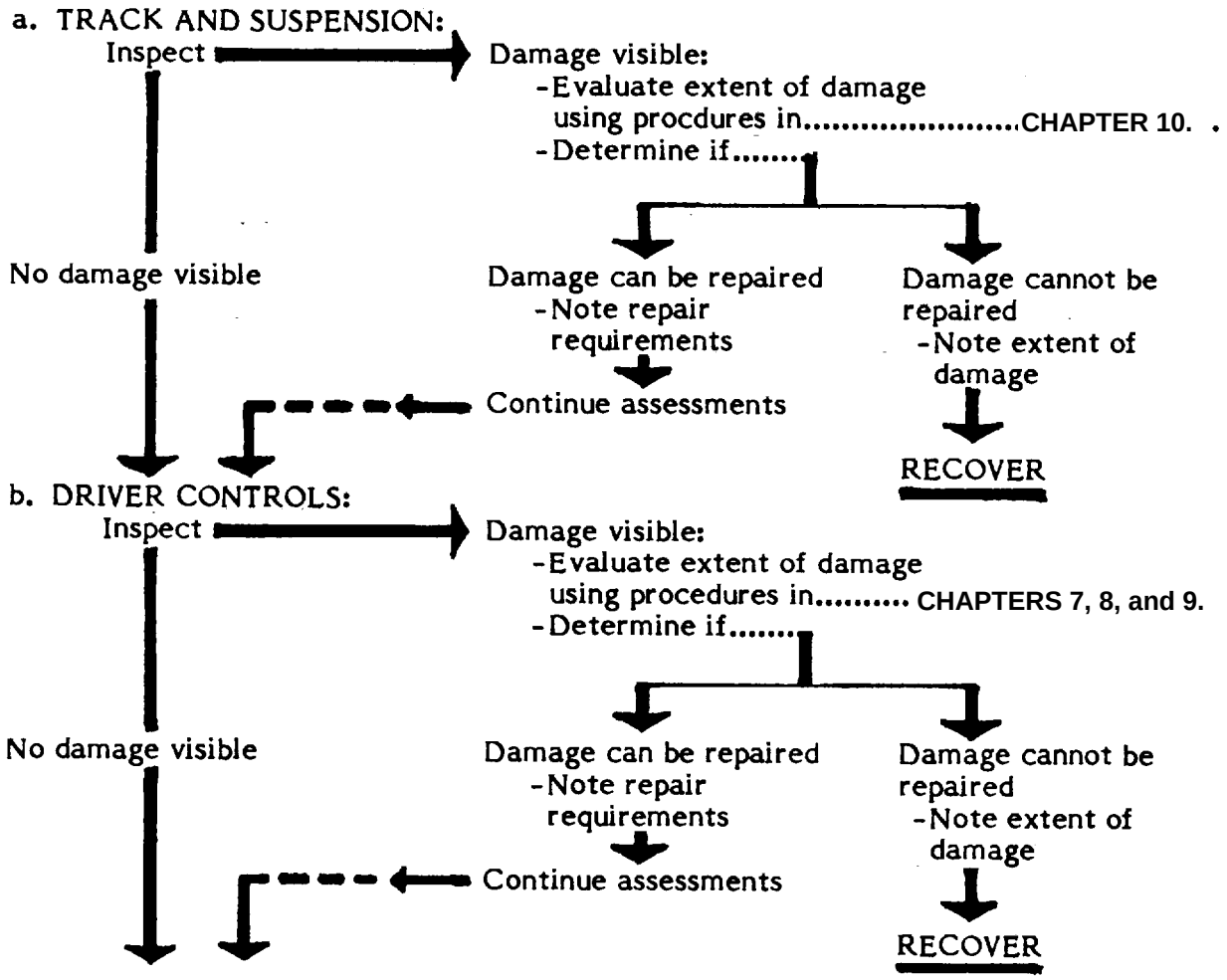


Table 2-1. Vehicle/System Assessment (Cont).

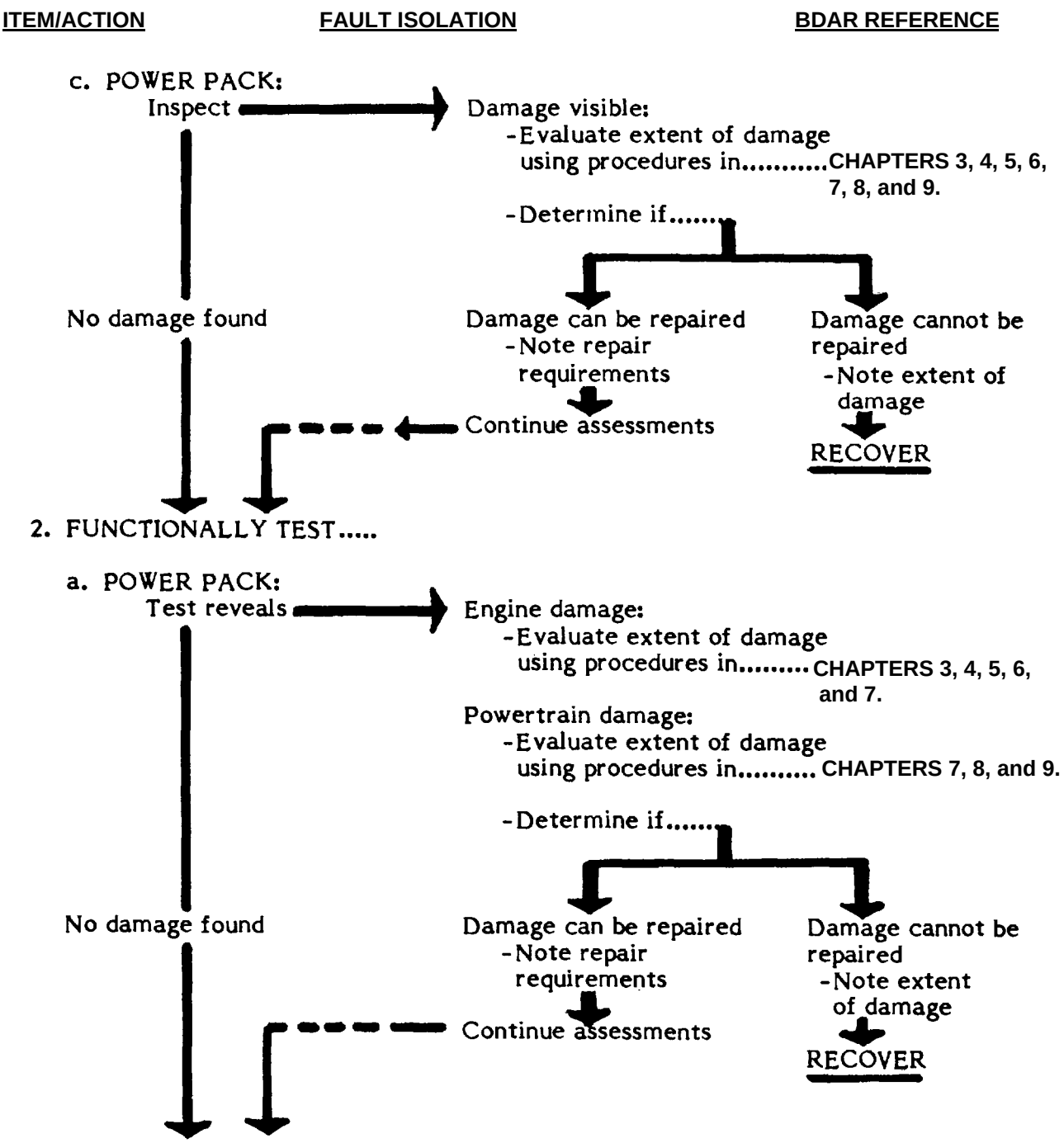
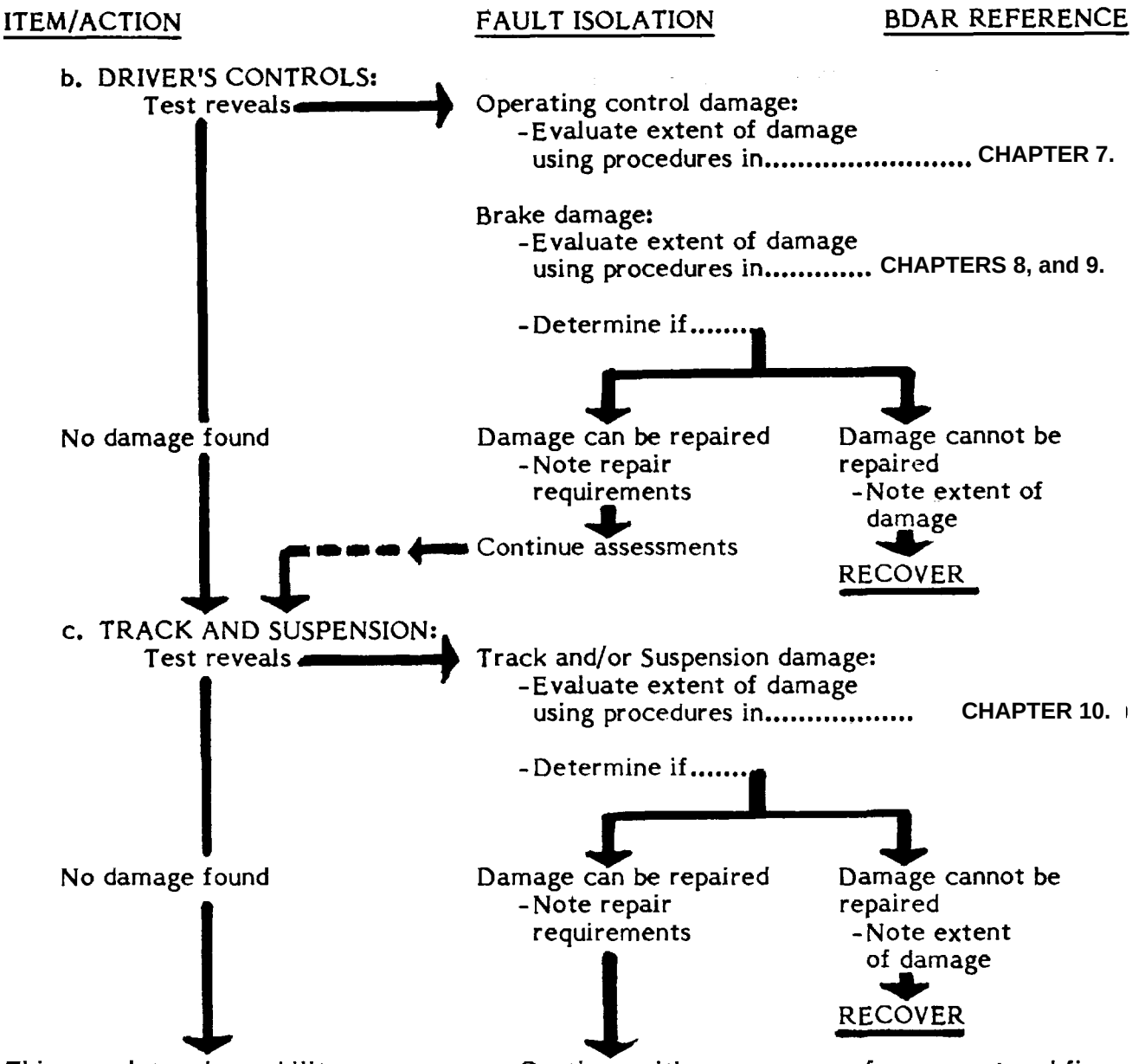


Table 2-1. Vehicle/System Assessment (Cont).



This completes the mobility assessments. Continue with assessments of armament and fire control if required. If after systems are operational, prepare to report.

Table 2-1. Vehicle/System Assessment (Cont).

ITEM/ACTION	FAULT ISOLATION	BDAR REFERENCE

B. ARMAMENT AND FIRE CONTROL ASSESSMENT.

1. VISUALLY INSPECT.....

a. MAIN GUN SYSTEM:
Inspect → Damage visible on:

Cannon assembly:
-Evaluate extent of damage using procedures in..... CHAPTERS 11, 13, 3 and vehicle specific TMs.

Breech mechanism assembly:
-Evaluate extent of damage using procedures in... CHAPTER 11, and vehicle specific TMs.
-Determine if.....

No damage found

Damage can be repaired
-Note repair requirements

Damage cannot be repaired
-Note extent of damage

Continue assessments

b. TURRET ASSEMBLY:
Inspect → Damage visible on:

No damage found

Hull/turret race:
-Evaluate extent of damage using procedures in...CHAPTER 13,] and vehicle specific TMs.

Traversing gearbox:
-Evalute extent of damage using procedures in... CHAPTER 13, and vehicle specific TMs.

Elevating cylinder:
-Evaluate extent of damage using procedures in..... CHAPTERS 11, 12,] and vehicle specific TMs.

Table 2-1. Vehicle/System Assessment (Cont).

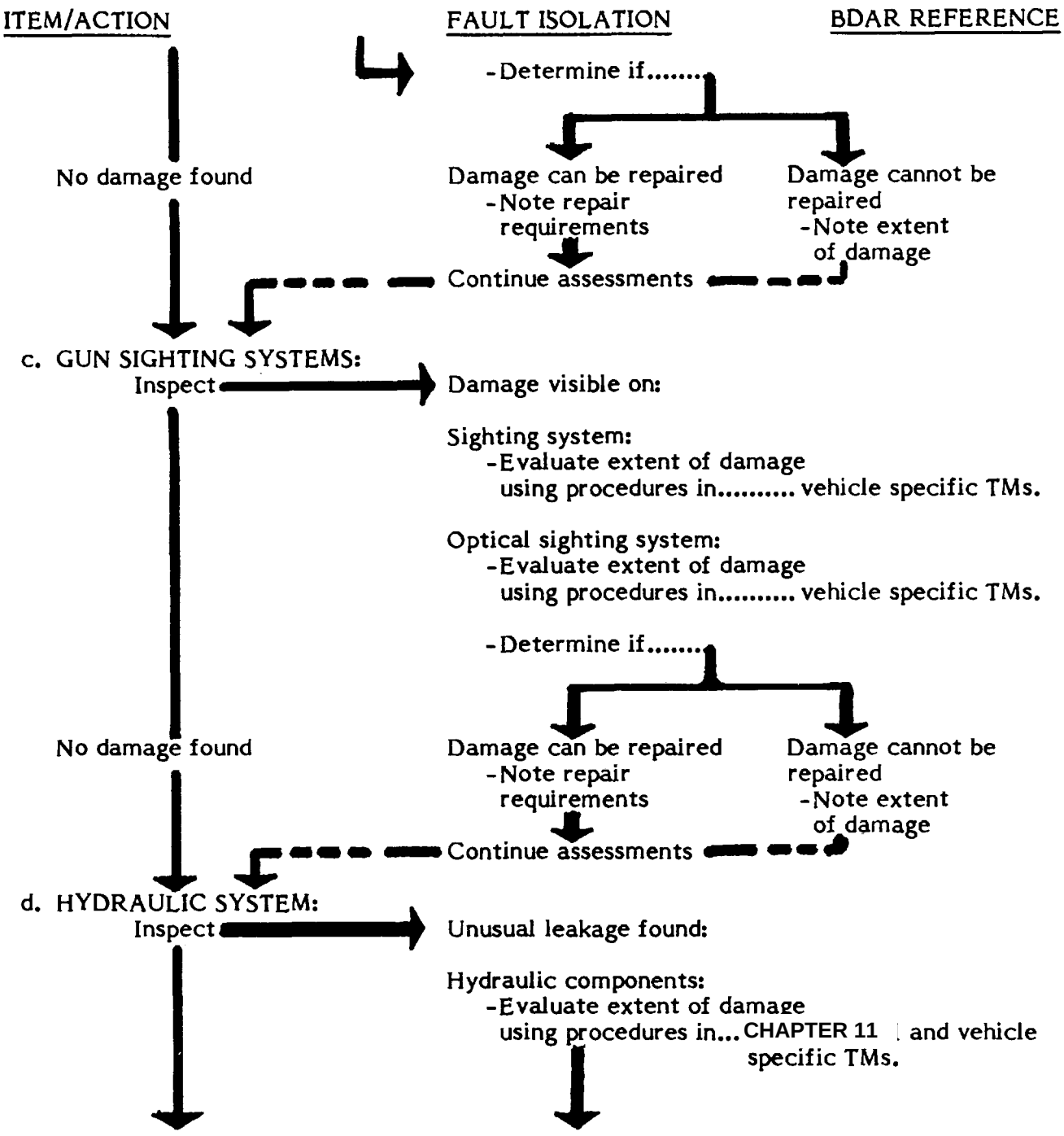


Table 2-1. Vehicle/System Assessment (Cont).

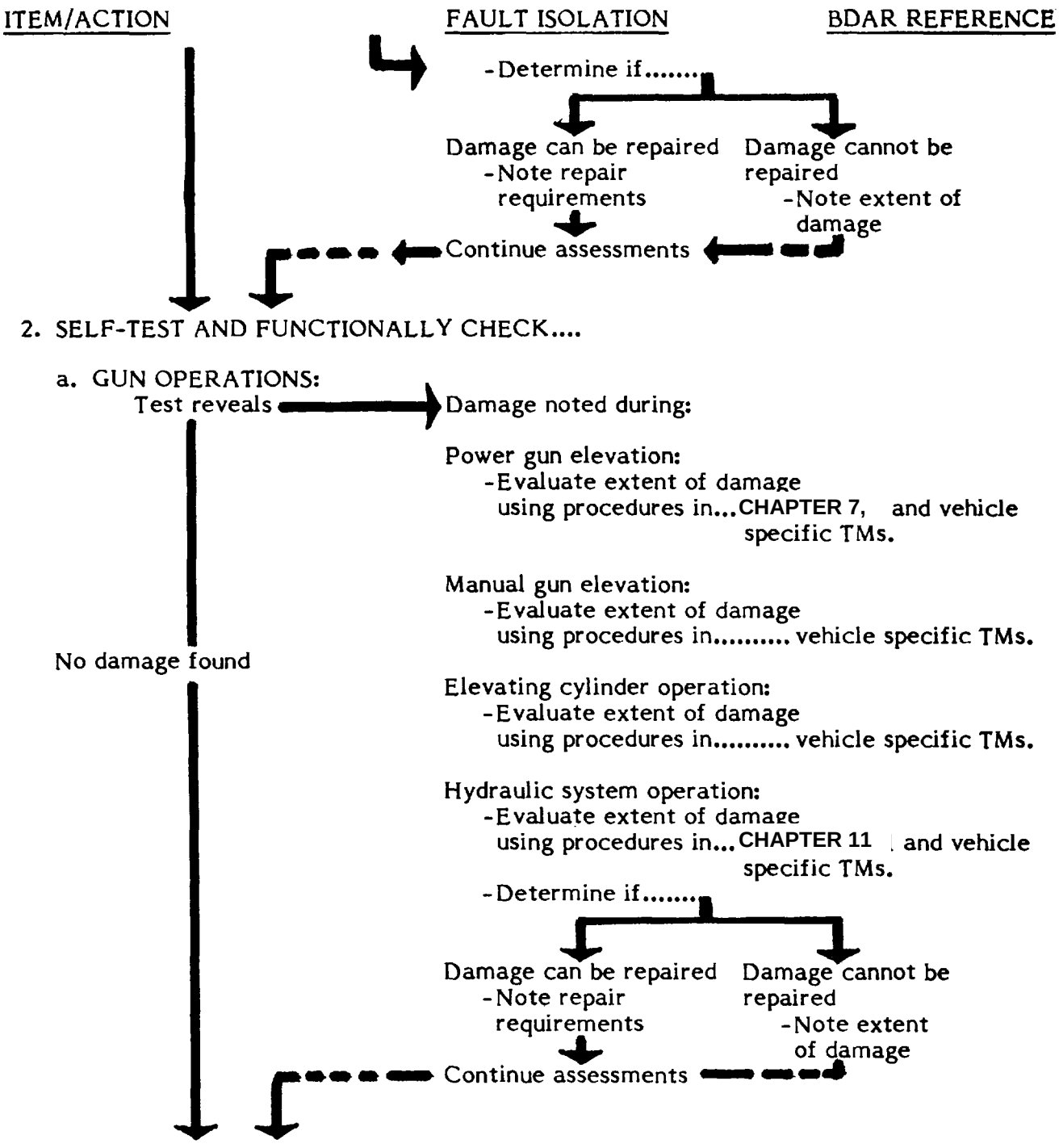


Table 2-1. Vehicle/System Assessment (Cont).

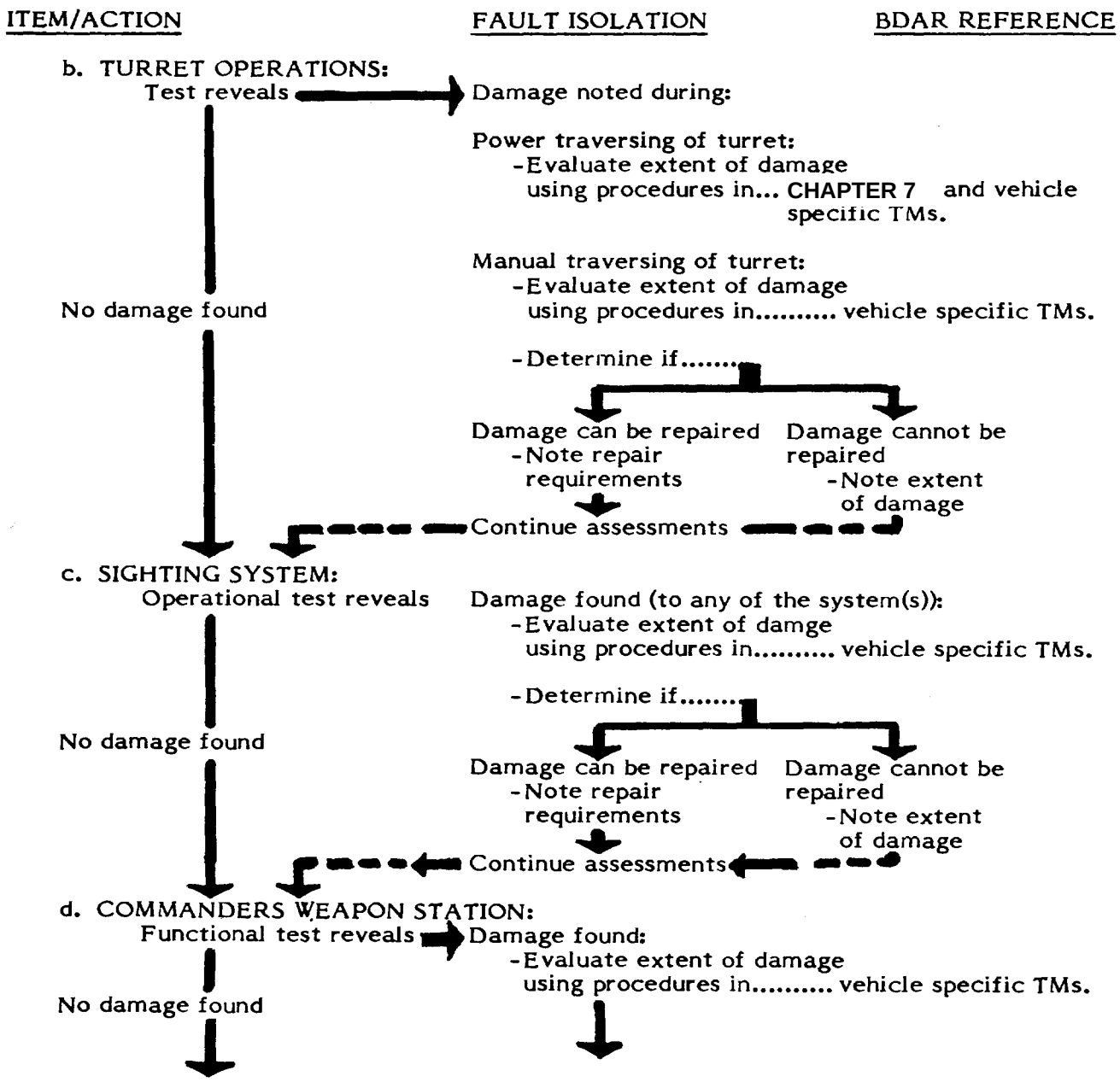
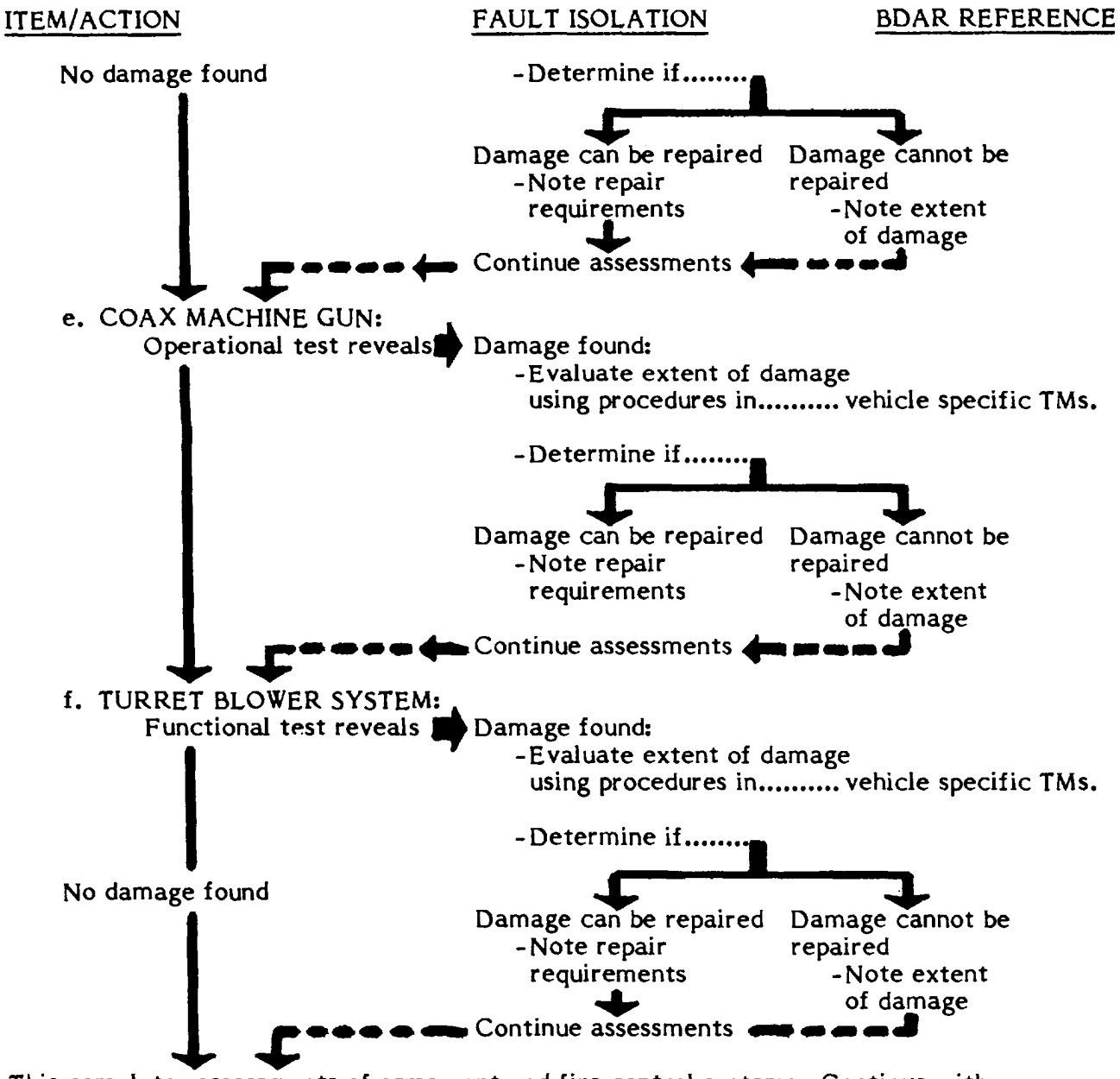


Table 2-1. Vehicle/System Assessment (Cont).



This completes assessments of armament and fire control systems. Continue with assessments of the communication system if required. If communication systems are operational, prepare to report.

Table 2-1. Vehicle/System Assessment (Cont).

ITEM/ACTION	FAULT ISOLATION	BDAR REFERENCE

C. COMMUNICATIONS ASSESSMENTS.

1. VISUALLY INSPECT....

WARNING

Before assessing and handling communications equipment turn off the power to all components of the communications system. Damaged equipment can cause severe shock to personnel and additional damage to equipment.

Inspection reveals → Damage to:

No damage found ↓

Antenna(s):
- -Evaluate extent of damage using procedures in.....CHAPTER 14.

R. F. Cables:
- -Evaluate extent of damage using procedures in.....CHAPTER 14.

Radio mounts:
- -Evaluate extent of damage using procedures in.....CHAPTER 14.

Radio:
- -Evaluate extent of damage using procedures in.....CHAPTER 14.

Receiver:
- -Evaluate extent of damage using procedures in.....CHAPTER 14.

AM 1780 amplifier:
- -Evaluate extent of damage using procedures in.....CHAPTER 14.

Control boxes:
- -Evaluate extent of damage using procedures in.....CHAPTER 14.

Table 2-1. Vehicle/System Assessment (Cont).

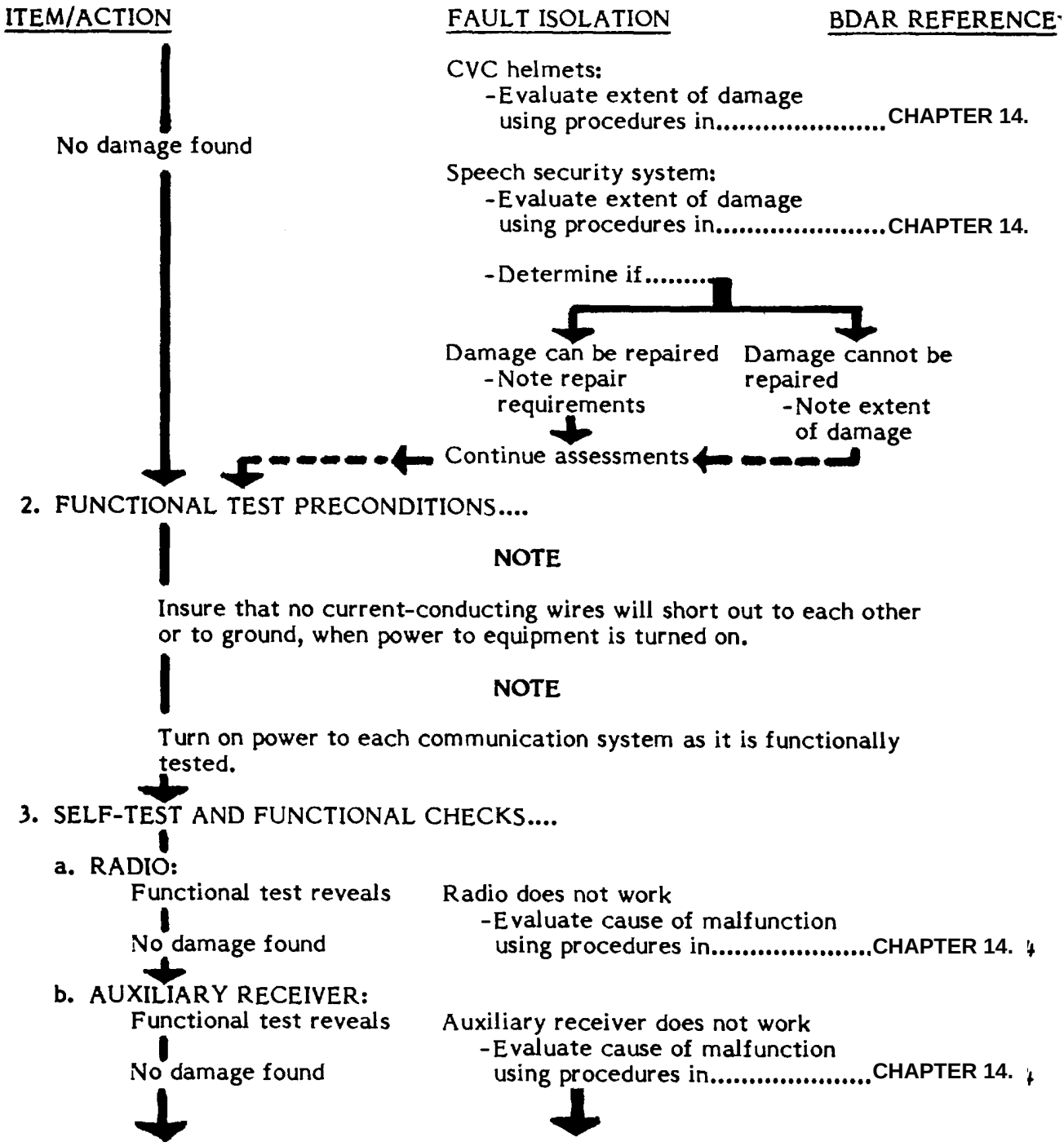
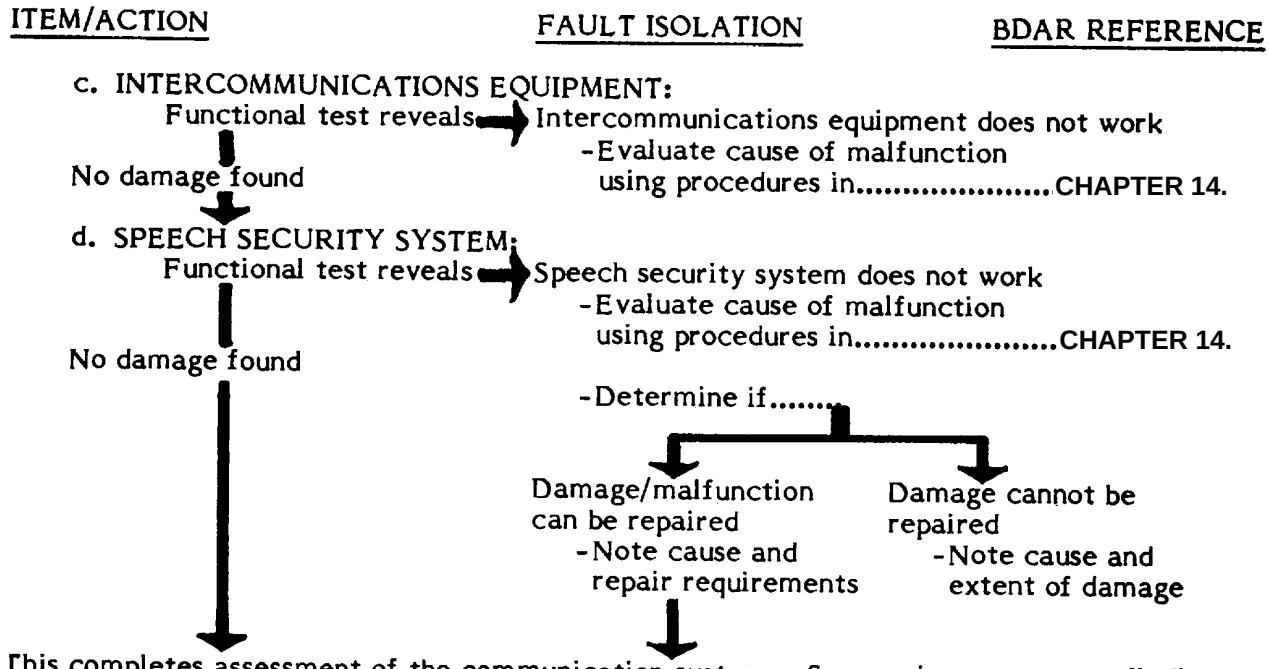


Table 2-1. Vehicle/System Assessment (Cont).



2-7. Index of Failures and Field Fixes

Table 2-2 below lists the BDAR procedures in this TM in alphabetical order.

Table 2-2. BDAR Procedural Index

Table 2-2. BDAR Procedure Index (Continued)

Table 2-2. BDAR Procedure Index (Continued)

SECTION III. Battlefield Damage Assessment/Repair Forms

2-8. General.

a. This section illustrates and describes the forms used in battlefield damage assessment. The forms are designed to assist Commanders in rapidly assessing battlefield damaged equipment, systematically assessing equipment to determine which subsystem(s) are affected, and the time, personnel and material required to effect repair. These forms will also assist in performing "vehicle triage." Vehicle triage is defined as a system of deciding in which order battlefield damaged equipment will receive repair, according to time, urgency, material and personnel required to accomplish the repair. The forms illustrated are to be used in assessing battlefield damage.

NOTE

These forms are locally reproducible and should be reproduced in necessary quantities to support local needs.

b. The battlefield damage assessment/repair forms are designed to assure that all necessary aspects of combat capability are evaluated during the assessment process.

c. All assessment procedures follow the sequence, (1) visually inspect (repair if necessary), (2) functionally test, (repair if necessary), and (3) assess the performance. The net assessment and field fixes will enable the vehicle to continue the mission or self-recover, but will typically be more useful to the MT/MST for scheduling and accomplishing both BDAR "quick fixes" and fix-forward repairs. Battlefield damage assessment will also provide the Commander with the necessary information for timely decisions as to whether to continue to "fight the vehicle" or recover it at the appropriate level.

d. Reporting of battlefield damage should be accomplished in accordance with local Standing Operating Procedures (SOP).

e. There are four forms to be used when assessing battlefield damage, BDARF-5, (System Summary), BDARF-6 (Hull Damage Report), BDARF-7 (Turret Damage Report), BDARF-8 (Communications Damage Report). These forms can be used by the crew, a MT, or a MST.

(1) BDARF-5 is used to determine:

Can the vehicle move, shoot and communicate?

What subsystems are affected?

Is the damage repairable?

If repairable, are there limitations?

Estimated time to repair?

Estimated number of personnel to effect repair.

What materials are required?

Recover status (recovery vehicle required or self-recovery.)

Once these questions are answered, a determination can be made as to whether the vehicle should be repaired on-site, recovered to a collection point and repaired, or recovered to the rear.

(2) BDARF-6, -7,and -8 address specific systems and subsystems. These forms are designed to assist the assessor to rapidly assess the damage and rapidly determine the appropriate BDAR fix. The portion of this form which addresses parts should be filled out only when the tactical situation permits. Where possible these forms should follow the damaged equipment or be sent to the rear as a record of what damages occurred and what repairs were effected and where.

SYSTEM SUMMARY

Serial No. _____

Vehicle Status	Yes	No
Move _____	☐	☐
Shoot _____	☐	☐
Communicate _____	☐	☐

Can Vehicle Be Repaired?	Yes	No
	☐	☐

Recovery Status	Yes	No
Self Recover	☐	☐
Can be Towed	☐	☐
Transportable	☐	☐

Sub-System	Repair	Recover	Limitations	Estimated - Time	Personnel
Engine	☐	☐	_____	____	_____
Transmission/Final Drive	☐	☐	_____	____	_____
Fuel System	☐	☐	_____	____	_____
Electrical System	☐	☐	_____	____	_____
Track & Suspension	☐	☐	_____	____	_____
Hydraulic System	☐	☐	_____	____	_____
Armor & Ammunition Stowage	☐	☐	_____	____	_____
Armament & Fire Control	☐	☐	_____	____	_____
Communications	☐	☐	_____	____	_____
Other _____	☐	☐	_____	____	_____
			Total	____	_____

Material Requirements

	Expendables	Parts	NSN	Tools	NSN
1.	_____	_____	_____	_____	_____
2.	_____	_____	_____	_____	_____
3.	_____	_____	_____	_____	_____
4.	_____	_____	_____	_____	_____
5.	_____	_____	_____	_____	_____

Remarks

HULL DAMAGE ASSESSMENT AND REPAIR

Serial No. _____

Estimated Total Time _____
No. of Mechanics _____

Exchanged Parts	NSN
1. _____	_____
2. _____	_____
3. _____	_____
4. _____	_____
5. _____	_____

Cannibalized Parts	NSN
1. _____	_____
2. _____	_____
3. _____	_____
4. _____	_____
5. _____	_____

Engine System	Time	Personnel
1. Starter	____	_____
2. Oil Tank	____	_____
3. Air Induction System	____	_____
4. Air Cleaner	____	_____
5. Oil Filter	____	_____
6. Low Oil Pressure	____	_____
7. Drain Valve	____	_____
8. Accessory Driveshaft	____	_____
9. _____	____	_____
10. _____	____	_____
11. _____	____	_____

Transmission & Final Drives	Time	Personnel
1. Transmission will not shift	____	_____
2. Broken Linkage	____	_____
3. Tank will not Steer	____	_____
4. Final Drive Locked	____	_____
5. Transmission Leaks	____	_____
6. Parking Brakes	____	_____
7. Service Brakes	____	_____
8. Oil Coolers	____	_____
9. _____	____	_____
10. _____	____	_____

Fuel System	Time	Personnel
1. Fuel Tanks	____	_____
2. Fuel Lines	____	_____
3. Fuel Filters	____	_____
4. Fuel Pumps	____	_____
5. _____	____	_____
6. _____	____	_____
7. _____	____	_____

BDARF-6

HULL DAMAGE ASSESSMENT AND REPAIR (Continued)

Serial No. _____

Electrical System	Time	Personnel
1. Wiring Harness	____	_____
2. Slipring	____	_____
3. Batteries	____	_____
4. Circuit Breakers	____	_____
5. Power Distribution Box	____	_____
6. _____	____	_____
7. _____	____	_____
8. _____	____	_____
Total	____	_____

Track & Suspension	Time	Personnel
1. Compensating Idlers	____	_____
2. Track Adjusting Link	____	_____
3. Road Wheel Arms	____	_____
4. Roadwheels	____	_____
5. Support Rollers	____	_____
6. Sprockets	____	_____
7. Shock Absorbers	____	_____
8. Torsion Bars	____	_____
9. Track Assembly	____	_____
10. _____	____	_____
11. _____	____	_____
12. _____	____	_____
Total	____	_____

Hydraulic System	Time	Personnel
1. Hydraulic Lines	____	_____
2. Hydraulic Fluid	____	_____
3. _____	____	_____
4. _____	____	_____
5. _____	____	_____
Total	____	_____

Other	Time	Personnel
1. Driver's Controls	____	_____
2. Driver's Instruments	____	_____
3. _____	____	_____
4. _____	____	_____
5. _____	____	_____
Total	____	_____

BDARF-6

TURRET DAMAGE ASSESSMENT AND REPAIR

Serial No. _____

Estimated Total Time _____
No. of Mechanics _____

Exchanged Parts	NSN
1. _____	_____
2. _____	_____
3. _____	_____
4. _____	_____

Cannibalized Parts	NSN
1. _____	_____
2. _____	_____
3. _____	_____
4. _____	_____

Electrical System	Time	Personnel
1. Turret Power	____	_____
2. Slipring	____	_____
3. Circuit Breakers	____	_____
4. Wiring Harnesses	____	_____
5. _____	____	_____
6. _____	____	_____
Total	____	_____

Hydraulic System	Time	Personnel
1. Aux Hydraulic Pump	____	_____
2. Hydraulic Fluid	____	_____
3. Hydraulic Reservoir	____	_____
4. Tubes & Hoses	____	_____
5. Accumulator	____	_____
6. _____	____	_____
7. _____	____	_____
Total	____	_____

Armor & Ammo Stowage	Time	Personnel
1. Ammo Stowage Racks	____	_____
2. Ammo Ready Rack	____	_____
3. _____	____	_____
4. _____	____	_____
Total	____	_____

Fire Control	Time	Personnel
1. CMDR Control Handle	____	_____
2. CMDR Weapon Sight	____	_____
3. Gunner's Primary Sight	____	_____
4. Gunner's Aux Sight	____	_____
5. Range Finder	____	_____
6. Stabilization System	____	_____
7. Cross Wind Sensor	____	_____
8. Wiring Harness	____	_____
9. Gunner's Control Handle	____	_____
10. Manual Traverse & Elevation	____	_____
11. Loader's Panel	____	_____
12. Blasting Machine	____	_____
13. _____	____	_____
14. _____	____	_____
Total	____	_____

Armament	Time	Personnel
1. Bore Evacuator	____	_____
2. Gun Tube	____	_____
3. Breech Group	____	_____
4. Main Gun Mount	____	_____
5. _____	____	_____
6. _____	____	_____
Total	____	_____

BDARF-7

COMMUNICATIONS DAMAGE ASSESSMENT AND REPAIR

Serial No. _____

Exchanged Parts	NSN	Cannibalized Parts	NSN
1. _____	_____	1. _____	_____
2. _____	_____	2. _____	_____
3. _____	_____	3. _____	_____
4. _____	_____	4. _____	_____

	Time	Personnel
1. Intercommunications	____	_____
2. Receiver/Transmitter	____	_____
3. Antennas	____	_____
4. AM 1780	____	_____
5. Security	____	_____
6. Cables	____	_____
7. _____	____	_____
8. _____	____	_____
Total	____	_____

CHAPTER 3

GENERAL AUTOMOTIVE COMPONENTS

BDAR FIXES SHALL BE USED ONLY IN COMBAT
AT THE DISCRETION OF THE COMMANDER
AND SHALL BE REPAIRED BY STANDARD MAINTENANCE PROCEDURES
AS SOON AS PRACTICABLE AFTER THE MISSION IS COMPLETED.

Section I. General

3-1. General. This chapter describes quick fix procedures for those automotive items common to automotive systems and functional elements of a combat vehicle.

3-2. Assessment Procedure. Visually inspect damaged components to determine the extent of damage and the repair required.

3-3. BDAR Procedure Index **Para**

Section II. Gaskets

3-4. General.
Gaskets may become damaged causing leakage from components. Procedures are available to make or repair gaskets if standard replacements are not available. Lift capability may be required to gain access to the gasket. Heat and pressure should be considered when selecting gasket materials.

3-5. GASKETS, LEAKING

General Information:
When some metal surfaces are bolted together a compressable gasket is required to reduce or eliminate the leakage of fluids or lubricants. Gaskets are also used to seal systems against fuel leakage or to keep contaminants from entering. Leaks can be tolerated if the fluid leaking does not constitute a fire hazard or does not leak at a rate which will deplete the required lubrication.

Limitations:
- Frequent inspections required

Personnel/Time Required:
- 1-2 soldiers
- 1-6 hours

Materials/Tools:
Gasket material such as:
- Leather
- Used gasket
- Cardboard
- Teflon tape
- Silicone gasket sealer
- Permatex type sealer

Other Options:
- Continue operation, refilling fluids as required.

Procedural Steps:

Option 1: Manufactured gasket.

1. Cut leather, cardboard or other material to fit the mating surfaces.

    a. Hold gasket against mating surface and mark an outline of the component, cut the material with a knife or shears.

Procedural Steps (Continued)

b. Hold material against mating surface. Tap the gasket material with a ballpeen hammer along the edges of the mating surfaces to remove unwanted gasket material.

2. Coat the gasket with a sealing compound.

3. Join components and bolt.

Option 2. Used gaskets.

1. Coat mating surface with sealing compound.

2. Place used gasket or sections of broken gasket onto mating surface.

3. Coat other mating surface with gasket sealer.

4. Join components and bolt.

Option 3. Gasket sealer.

1. Remove old gasket material and residue.

2. Coat mating surfaces with silicone gasket sealer.

3. Allow silicone sealer to form a skin (10 to 15 minutes).

4. Join components and bolt.

Record the BDAR action taken. When the mission is completed, as soon as practicable, repair the vehicle using standard maintenance procedures.

3-6. GASKETS, ENGINE

General Information:.

Engine cylinder head gaskets seal both compression and fluid galleries. Leakage's can be detected through:

a. lack of power,

b. rough, uneven engine operation,

c. abnormal pressure in crankcase or cooling system,

d. contaminants in oil or cooling system.

General Information (Continued):
BDAR procedures are more difficult to perform on cylinder head gaskets but limited operation can be restored. Frequent checks must be made for leakage and temperature changes. Engine speeds should be reduced.

Limitations:
- Degraded mobility

Personnel/Time Required:
- 1-2 soldiers
- 2-6 hours

Materials/Tools:
- Epoxy
- Copper wire
- Hardening gasket sealer

Other Options:
- Continue operations

Procedural Steps:

Option 1: Gasket sealer.

1. Remove cylinder head.
2. Locate leaking area.
3. Liberally coat leaking area with hardening gasket sealer.
4. Replace cylinder head, tighten mounting bolts or studs.
5. Check engine operation.

Option 2: Wire and sealer.

1. Remove cylinder head.
2. Remove gasket or O-rings.
3. Lay soft copper wire around each cylinder bore and trim to eliminate any overlap.
4. Reinstall old gasket coated with gasket sealer, varnish or paint.
5. Reinstall cylinder head, tighten mounting bolts or studs.

Record the BDAR action taken. When the mission is completed, as soon as practicable, repair the vehicle using standard maintenance procedures.

3-7. GASKETS, ENVIRONMENTAL

General Information:
Inspect for water or foreign matter in compartments or areas that should be sealed.Rubber weatherstripping from civilian vehicles or any rubber hose securely glued and sealed will stop leaks. Canvas or rubber inner tubes will also seal the system. These seals will prevent excessive water and air leaks but may not provide adequate NBC protection.

Limitations:
- None

Personnel/Time Required:
- 1-2 soldiers
- 20-60 minutes

Materials/Tools:
- Rubber hose
- Rubber weather stripping
- Inner tubes
- Adhesive
- Canvas tarp
- Poncho
- Epoxy

Procedural Steps:

1. Locate leak, remove component or cover.

2. Remove defective gasket and clean the sealing surfaces.

3. Obtain material to fabricate sealing gasket.

4. Cut gasket to fit.

5. Apply available adhesive, follow instructions on container.

6. Place gasket in proper location.

7. Reinstall component or cover.

Record the BDAR action taken. When the mission is completed, as soon as practicable, repair the vehicle using standard maintenance procedures.

Section III. Belts

3-8. General.

V-Belts provide direct drive and can be substituted or replaced if the basic factors about each belt is considered. Substitute belts must be wide enough to prevent bottoming in the pulley "V" and of the correct length to maintain tension. Inspect width and length of the belt. Smaller, narrower belts may be substituted or V-belts may be taken from one vehicle if there are twin belt drives. Direct vehicle-to-vehicle removal and installation is a simple method of replacing missing belts.

3-9. V-BELT-MISSING OR BROKEN

General Information:

Some vehicle subsystems are driven by V-belts. Most liquid cooling system coolant pumps and fans for moving air over or through a radiator require V-belts. Power generation is also belt driven. Worn or frayed V-belts can slip or break causing the system to fail. V-belts can be replaced or substituted to restore system functions. Frequent adjustment may be required for substitute V-belts.

Limitations:

- Degraded mobility

Personnel/Time Required:

- 1 soldier
- 15-60 minutes

Materials/Tools:

- Adjustable link V-belts
- Rope
- Wire

Procedural Steps:

Option 1:

1. Rope or wire can also be used but thin wire must be braided to ensure the needed friction is provided.

2. Assemble the rope or wire as close as possible to the original length of the correct belt.

3. Adjust with the tensioner assembly.

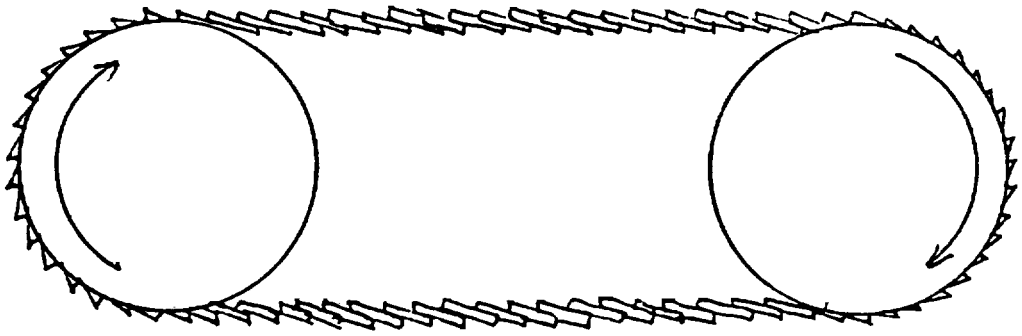
Procedural Steps (Cont)

Option 2:

1. Separable-link belts can be used, if available.

2. Assemble the belting as close as possible to the original length of the correct belt and adjust with the vehicle belt tensioner.

3. Install the belt as shown. This prevents undue strain on the belt links.

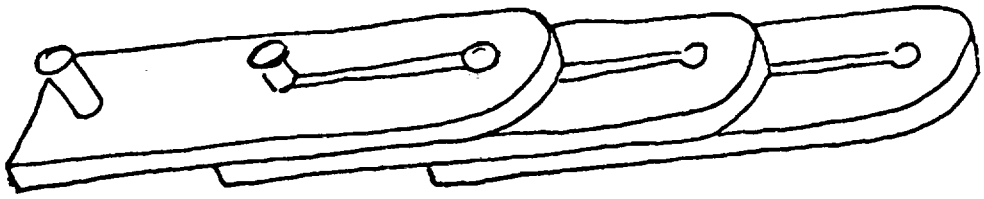


DIRECTION OF ROTATION

Table 3-1. Adjustable-Link V-Belt Data

BELTING, V, ADJUSTABLE LINK

Size	NSN	u/i
A SIZE 1/2 in. W	3030-00-224-8358	FT
B BELTING 3/4 in. W	3030-00-233-9126	FT



Record the BDAR action taken. When the mission is completed, as soon as practicable, repair the vehicle using standard maintenance procedures.

Section IV. Housings, Castings, Plates

3-10. General.

Castings or plates may be serviceable even with holes or cracks providing the internal structure is not significantly weakened. Internal structures such as crankshaft bearing journal webs are necessary to distribute loads within the casting. Some damage to these elements of the structure can be allowed but fatigue failures from crack growth cannot be predicted, and service life will depend on the extent of damage.

3-11. ENGINE/TRANSMISSION HOUSING DAMAGE

General Information:

Small cracks or holes may develop in a cylinder head, block or transmission housing, caused by vibrations overheating or explosive shocks. Cracks that do not harm the structural strength of a housing can be deferred but cracks that allow coolant or oil to escape must be repaired. Large holes or cracks will require exchange of the component. Frequent fluid level checks must be performed. Depending on the extent and location of the damage the pack may have to be removed.

Limitations:

- Reduced mobility

Personnel/Time Required:

- 3 soldiers
- 2-24 hours

Materials/Tools:

- Sandpaper
- Epoxy
- Plastic steel
- Metal plate
- Bulk issue fiberglass or epoxy kit
- Permatex (hardening)
- Lift capability

Procedural Steps:

Use of one of the following steps to repair a small crack or hole in housing:

Option 1: Repair of small crack.

1. Remove all paint from around the crack.

2. Cover the crack and 1/4 inch or more of the surrounding area with quickdrying epoxy plastic.

Procedural Steps (Continued})

3. Allow epoxy to harden before running an engine. Use heat (heat lamp) to speed up curing of epoxy.

Option 2: Repair of small crack or hole.

1. Remove all paint from around the area where metal plate is to be positioned.

2. Cover the area with a plate from any available metal large enough to cover the crack or hole. Seal the edges of the plate with quick-drying epoxy.

3. Allow epoxy to harden before running engine.

Option 3: Repair of a small crack or hole.

1. Clean damaged area.

2. Fill small crack or holes in low stress area either with Permatex, fiberglass, or epoxy.

Record the BDAR action taken. When the mission is completed, as soon as practicable, repair the vehicle using standard maintenance procedures.

Section V. Brackets and Weldments

3-12. General.

Brackets are used on all vehicles to mount or store items. Brackets are mounted to the vehicle by bolting or welding in place and are subject to damage through vibrations, impact or explosive forces. Repairs must be made to restore the brackets needed for restoring essential vehicle functions.

3-13. BRACKET BROKEN

General Information:

Equipment mounting brackets welded to the hull or turret sometimes will break due to vibrations or collision with obstacles. Brackets are needed to mount components and devices in locations or positions where they can be used to perform their required functions. Bolted brackets should be remounted using bolts if possible, their removal may be required to gain access to other components.

Limitations:

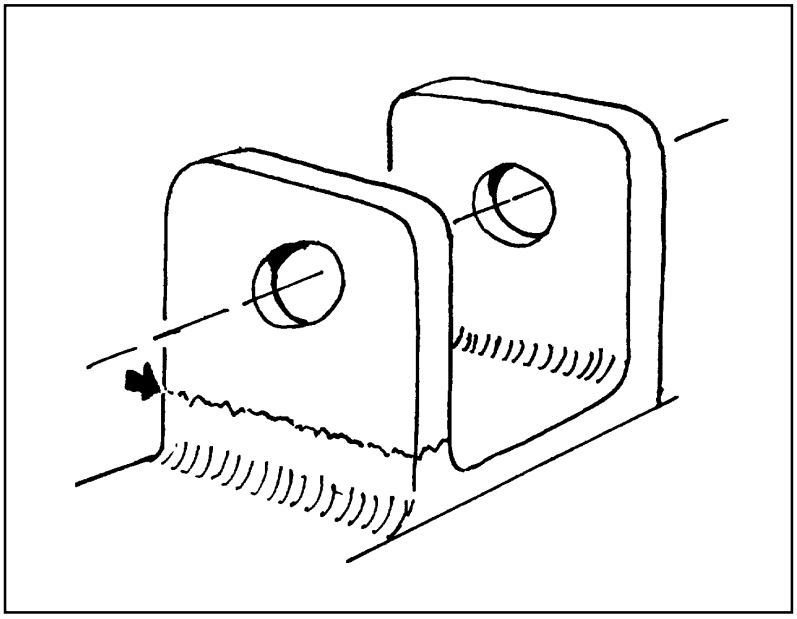
- None

Personnel/Time Required:

- 2 soldiers
- 1 hour

Materials/Tools:

- Welding equipment
- Elastic cords
- Wire or rope
- BII tiedown straps



Procedural Steps:

Option 1. If bracket is broken off at the base metal, with component mounting holes unaffected, reweld in place. Mounting holes may be elongated to compensate for mis-alignment of attaching items.

Option 2. If the bracket mounting holes cannot be used because of stripped threads or broken bolts cannot be removed, weld the bracket to the location.

Option 3. If brackets cannot be welded or bolted, tie the component in place using rope, common wire, Bungee cords or BII straps.

Record the BDAR action taken. When the mission is completed, as soon as practicable, repair the vehicle using standard maintenance procedures.

Section VI. Hardware, Mechanical Linkages, Cables and Pulleys

3-14. General

Various elements of hardware and linkages are used throughout combat vehicles to transfer the control actions from the crew to the components being controlled. Damage can occur to the mounting hardware or the rods, cables and levers in the mechanical linkage systems. Pins can become lost, linkages can bend or break which will disable or hamper the vehicle operation. This section will give various procedures that may be used to repair or restore needed functions.

3-15. FORCING MISMATCHED THREADING.

The proper bolts may not always be available to make repairs. Mismatched bolts can be used to make BDAR repairs but care must be taken so as not to break bolts by forcing them too far. Coarse threaded bolts may be used in holes with fine threads. Forced threads will not hold as much stress as standard threads but will provide a limited operational capability.

3-16. THREAD CLEAN-UP.

Damaged threads decrease the load bearing capability of bolts. Damaged threads can be repaired or cleaned up using a thread file or a triangular shaped file. The threads must be cleaned to remove any dirt or metal particles which might cause further damage to threaded holes. Use a wire brush and a nail or scribe to remove stuck metal particles. Damaged threads must have burrs removed. Cross-threaded bolts must have the torn metal removed where they connect between threads. Turning a hardened steel nut onto the bolt can help realign damaged threads.

3-17. HARDWARE MOUNTING.

Brackets and components can be connected or mounted without proper bolts. An iron rod or stud can be inserted through the connecting holes and peened over on each side. The mushroomed ends will keep the components together. A stud can be screwed into a threaded hole and a nut used to hold the component. If the proper size nut is not available, use a nut larger than the stud threads and peen the stud end to hold the nut in place. Linkages can also be connected by inserting a rod or bolt and peening the ends to keep it from dropping out of position.

3-18. GEARSHIFT LEVER BROKEN

General Information:

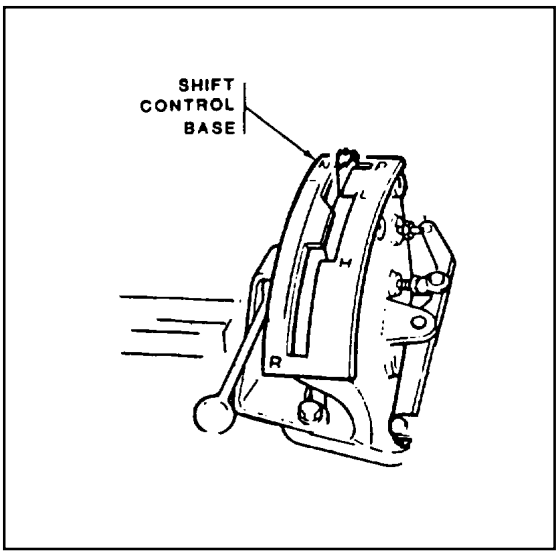
Binding shifting linkage can cause the transmission range selector lever to break resulting in the loss of shifting control. Binding linkages must be repaired to allow shifting without undue strain on the mechanism. An expedient shift lever can be substituted to provide control of the transmission gear ranges.

Limitations:
- Degraded mobility

Personnel/Time Required:
- 1 soldier
- 10-30 minutes

Materials/Tools:
- Vise grips
- Channel locks

Other Options:
- If the shift lever is hollow, insert a screwdriver into the remaining section to allow shifting.



Procedural Steps:

1. Remove shifting gate to gain access to the shift linkage shaft.

2. Clamp vise grips onto the broken remaining portion of the shift lever.

3. Shift gears to determine range of movement and adjust to allow reverse and one forward gear.

4. Record the BDAR action taken. When the mission is completed, as soon as practicable, repair the vehicle using standard maintenance procedures.

3-19. PUSH/PULL ROD DAMAGED

General Information:
Mechanical linkage rods can bend or break from explosive shock, impact or binding components. Rods can be repaired or improvised to regain usage of the system involved. The cause of breakage must be determined and corrected. Rods or shafts that are bent must be straightened. Place the rod/shaft on a hard flat surface and hit with a hammer to bend it straight. Broken rods/shafts can be splinted using scrap metal.

Limitations:
- Possible degraded mobility

Personnel/Time Required:
- 1-2 soldiers
- 1-2 hours

Materials/Tools Required:
- Welding equipment
- Drill
- Hacksaw
- Plate stock

Other Options:
- When push/pull rod damage is beyond repair, a substitute may be manufactured from plate stock.

Procedural Steps:

Option 1: Welding equipment available.

1. Determine if damaged rod is made of steel or aluminum alloy.

2. Measure rod length between connecting points.

3. Remove rod and weld.

4. Remove all metal fragments which would hinder rod operation.

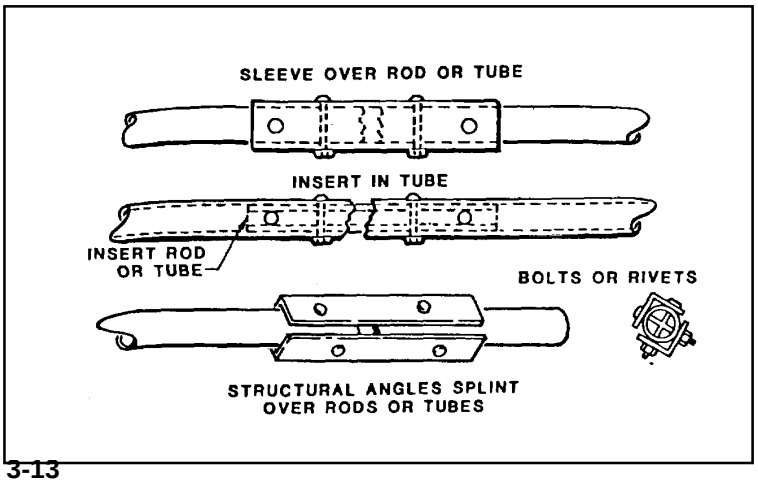
Option 2: Welding equipment is not available.

1. Cut needed material from bussle rack or hand rails to splint rod.

2. Measure rod length and drill holes through re-enforcement and rod.

3. Rivet or bolt re-enforcement to damaged rod.

Record the BDAR action taken. When the mission is completed, as soon as practicable, repair the vehicle using standard maintenance procedures.



3-20. PULLEY DAMAGED

General Information:
When cable pulleys are damaged beyond use, a replacement may be cannibalized from another vehicle or the damaged pulley may be welded or wedged into position. A spacer, bolt and two flat washers can be used as an improvised pulley to guide the cable.

3-21. CABLE, MECHANICAL, BROKEN

General Information:
Cables may break causing a system to become inoperative. Cables may be repaired by splicing. When replacement cable is not available, prepare cable for splicing as follows:

Limitations:
- None

Personnel/Time Required:
- 1 soldier
- 1-2 hours

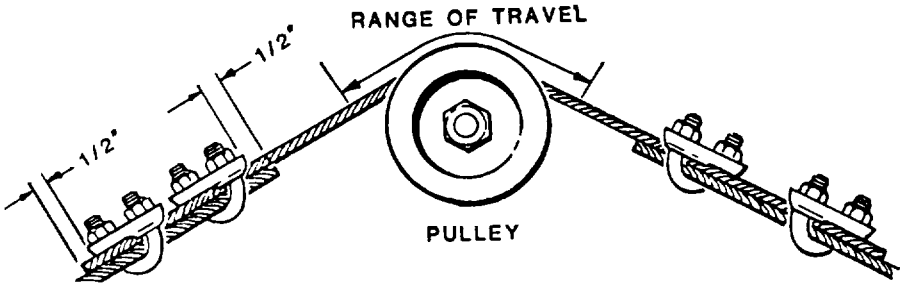
Materials/Tools:
- New or reclaimed cable
- Cable clamp or nicropress sleeves and installation tool
- Vise
- Vise-grips

Other Options:
- Damaged cable may be replaced with braided wire, commo wire, 5 to 7 strands, or rope where the cable function will permit.

Procedural Steps:

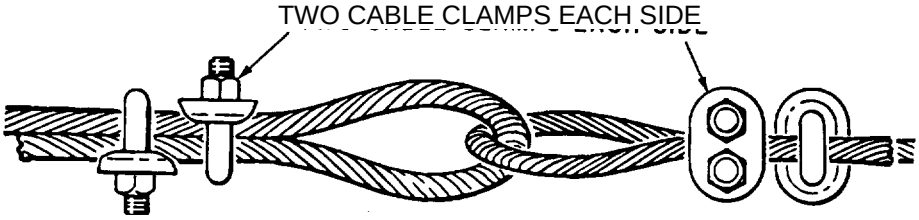
1. Loosen the cable.

2. Select a length where the cable splices will not restrict the range of cable travel and splice cable using one of the methods shown.

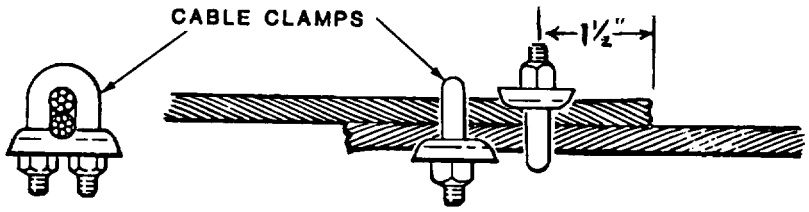


Procedural Steps (Cont)

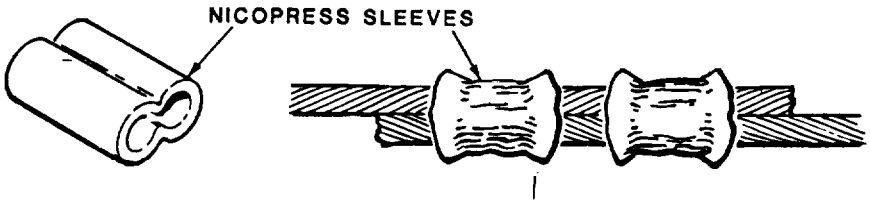
a. Make a loop at the end of one cable, thread the other cable end through the loop, and make another loop. Secure both loops as shown.



b. Splice cable with two clamps. The end of the cable should extend at least 1/2 inch beyond the clamp as shown.



c. Splice the cable with two nlcropress sleeves. Swage the sleeves on the cables with installation tool, a vise, or a hammer.



3. Adjust cable to its proper tension.

4. Record the BDAR action taken. When the mission is completed, as soon as practicable, repair the vehicle using standard maintenance procedures.

3-22. PIN-ALIGNMENT, CLEVIS, COTTER, DOWELS, QUICK RELEASE, ETC.

Most linkages have retainer devices, cotter keys, lacing wire or safety pins, to keep the connecting bolts or pins in place. During BDAR repairs, small pins may become lost or forgotten which will cause linkage or component failure. Repairing the vehicle by securing connecting bolts or pins can be accomplished using wire, welding rod, bolts or nails. Place the item through the hole and bend the ends to keep it from falling out. Castelated nuts can also be retained using this method. Alignment pins or dowels can be replaced with cut bolts. Use a bolt that is a tight fit in the hole, tap the bolt in and cut to proper length.

CHAPTER 4
ENGINE

**BDAR FIXES SHALL BE USED ONLY IN COMBAT
AT THE DISCRETION OF THE COMMANDER
AND SHALL BE REPAIRED BY STANDARD MAINTENANCE PROCEDURES
AS SOON AS PRACTICABLE AFTER THE MISSION IS COMPLETED.**

Section I. General

4-1. General.

All the current combat vehicles are powered by diesel fueled engines. Engine operation is monitored by sending units transmitting impulses to dash mounted gages and warning lights. Engine malfunctions can be detected by:

a. Abnormal oil pressure or temperature readings or warning lights.

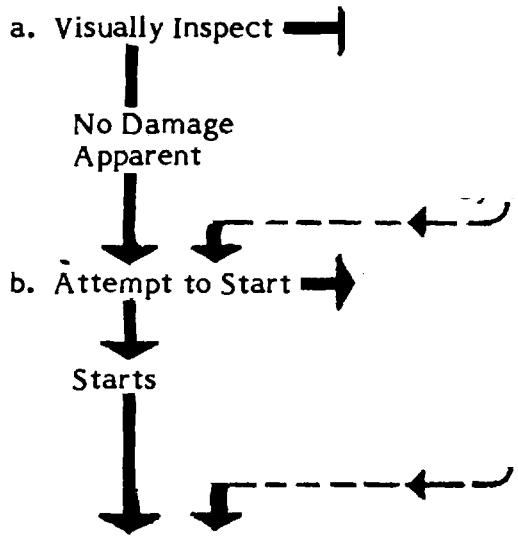
b. Abnormal noises.

c. Abnormal amounts or coloration of exhaust smoke.

d. Sudden loss of power or excessive fuel consumption.

This chapter gives various expedient fixes which can restore the vehicle's mobility in event of engine system failure.

4-2. Assessment Procedure.



Damage observed on:
- -Cooling System; ..... go to Chapter 6
- -Fuel System; ..... go to Chapter 5
- -Lubrication; ..... go to Section V

-Air Intake/Exhaust System; ..... go to Section III, IV

Will Not Start:
- -Check Fuel System; ..... go to Chapter 5
- -Check Air Intake/Exhaust System; ..... go to Section III, IV

-Check Starting System; ..... go to Chapter 7

c. Observe Operation ➡ Damage Detected when Operating or system not working:

No Significant Damage and Subsystems	-Mechanical failures (Internal Engine Failures); ..... go to Section II Damage -Cooling System Failures: ..... go to Chapter 6 -Lubrication System -Failures; ..... go to Section V -Fuel System Failures: ..... go to Chapter 5

4-3. BDAR Procedure Index **Para**

Section II. Engine Failure

4-4. General.

Basic engines in combat vehicles of a single family, such as the M60 tank, are the same but motor supports, manifolds, exhaust or cooling systems require different brackets to fit a particular vehicle. Accessories and brackets must be swapped from the unserviceable engine to make the replacement engine fit another application.

4-5. ENGINE INTERCHANGEABILITY

General Information: Replace engine with any engine that can be converted and installed. Availability of engines may become restricted to those found in damaged vehicles. Basic engines from other vehicles can be modified or reconfigured to fit the vehicle needing the engine. .See Table 1-I for an Interchangeability list. Internal engine components may be different giving increased or decreased engine performance. The proper engine should be obtained as soon as possible to normalize vehicle operation. Remove transmission connecting links and use the vehicle as a towed firing platform if the firepower systems function. The towed vehicle electrical power will rapidly discharge. Use manual controls to conserve power.

Table 4-1. Engine Application- Combat Vehicles

System	Continental AVDS 1790	Detroit 8V71 Series	Diesel 6V53 Series	Cummins 903
Piranha, Mowag (Swiss Made)			X	
10,000 R.T. Forklift			X	
M113 Family			X	
GMC Bus			X	
Canadian LAV 8 x 8			X	
Lance M730			X	
Chaparral			X	
M60	X			
M48	X			
M88A1	X			
M728	X			
M110 S.P. HOW		X		
M109 S.P. HOW		X		
M107 S.P. HOW		X		
M578 Recovery Vehicle		X		
Roland M975		X		
M2 IFV				X
M3 CFV				X
MLRS				X
Marine LAV				X

Section III. Engine Air Intake Systems

4-6. ENGINE AIR INTAKE FOR NORMALLY ASPIRATED ENGINES.

Normally aspirated engines require that the first cycle piston movement is downward to create a vacuum drawing air into the intake system. The key to avoiding damage to this type system is to prevent drawing unfiltered air into the engine. Repairs to this system should always be done with materials that do not block the air flow and are securely attached to prevent them being sucked into the engine intake manifold cylinder.

4-7. ENGINE AIR INTAKE FOR TURBOCHARGED ENGINES.

Turbocharged engines use exhaust gases to drive the turbocharger to compress air and force it into the cylinder under pressure. The engine air intake system is therefore vacuum and pressure. Assessment and repairs to Turbocharged air system should therefore be based on the rules above for the system up to the turbocharger inlet. For the outlet, the repairs should seal so that the air pressure does not escape. Because the turbocharger is driven by exhaust gases, repair of the drive system must seal the exhaust gases to prevent de-pressurization.

4-8. ENGINE AIR INTAKE FOR SUPERCHARGED OR TURBOSUPERCHARGED ENGINES.

Supercharged engines use a mechanical system to drive the air intake compressor. The supercharger is usually mounted directly on the intake manifold or engine block. Some Detroit Diesel models are turbo-supercharged. Damage assessment and repair to these engines require the same techniques and precautions that turbocharged engines require for the vacuum and pressurized parts of the air intake system. Because superchargers are mechanically driven, repairs to the drive system will usually require repair parts to effect repair.

4-9. BLOWER DRIVE SHAFT BROKEN

General Information

The blower provides pressurized air to the engine air box. The blower is driven by a drive shaft (quillshaft) which acts as the fuse for the supercharger system. The shaft shears when it is overloaded to protect the blower from damage. The shaft can be repaired if a new part is not available.

Limitations:
* Blower may be damaged

Personnel/Time Required:
* I soldier
* 1 hour

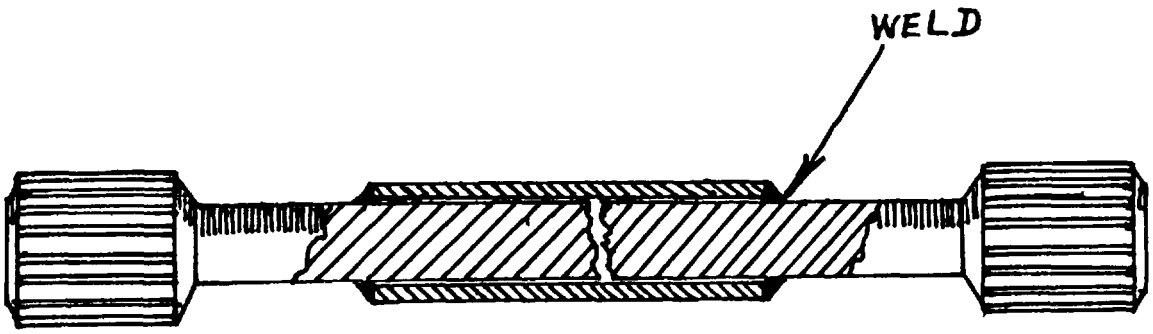
Materials/Tools
*Tubing of sleeve
* Welding equipment

Procedural Steps:

1. Gain access to the drive shaft and remove both broken ends.

2. Use heavy steel tubing, or machine a sleeve, that will fit the broken shaft.

3. Install sleeve or tube on shaft. Ensure that the proper length is maintained.



5. Reinstall blower drive shaft.

6. Record the BDAR action taken. When the mission is completed, as soon as practicable, repair the vehicle using standard maintenance procedures.

4-10. AIR CLEANER CLOGGED

General Information:
The air cleaner is essential for keeping dirt and dust from getting into the engine. Under heavy dust conditions it can become clogged and restrict the air flow. Lack of air will result in incomplete fuel combustion resulting in reduced power and excessive exhaust smoke. Dirt should be blown out of the filter with compressed air directed from the inside of the filter element. The filter element should not be hit to dislodge dirt as this can deform the sealing element and let dirt into the engine causing internal damage.

Limitations:
* None

Personnel/Time Required:
* 1 soldier
* 15 minutes

Other Options:
* Use vacuum cleaner
* Gently tap filter against hard surface

Procedural Steps:

1. Remove air cleaner elements.

2. Clean filters using one of the following possibilities:

a. Dismount a blower motor (such as dust exhausts), connect to power source with long leads, and blow dirt from air cleaner.

b. Disconnect exhaust hoses from all but one blower. Connect hoses together using tape to gain sufficient length to reach outside. Start engine and blower, blow dirt deposits from filters.

c. Use air from a disabled wheeled vehicle's tires. Remove valve stem and connect rubber hose to valve and proceed to blow out filters.

d. Use brake air tank from wheeled vehicle by connecting rubber hose or place filter directly under air flow from valve.

3. Record the BDAR action taken. When the mission is completed, as soon as practicable, repair the vehicle using standard maintenance procedures.

4-11 . AIR CLEANER DAMAGED/LEAKING

General Information:

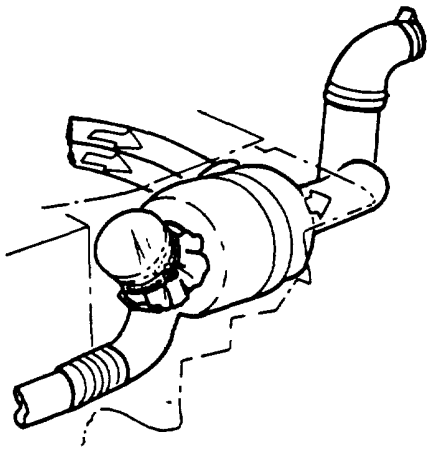
The air cleaner must filter all incoming air for the engine. Damage or leaks that cause the air cleaner to be ineffective must be repaired. Any leaks in the filter housing or duct work can be taped over or covered by a rag that will filter any air coming through the leak. Sealing the leak is preferred. Only as a last resort should the air cleaner be bypassed or eliminated. Damage will occur as the engine ingests the dirt and dust in unfiltered air. If the only option is to eliminate the air filter this procedure will allow a minimum amount of air filteration.

Limitations:
* Possible degraded mobility

Personnel/Time Required:
* I soldier
* 30 minutes

Materials/Tools:
* Duct or electrical tape
* Section cut from blanket or shirt

Other Options:
* Bypass or eliminate air cleaner



Procedural Steps:

1. Disconnect the air hose at the attachment to the engine.

2. Cover the air inlet with a clean rag (use a shirt or blanket if no rags are available). Clean the rag whenever it gets dirty.

3. Anchor the cloth tightly to the air intake with a hose clamp or wire, otherwise the strong vacuum will suck the rag into the engine.

4. Record the BDAR action taken. When the mission is completed, as soon as practicable, repair the vehicle using standard maintenance procedures.

4-12. INTAKE MANIFOLD OR OTHER CASTINGS OR CONTAINERS DAMAGED

General Information:
Intake manifolds are difficult to repair. Autobody fillers, epoxy or gasket sealers can seal cracks. Holes will require welding because of irregular surfaces. Tape will provide a temporary seal on unpressurized air intake portions but has minimal value for pressurized systems without metal or wire re-enforcement. Epoxy kits will make an almost permanent repair, if time is available for curing. Follow the individual kit directions.

Section IV. Engine Exhaust Systems

4-13. General.

The engine exhaust system consists of the exhaust manifold, muffler and pipes to route the gases to the muffler and out of the vehicle. Turbocharged engines have the exhaust gases routed through the turbocharger to drive the vanes. Damage to the muffler or pipes, not including the ducting for the turbocharger drive circuit, are inconvenient but the vehicle can still be operated. Care must be taken, however, to keep carbon monoxide out of the crew compartments. Turbocharger drive circuits must be repaired or engine performance will be degraded.

4-14. EXHAUST MANIFOLDS DAMAGED

General Information:
Damaged manifolds are indicated by loud noises. Any damage to the exhaust manifolds upstream of the turbocharger will degrade vehicle operation. Continued engine operation may set the fuel lines on fire.

Limitations:
* None

Personnel/Time Required:
* I soldier
* 15-30 minutes

Materials/Tools:
* Asbestos sheet or sheet metal
* Clamps

Other Options:
* Weld or braze the manifold

Procedural Steps:

1. Gain access to the damaged manifold.

2. Obtain a sealing material, (asbestos sheet preferred), cut sheet to cover the hole or leak.

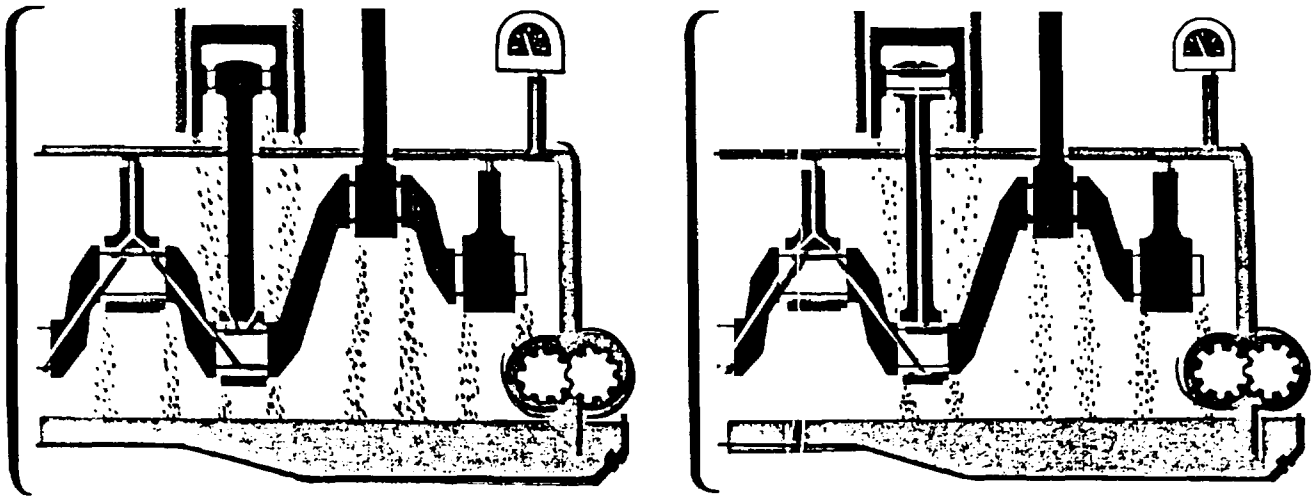
3. Secure the sheet in place using hose clamps.

4. Record the BDAR action taken. When the mission is completed, as soon as practicable, repair the vehicle using standard maintenance procedures.

Section V. Engine Lubrication Systems

4-15. General.

Engine lubrication is essential for all moving components, however, crankshaft bearings and diesel engine piston crowns are critical. The pressure lubrication of the bearings and the cooling spray to the piston crowns are examples of the dual purpose of the engine lubricant. By-passing or rendering any portion of the lubrication system inoperative will degrade the length of the engine life.



Force-feed lubrication system. *Full force-feed lubrication system.*

Fig 4-1. Typical Lubrication Systems

4-16. LUBRICATION SYSTEM PUMP FAILURE

General Information:

The oil pump is needed to provide lubrication to engine components. Low or no reading of gage or warning light indicates a problem. The main and rod bearings as well as a minimal splash lubrication of the pistons is possible by overfilling the crankcase with oil. However, components such as blower, blower drive gears, or turbocharger will not receive any lubrication from overfilling. Valve train components will also lack lubrication but can operate for short time periods. Overfilling the crankcase with oil is a last resort option which should only be used to move under cover. Engine failure will occur if used for normal or limited operation.

Limitations:
* Severely Degraded Mobility

Personnel/Time Required:
*·1 soldier
* 15-20 minutes

Materials/Tools:
* Cooking oil
* Engine oil
* Transmission oil
* Diesel fuel

Procedural Steps:
1. Check oil level.

2. Obtain enough engine oil or substitute to overfill crankcase.

3. Overfill the crankcase.

Record the BDAR action taken. When the mission is completed, as soon as practicable, repair the vehicle using standard maintenance procedures.

4-17. OIL LEVEL LOW

General Information:

Oil levels can become low because of leakage or burning the oil through normal engine operation. If oils prescribed by the LO are not available use substitutes listed in Appendix C. Oils other than those designed for use in engines will provide only limited lubrication. When using diesel fuel, do not dilute the lubrication oil more than approximately 3 parts diesel fuel to I part engine oil except in extreme emergencies. Drive slower to prevent damage to the engine. Do not dilute lubricating oil with gasoline.

CHAPTER 5

FUEL SUPPLY SYSTEM

**BDAR FIXES SHALL BE USED ONLY IN COMBAT
AT THE DISCRETION OF THE COMMANDER
AND SHALL BE REPAIRED BY STANDARD MAINTENANCE PROCEDURES
AS SOON AS PRACTICABLE AFTER THE MISSION IS COMPLETED.**

Section I. General

5-1. General.

Fuel supply systems consist of fuel storage tanks, fuel pumps, filters and the tubes and hoses needed to route the fuel to the engine. Some systems use electrical fuel pumps located in the tanks and a mechanized engine mounted fuel pump to move the fuel. Other systems mount the fuel storage tank in a location which allows gravity flow of the fuel to the engine assisted by an engine mounted mechanized pump. Two filters are mounted in series to provide a primary and secondary filteration system to trap dirt and other contaminants.Fuel filters must be checked for accumulations of dirt and water. A diesel engine can be severely damaged by using unfiltered fuels.

5-2. Assessment Procedure

a. Visually inspect → Damage found to:
-fuel tank; ..... go to Section II
-fuel lines; ..... go to Section IV
-fuel filters: ..... go to Section V

No apparent damage found

b. Check for impurities in the fuel such as water or dirt.

c. Attempt to Operate → Damage found to:
-tank or lines; ..... go to Section II and IV.
-pump or pump inoperative; ..... go to Section III.
-fuel filters or filters inoperative; ..... go to Section V.

Fuel system delivers fuel and does not leak.

5-3. BDAR Procedure Index **Para**

Section II. Fuel Storage Systems.

5-4. General.

Fuel storage systems may be enclosed metal containers, nylon fiberglass tanks or rubber re-enforced fuel bladders installed in vehicle bulkheads. All systems are susceptible to contamination from dirt or water. Metal tanks are susceptible to corrosion which will contaminate the stored fuel. Draining and purging fuel tanks of contaminants are of major importance for long combat usage. Leakages caused by normal vibration or actual combat induced damage must be repaired before the vehicle can be used for combat.

5-5. FUEL TANK LEAKS

General Information: Fuel tank leaks are difficult to repair in a battlefield environment. Combat vehicle fuel tanks are normally obstructed by the powerpack or other major assembly. The repairs are also dictated by the type of material from which the fuel tank, cell or fuel bladder is manufactured. Fuel leakage is an indication that a fuel storage container is damaged. Time required for repairs will vary with the fuel tank location and ease of access for repairs. The area surrounding the damage must be cleaned to make a good repair. Heat will hasten curing of fiberglass or epoxys.

Option 1: Aluminum fuel tanks:

Limitations:
* None if welded

Personnel/Time Required:
* 1-3 soldiers
* 2-6 hours

Materials/Tools:
* Welding equipment
* Aluminum scrap
* Rivets or screws

Other Options:
* Use fiberglass repair or plug

Procedural Steps:

1. Gain access to the damaged area on the fuel tank.

2. Drain and vent fuel tank. (Purge the tank using vehicle exhaust gases.)

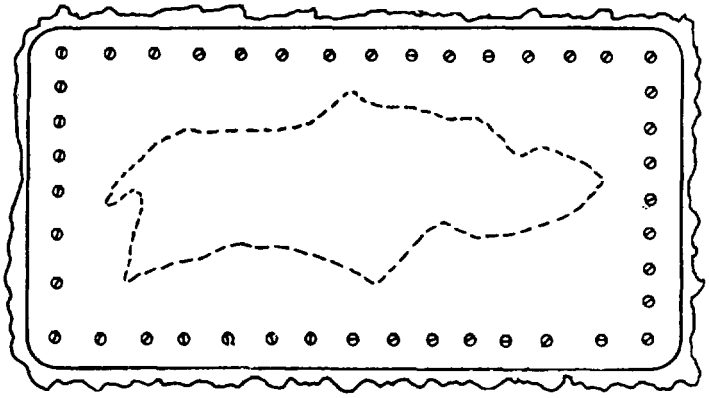
Procedural Steps (Cont)

3. Cut an aluminum patch large enough to extend 1-2 inches over the hole edges.

4. Attach the patch to the tank.

If available,

a. MIG or TIG weld the patch to the fuel tank.



b. Drill holes in plate and tank approximately one inch apart. Apply sealer to the patch and rivet or screw the plate to the fuel tank.

5. Reinstall fuel tank, if removed.

Option 2: Fiberglass fuel tanks.

Limitations:
* None, if fiberglass kit is used

Personnel/Time Required:
* 1-3 soldiers
* 2-6 hours

Materials/Tools Required:
* Epoxy
* Fiberglass repair kit
* Gasket sealer
* Pop-rivets

Other Options:
* Plug hole

Procedural Steps:

1. Gain access to fuel tank.

2. Drain fuel tank.

3. Clean oil and fuel residue from damaged area.

4. Rough up area around damage with sandpaper or a file.

5. Repair using one of the following:

a. Apply fiberglass following kit instructions.

b. Mix and apply epoxy following kit instructions.

c. Cut sheet metal patch, drill tank and patch, coat patch liberally with fuel resistant gasket sealer. Attach patch with pop-rivets, seal rivet heads with sealer.

6. Reinstall fuel tank, if removed.

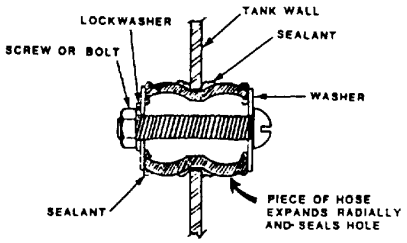
Option 3: Plugging holes, metal or fiberglass tanks.

Limitations: * None

Personnel/Time Required: * 1-3 soldiers * 1-3 hours

Materials/Tools: * Rubber hose * Bolt and Nut * Two (2) large flat washers

Other Options: * Use fiberglass or epoxy



Procedural Steps:

1. Gain access to fuel tank hole.

2. Drain fuel until level is below the hole.

3. Obtain hose the approximate size of the hole.

* 4 Using a round file, file the hole to a size equal to the hose diameter.

5. Assemble the hose, bolt, nut and washers as shown.

6. Coat the hose assembly with sealer to aid in the repair.

Procedural Steps (Cont)

7. Insert the hose assembly into the hole.

8. Tighten the bolt and nut to make the hose expand and seal the fuel tank hole.

9. Reinstall the fuel tank, if removed.

Record the BDAR action taken. When the mission is completed, as soon as practicable, repair the vehicle using standard maintenance procedures.

5-6. BLADDER CELL LEAKAGE

General Information:

Bladder type fuel cells can be repaired similar to patching tire inner tubes. Repairs can be placed inside or outside of the bladder depending on access to the damage.

Limitations:
None

Personnel/Time Required:
* 1-2 soldiers
* 1-2 hours

Materials/Tools:
* Rubber adhesive
* Rubber patching material, such as poncho or inner tube
* Tube patches

Procedural Steps:

1. Gain access to damaged area.

2. Smooth the damaged area out.

3. Clean and lightly buff an area slightly larger than the patch.

4. Fabricate a patch from rubber liner sheet, or other available material, that extends sufficiently in all directions past the damaged area.

5. Apply the patch with available rubber cement or adhesive.

6. After curing, check the patch for leakage.

7. Re-install the fuel bladder, if removed.

8. Record the BDAR action taken. When the mission is completed, as soon as practicable, repair the vehicle using standard maintenance procedures.

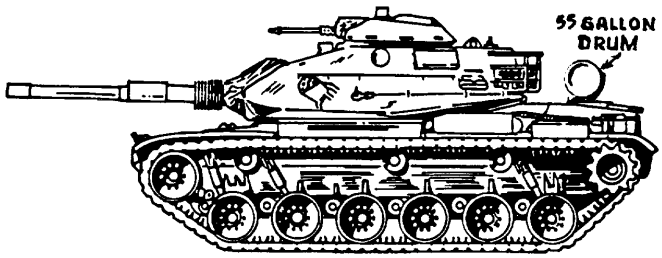
5-7. FUEL TANK SUBSTITUTE

General Information:

Tactical operations may not allow sufficient time to make normal or expedient repairs to the vehicle's fuel tank. A more rapid repair can be improvised by installing a substitute fuel tank. The fuel tank should be mounted to avoid interfering with operating components. Use as large a container as possible. Frequent refueling will be required.

Limitations:
* Limited capability traversing
* Limited mobility (range)

Personnel/Time Required:
* 1 soldier
* 30-60 minutes



Materials/Tools:
* Fuel container (5 gallon gas or oil can, 55 gallon drum, etc.)
* Rubber fuel line
* Hose clamp
* Rope or straps

Procedural Steps:

1. Locate a temporary fuel container.

2. Obtain a fuel line.

3. Connect fuel line to container.

4. Secure temporary fuel container to the outside of the vehicle in a position to allow gravity feed for the fuel.

5. Connect fuel line to the inlet side of the mechanical or electrical vehicle fuel pump.

6. Bleed the air from the fuel line.

7. Record the BDAR action taken. When the mission is completed, as soon as practicable, repair the vehicle using standard maintenance procedures.

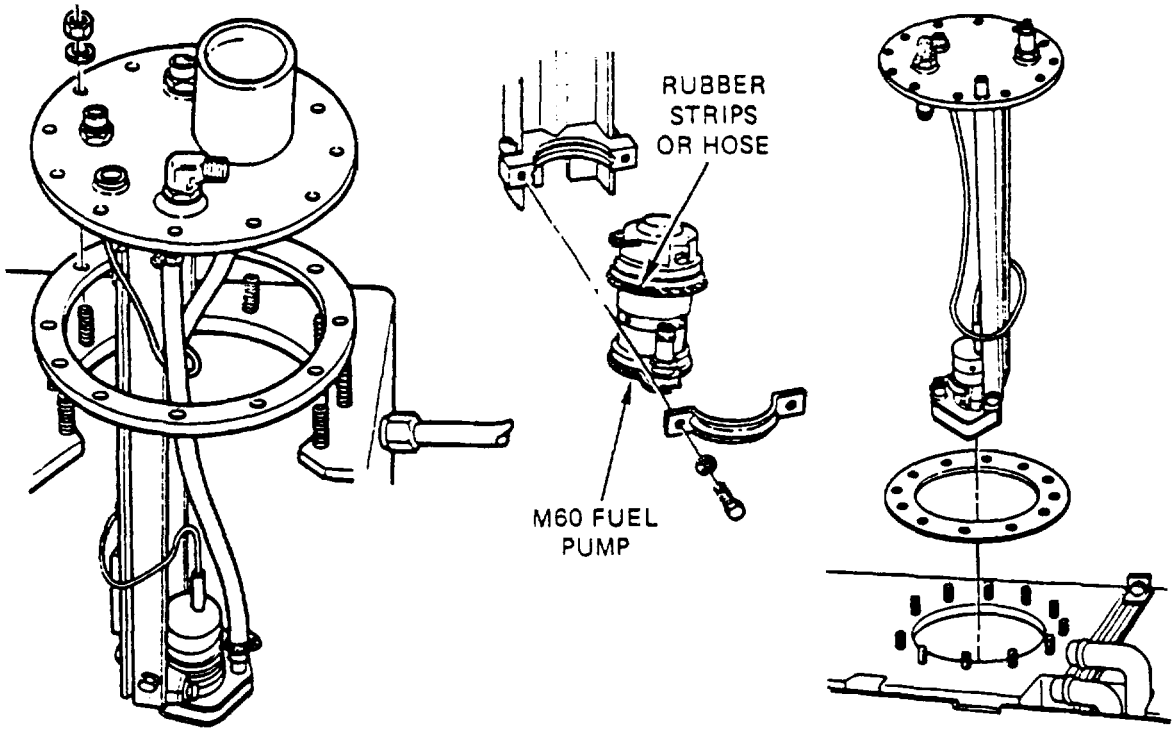
Section III. Fuel Pumps

5-8. General.

Combat vehicles use electrical and mechanical fuel pumps. Fuel pumps can be repaired with instruction provided in respective equipment TMs. In a battlefield environment replacement of a fuel pump is most often the most expedient means to solve the problem. Fuel pumps on most combat vehicles are interchangeable with fuel pumps of other vehicles.

5-9. FUEL PUMP, IN TANK INTERCHANGEABILITY

General Information: In-tank fuel pumps on combat vehicles can be interchanged with other vehicles. The difference in the pumps is normally the brackets used to locate the electrical unit. The pump must be placed in the proper location for efficient fuel pickup. The electrical unit can be dismounted from the brackets and installed in the bracket for the vehicle being repaired.



The electrical unit can be clamped using the existing clamps or using an adjustable clamp from an air cleaner ducting system. Use a strip of rubber or a rubber hose to aid in holding the pump in position.

Available fuel pumps:

M44A2 Series, 2-1/2 Ton Truck
M48/M60 Series Tank
M88 Recovery Vehicle
M 109/MI 10 Self-propelled Howitzer
M578 Recovery Vehicle
M39A2 Series 5-Ton Trucks

5-10. FUEL PUMP MECHANICAL FAILURE

General Information:

Electric fuel pumps will not normally supply the fuel pressure required by the injector system if the mechanical fuel pump fails. However, limited operation in a degraded mode is possible by replacing the mechanical pump with an electrical unit. Mechanical pumps are substitutable with adequate operational capabilities within the same engine family. The heater fuel pump can be used to provide fuel to the engine.

a. All AVDS 1790 engine fuel pumps are interchangeable.

b. Detroit Diesel 3-53 thru 8V71 engine fuel pumps are substitutable..

Section IV. Fuel Lines and Valves

5-11. General.
Fuel lines route the fuel from the storage tanks to the filters and the engine fuel system. Lines are a combination of rubber hoses and metal tubes. Leaks and fuel line blockages are common failures. Clogged lines can be cleared by blowing compressed air through them. Broken or cracked lines must be repaired or bypassed. Various methods of repairs are given in this section, other line repairs are also listed in the Hydraulics Systems chapter.

5-12. SEALS, FUEL SYSTEM, LEAK

General Information:
O-rings are used in some systems to seal the fuel in the lines. BDAR as well as normal repairs will damage the O-rings. Fuel absorbtion will cause the O-rings to swell causing reinstallation problems since they no longer fit into the O-ring groove. Some repairs are possible if the O-ring is damaged. Swelled O-rings can be allowed to dry until they shrink in size enough to fit. Torn or cut O-rings can be replaced using a larger O-ring and cutting it to length. If an adhesive is available glue the cut ends together. O-rings with small cuts can be coated with a silicone gasket sealer to seal the leakage caused by the cut, if it is not sealing against a moving surface. See also paragraph 11-5 in the Hydraulics Systems chapter.

5-13. FITTINGS LEAKING

General Information:

Flared fuel fittings will start to leak because of engine vibrations or overtightening. Leaking fittings should first be tightened to attempt stopping the leak. If tightening does not stop the leak, string can be used to push the flared tubing more firmly against the connecting surface. Coating the string with a gasket sealing compound will aid in stopping leaks in a low pressure fuel line.

Limitations:
* None

Personnel/Time Required:
* I soldier
* 30-60 minutes

Materials/Tools:
* Fuel resistant sealant (silicone, rubber or similar material)
* String or light tie cord

Other Options:
* Wrap Teflon tape around lines and tighten fitting.

Procedural Steps:

1. Remove coupling flange nut.

2. Slide coupling flange nut up, aware from flared end.

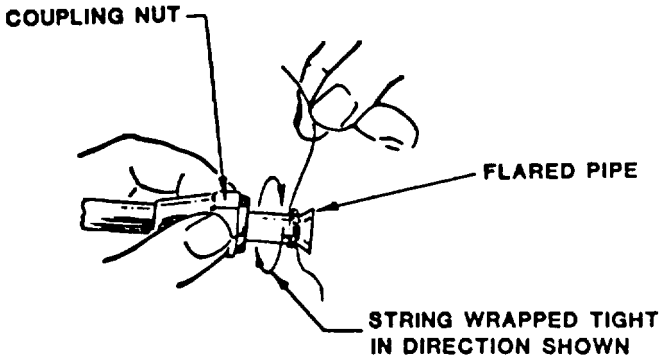
3. Clean grease, oil and fuel from flared end.

4. Wrap string around flared end of line.

5. Coat string liberally with fuel resistant sealant.

6. Reinstall line and tighten nut securely.

7. Check for leaks. If still leaking, repeat procedure using more string.



8. Record the BDAR action taken. When the mission is completed, as soon as practicable, repair the vehicle using standard maintenance procedures.

5-14. FUEL LINE (LOW PRESSURE RUPTURE)

General Information:

Low pressure fuel lines can rupture or crack because of various reasons. Frozen water in the lines, vibrations, rubbing against other components or impact can all cause the line to rupture or crack. Repairs can be performed rapidly to stop the leakage and continue the mission.

Limitations:
* None

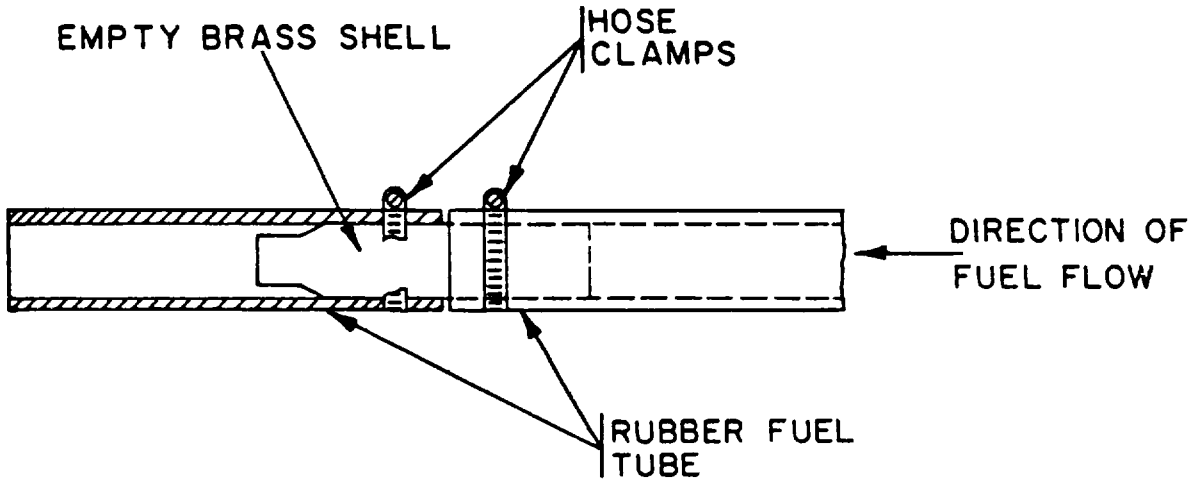
Personnel/Time Required:
* I soldier
* 30-60 minutes

Materials/Tools:
* Rubber sheet (tire inner tube, or similar material)
* Tape
* Wire
* Rubber hose
* Hose clamps
* Sealant
* Metal tubing (mirror arms, old hydraulic line, or similar material)
* Thin sheet metal (coffee can, C-ration can, or similar material)
* Shell casing, 5. 56 mm or 7.62 mm

Other Options:
* Seal the crack with epoxy

Procedural Steps:

Option 1: For damaged rubber hose:



Procedural Steps (Cont):
1. Cut out damaged portion of hose.

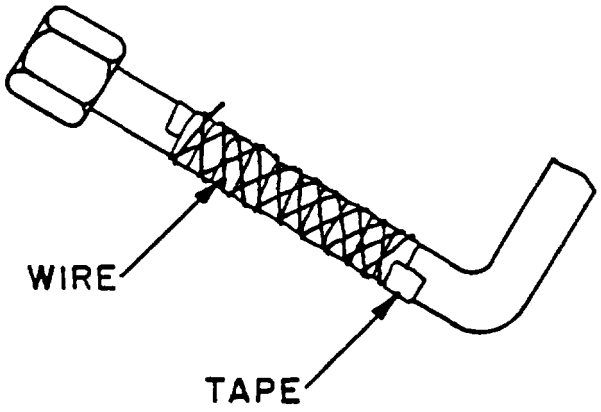
2. Cut a piece of metal tubing longer than the length of the hose section removed. If tubing is not available, cut the ends from a 5.56 or 7.62 mm shell casing.

3. Apply a sealant to the ends of the tubing.

4. Insert the metal tubing into the hose ends.

5. Clamp the hose ends with hose clamps or wrap tightly with wire and twist the wire ends together.

Option 2: For metal tubing cracks:



1. Clean all dirt and grease from around the crack.

2. Coat the crack with sealant.

3. Wrap tubing with a sheet of fuel resistant material.

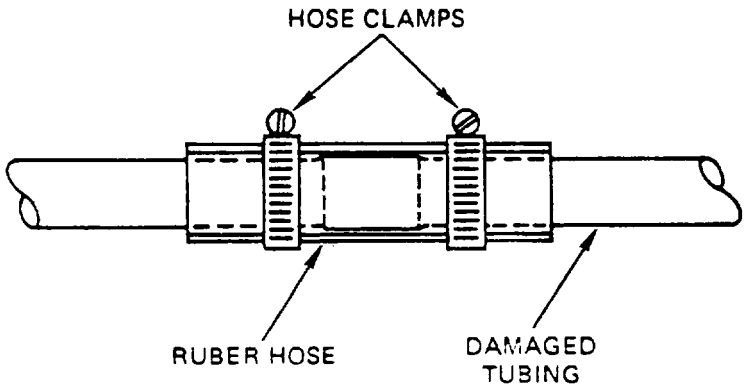
4. Clamp the sheet, directly over the crack.

5. If clamps are not available, wrap the tubing with tape.

6. Wrap wire around the tape as re-enforcement.

7. Wrap an additional coating of tape over the wire.

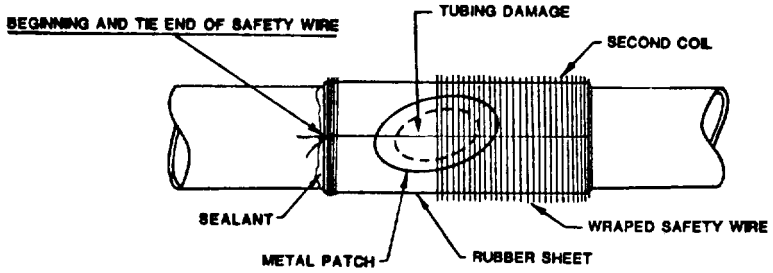
Procedural Steps (Cont):
Option 3: For holes in metal tubing:



1. Cut out damaged portion of metal tubing.
2. Clean both ends of tubing.
3. Cut a piece of rubber hose two inches longer than the length of removed tubing.
4. Apply sealant to both ends of tubing.
5. Insert the tubing ends one inch into the hose.
6. Secure with hose clamps or tightly twisted wire.
7. If the hose is too large, the tubing can be flared or sleeved to fit.

Option 4: Patching large metal lines:

Procedural Steps (Cont)



1. Smooth damaged areas to remove rough edges.

2. Clean dirt and oil from damaged area.

3. Cut a metal patch from sheet metal.

4. Coat the metal patch and tubing with sealant and place over damaged area.

5. Cut a patch from rubber or other fuel resistant material and wrap over metal patch.

6. Wrap rubber patch with wire to equalize the pressure over the repair.

Option 5: Repairing damaged bends:

1. Cut a bend from an old hydraulic line, mirror arm or similar material.

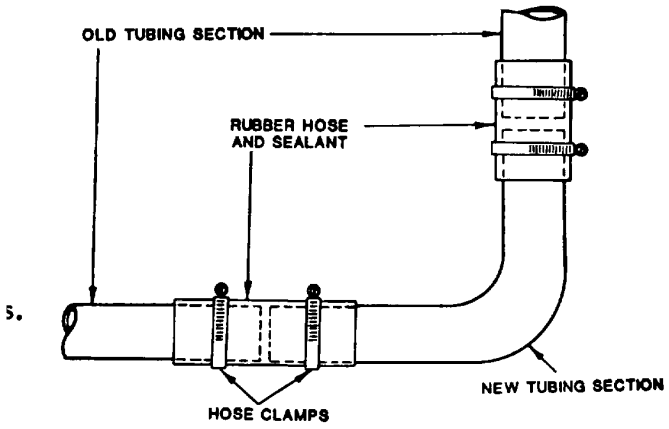
2. Remove the damaged bend from the line.

3. Clean the cut tubing ends.

4. Apply sealant to tubing ends.

5. Using two, 2-inch sections or rubber hose, install the replacement bend.

6. Clamp with hose clamps or tightly twisted wire.



Record the BDAR action taken. When the mission is completed, as soon as practicable, repair the vehicle using standard maintenance procedures.

5-15. FUEL INJECTOR LINE, RUPTURE

a. If a high pressure fuel line is damaged and there is no time for a better repair, cut the line and weld or crimp shut the injector pump side. The engine will run for a limited time on fewer cylinders.

b. If a replacement line is not available, repair the defective line. Remove it from the vehicle and clean it. Braze pin holes closed. If the hole is too large for this procedure, cut out that section of line. Use a piece of slightly larger metal tubing as a sleeve, overlapping both cut ends of the injector line. The sleeve should fit tightly over the injector line; if it is too loose, crimp to get a tight fit. Then braze or silver solder both ends of the sleeve to the fuel line.

Section V. Fuel Filters

5-16. General.

Fuel filters are needed to remove dirt and water from the fuel. Dirt and water will cause damage to the fuel injectors if fuel is not filtered. Fuel filters are normally mounted in series, a primary and a secondary filter. Fuel filters should only be bypassed as a last resort.

5-17. FUEL FILTER CLOGGED OR FROZEN

General Information

The first indication of clogged or frozen fuel filters will be a failure of the engine to start or degraded performance because of insufficient fuel. Fuel filters if drained periodically should not freeze. Clogged filters must be cleaned or changed to correct the problem.

Limitations:
* Possible engine internal damage if filters are bypassed.

Personnel/Time Required:
* 1-2 soldiers
* 15-30 minutes

Other Options:
* Remove filter elements

Procedural Steps:

Option 1: Cleaning filters.

1. Gain access to fuel filters.

2. Remove the fuel filter from the canister.

3. Rinse the filter in a pan of fuel or blow out with compressed air; if frozen thaw out.

4. Reinstall the fuel filter.

5. Start the engine.

Option 2: Bypassing the filters.

1. If the engine will not start, disconnect the fuel inlet line.

Procedural Steps (Cont)

2. Disconnect the fuel outlet line and reconnect it to the fuel inlet line.

Record the BDAR action taken. When the mission is completed, as soon as practicable, repair the vehicle using standard maintenance procedures.

CHAPTER 6
COOLING SYSTEM

**BDAR FIXES SHALL BE USED ONLY IN COMBAT
AT THE DISCRETION OF THE COMMANDER
AND SHALL BE REPAIRED BY STANDARD MAINTENANCE PROCEDURES
AS SOON AS PRACTICABLE AFTER THE MISSION IS COMPLETED.**

Section I. General

6-1. General. Cooling system problems may be indicated by a variety of faults. Typically the driver's indicator panel will show overheating.

6-2. Assessment Procedure

a. Air cooling system assessment.

(1) Visually inspect → Damage found to:

- fans; ..... go to specific TM.
- fan drive; ..... go to specific TM.
- shrouds; ..... go to Section II.
- ducts; ..... go to Para 4-11.
- engine compartment covers; ..... go to Para 12-1.
- engine compartment seals; ..... go to Para 3-7.

No damage found ↓

(2) Start engine → Damage found to:

- fan air intake; ..... go to specific TM.
- fan drive; ..... go to specific TM.
- engine compartment covers; ..... go to para 12-1.
- engine compartment seals; ..... go to Para 3-7.

No damage found ↓

b. Liquid cooling systems assessment.

(1) Visually inspect → Damage found to:

- hoses, hose clamps; ..... go to Section III.
- gaskets; ..... go to Para 3-4.
- radiator; ..... go to Section III.
- V-belts; ..... go to Para 3-9.

No damage found

(2) Start engine → Damage found to:

- head gasket; ..... go to Para 3-6.
- internal engine water jacket; ..... go to Para 3-5.
- thermostat; ..... go to Section III.
- coolant flow/water pump; ..... go to Section III.
- cooling fan; ..... go to specific TM.
- air flow through radiator; ..... go to Section II.

No damage found

6-3. BDAR Procedure Index. **Para**

Section II. Air Cooling Systems

6-4. General.

Cooling system failures can result in engine failure and therefore must be dealt with if the engine is expected to operate for any length of time. Cooling system problems most often are indicated on the driver's instrument panel. While temporary overheating indications may result from excessive workload on the engine, repeated overheating indication or constant indication of overheating is almost always followed by a major cooling problem.

6-5. SHROUDS, AIR COOLING DAMAGED

General Information:
Shrouds are used to direct the cooling air over the hot engine. Bent or torn shrouds will upset the flow of air and cause hotspots to occur which can cause internal engine failures. Torn shrouds can be bent back into shape and patched with sheet metal, epoxy kits or tape to restore the proper air flow. At a minimum, they must be bent to prevent contact with moving components. If the existing shrouds cannot be repaired, new shrouds must be fabricated from sheet metal.

Section III. Liquid Cooling System

6-6. General.

During performance of repairs or as a result of leakage the coolant may become lost. A liquid cooled engine cannot operate for long without coolant. When normal coolants are not available, a substitute may be used. Any liquid, except gasoline or jet fuels, can be used as a substitute but some liquids will deteriorate the cooling system rubber components. Petroleum products will not transfer the heat as efficiently as a water based coolant, but will work if nothing else is available. Old engine oil or fluids drained from damaged vehicles, transmission oil, hydraulic systems, may be a possible source of fluids. The cooling system must be drained and flushed as soon as possible if petroleum based fluids are used.

6-7. THERMOSTAT STUCK

The thermostat regulates the engine operating temperature, from 1800 to 1950 F., by controlling coolant flow through the engine. When the thermostat is stuck in the closed position it prevents coolant from circulating and causes engine overheating. BDAR repair is to remove the thermostat and operate the vehicle. If the thermostat is stuck in the open position or removed, it may degrade engine performance and increase fuel consumption.

6-8. ENGINE COOLANT FROZEN

General Information:

During cold weather, inadequate antifreeze protection will cause the coolant to freeze. Care must be taken when thawing the cooling system that further damage is avoided. The water pump may be unable to turn which will damage drive belts as well as the pump itself. The thawing procedure must include frequent inspections for leaks which will indicate cracked or broken components. Engine temperature must also be monitored to prevent overheating damage.

Limitations:

- None if engine is left running or antifreeze protection is upgraded.

Personnel/Time Required:

- 2 soldier
- 30-60 minutes

Other Options:

- Route air from fuel operated vehicle heater over the radiator
- Route another vehicle’s exhaust gases over the radiator

Procedural Steps:

1. Gain access to radiator and powerpack.

2. Inspect for amount of ice and obvious cracks in coolant system components.

Procedural Steps (Cont):
3. If coolant is solid, remove or disengage the water pump drive belts.
4. Start the engine and allow to warm up, but not get hot.
5. Attempt to turn water pump pulley.
6. Shut down the engine and allow the heat to radiate into and melt the ice.
7. When the water pump pulley can be turned reinstall the drive belts.
8. Restart the engine and allow to warm up but not overheat.
9. Record the BDAR action taken. When the mission is completed, as soon as practicable, repair the vehicle using standard maintenance procedures.

6-9. RADIATOR LEAKING

General Information:
Radiator leaking may be detected by low coolant levels. Obvious wet areas or overheating will indicate that the coolant level must be checked. The repair procedure used is dependent on the size of the hole(s) causing the leak. The following procedures provide options to stop or reduce the leakage rate.

Option 1: Small Hole.

Limitations:
- None

Personnel/Time Required:
- I soldier
- 15-30 minutes

Materials/Tools:
- Stop leak chemical
- Cigarette or tobacco
- Pepper
- Eggs
- Oatmeal
- Farina (cream of wheat)
- Corn meal

Procedural Steps:

1. Remove radiator cap and start engine.

Procedural Steps (Cont):

2. Add coolant to bring coolant to the proper level.

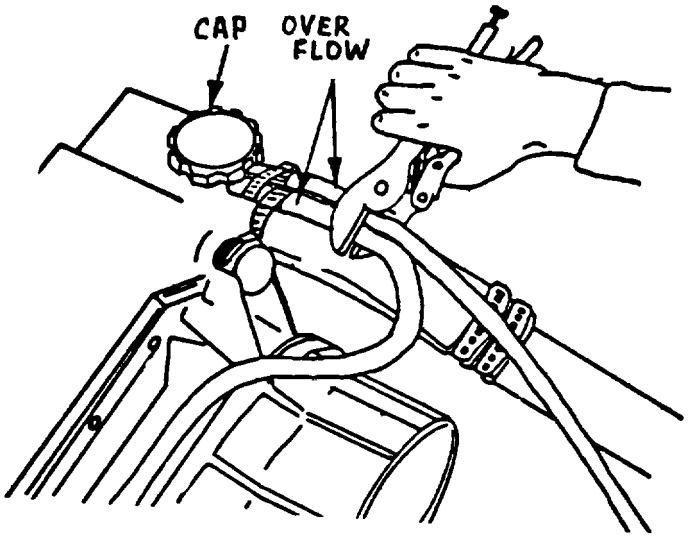
3. Sprinkle or pour one of the materials listed above into the coolant.

4. Inspect the hole for evidence of reduced or eliminated leakage.

5. Add more material if leak has not stopped or been reduced to an acceptable limit.

6. Leave radiator cap loose.

7. Plug overflow lines on surge tank equipped coolant systems (M 109 S. P. Howitzer family).



Option 2: Tubing to Heater Joint, Leak.

Limitations:
- None

Personnel/Time Required:
- I soldier
- 1-4 hours

Material/Tools:
- Wire brush
- Solvent
- Epoxy

Procedural Steps:

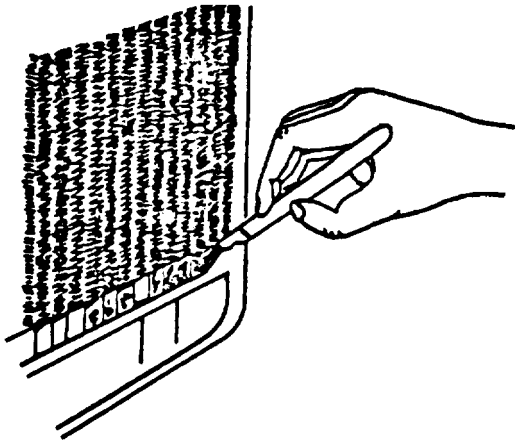
1. Gain access to radiator.

2. Inspect the radiator and pinpoint the leak location.

3. Drain the coolant.

4. Clean the leak area with solvent or available cleaner.

5. Scrape or rough up the damaged surface with a wire brush or knife as shown.



Procedural Steps (Cont):.

6. Mix epoxy according to kit instructions and fill the hole with the mixture. Work the epoxy well into the crack.

7. Allow epoxy to cure. A heat lamp will speed the curing.

8. Reinstall coolant and check for leaks.

Option 3: Core Punctured.

Limitations:

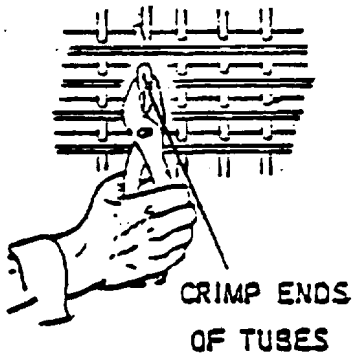
- Possible reduced cooling

Personnel/Time Required:

- I soldier
- 30-60 minutes

Materials/Tools:

- Side cutters
- Epoxy or solder



Procedural Steps:

1. Gain access to radiator.

2. Inspect the radiator to pinpoint the leak location.

3. Drain the coolant.

4. Using side cutters, cut or break away the cooling fins from the coolant tubes, I to 2 inches each side of the leak.

5. Cut the coolant tube at the leak location, taking care not to tear or puncture the other tubes.

6. Squeeze the tube ends together and fold over on itself approximately 1/2 inch.

7. If epoxy or solder is available, seal the coolant tube ends.

8. If no epoxy or solder is available, fold the tube once more 1/2-inch to restrict the coolant leaks.

9. Reinstall the coolant. Inspect radiator for leaks.

Record the BDAR action taken. When the mission is completed, as soon as practicable, repair the vehicle using standard maintenance procedures.

6-10. HOSE CLAMP BROKEN

General Information:

A broken hose clamp will allow the hose to leak coolant and cause engine overheating. The clamp must be replaced or a substitute improvised to regain a sealed cooling system. If a replacement clamp is not available wire can be used as a substitute. Care must be taken that the wire does not loosen.

Limitations:

•7 None

Personnel/Time Required:

- I soldier

· 5-10 minutes

Materials/Tools:

- Wire, safety (lacing) or commo

Other Option(s)k

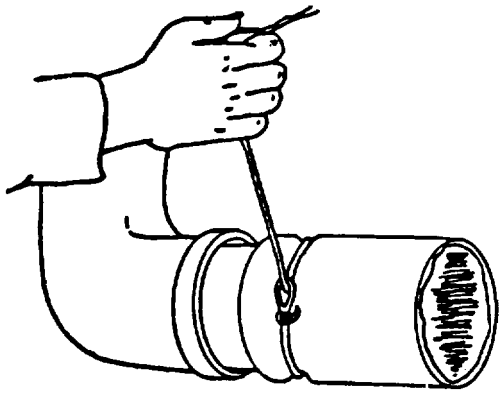
- Wrap the hose with wire. Using a stick, twist wire ends together like a tourniquet. Tape ends of stick to hose.

Procedural Steps:

1. Make a loop in one end of a wire. Twist the wire so that a permanent loop is formed.

2. Loosely wrap the wire once around the hose and pull the other end through the loop.

3. While pressing the loop tightly against the hose, pull the wire through the loop as tight as possible. Bend the wire back on itself, crimping it, so that the wrap will be tight and secure.



4. Secure the loose end by making one more wrap, opposite direction of the first.

5. Record the BDAR action taken. When the mission is completed, as soon as practicable, repair the vehicle using standard maintenance procedures.

6-11. HOSE LEAKAGE

General Information:

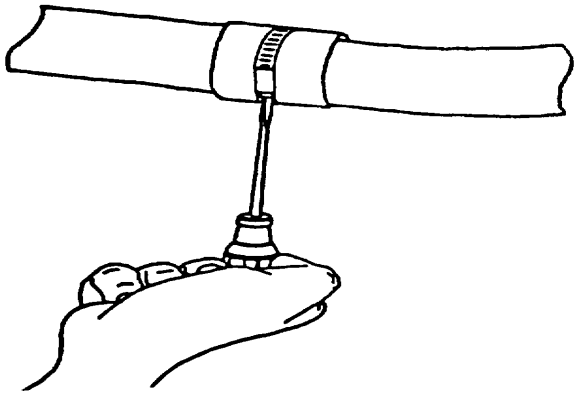
A leaking hose can be detected by obvious wet areas or engine overheating. Weak hoses feeling soft and spongy should be re-enforced with metal if repaired. The soft

spongy feeling indicates the rubber is deteriorated and will not withstand normal cooling system pressures. Option 1, below, provides two procedures for repairing a small leak in a hose. Option 2 shows how to correct a larger split in a hose.

Limitations
- Reduced mobility

Personnel/Time Required:
- I soldier
- 30 minutes

Materials/Tools:
- String or wire
- Non-porous material (rubber, poncho, raincoat)
- Thin sheetmetal (C-ration cans)
- Gasket sealer
- Clamps



Other Options:
- Use a tire patch repair kit

Procedural Steps:

Use one of the following procedures:

Option 1:
A. Hose, Small Leak

1. Gain access to leaking hose.
2. Clean dirt and oil from damaged hose.
3. Coat the damaged area with gasket sealer.
4. Wrap a non-porous material (poncho, rubber mat) over the leak.
5. Secure the material with a clamp.

B. Hose, Small Leak

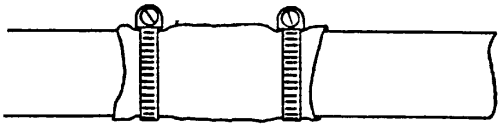
1. Gain access to leaking hose.
2. Clean dirt and oil from damaged area.
3. Cover the damage with a rubber mat section.

Procedural Steps (Cont)

4. Wrap the patch with electrical or duct tape.

5. Re-enforce the patch with wire or string to distribute the patch sealing pressure evenly over the damaged area.

Option 2: Hose, Large Leak



1. Gain access to leaking hose.

2. Clean dirt and oil from damaged area.

3. Coat the damaged area with gasket sealer.

4. Cut a metal patch from a tin can or other thin metal.

5. Bend the metal into a cylindrical shape the size of the damaged hose and coat the inside with sealer.

6. Wrap the metal patch over the damaged hose.

7. Secure the patch with adjustable clamps or tape.
8. Check for leaks.

Record the BDAR action taken. When the mission is completed, as soon as practicable, repair the vehicle using standard maintenance procedures.

6-12. HOSE COLLAPSE

General Information:
When the rubber in the coolant hoses starts to deteriorate it becomes soft and has a spongy feeling. Overheating problems that occur only at high engine speeds are normally from a deteriorated hose on the suction side of the water pump collapsing. The hose can be re-enforced by inserting a rigid hollow object like a can or wire coiled to prevent the hose from collapsing. The inserted item will help the hose remain open even though the suction is trying to close it.

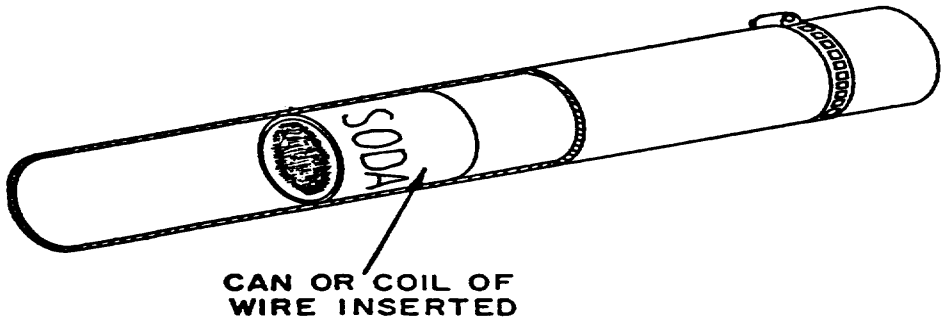
Limitations:
- None

Personnel/Time Required:
- I soldier
- 15-60 minutes

Materials/Tools:
- Tin can
- Stiff wire (coat hanger, welding rod)

Other Options:
- Operate at reduced engine speed.

Procedural Steps:



1. Gain access to hose.
2. Drain coolant.

3. Loosen and remove clamp from one end of the hose.

4 Insert a can, with ends removed ,or bent wire into the hose.

5. Reconnect and tighten the hose.

6. Refill coolant to proper level.
7. Check for leaks.

8. Record the BDAR action taken. When the mission is completed, as soon as practicable, repair the vehicle using standard maintenance procedures.

6-13. HOSE IMPROVISATION (LOW PRESSURE)

General Information:
Coolant hose or tube damage will sometimes be such that a patch will not stop the leak. The damaged portion must be removed and replaced with a substitute. Several repairs can be made using one of the following procedures.

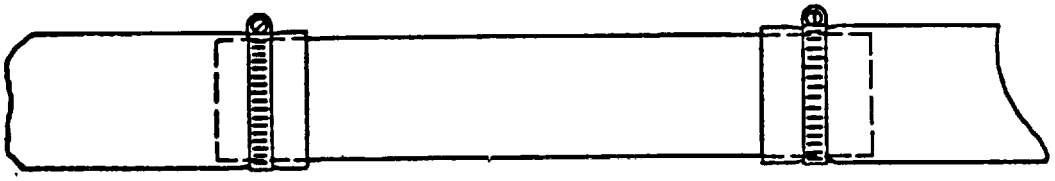
Limitations:
- None

Personnel/Time Required:
- I soldier
- 15-60 minutes

Materials/Tools:
- Gasket sealer.
- Garden hose, heater hose
- Pipe
- Clamps or wire
- Hacksaw

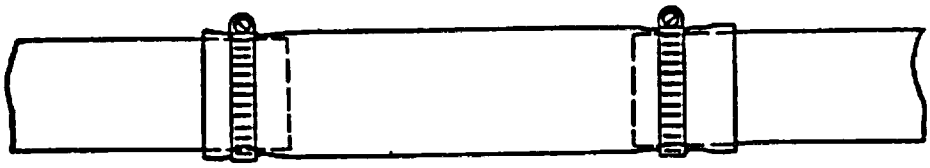
Procedural Steps:

Option 1: Pipe Insert.



1. Cut out damaged hose section.
2. Cut a section of pipe longer than the removed hose.
3. Coat the pipe ends with gasket sealer.
4. Insert the pipe into the damaged hose ends.
5. Secure the hose ends with clamps or twisted wire.
6. Refill coolant to proper level and check for leaks.

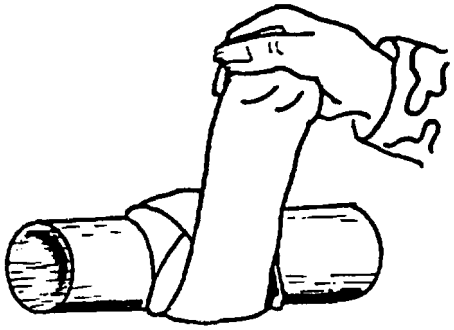
Option 2: Other Hose.

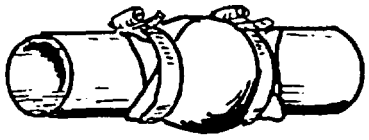


Procedural Steps (Cont):

1. Remove the damaged section of hose or tube.
2. Cut a section of substitute material longer than the removed section.
3. Coat ends of damaged hose or tube with gasket sealer.
4. Slip the hose over the ends of the damaged hose or tube.
5. Secure the hose with clamps or twisted wire, do not overtighten and restrict the coolant flow.
6. If the damaged hose inside diameter equals the outside diameter of the hose, the hose can be inserted into the damaged hose and secured. This, however, will not work with tubing.
7. Refill coolant and check for leaks.

Option 3: Short Hose Fabrication.





1. Use a short section of innertube, or rubber sheet cut to required length.
2. Coat the tubing ends with sealant.
3. Slip the material over the tubing ends.
4. Wrap the innertube as tightly as possible on the tubing.
5. Secure the innertube using hose damps or tightly wound wire.
6. Refill coolant to proper level.

Record the BDAR action taken. When the mission is completed, as soon as practicable, repair the vehicle using standard maintenance procedures.

CHAPTER 7

ELECTRICAL SYSTEM

**BDAR FIXES SHALL BE USED ONLY IN COMBAT
AT THE DISCRETION OF THE COMMANDER
AND SHALL BE REPAIRED BY STANDARD MAINTENANCE PROCEDURES
AS SOON AS PRACTICABLE AFTER THE MISSION IS COMPLETED.**

Section I. General

7-1. General.

Electrical systems on combat vehicles are 24 volt negative ground, direct current systems. Electrical current storage for starting and standby circuits is provided by batteries. The batteries are connected in a series-parallel configuration to provide 24vDC current. All electrical power to circuits can be turned off by a main power witch. The main power switch prevents accidental discharge of the batteries if a subsystem is not turned off.

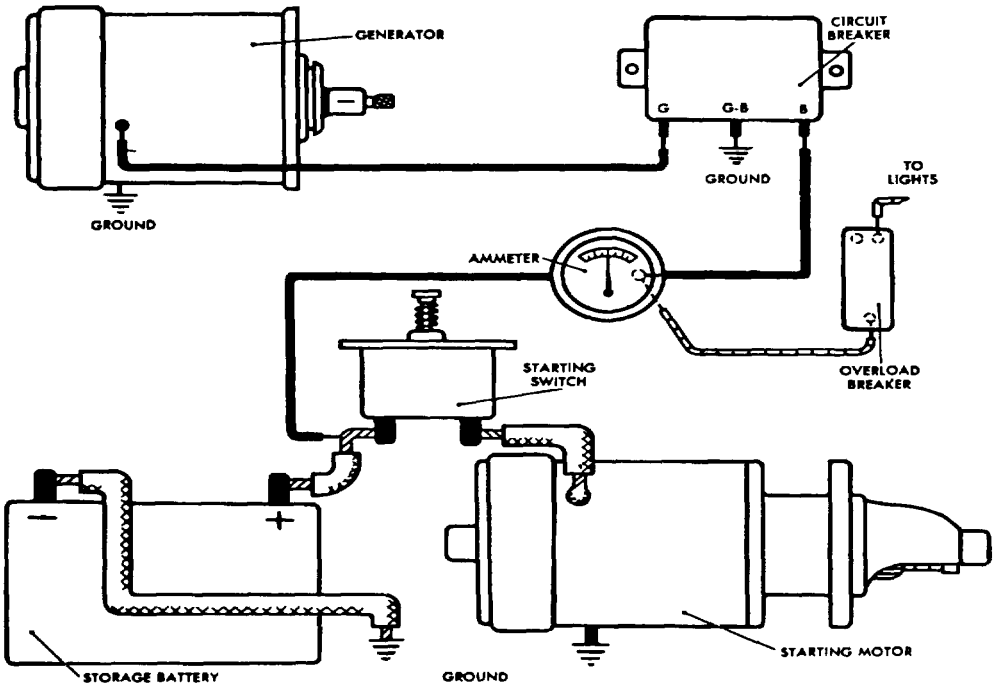


Figure 2-1. Basic Vehicle Electrical System

(2) Start engine → Damage found to:

No damage found

- batteries; ..... go to Section VI.
- switches; ..... go to Section II.
- fuses; ..... go to Section II.
- circuit breakers; ..... go to Section II.
- voltage regulator; ..... go to specific TM.
  alternator; ..... go to specific TM.

(2) Start engine → Damage found to:

No damage or trouble found

- alternator output function; ..... go to specific TM.
- voltage regulator function; ..... go to specific TM.
- circuit breakers; ..... go to Section II.

Evaluate system performance:

Charging System Assessment

	Fully Mission Capable	Combat Capable	Combat Emergency Capable	Self Recovery Capable	Recover
- Charging system works OK	X	X	X	X	
- Charging system works marginally		X	X	X	
- Charging system does not work		X	X	X	X

7-3. BDAR Procedure Index. **Para**

Section II. Electrical Components

7-4. General.

Electrical circuits contain switches and protection devices. Bypassing a failed switch or protection device is a rapid repair but may create more damage. The circuit must be checked for shorts before bypassing a protection device.

7-5. NEUTRAL SAFETY SWITCH DEFECTIVE

General Information:
Engine starter will not energize. This procedure will allow the engine to be started with the shifting lever in any position.

Limitations:
- None

Personnel/Time Required:
- 1 soldier
- 15 minutes

Materials/Tools:
- Electrical tape
- Duct tape
- Bandaid
- Shoelace

Procedural Steps:

1. Locate neutral safety switch.
2. Disconnect both wires.

3. Slide protective insulation boots back on the wires to expose the electrical connectors.

4. Lay the two connectors side by side and secure with tape.

5. Record the BDAR action taken. When the mission is completed, as soon as practicable, repair the vehicle using standard maintenance procedures.

7-6. SWITCH, STARTER, INOPERATIVE

General Information:
If the engine will not crank, bypass the starter switch and jump the starter terminals.

Limitations:
- None

Personnel/Time Required:
- I soldier
- 15 minutes

Materials/Tools:
- Piece of wire
- Tape

Procedural Steps:

Option 1: Bypass starter switch.

1. Locate the starter switch.

2. Remove the wire from the starter switch.
3. Use a jumper wire or touch the wires, removed in step 2, together.

4. After engine starts, disconnect jumper, or leads.

5. Insulate lead with tape.

Option 2: Jump starter terminals.

1. Gain access to engine starter.

2. Using a piece of wire or suitable object, connect the main power terminal to the solenoid terminal.

3. After engine starts, disconnect jumper.

Record the BDAR action taken. When the mission is completed, as soon as practicable, repair the vehicle using standard maintenance procedures.

7-7. FUSE OR CIRCUIT BREAKER FAILURE

A short or overload in a circuit will cause the fuse to burn out or the circuit breaker to trip. The circuit becomes inoperative. A temporary repair can be made by by-passing the protection device with straight wiring or by replacing the fuse with tinfoil, wire, ball point pen spring, or similar conductor. Use of solder will provide some amount of circuit protection. Damage to the equipment can occur when the circuits are not properly fused.

SECTION III. Shielded Cables

7-8. General.

Some high voltage or high current electrical circuits are shielded to prevent the circuit from inducing a current in a parallel circuit. The shield is connected to ground which will stop current from escaping or entering the conductor from any source other than it's own circuit. Shielded cables should be replaced whenever possible, communications cables are covered in Chapter 14 for interchangeability.

7-9. SHIELDED CABLE DAMAGE

General Information:
Repairs are possible if replacement cables are not available. Care must be taken so the shield is not connected to the conductor.

Limitations:
○ Possible radio frequency interference (R.F.I.)

Personnel/Time Required:
- 1 soldier
- 20-40 minutes

Materials/Tools:
- **S**older, rosin-core
- Tape
- Soldering iron

Procedural Steps:

Option I:

1. Cut back coaxial cable cover three inches from each wire end as shown.

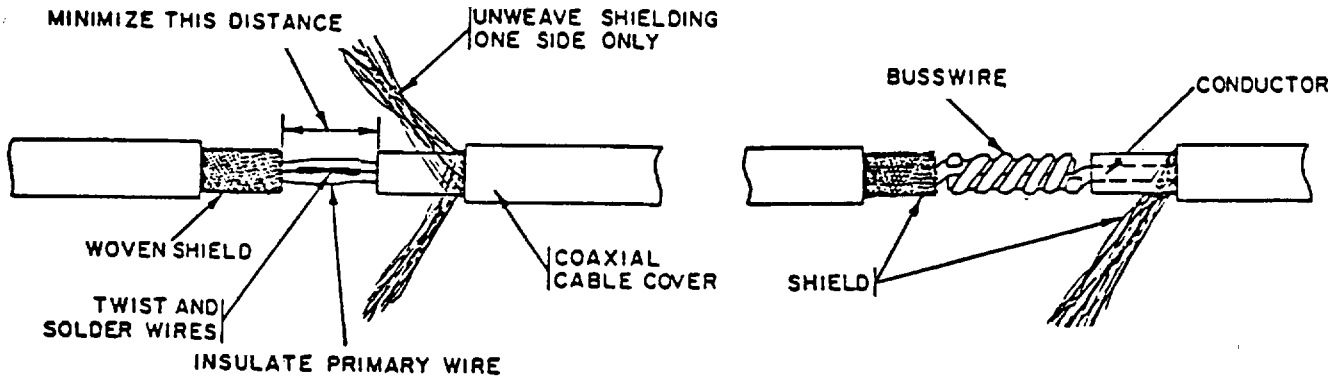
2. Cut back woven shield and inner conductor insulation on one wire two inches from the end.

3. On the other wire unweave the shielding and remove the inner conductor insulation two inches from the end.

4. Splice the broken wires by twisting and soldering. If soldering iron is not available, lay wires side by side, wrap with a bus wire as shown.

5. Insulate wire splice with several layers of tape.

Procedural Steps (Cont):

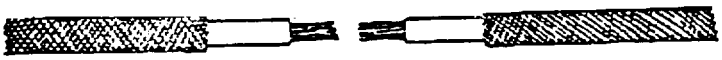


6. Lay the unwoven shielding over the insulated splice and make contact with the woven shield on the other side. Distribute the unwoven shielding carefully around the diameter of the wire and solder or wrap with bus wire.

7. Cover the entire splice with several layers of tape.

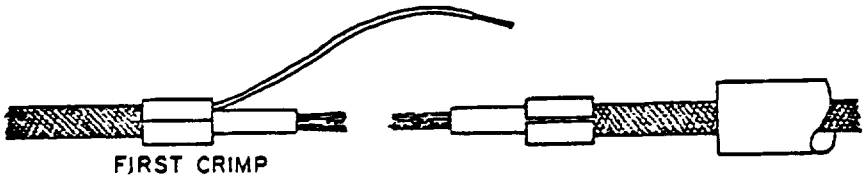
Option 2:

1. Prepare the severed ends of the cable as shown.



2. Slide shrinkable or flexible transparent tubing over the splice. The sleeve must be long enough to extend beyond the two ground sheath connectors.

3. Attach a grounding sheath connector to one end of the severed wire and crimp.

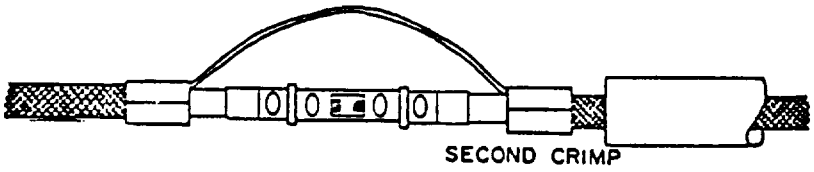


Procedural Steps (Cont):

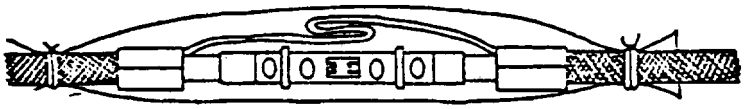
4. Install a grounding sheath connector to the other side of the break. Do not crimp this one yet.

5. Use a permanent splice to join the severed inner conductor or use the barrel of a terminal lug when a permanent splice is not available. A ballpoint pen refill will work as a terminal splice; crimp onto wires. Insulate from the shielding.

6. Push the free end of the grounding wire into the uncrimped grounding sheath connector. Crimp securely.



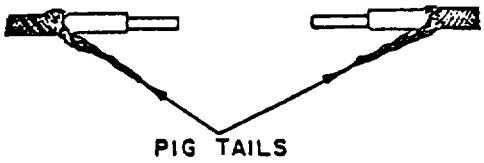
7. Slide outer insulating sleeve into place. If flexible tubing is used, tie both ends with nylon braid or cord.



TIE WITH TWINE AT BOTH ENDS

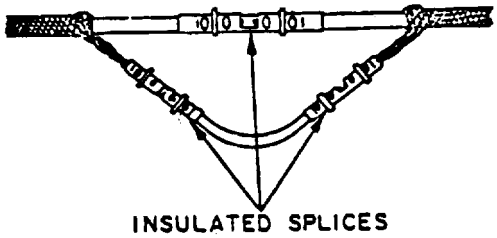
Option 3:

1. Prepare the severed ends of the cable for pigtail method of shield termination.



Procedural Steps (Cont)

2. Use the insulated splice connector to join the inner conductors.



3. Use two splice connectors to add a short length of insulated wire as an extension to complete the shield connection.

4. Cover area with tape or vinyl sleeve.

Record the BDAR action taken. When the mission is completed, as soon as practicable, repair the vehicle using standard maintenance procedures.

Section IV. Wiring Harnesses

7-10. General.

Wiring harnesses are normally replaced when extensive damage occurs. Because of improvements or different configurations, replacement harnesses from other vehicles of the same vehicle family may use some different style connectors. Try to obtain harnesses from an identical model; however, connectors can be exchanged with the damaged harness. The same procedure is followed to change a complete connector or splice a complete harness. If a wire is damaged but the fault cannot be located, it should be replaced with a jumper wire.

7-11. WIRING HARNESS DAMAGE

General Information
Wire harness repairs are generally a series of single wire repairs. Establishing circuit continuity in a bundle of wires is difficult because individual wires are not color coded. Wires must be identified before they are connected. Most essential electrical functions can be rapidly restored by using jumper wires.

Limitations:
- None

Personnel/Time Required:
- 1 soldier
- 1-2 hours

Materials/Tools:
- Wire
- Splices
- Electrical tape
- Soldering iron
- Plastic ties

Procedural Steps:

Option 1: Wire Bundle Repairs:

1. Repair the first wire and tape. Leave the tape hanging from the repair.

2. Repair the next wire, lay it on top of the first repair.

3. Continue wrapping with insulation tape.

4. Repeat these steps as often as necessary to repair the wire bundle without cutting or breaking the tape until the repair has been completed.

Procedural Steps (Cont)

5. Stagger splices, when possible, at least one splice length.
6. Insure that minimum essential cable clamps have been replaced.
7. Clamp cushions can be replaced by tape.

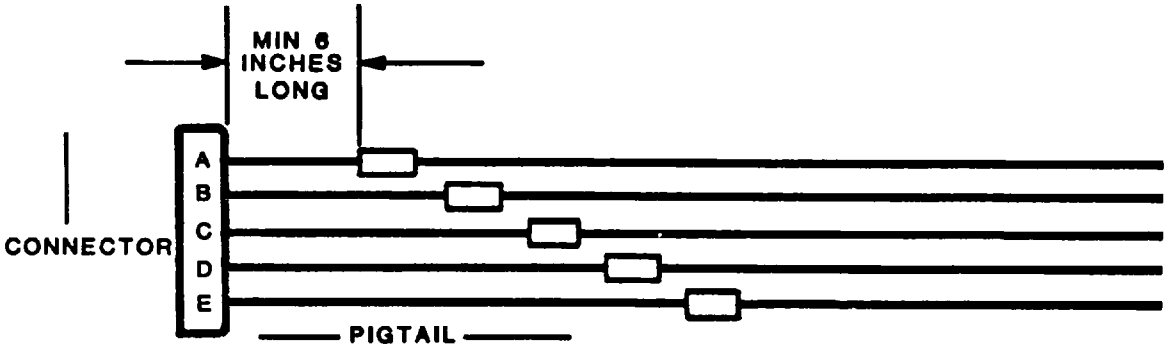
Option 2: Jumper Wire.

1. Identify the connector pin at each end of the harness.
2. Cut off the end of the defective wire.
3. Thread the jumper wire along the path of the cable harness passing the wire through the clamps.
4. Attach the jumper wire.
5. Tape the jumper wire securely to the harness at intervals that will provide protection from vibration or sagging.

Record the BDAR action taken. When the mission is completed, as soon as practicable, repair the vehicle using standard maintenance procedures.

7-12. CONNECTOR PIN DAMAGED (BROKEN OR MISSING)

General Information:
If the pins are too small, or time is insufficient, the entire connector should be replaced. A replacement connector complete with a pigtail removed from another vehicle can be spliced to the vehicle wiring harness as shown. If the connector is attached to shock mounted equipment, the wires should be long enough to insure free movement of the equipment on its shock mounts. Procedures are the same as repairing a wire bundle, see paragraph 7-11.



7-13. WIRES BROKEN

General Information:
Broken wires can be spliced several different ways to restore an electrical circuit. The available tools and materials will determine the method used. Soldered connections conduct current the best and should be used whenever possible.

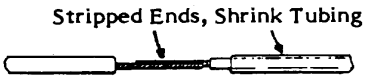
Limitations:
- None

Personnel/Time Required:
- 1 soldier
- 10-20 minutes

Materials/Tools:
- Crimping tool
- Solder, rosin-core
- Wire splice
- Heat shrink tubing
- Soldering iron

Procedural Steps:

Option 1: Solder Wire Method.



1. Strip end of broken wires.
2. Install a section of plastic sleeving or shrink tubing, if available, over one end of the broken wire.
3. Lay the stripped ends side by side.

4. Twist the wire ends together.

5. Solder wires together using rosin-core solder.
6. Slide sleeve or tubing over the soldered wires or tape to insulate the conductor.

Procedural Steps (Cont):

Option 2: Wire Splice Method.

1. If terminal lug barrel is used for splicing, select barrel diameter large enough to accept both wires.

2. Cut off terminal flush with pre-insulation.

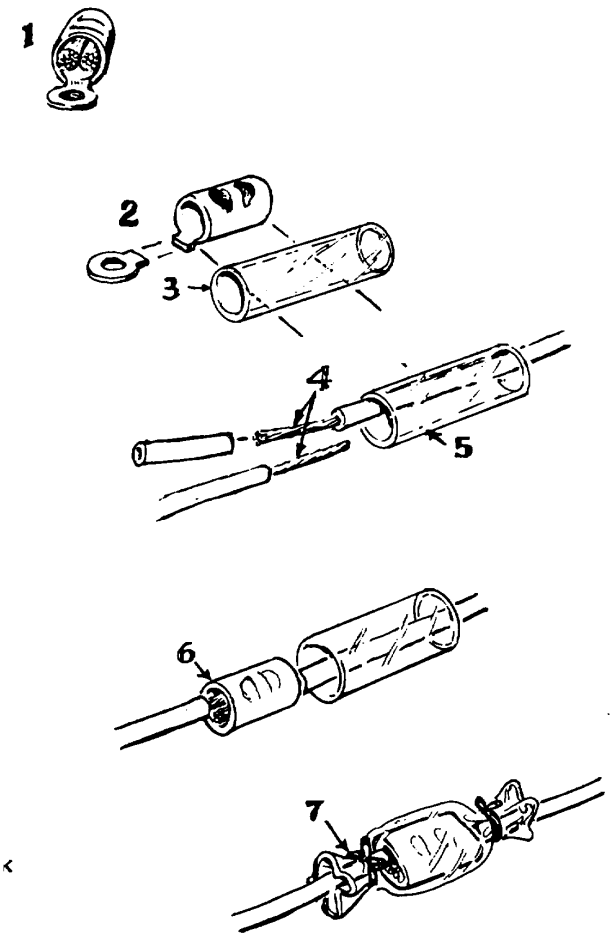
3. Cut insulating sleeve one inch longer than the barrel.

4. Strip end of broken wires.

5. Install insulating sleeve or shrink tubing, if available, over one end of broken wire.

6. Insert wires into the prepared splice barrel and crimp to secure the wires. Use crimp tool matching the size of the barrel.

7. Slide sleeve or tubing over the splice or use tape to insulate the conductor and apply heat to shrink material. Ends of non-shrink sleeve must be tied.



Procedural Steps (Cont):

Option 3: Splicing Different Size Wires.

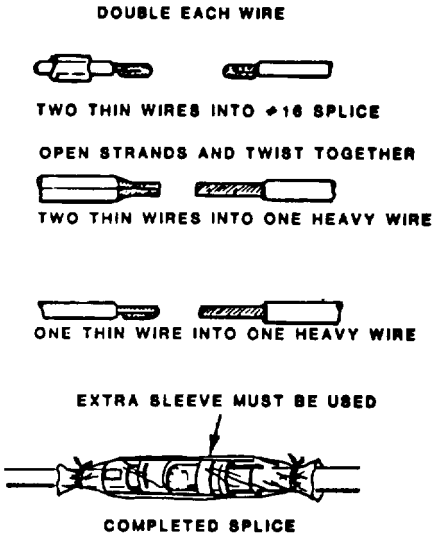
1 Strip broken wire ends, strip enough insulation to allow the smaller wire to be doubled as shown.

2. Install plastic sleeve or shrink tubing, if available, over one end of broken wire.

3. Connect wires by using a splice or terminal lug prepared as in Option 2.
4. Crimp splice or lug to secure the wires.

5. Slide the sleeve or tubing over the splice or tape to insulate the conductor.

Record the BDAR action taken. When mission is completed, as soon as practicable, repair the vehicle using standard maintenance procedures.



7-14. CABLE, HEAVY DUTY, DAMAGED

General Information:

Heavy electrical cables are more difficult to repair than small wires; however, they can be repaired using several different methods. Splicing procedures can be used to repair a break.

Limitations:

- None

Personnel/Time Required:

- 1 soldier
- 15-60 minutes

Materials/Tools:

- Terminal lugs, screw clamp or small hole clamp
- Insulating sleeve or electrical tape
- Soldering iron or torch and solder
- Short bolt with matching nut
- Safety wire
- Clamp cable

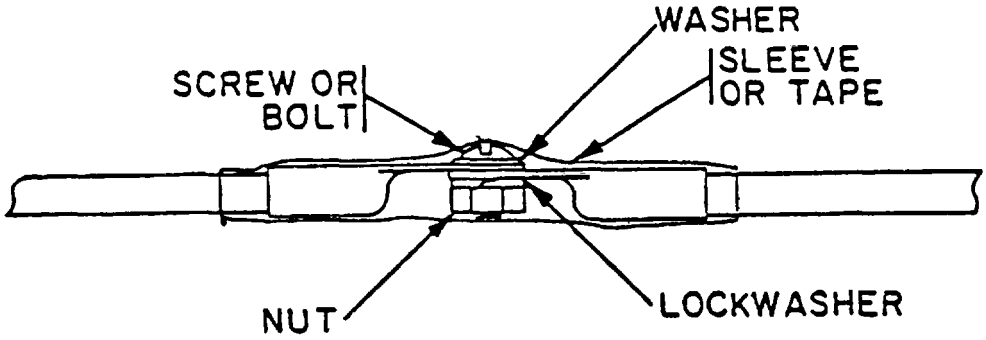
Procedural Steps:

Option 1: Splicing cable with terminal lugs:

1. Clean area to be repaired.

2. Trim the broken ends of the wire and install an insulating sleeve over one end of the wire.

3. Strip wire and crimp an insulated terminal lug to each wire end.



4. Bolt the terminal lugs together using short bolt with nut.

5. Slide the insulating sleeve over the connection and either heat-shrink or tie securely at each end. Tape may be used in place of sleeve.

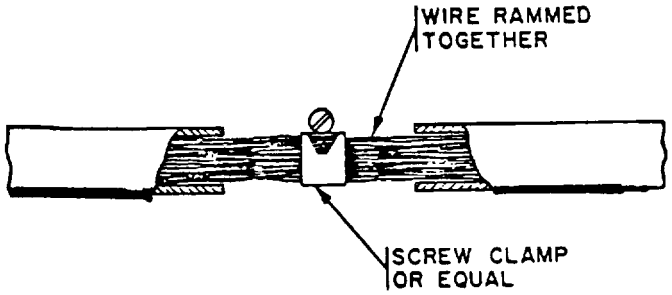
Procedural Steps (Cont)

Option 2: Splicing stranded cable:

1. Remove two inches of insulation from each end of broken wire.
2. Split the ends of cable into manageable strands and join the two ends by twisting like strands together.
3. Bend the twisted end parallel to the cable and insulate with tape.

Option 3: Clamp, Splicing

1. Remove one inch in insulation from each end.
2. Fan out the strands on each end.
3. Ram the two ends together as far as possible, so that the strands intermesh.



4. Solder the intermeshed wires together. If a soldering iron is not available, the two intermeshed ends may be secured with a screw clamp, cable clamp, or safety wire.
5. Insulate with tape.

Record the BDAR action taken. When the mission is completed, as soon as practicable, repair the vehicle using standard maintenance procedures.

SECTION V. Electrical Motors

7-15. General.

Repair on automotive motors should be restricted to relays, solenoids and brushes. Damage to casings and winding cannot be expediently repaired.

7-16. BRUSH, ELECTRICAL, GENERATOR/MOTOR, WORN

General Information:

Electrical motors and generators use a carbon composition brush to transfer electrical energy to or from the armature commutators. The transfer of energy creates an electrical arc which will burn the brushes. Arcing and normal friction will cause the brushes to become worn and inefficient for electrical power transfer. The brushes can be substituted with the carbon core from a BA30 or BA31 battery. Care must be taken when opening the battery, the contents are corrosive. Brush retaining springs can be used to transfer the energy or to hold the old brush wires in place.

Limitations:

- Shorter motor/generator life

Personnel/Time Required:

- 1 to 3 soldiers
- 1 to 8 hours

Materials/Tools:

- BA30 or BA31
- Hacksaw
- Sandpaper

Other Options:

- Modify and use other electrical brush sets

Procedural Steps:

1. Gain access to motor or generator.
2. Remove electrical brush plate.
3. Obtain a BA30 or BA31 battery.

Procedural Steps (Cont)

4. Using a hacksaw or other available tool split the battery open taking care not to damage the carbon core.

5. Clean and cut the carbon core to fit the brush plate receptacles.

6. Insert the core into the brush plate and position the old brush wires under the retaining springs to ensure electrical continuity.

7. Seat the brushes:

a. Cut a strip of sandpaper slightly wider than the commutator surface.

b. Tape the sandpaper strip over the commutator.

c. Install the brush plate.

d. Rotate the armature in the normal direction of rotation until the carbon core face conforms to the armature surface curvature.

e. Remove sandpaper and blow out dust and sand.

8. Re-assemble motor/generator and test operation.

9. Reinstall motor/generator.
10. Record BDAR action taken. When mission is completed, as soon as practicable, repair the vehicle using standard maintenance procedures.

7-17. STARTER SOLENOID DEFECTIVE, DELCO-REMY ONLY

General Information
With uneven wear of the solenoid plunger shaft, a lip will form on one side of the shaft and the engine starter will not engage. Temporary repair can be made by removing solenoid and rotating solenoid plunger shaft 180 degrees.

Limitations:
• Starter solenoid life is shorter than new part.

Personnel/Time Required:
• 1-3 soldiers
• 1-6 hours

Materials/Tools:
• None

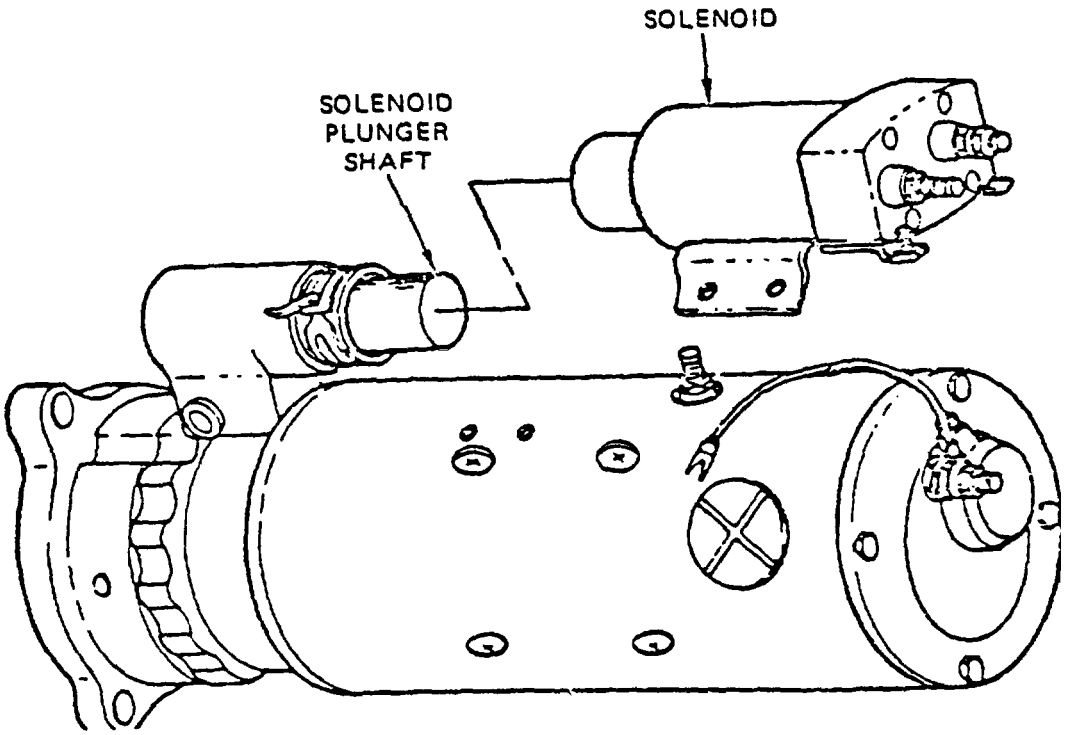
Procedural Steps:

1. Disconnect power. (Unhook negative battery terminal.)

2. Gain access to engine starter; remove if required.

3. Remove solenoid from starter.

4. Rotate solenoid plunger shaft 180 degrees.



5. Install solenoid on starter.

6. Reconnect power.

7. Test starter operation.

8. Record the BDAR action taken. When the mission is completed, as soon as practicable, repair vehicle using standard maintenance procedures.

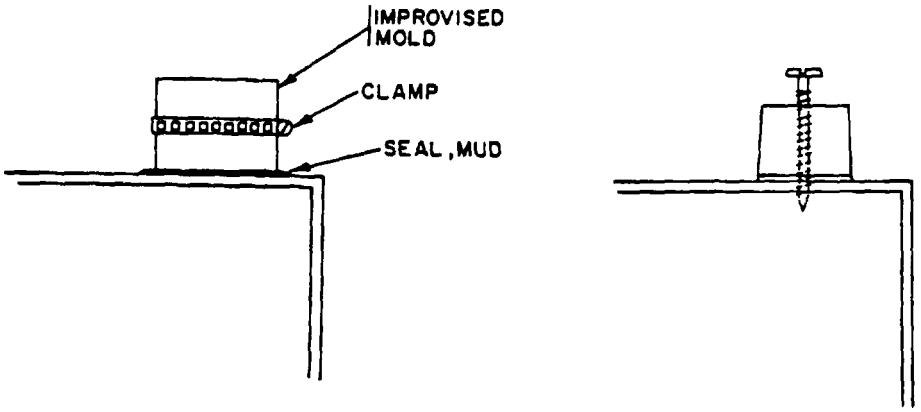
Section VI. Batteries and Battery Cables.

7-18. General.

The batteries store electrical energy to start the vehicle engine and to supply energy for accessory systems to operate without requiring engine operation. The batteries also act as a buffer for the electrical charging system. Without a battery in the circuit the charging system will charge at its maximum rate and rapidly burn out. Battery configuration is a minimum of two 12 volt batteries connected in series to give a 24vDC output.

7-19. BATTERY TERMINAL POST BROKEN

Battery terminal posts can be repaired if they are broken. The stub can be built back up with lead. If melting facilities or tools are not available a post can be secured with a self-tapping screw or bolt. The battery should be replaced as soon as possible if the post is only screwed or bolted in place.



7-20. BATTERY CRACKS

Batteries can become cracked from vibrations, impact or freezing. Cracks can be repaired or sealed until replacements can be obtained. Batteries which are cracked from freezing must be inspected for internal shorts or broken plates. Most epoxy will not shrink and is resistant to acid. Epoxies make a semi-permanent repair and should be used as a first option.

CHAPTER 8
POWERTRAIN / STEERING

BDAR FIXES SHALL BE USED ONLY IN COMBAT
AT THE DISCRETION OF THE COMMANDER
AND SHALL BE REPAIRED BY STANDARD MAINTENANCE PROCEDURES
AS SOON AS PRACTICABLE AFTER THE MISSION IS COMPLETED.

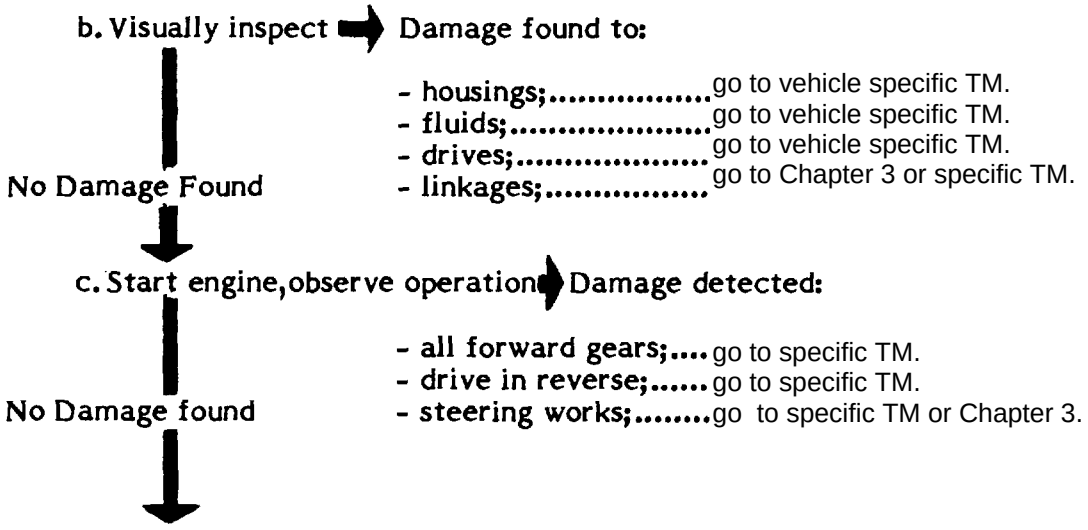
Section I. General

8-1. General.

The powertrain, separate from the engine, consists of a transfer case, transmission and final drives. Most track vehicle systems incorporate the steering and braking functions in the transmission but other vehicles have a control differential for steering and brakes. Steering is provided by applying braking action to one track to slow it down. The other track continues at the same speed and thereby changes the direction of the vehicle. Neutral steer is attained by driving the final drives and tracks in opposite directions, without any braking action.

8-2. Assessment Procedure.

a. Preconditions: Vehicle engine and brakes should be in working condition. The vehicle engine must be running during this assessment of powertrain of powertrain and steering components.



8-3 BDAR Procedure Index.....Para

SECTION II. TRANSMISSIONS

8-4. General.

Transmissions within a vehicle series or family are generally interchangeable, M48/M60 and variants use the same basic transmission. Within the self-propelled howitzer family the variations also use a basic transmission interchangeable within the family. The M 113 Family of Vehicles variants all use the same transmission. BDAR procedures will consist of cannibalizing subassemblies from other vehicles. Complete assemblies can be obtained from a vehicle within the same family.

8-5. TRANSMISSION FAILURE

General Information:

1. CD 850, high gear, low gear, reverse gear, and brake band failures can be repaired without removing the transmission from the engine. Repair parts can be new or cannibalized. Since the main concern is saving time, repairing a transmission in the forward area may be quicker than waiting for a replacement.

2. M48A5, M60, M60AI, M60A3, M88AI use the same basic CD 850 transmission.

3. The transmission is interchangeable between the following vehicles: M107, M108, M109, M109AI, M109A3, MIIO, MIIOAI, MIIOA2, M578.

4. Record the BDAR action taken. When the mission is completed, as soon as practicable, repair the vehicle using standard maintenance procedures.

Section III. Transfer Assemblies

8-6. General.

Transfer assemblies are interchangeable within the same families of vehicles. Some transfers also drive other accessories such as hydraulic pumps, cooling fans, or power take-offs. Care must be taken to use a transfer case which will provide the minimum essential operations required for the vehicles mission; i.e., ramp systems have standard procedures for operating without hydraulic power. BDAR repairs will be limited to parts exchange to repair one from other defective units.

8-7. TRANSFER ASSEMBLY INTERCHANGEABILITY

General Information:
1. Transfer Assemblies are interchangeable between the following vehicles:M107, M108, M109, M109AI, M109A2, M109A3, MIIO, MIIOAI, MIIOA2, M578.

2. M113 family vehicles normally use the same basic transfers.

8-8. STEERING.

Tracked vehicle steering is accomplished by braking action against the driving force restricting motion. Failures of linkage can be repaired using procedures in Chapter 3 or in the vehicle specific TM. Brake failure repairs are covered in each vehicle specific BDAR manual and Chapter 9 of this manual.

CHAPTER 9
BRAKES

BDAR FIXES SHALL BE USED ONLY IN COMBAT
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AS SOON AS PRACTICABLE AFTER THE MISSION IS COMPLETED.

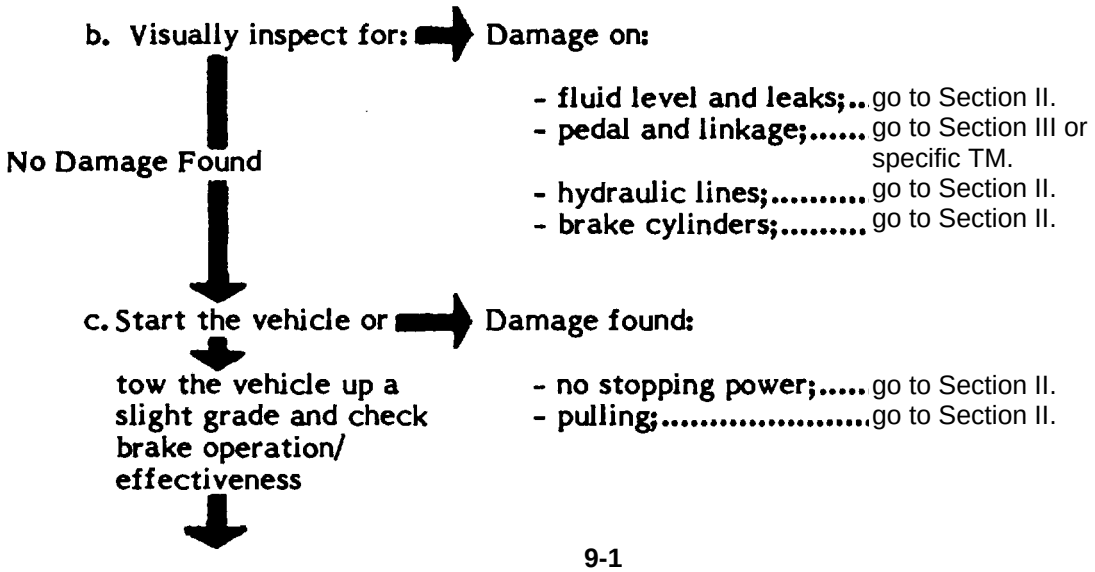
Section I. General

9-1. General.

Mechanical linkage repair/improvisation is covered in Chapter 3. Brake systems are mechanically and/or hydraulically actuated. Correction of brake system problems include repairs of linkages, cylinders, cables and hydraulic lines. Brakes provide steering control and braking action.

9-2. Assessment Procedure.

a. Assessment Preconditions: Before testing the vehicle brakes, clear the immediate area or connect a restraining vehicle to the vehicle to be tested with chains or cables. The brakes can be tested using either the test vehicle power or it can be towed by the restraining vehicle up a slight grade for the test.



9-3 BDAR Procedure Index.....Para

Section II. Hydraulic Brakes

9-4. General.

The common result of hydraulic brake system failure is the loss of fluid. The system must be sealed or leakage reduced. Some holes in the hydraulic system can be repaired using procedures provided in Chapter 3 of this manual. Tubing or hose leaks can be repaired using methods shown in Chapter 11.

9-5. BRAKE MALFUNCTION, HYDRAULIC SYSTEMS

General Information:

If BDAR fixes have been applied to hydraulic components to slow down fluid loss, lost hydraulic fluid must be replaced to make hydraulic brake action possible. If hydraulic fluid is not available, the following fluids will work as emergency substitutes:

- Alcohol
- Ethylene glycol (antifreeze)
- Water, or water based fluid
- Hydraulic fluid
- Diesel fuel
- Petroleum based fluids.

NOTE

If the fluid leverage cannot be restored, braking may be possible through the steering. Short, rapid applications of left and right steer will slow the vehicle. The vehicle can be slowed by sideswiping objects such as trees, but care must be taken not to hit solid objects which will cause damage to the track and suspension. As a last resort only, shift to reverse, this will normally damage internal transmission components and propeller shafts.

9-6. BRAKE MASTER CYLINDER FAILURE

Brake fluid will absorb small amounts of water and cause corrosion in the brake cylinder bores. The corrosion prevents the rubber caps from sealing against the cylinder walls and allows fluid leakage. Brake cylinders can be disassembled and cleaned to remove corrosion. To correct leakage, remove cylinder and use a fine grit sandpaper to lightly sand the cylinder walls. Do not sand end to end but rotate the cylinder to get a circular pattern. Reassemble and install the cylinder, refill with replacement fluid and bleed the system.

Section III. Mechanical Brakes

9-7. General.

Mechanical brake repairs are covered in the specific BDAR manual or the specific standard maintenance TMs. General linkage repairs are covered in Chapter 3 of this manual.

9-8. BRAKES LOCKED

Locked brakes are frequent in cold weather. The parking brake seizes as it cools. The brake linkage should be disconnected and pryed into a released position. Reconnect them and check operation. If the brakes lock again, or cannot be released, disconnect the linkage and tie the levers in a released position. Block the tracks when parking.

Record the BDAR action taken. When the mission is completed, as soon as practicable, repair the vehicle using standard maintenance procedures.

CHAPTER 10
TRACK AND SUSPENSION

**BDAR FIXES SHALL BE USED ONLY IN COMBAT
AT THE DISCRETION OF THE COMMANDER
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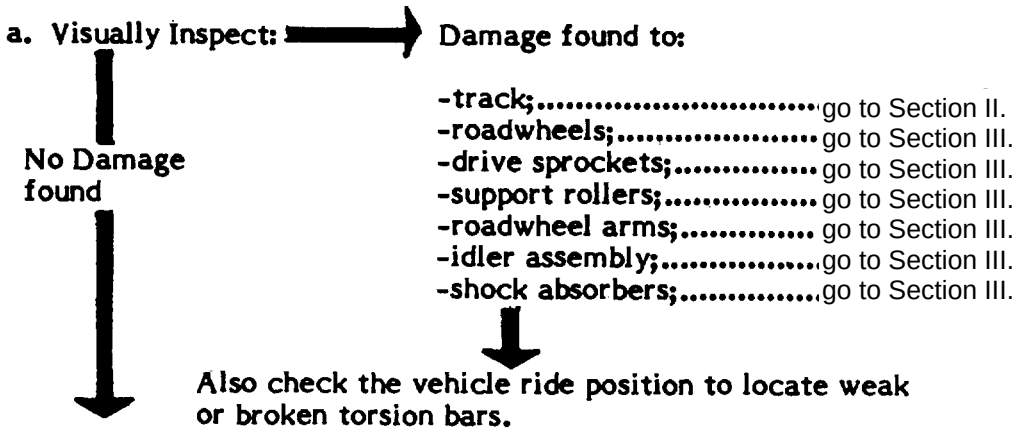
AS SOON AS PRACTICABLE AFTER THE MISSION IS COMPLETED.**

Section I. General

10-1. General.

The track and suspension systems are designed to work together. When the track and/or suspension becomes damaged and no replacements are available, the track can be shortened and suspension positions can be bypassed. Some vehicles cannot be short tracked because of hull interference, the track will not have clearance to operate. After the vehicle has been short-tracked, the major problem will be to maintain track tension. As road wheels, arms, and torsion bars are eliminated, there will be less ground clearance and heavier loading on the remaining components. The driver must reduce speed and select smoothest terrain possible. Vehicle operation can continue if sufficient material is left in the hull to support either the shock absorber or torsion bar housing. Many items within the suspension system are identical regardless of position, but some have minor differences from left to right and front to rear.



b. Functionally Check: → Damage found to:

No Damage found ↓

-track;..... Go to Section II.
-roadwheels;..... go to Section III.
-drive sprockets;..... go to Section III.
-support rollers;..... go to Section III.
-roadwheel arms;..... go to Section III.
-idler assembly;..... go to Section III.
-shock absorbers;..... go to Section III.
-torsion bars;..... go to Section III.

c. Evaluate System Status:

TRACK AND SUSPENSION ASSESSMENT

	Fully Mission Capable	Combat Capable	Combat Emergency Capable	Self Recovery Capable	Recovery
-Both tracks and all components serviceable	X	X	X	X	
-Both tracks, drive sprockets, idlers, and positions 1 and 6 with 3 other positions serviceable		X	X	X	
-Both tracks, drive sprockets, idlers and positions 1 and 6 serviceable		X	X	X	
-Either track, drive sprocket, idler or position 1 and 6 unserviceable					X

10-3 BDAR Procedure Index **Para**

Section II. Track

10-4. General.

a. A track is a temporary roadbed laid for vehicle wheels to roll on, without sinking in. Center guides ensure that the wheels remain on the road. Track pins are hinge-pins which permit pick-up and transport of the road (track). Because the ground contact area of the track is much greater than the combined contact areas of all wheels, tracks distribute the vehicles weight better than wheels. The more rigid the ground contact area is, the better the weight distribution will be. Track rigidity is achieved through tension applied to the track by roadwheels, arms and torsion bars.

b. When track and suspension components are damaged the vehicle can still operate by eliminating some wheel positions. With reduced ground contact area, however, weight distribution is decreased, and each of the remaining wheel and suspension positions must support a heavier load. This will result in reduced ground clearance, loss of agility, imbalance in steering, and loss of engine power, thereby directly affecting top speed of the vehicle. To compensate, the crew must reduce vehicle speed, select smoothest terrain available and avoid sharp turns.

c. Track and suspension repairs vary with vehicle and track configuration and are covered in more detail in vehicle specific BDAR manuals and vehicle specific TMs.

10-5. TRACK DAMAGE, SHORT TRACKING

Most track vehicles can be short-tracked. This is accomplished by removing track blocks to shorten the track and reroute it over fewer suspension positions. When the track tensioning components are bypassed, the track cannot be adjusted. Relocate suspension components from other positions to keep as much track as possible in contact with the ground.

10-6. CENTER GUIDES.

Track center guides, as structural design elements of track blocks, are designed to keep the track on vehicle's wheels. An occasional broken-off center guide tooth will have little or no effect on the vehicle's operation as long as the base of the center guide is still present. A vehicle may still be functional if every other center guide is missing. If several consecutive center guides are missing, the likelihood of throwing a track is increased greatly. When several center guides are missing in a row, great stress is placed on the track pins, which may shear at high speeds and during sharp turns in soft, sandy soil.

Section III. Drive and Road Wheels

10-7. General.

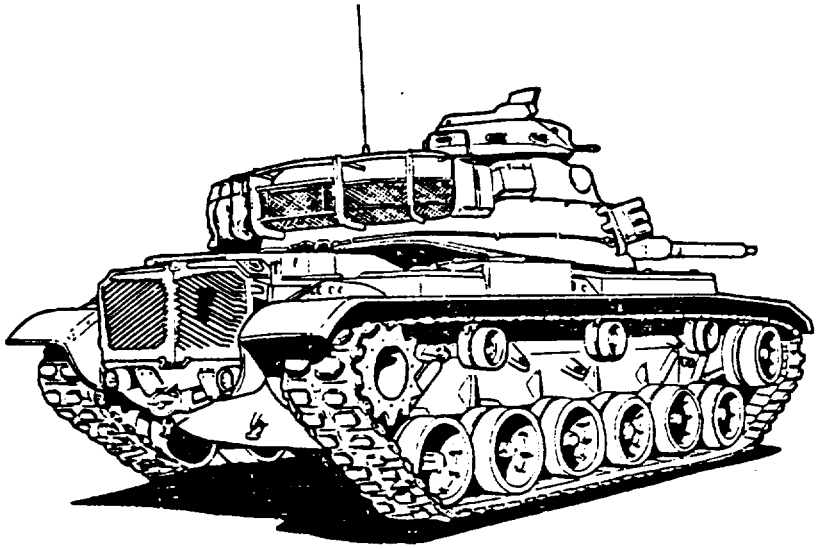
Damaged drive sprockets cannot be repaired and must be replaced. If the hub is still intact, field expedients' methods can restore its function for limited (low-stress) operation. Roadwheels damaged beyond repair must be removed. The vehicle can operate in a limited manner with fewer than its normal set of roadwheels.

10-8. SPROCKET DAMAGE

A tracked vehicle cannot operate when a drive sprocket has sustained substantial damage. Sprockets with one or several non-consecutive teeth missing can operate at reduced speeds. A replacement sprocket can be welded in place if bolts are not available.

10-9. SUPPORT ROLLERS

Support rollers are used to support the top run of track. This support keeps the track from sagging and stops the whipping action of the track. Repairs to damaged support rollers can be deferred if the hub and wheels are still intact. Components which may interfere with track operation must be removed.



10-10. ROADWHEELS

Operating with less than the standard number of roadwheels is possible. Do not put two single wheel positions next to one another. If necessary, make them alternating single inner and single outer. When positioning a wheel as an outer guide, a shim plate must be installed.

10-11. ROADWHEEL ARM OR HUB DAMAGED

The roadwheel hub must be serviceable to use single or double roadwheels. If the hub or spindle is damaged and interferes with track operation it must be removed or tied up. The arm can be secured away from the track with a 4 x 4, board, log, tankers bar or other available support. The roadwheel hub can be removed by using a support or by loosening the track tension and driving the vehicle over a hole which will allow the track to sag and remove the tension from the damaged positions torsion bar. The torsion bar and roadwheel hub can be removed allowing the suspension arm to rotate up and away from the track. Secure the arm to the improvised support with chain, rope, or BII straps. The disabled position should be one of the intermediate positions to provide as much track on the ground as possible. The first and last roadwheel positions will accept intermediate position components. Exchange parts from intermediate positions, if required, to keep the first and last positions operative.

10-12. TORSION BAR DAMAGE

Torsion bars have a pre-twist which makes the bar spring in one direction. To prevent improper installation the bars use a blind spline for alignment purposes. If a first or last support position torsion bar is damaged, replace it with one from the intermediate positions. A broken torsion bar should be removed to prevent other damage. Tie up the disabled roadwheel arm.

CHAPTER 11
HYDRAULIC POWER DISTRIBUTION

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Section I. General

11-1. General.

BDAR for a hydraulic system is generally confined to component replacement, expedient line repairs, or bypassing damaged lines. If a hydraulic circuit cannot be repaired, it may be necessary to isolate it (cutting it off) from the system to permit operation of some other hydraulic functions. Damage to the hydraulic system almost always requires replenishment of lost fluids.

WARNING

Bring hydraulic system to Zero Pressure before making repairs.

11-2. Assessment Procedures.

No specific assessment procedures are needed to locate leaks and ruptured lines. System specific TMs must be checked before any isolation is performed.

11-3. BDAR Procedure Index.

Section II. Fluids and Seals

11-4. General.

Hydraulic circuits use fluids under pressure to activate, regulate or drive mechanisms in the vehicle. To contain the pressure within the hydraulic system all moving parts are sealed with gaskets, packing, and O-rings. Leakage at any of these, or at hydraulic devices or the lines that connect them will render the entire system as useless until the leak has been stopped.

11-5. HYDRAULIC FLUID SUBSTITUTIONS

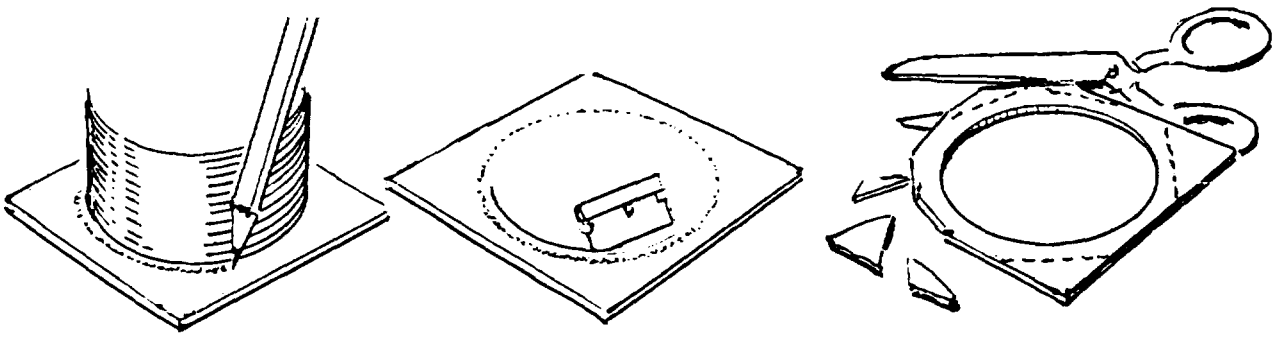
If the original intended fluid is lost and standard replacement is not available, a substitute fluid must be used. Check Appendix C for a compatible fluid. If a compatible fluid is not available, any liquid can be utilized.

11-6. O-RING LEAKAGE

The following fixes could be used:

a. A damaged O-ring could be repaired using plastic rubber. Apply the plastic rubber to the damaged area and press out air pockets. Allow to cure 1 hour (overnight for best results) before reinstallation.

b. Cut a section of rubber having the same size as the damaged O-ring, using a sharp tool such as a razor blade.



Section III. Metal Tubing

11-7. General.

To operate some of the vehicle mechanisms a considerable amount of energy must be exerted. Hydraulic power is used to perform these high-energy tasks. High energy requirements (or high speed tasks) are usually met with high-pressure hydraulic lines or tubing, made of metal. There are also metal low pressure lines, usually used when heat is a consideration of shape is critical. This section covers expedient repairs on metal tubing.

11-8. METAL TUBE BENDING

Bending may be required to make tubing repairs. Dry sand can be poured into the tube to be bent. The ends must be plugged to keep the sand from falling out. Soft metal tubes can be sealed with finger pressure but harder lines should have a plug inserted.

After bending the tube, flush the sand from the tubing with a liquid to ensure removal of all the particles.

11-9. HYDRAULIC LOW PRESSURE METAL TUBING REPAIR

General Information:
Damaged low pressure metal hydraulic lines can be replaced with other available lines (high pressure, metal or rubber hoses).

Limitations:
• None

Personnel/Time Required:
• I soldier
• 30-120 minutes

Materials/Tools:
• AN/MS fittings
• Hacksaw
• Hand file
• Beading tool
• Wire
• String
• Sealant
• Shrink tubing
• Tube cutter

Other Options:
• See Chapter 5

Procedural Steps:

Option 1: Replacement of a Short Damaged Tube Section.

1. Cut out the damaged portion of the tubing.

2. Square, deburr and clean the ends.

3. Bead the tubing 1/2 inch from the ends.

NOTE

If a beading tool is not available, make an improvised head by wrapping string or wire around the tube, coat the string or wire with sealant or hardening epoxy.

4. Select a length of medium or high pressure hose with an inside diameter equal to the outside diameter of the tube. Cut the length 4 inches longer than the removed piece of tubing.

5. Slide the hose ends over the ends of the tubing. Use grease or system fluid to aid in sliding the hose over the tubing, particularly the bead.

6. Secure the hose on each end with two hose clamps on each end as shown in figure 1. Position clamp screws 1800 to each other. Pressure test the assembly.

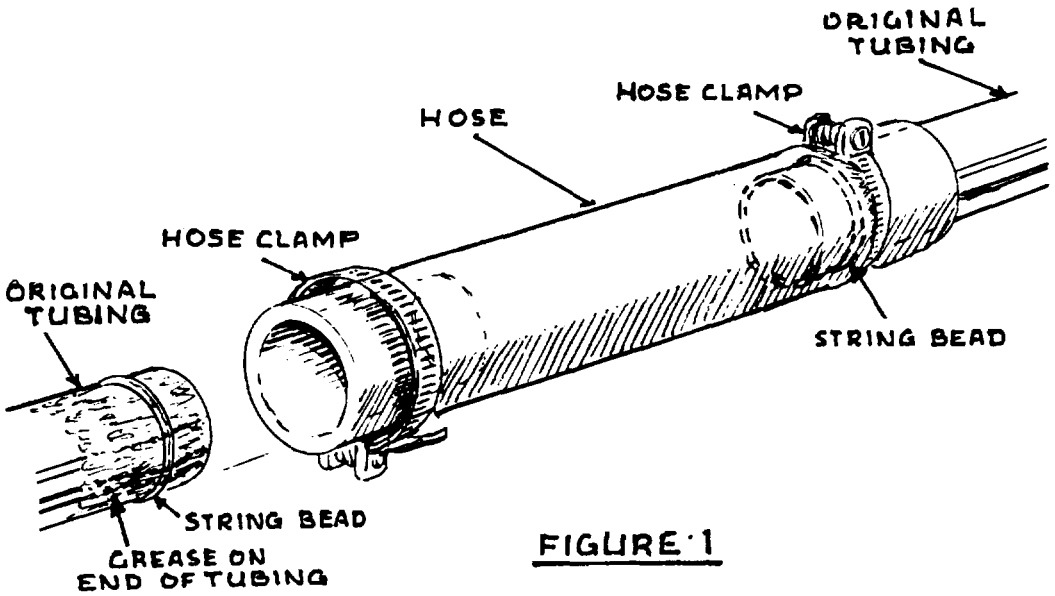


FIGURE 1

Procedural Steps (Cont)

Option 2: Replacement of Long Damaged Tube Section.

A long damaged section of metal tubing should be replaced with a new section of metal tubing, using at each end a piece of rubber hose to install the replacement section, Figure 2.

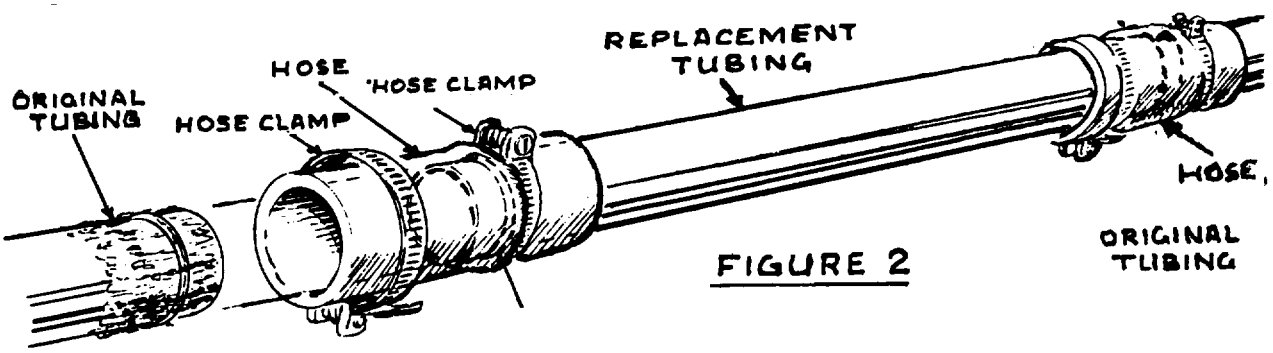


FIGURE 2

Option 3: Heat Shrink Tubing (Short Damaged Lengths).

1. Cut out damaged section of tubing; deburr and clean ends.

2. Select a piece of shrink tubing with inside diameter equal to the outside diameter of the tube and cut a piece 2 inches longer than the piece of removed tubing.

3. Slip the shrink tubing I inch over each end of the cut installation.

4. Heat the portion of the heat shrink tubing that is over the metal tubing to seal the connection.

Option 4: Tube Patch.

1. Use a piece of reinforced hose with an inside diameter equal to the outside diameter of the tube.

2. Split the hose lengthwise.

3. Install hose over the leak with the split opposite the leak. If available, coat the inside of the tube with sealant.

4. Secure with a hose clamp directly over the leaking area as shown in Figure 3.

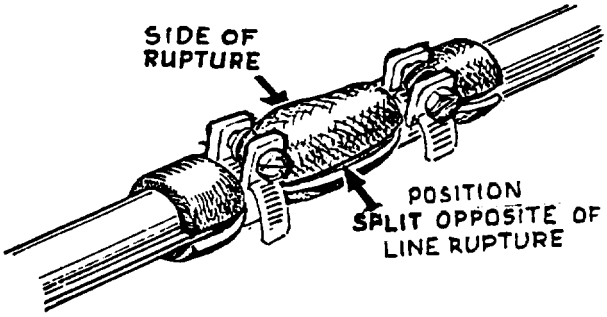


FIGURE 3

Procedural Steps (Cont):

NOTE

If a rubber hose is not available, use a piece of patch material, rubber (piece of innertube), gasket, or poncho material. If a hose clamp is not available, use tape, lacing wire, or copper wire. Check system fluid level frequently.

Record the BDAR action taken. When the mission is completed, as soon as practicable, repair the vehicle using standard maintenance procedures.

11-10. HYDRAULIC HIGH PRESSURE METAL TUBING REPAIRS

General Information

The following options are offered for the repair/replacement of high pressure metal lines.

Limitations:
* None

Personnel/Time Required:
* 2 soldiers
* 3090 minutes

Materials/Tools:
* Hose
* Hose clamps
* AN fittings
* MS fittings
* Tube repair kit
* Tube cleaner
* Coupling
* Tube cutter
* Hacksaw
* Swage tool
* Hand file

Procedural Steps:

Option 1: Manufacture a New Line. Use the damaged line as a template, or make a template from any available soft wire.

Option 2: Substitute with High Pressure Hose. Make a high pressure hose to replace the damaged line. The temporary hose may follow a different path than the original line and may be easier to install. Clamp the hose to hard supports at convenient intervals to secure the hose.

Procedural Steps (Cont)

Option 3: Permaswaging. Permaswaging fittings may be used to repair damaged tubing. These repairs require cutting out and replacing the damaged tube section. Permaswaging fitting and replacement tubing are rated up to 3000 psi operating pressure. Use the tube repair kit D12323-1-3456, NSN 5180-01-026-0253.

NOTE

Effective, leak-proof Permaswaging depends on tube ends being square, deburred and very clean, and precise marking of tubing to avoid twisting of line (stress) and centering inside fitting(s).

1. Long Axis marking. Using a marking pen and a ruler, draw a straight line on the tubing, starting in the undamaged area, through to the damaged section, into the other undamaged area, as shown in Figure 4.

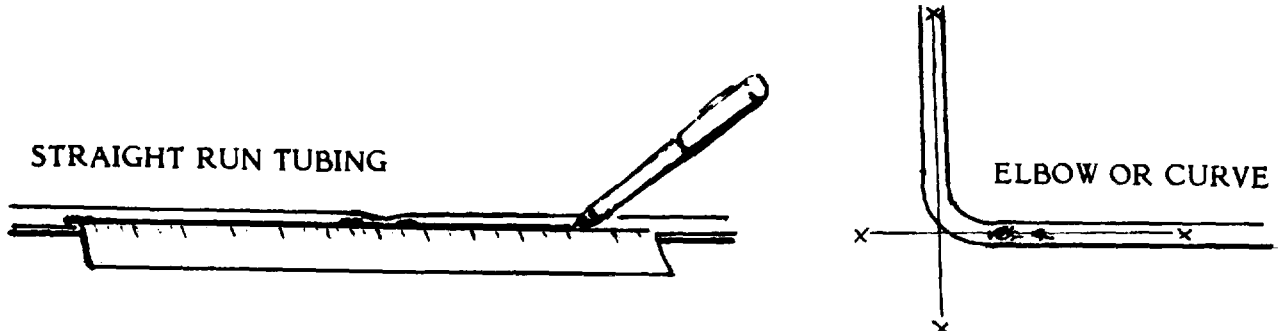


Figure 4. Long Axis Marking.

2. Refer to Figure 5, 6, 7, and 8 to determine the repair method required.

NOTE

Continue with steps 3 and 4 next to the figure which resembles most of the repair required.

Procedural Steps (Cont)

3. Make one or two custs as necessary to enable removal of damaged section. It two cuts are cuts are required, the distance between them shall not exceed 0.30 inch. If this measurement is exceeded, go to repair method in Figure 6

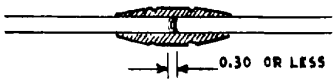


Figure 5.
Repair of Pin Hole Leak or Circumferential Crack in Tubing.

4.Continue with step 5 in Figure 9. Tube-end. Use tube-to-tube union when performing steps 6 through 10.

3. Make two cuts and remove the damaged section Prepare a replacement tubing section

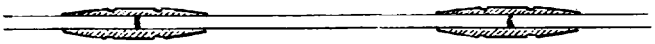


Figure 6.
Repair of Longitudinal Crack in Tubing (Crack Length Exceeds 0.30 Inch)

4.Continue with step 5 in Figure 9. Tube-end marking. Use two tube-to-tube unions when performing steps 6 through 10.

3.Cut out defective tee or elbow and duplicate tubing sections for each branch.

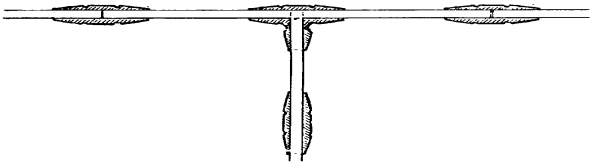


Figure 7. Repair of Leaking Tee or Elbow (Permanent Tube Connection Type).

4. Continue with step 5 in Figure 9. Tube-end marking. Use three tube-to-tube unions and one tee when performing steps 6 through 10.

3. Cut tubing to remove damaged tube end and end fitting. Connect a new end fitting to the mating equipment connection. Cut replacement section to fit between cut tube end and end fitting. Install splice section in new end fitting first and tighten

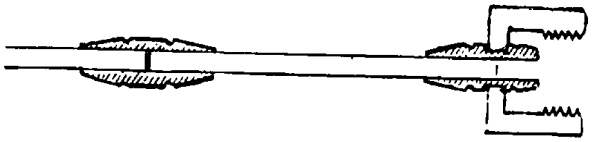


Figure 8.
Repair of Leaking End Fitting

nut as required.

4. Perform step 5 in Figure 9. Tube-end ,marking. Use a tube-to-tube union when performing steps 6 through 10.

Procedural Steps (Cont):

5. Ends of tubing to permaswaged must be centered inside the permaswage fitting. Use the permaswaging marking tool and centering/marking instructions supplied with the permaswaging kit. Use the marking method below only if the marking tool is not available.

a. Mark half of the overall length of the permaswage fitting on the tubing end as shown.

b. Repeat marking procedure on the other tubing end to be swaged.

6. Slide permaswage fitting(s) all the way on the undamaged tube ends.

7. Position replacement section between cut ends of undamaged tubing and slide permaswage fittings over gaps between.

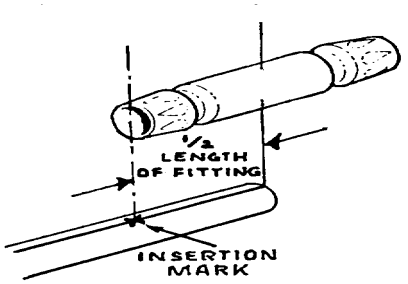


Figure 9. Tube-end marking tube ends.

8. Make sure insertion marks are visible on either side of the fitting. Also, rotate fitting and replacement section until long-axis marking aline with marking on the undamaged tube end.

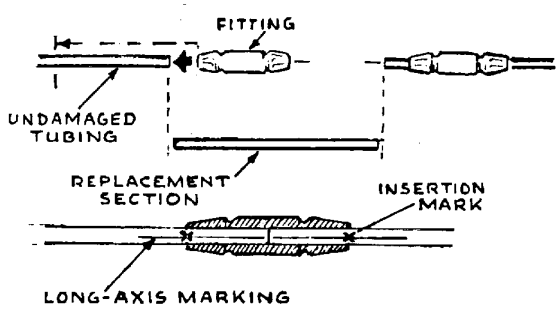
NOTE

For replacements requiring an end fitting, swage end fitting to replacement section first, as described in step 9. Then secure nut of the end fitting fingertight to the adapter.

9. Position the permaswage tool one side the fitting and swage. Then swage the other side of the fitting.

10. Repeat steps 8 and 9 on the other end of the replacement section.

11. Record the BDAR action taken. When the mission is completed, as soon as practicable, repair the vehicle using standard maintenance procedures.



Section IV. Hydraulic Line Repairs

11-11. General.

This section provides expedient repair procedures for the hydraulic system. Procedures cover different methods of repair for high and low pressure tubes and hoses.

11-12. HYDRAULIC TUBE AND HOSE REPAIR

General Information-
These procedures tell how to repair damaged hydraulic tubes and hoses. Use the following options to repair any damaged hydraulic tube or hose. To repair high-pressure lines use only the high-pressure options recommended. High-pressure procedures also may be used for low-pressure line fixes if the situation calls for it.

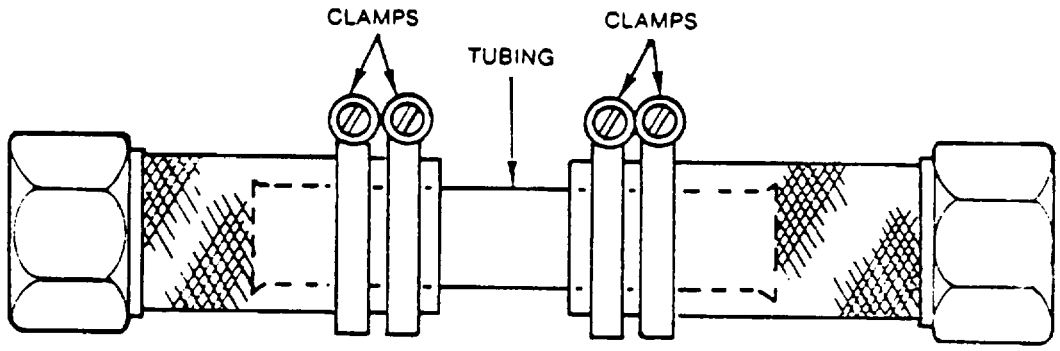
Personnel/Time Required:
• I soldier
• 25 to 40 minutes

Option 1: Low Pressure Line Repair (Same Size Tube Ends).

Limitations:
• Not recommended for pressures above 70 psi.

Materials/Tools:
• Correct size hydraulic hose
• Four clamps
• Sealing compound

Procedural Steps:



1. Squarely cut each end of damaged tube. Flare each end of damaged tube if possible, and remove burrs.

Procedural Steps (Conti)

2. Measure and record distance between cut ends of damaged tube.

3. Cut a length of correct diameter rubber hose 6-inches longer than distance measured.

4. Spread a light coat of sealing compound inside of rubber hose.

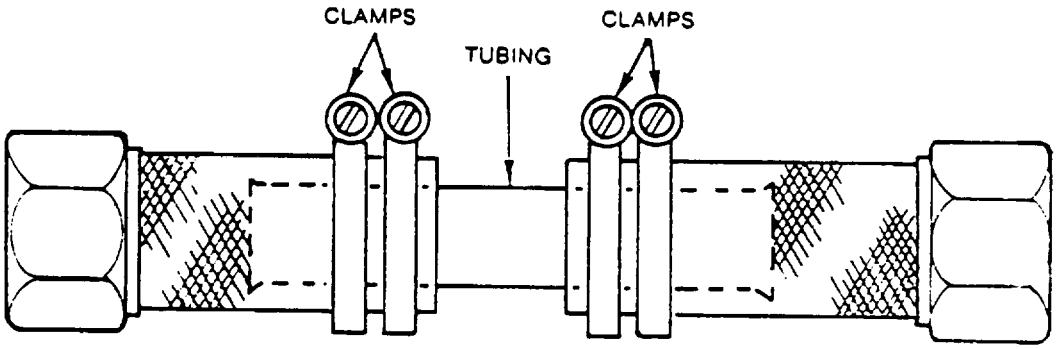
5. Position hose between flared tube ends and secure in place with four clamps.

Option 2: Low- Pressure Line Repair (Same Size Line Ends).

Limitations:
•Not recommended for pressure above 70 psi

Materials/Tools:
• Correct size hydraulic tubing
• Four clamps
• Sealing compound
• Adhesive tape

Procedural Steps:



1. Wrap each end of hose to be cut with tape. Squarely cut each end of damaged hose. Clean loose particles from ends of rubber hose.

Procedural Steps (Cont):

2. Measure and record distance between cut ends of damaged hose.

3. Cut length of correct diameter tubing 6-inches longer than distance measured.

4. Flare each end of tube if possible, and remove burrs.

5. Spread a light coat of sealing compound around each end of tube.

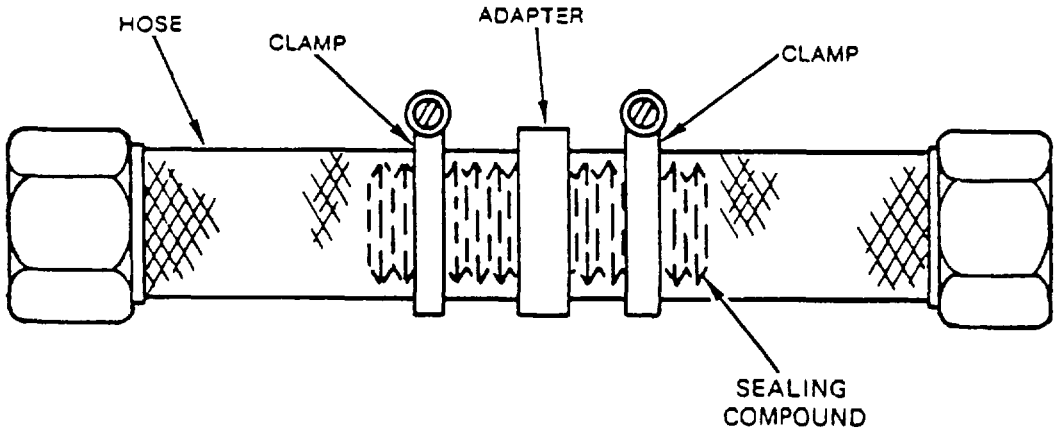
6. Position tube inside each end of cut hose and secure in place with four clamps.

Option 3: High- Pressure Line Repair (Same Size Hose Ends).

Limitations:
o None

Materials/Tools:
• Tube pipe fitting kit
• Clamps
• Sealing compound
• Adhesive tape

Procedural Steps:



1. Wrap each end of hose to be cut with tape. Squarely cut each end of damaged hose. Clean loose particles from ends of hose.

Procedural Steps (Cont):
2. Spread a light coat of sealing compound on threads of adapter or tube.

3. Install adapter or tube into each end of hose.

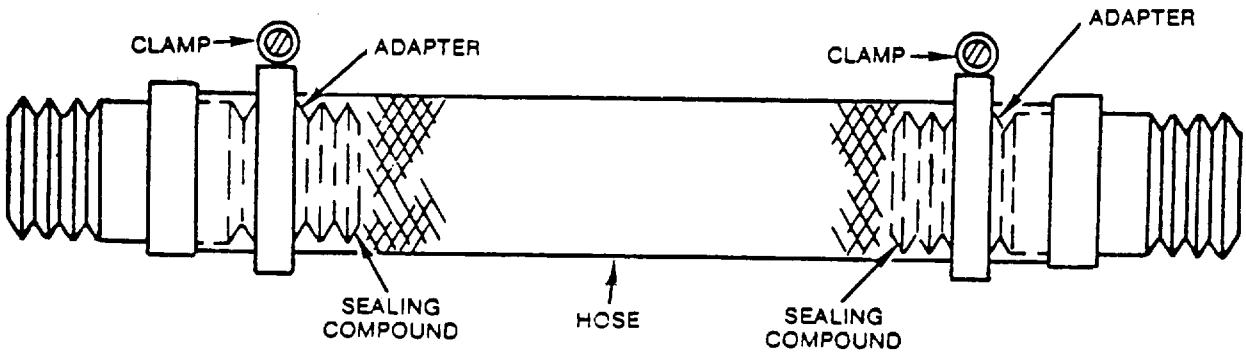
4. Secure hose and adapter with clamps.

Option 4: High- Pressure Line Repair (Same Size Hose Ends).

Limitations:
• None

Materials/Tools:
• Tube pipe fitting kit
• Clamps
• Sealing compound
• Adhesive tape

Procedural Steps:



1. Wrap each end of hose to be cut with tape. Cut section of hose to length required. Be sure each end is squarely cut.

2. Spread a light coat of sealing compound on threads of one end of adapter or tube.

3. Install end with sealing compound into hose. Secure with clamps.

4. Repeat steps 2 and 3 for other end of hose.

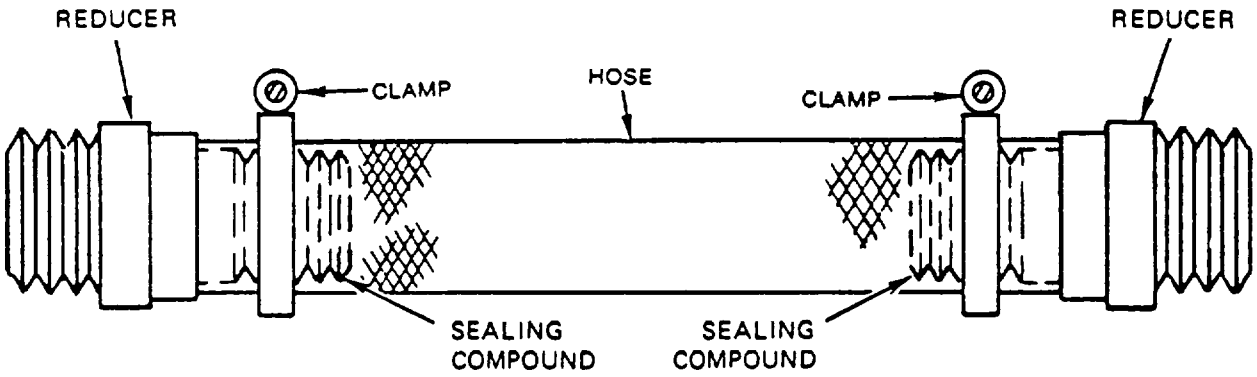
Procedural Steps (Cont):

Option 5: High Pressure Line Repair (Different Size Line Ends).

Limitations:
• None

Materials/Tools
• Tube pipe fitting kit
• Clamps
• Sealing compound
• Adhesive tape

Procedural Steps:



1. Wrap each end of hose to be cut with tape. Cut section of hose to length required. Be sure each end is squarely cut.

2. Spread a light coat of sealing compound on threads of one end of reducer.

3. Install end of reducer with sealing compound into hose. Secure with clamp.

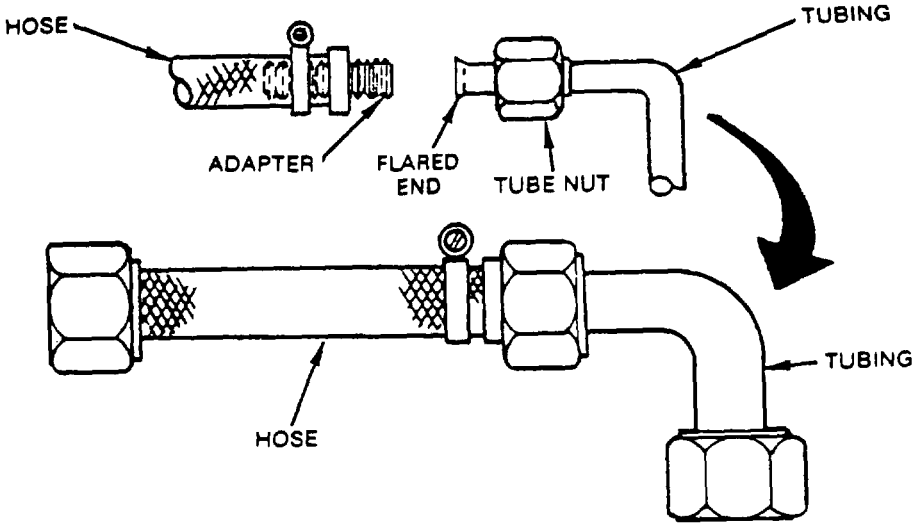
4. Repeat steps 2 and 3 for other end of hose.

Option 6: High- Pressure Line Repair (Hose and Tube Splice).

Limitations:
• None

Materials/Tools:
• Tube pipe fitting kit
• Clamps
• Sealing compound
• Adhesive tape

Procedural Steps (Cont):



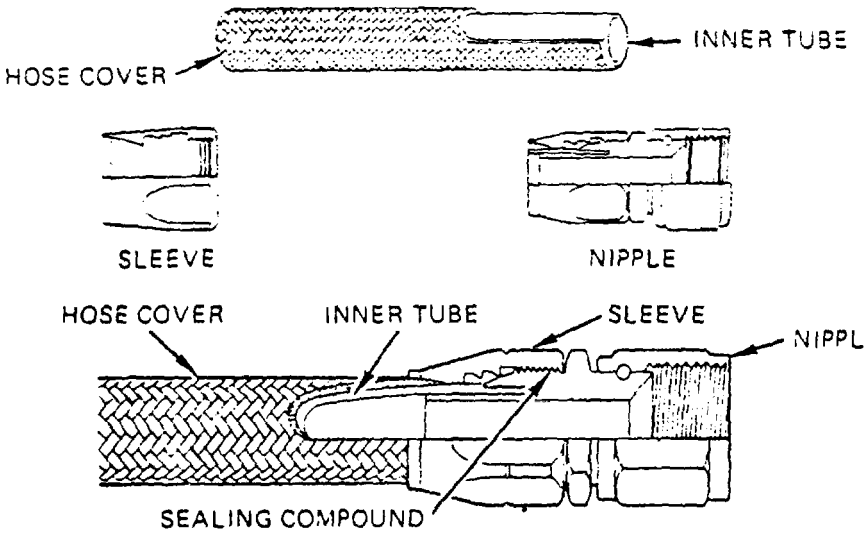
1. install adapter in hose. See options 3, 4, or 5.
2. Squarely cut end of tubing. Slide tube nut over tube.
3. Flare end of tube and remove burrs.
4. Connect hose and tube together.

Option 7: High-Pressure Line Repair (Same Size Line End).

Limitations:
• None

Materials/Tools:
• Tube pipe fitting kit
• Clamps
• Sealing compound
• Adhesive tape

Procedural Steps (Cont)



1. Measure desired length of hose. Tape and mark area to be cut.

2. Squarely cut hose and remove loose particles and tape.
3. Install sleeve over hose cover.

4. Install nipple between hose cover and inner tube. Apply light coat of sealing compound on threads of nipple.

5. Install sleeve on nipple and tighten.

Record the BDAR action taken. When the mission is completed, as soon as practicable, repair using standard maintenance procedures.

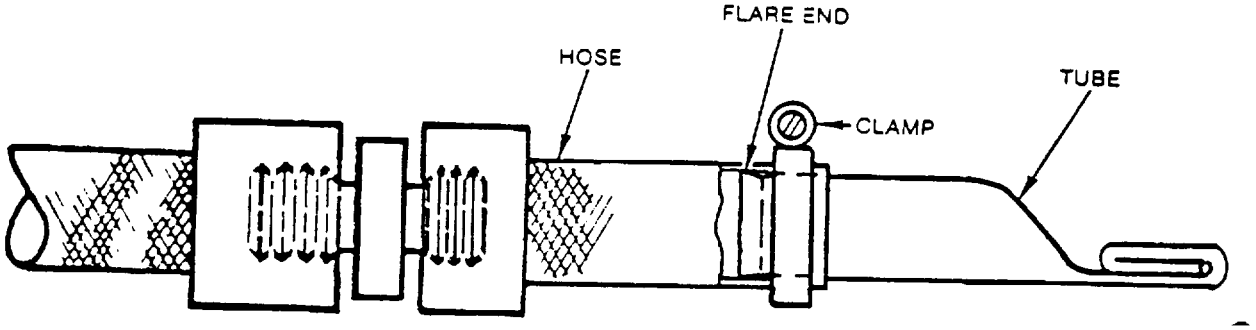
11-13. HYDRAULIC TUBE AND HOSE ISOLATION

General Information:
These procedures tell how to isolate damaged hydraulic tubes and hoses. Use the following options to plug or seal a damaged hydraulic circuit, so that the rest of the system can operate without loosing fluid.

Option 1: Low Pressure Hose Isolation
Limitations:
• Not recommended for pressures above 70 psi

Materials/Tools:
• Correct size tubing
• Clamps
• Adhesive tape
• Sealing compound

Procedural Steps:



1. Wrap tape around area to be cut. Squarely cut end of hose and remove loose particles.

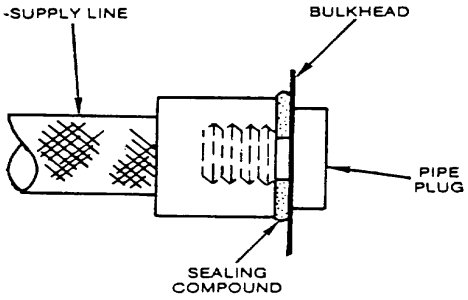
2. Flatten about 4 inches of one end of tubing. Fold flat end over twice.

3. Flare other end of tubing if possible and remove burrs. Apply light coat of sealing compound around flared end of tube.
4. Slide flared end of tube inside hose and secure with clamp.

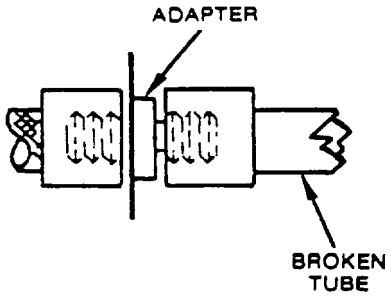
Option 2: High-Pressure Line Repair (Tube Isolation) Using Plugs.

Limitations:
• None

Materials/Tools:
• Tube pipe fitting kit
• Sealing compound



Procedural Steps (Cont)k



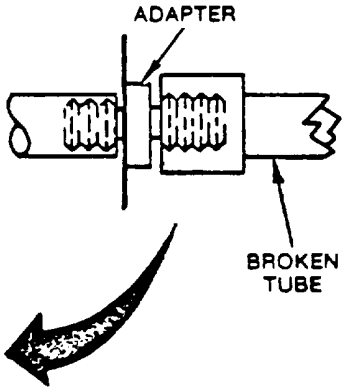
1. Remove broken tube from bulkhead adapter.
2. Remove adapter from bulkhead and supply hose.
3. Coat threads of pipe with sealing compound.
4. Install pipe plug in supply hose from other side of bulkhead.

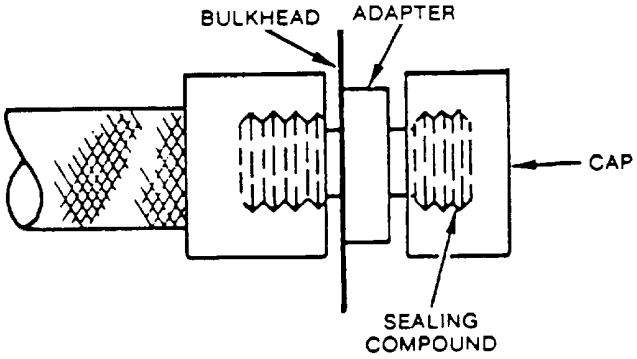
Option 3: High Pressure Line Repair (Tube Isolation) Using Cap.

Limitations:
• None

Materials/Tools:
• Tube pipe fitting kit
• Sealing compound

Procedural Steps:

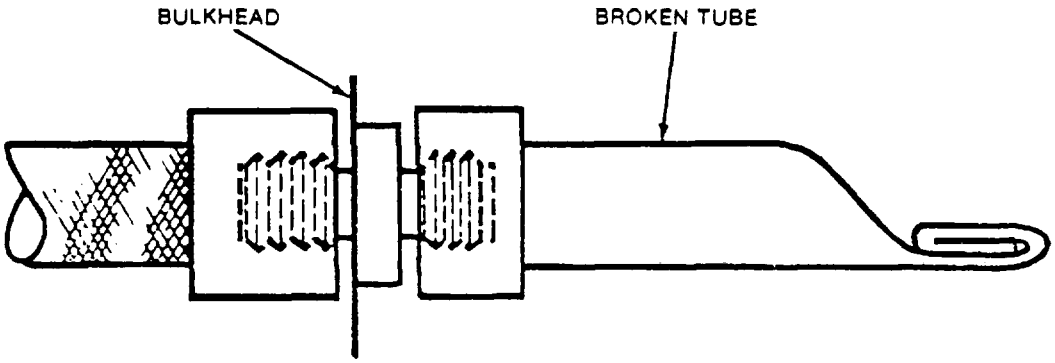




1. Remove broken tube from adapter.
2. Coat threads of pipe plug with sealing compound.
3. Install cap on adapter.

Option 4: High Pressure Line Repair (Tube Isolation) Using Flattened Tube End.

Limitations:
• None
Materials/Tools:
• None
Procedural Steps:



1. Remove broken tube, if necessary.

2. Flatten about 6 inches of tubing near break.

3. Fold flattened portion of tube over twice.
4. Install repaired tube if removed.

Option 5:. High-Pressure Line Repair (Hose Isolation) Using Bolt.

Limitations:
• None

Materials/Tools:
• Hexagon head screw
• Pressure sensitve adhesive tape
• Clamps

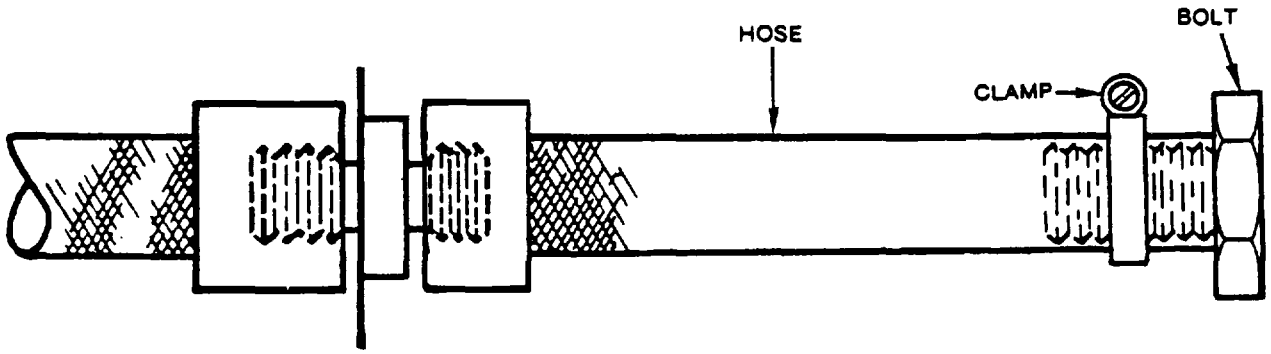
Procedural Steps:

1. Wrap tape around area to be cut. Squarely cut end of hose and remove loose particles.

2. Install long hexagon head bolt inside hose.

3. Secure with clamps.

Record the BDAR action taken. When the mission is completed, as soon as practicable, repair the vehicle using standard maintenance procedures.



CHAPTER 12

ARMOR

**BDAR FIXES SHALL BE USED ONLY IN COMBAT
AT THE DISCRETION OF THE COMMANDER
AND SHALL BE REPAIRED BY STANDARD MAINTENANCE PROCEDURES
AS SOON AS PRACTICABLE AFTER THE MISSION IS COMPLETED.**

Section I. General

12-1. General.
All combat vehicles have varying degrees of armor protection. The configuration and alloy will vary with the type of vehicle and its intended mission. Some vehicles have removable armor covers which facilitate battlefield repairs. Fender skirts, access covers and add-on armor plating are easily removed and replaced with fabricated substitutes. Cast hulls and turrets as well as hulls and turrets manufactured from welded armor plates are difficult to repair. Armor alloys require preheating to perform proper repairs which will still retain the required protection. Improvised armor repairs can be made but will be limited to improvised patching using bolt-on type repairs or repairs using expedient welding procedures in Appendix B to weld on patches if normal welding equipment is not available.

12-2. Assessment Procedure.
Assessment of armor will consist of a visual inspection to determine the extent of damage and repairs required.

12-3. BDAR Procedure Index.

CHAPTER 13
ARMAMENT AND FIRE CONTROL

**BDAR FIXES SHALL BE USED ONLY IN COMBAT
AT THE DISCRETION OF THE COMMANDER
AND SHALL BE REPAIRED BY STANDARD MAINTENANCE PROCEDURES
AS SOON AS PRACTICABLE AFTER THE MISSION IS COMPLETED.**

Section I. General

13-1. General.

Armament and fire control systems are two classes of equipment. Fire control systems are essentially aids to improve the accuracy speed of armament firing operations. All armament systems provide manual back up devices should the power controlled systems fail.
This chapter provides information primarily intended to assess armament system failures.

13-2. Assessment Procedure.

Vehicle/System Assessment

ITEM/ACTION	FAULT ISOLATION REFERENCE

B. ARMAMENT AND FIRE CONTROL ASSESSMENT

1. VISUALLY INSPECT ➧ Obvious damage found on:

- cannon assembly;	Go to vehicle sepcfic TM.
- sighting system;	go to vehicle specific TM.
- hull turret race;	go to vehicle specific TM.
- breech mechanism assembl	go to vehicle specific TM.
- traversing gear box;	go to vehicle specific TM.
- elevation cylinder;	go to vehicle specific TM.
- obvious hydraulic leakage;	go to vehicle specific TM.
- inspect optical sighting equipment;	go to vehicle specific TM.

No damage found.

Vehicle/System Assessment (Cont)

2. SELF-TEST AND FUNCTIONALLY CHECK DAMAGE:

Operate system(s) → Damage found to:

- gun elevates/traverses electrically or mechanically..... Go to vehicle specific TM
- main gun power; go to vehicle specific TM
- one sighting system (function..... go to vehicle specific TM TM
- commander's weapon station..... go to vehicle specific TM TM
- coax machine gu go to vehicle specific TM TM
- turret blower..... go to vehicle specific TM system;

No damage found.

3. EVALUATE SYSTEM STATUS :

ARMAMENT AND FIRE CONTROL ASSESSMENT

	Fully Mission Capable	Combat Capable	Combat Emergency Capable	Self Recovery Capable	Recover
- System operates normally	X	X	X		
- System is degraded, however, redundant system available		X	X		
- System is degraded, No redundant system.			X		
- Main gun will not elevate or depress.			X		
- Main gun will not traverse.			X		
- Main gun incapable of firing.				X	
- Turret damaged beyond repair.					X

CHAPTER 14

COMMUNICATION SYSTEM

**BDAR FIXES SHALL BE USED ONLY IN COMBAT
AT THE DISCRETION OF THE COMMANDER
AND SHALL BE REPAIRED BY STANDARD MAINTENANCE PROCEDURES
AS SOON AS PRACTICABLE AFTER THE MISSION IS COMPLETED.**

SECTION I. General

14-1. Scope.

This chapter contains the fault assessment and expedient repair procedures needed to locate and fix battlefield damage to a vehicle's communications system.

14-2. General.

The procedures in this chapter are used to repair battlefield damage to the AN/VIC-I intercommunications set, the radio systems, the KY-57 (KY-38) speech security system and all associated wiring and cables.

14-3. Functional Details.

a. The AN/VIC-I intercom set consists of the AM-1780 amplifier, four C-10456 or C-2298 control boxes, one C-2742 remote switching control box, four CVC helmets and all associated wiring and cables. The AN/VIC-I allows voice intercom between the vehicle commander and all crew members.

b. Three basic configurations of radio systems are installed in most tracked vehicles. All three radio systems supply nonsecure frequency modulation (FM) voice radio capabilities through the AN/VIC-I intercom set to the tank commander and all crew members. All three radio systems utilize the MT-1029 mount for the basic receiver-transmitter and the MT-1898 mount for the auxiliary receiver. The MX-6707 matching unit is used in conjunction with all receiver-transmitters and the AB-558 mast base is used in conjunction with the auxiliary receivers. The AS-1729 antenna system is used with all receiver-transmitters and either the MS-116A, MS-117A, and the MS-118A antenna elements or the AT-1095 antenna element is used with the auxiliary receivers. All associated wiring and cables are the same for each system.

(1) The AN/VRC-12 consists of a RT-246 receiver-transmitter which has 10 preset channels which can be automatically switched and tuned by means of the C-2742 remote switching control box and a R-442 auxiliary receiver.

(2) The AN/VRC-47 consists of a RT-524 receiver-transmitter and R-442 auxiliary receiver.

(3) The AN/VRC-64 consists of a RT-841 receiver-transmitter, an AM-2060 I amplifier.

c. The two currently used speech security systems provide for secure voice communications when used in conjunction with any of the receiver-transmitters mentioned above.

(1) The Vinson speech security system consists of a J-3513 interconnection box, J-3514 distribution box, KY-57 speech security device, MT-4626 mount and all associated wiring and cables.

(2) The Nestor speech security systen consists of a 3-2731 distribution box, J- 3024 interconnection box, KY-38 speech security device, MT-3823 mount, AM-4979 amplifier and all associated wiring and cables.

SECTION II. General Operating Procedures

14-4. General.

This section contains general operating procedures for the AN/VRC-12 series radios (AN/VRC-12, AN/VRC-47 and AN/VRC-64) when used in conjunction with the AN/VIC-1 intercommunications set. TM 11-5830-340-12 lists operating procedures for the system, but for convenience, the main points have been reproduced here.

a. Normal Radio Operation with AN/VIC-1 Intercommunications Set.

(1) Turn turret power on. Turn MAIN PWR on the AM-1780 to NORM. This position makes power available to the radio and the aux receiver connected to the AM-1780. See figure 14-1.

(2) Turn POWER switch on the radio (connected to J501) to either HIGH or LOW. This supplies power to the AM-1780.

(3) Turn POWER CKT BKR switch on the AM-1780 to ON. This supplies power to the AM-1780 and to all control boxes connected to the AM-1780.

(4) Turn INSTALLATION SWITCH on the AM-1780 to OTHER position. This is the normal position which allows the radio accessories connected to the control boxes to operate both the radio and the intercom equipment.

(5) Use the RADIO TRANS switch on the AM-1780 to select crew members allowed to transmit with the radio.

CDR and CREW - if all crew members are allowed to transmit.
CDR ONLY - if only the crew commander is allowed to transmit.
LISTENING SILENCE - if no one is allowed to transmit.

(6) Select the desired loudness of the intercom and radio signals with the INT ACCENT switch on the AM-1780,

OFF position - both signals have the same loudness.
ON position-the loudness of the radio signals is reduced below the level of the intercom signals.

(7) To turn off the AM-1780 and radio equipment, turn the MAIN PWR switch on the AM-1780 and the POWER switch on the radio to OFF.

b. Normal Intercom Operation with the AN/VIC-1 Intercommunications Set without radios.

(1) Turn turret power on. Turn MAIN PWR switch on the AM-1780 to INT ONLY. Power is now available for only intercom equipment. See figure 14-1.

(2) Turn POWER CKT BKR switch on the AM-1780 to ON. This supplies power to AM-1780 and all control boxes connected to the AM-1780.

NOTE

Do not place INSTALLATION switch in the INT ONLY position when the AM-1780 is connected to a radio system

(3) Turn INSTALLATION SWITCH on the AM-1780 to OTHER.
(4) Intercom only operation is now possible using the control boxes and the audio accessories connected to them.
(5) To turn off the AM-1780, place the MAIN PWR and POWER CKT BKR switches to OFF.

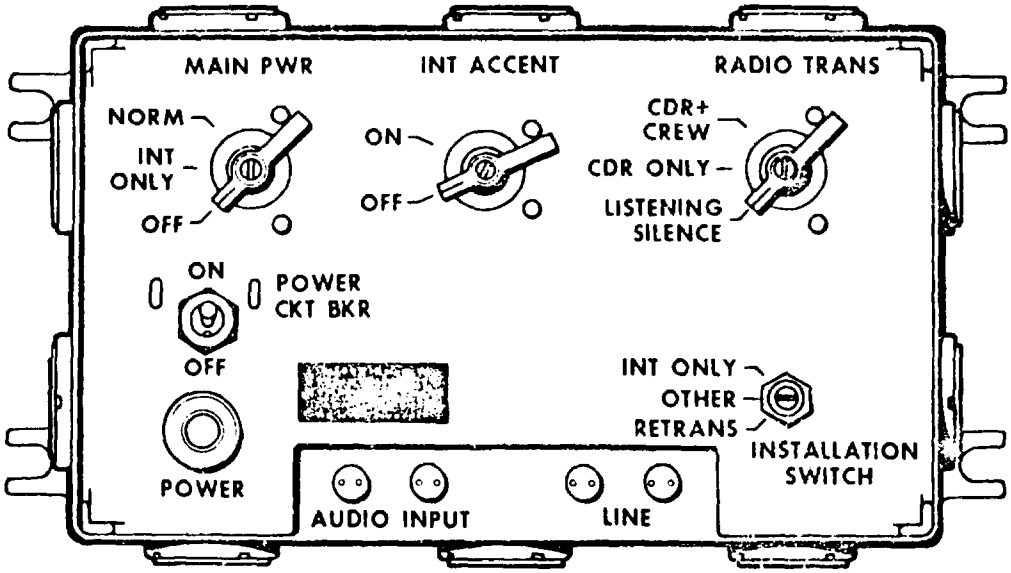


Figure 14-1. AM-1780 Amplifier

c. Normal Radio and Intercom Operation with Crew Members Control Box. See figure 14-2.

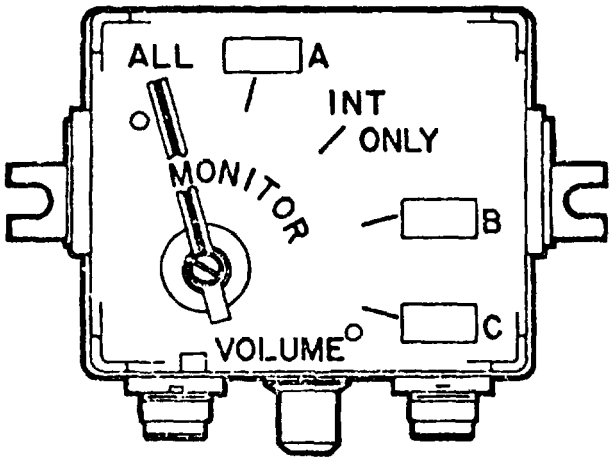


Figure 14-2. Crew Members Control Box

(1) Place the MONITOR switch in the desired position.

(a) ALL - Receives all radio and intercom transmission. Transimit on primary radio and intercom.

(b) A - Receives primary radio and intercom transmission. Transmits on primary radio and intercom.

(c) INT ONLY - Receives and transmits on intercom only. There are no radio capabilities.

(d) B - Receives secondary radio (if equipped) and intercom transmission. Transmits on primary radio and on intercom.

(e) C - Receives third radio (if equipped). Transmits on third radio (if equipped). With this switch position, the only crew member with intercom capability is the crew commander.

(2) Adjust the VOLUME control to a comfortable listening level.

SECTION III. Fault Assessment Tables and Procedures

14-5. Fault Assessment Table and Procedures.

a. Be sure to read Chapter 2 before troubleshooting. The appearance of an assembly or component may indicate its general condition and reflect the type of damage it has suffered. Examine for dented surfaces or holes, torn insulation, severed cables, or other evidence of damage. This might indicate the source of trouble and the need for repairs. Also check component boxes for unusual odors. After obvious damage has been repaired, attempt to operate the communications system to check for damage that might not be so obvious. The procedure below will direct you to a detailed assessment procedure. The detailed assessment procedure leads to an expedient repair procedure, if one exists, for the particular battlefield damage or to another chapter in

b. Intercommunications Set Assessment.

Inspection reveals	Damage:	
No Damage Found	-AM 1780 Inoperative;	Go to para 14-6
	C-2298 or C-10456 Inoperative;	go to para 14-7

c. Radio System Assessment.

Inspection reveals	Damage:	
No Damage Found	-Radio Inoperative (No Power);	go to para 14-8
	-Radio does not receive;	go to para 14-9
	-Radio does not transmit;	go to para 14-10
	-Radio Inop. in "New Squelch" position;	go to para 14-11
	-Aux Receiver Inoperative;	go to para 14-12

d. Speech Security System Assessment.

Inspection reveals	Damage:	
No Damage Found	-System Inoperative (No Power	go to para 14-13 / go to para 14-14
	-System Inoperative;	go to para 14-14

14-6. OBSERVABLE SYMPTOM: THE INTERCOM DOES NOT WORK ON ANY CONTROL BOX

Detailed Assessment Steps:

1. Make sure the DC power is available to the turret by checking the dome light or other electrical equipment in the turret.

2. Make sure the MK-2096 Transient Voltage Suppressor is operational by checking for a red light on the suppressor. If the light is lit, replace or remove the suppressor.

3. Make sure that the MX-7777 or MX-7778 Transient Voltage Suppressor is operational by depressing the Battle-Override switch. If the suppressor is bad, replace or repair as necessary.

4. Check that communication equipment is turned on and the switches are in the proper positions.

5. Check that cables are connected to the proper connectors, correctly aligned, and tightly connected to the receptacles.

6. Jiggle the cables to check for intermittent opens or shorts.

    a. If a defective cable is found, follow the procedures listed below:

        (1) Replace the defective cable in accordance with standard repair procedures.

        (2) Replace the defective cable with an acceptable replacement cable (refer to para. 14-35.

        (3) Repair the defective cable in accordance with the repair procedures in para. 14-30.

    b. If a defective cable is not found, then follow the troubleshooting procedures in TM 11-5820-401-12.

14-7. OBSERVABLE SYMPTOM: THE INTERCOM WORKS ON SOME CONTROL BOXES BUT NOT ALL

Detailed Assessment Steps:

1. Repeat steps 4 thru 6 in para. 14-6.

2. Replace CVC helmet and connecting cable with a known operational CVC helmet and connecting cable.

    a. If the problem no longer exists, replace the defective CVC helmet or connecting cable.

    b. If the problem has not been corrected, go to step 3.

3. Disconnect CX-4723 cable leading to the non-operational control box at the AM- 1780, and switch it with another CX-4723 cable at the AM-1780 receptacles.

a. If the same problem occurs in the control box now connected to that receptacle, repair or replace the AM-1780.

b. If the problem stays with the same control box, go to step 4.

4. Switch the CX-4723 cables back to their original positions on the AM-1780, and replace the non-operational control box with a known operational control box.

a. If the problem no longer exists, replace or repair the C-10456.

b. If the problem still exists, replace or repair the CX-4723 cable between the control box and the AM-1780. (Refer to para. 14-30.)

5. If the cable and/or the control box cannot be repaired or replaced, install the field expedient intercom described in para. 14-22.

14-8. OBSERVABLE SYMPTOM: RADIO AND/OR INTERCOM ARE NOT WORKING PROPERLY

Detailed Assessment Steps:

1. If the radio is working properly but the intercom is not working properly, refer to para. 14-6 and/or 14-7.

2. Make sure the control settings on the AM-1780 are correct.

3. Make sure the switches on all control boxes are set to ALL.

4. Set all switches on all CVC helmets to the LISTEN or center position.

5. Check CVC helmets and connecting cables in turn by substituting a known operational CVC helmet and connecting cable at each control box.

a. If the problem no longer exists, replace or repair the CVC helmet or connecting cable using standard maintenance procedures.

b. If the problem still exists, go to step 6.

6. Make sure the radio is firmly seated in the mount by loosening the mount to radio clamps. Move the radio forward. Line up the guide pins and slide the radio firmly back into the mount. Tighten the clamps.

a. If the problem no longer exists, no further actions are necessary.

b. If the problem still exists, go to step 7.

7. Replace radio with a known operational radio.
   a. If the problem no longer exists repair the radio using standard maintenance procedures.

   b. f the problem still exists, go to step 8.

8. Make sure all cables are connected properly.

   a. If a defective cable is found follow the procedures listed below:

      (1) Replace the defective cable in accordance with standard repair procedures.

      (2) Replace the defective cable with an acceptable replacement cable listed in para. 14-35.

      (3) Repair the cable in accordance with the procedures in para. 14-30 or the electrical chapter.

   b. If a defective cable is not found, follow the troubleshooting procedures in TM 11-5820-401-12.

14-9. OBSERVABLE SYMPTOM: THE RADIO DOES NOT RECEIVE THE DISTANT STATION

Detailed Assessment Steps:

1. Check that all switch settings are as described in para. 1-4.

   a. If the problem still exists, refer to para. 14-8 to check for possible intercom problems.

   b. If the blower motor does not run or the above procedures do not isolate the fault, go to step 2.

2. Make sure the radio is firmly seated in the mount by loosening the clamps. Move the radio forward. Line up the guide pins and slide the radio firmly back into the mount. Tighten the clamps.

3. Make sure the circuit breaker has not been tripped by turning the radio power switch to OFF BREAKER RESET and then back to LOW or HIGH.

4. Make sure the MK-2096 Transient Voltage Suppressor is operational by checking for a red light on the suppressor. If the light is lit, replace or remove the suppressor.
5. Make sure the MX-7777 or MX-7778 Transient Voltage Suppressor is operational by depressing the Battle-Override switch. If the suppressor is bad, replace or repair as necessary.

6. Check the antenna coax cables from the radio to the MX-6707 to make sure they are connected properly.

a. If a defective cable is found, follow the procedures listed below. The matching unit control cable, CX-4722 may need to be disconnected.
(1) Replace the defective cable in accordance with standard repair procedures.

(2) Replace the defective cable with an acceptable replacement cable listed

b. If a defective cable is not found, go to step 7.

7. Replace radio with a known operational radio. If the problem no longer exists, then the radio should be replaced or repaired using standard maintenance procedures.

14-10. OBSERVABLE SYMPTOM: THE DISTANT STATION DOES NOT ANSWER RADIO CALLS.

Detailed Assessment Steps:

1. Make sure the radio is transmitting by listening for sidetone when transmitting.

2. Make sure the tuning controls on the radio are set on the proper frequency by tuning them to a different frequency and then resetting them on the assigned frequency.

3. Make sure there is sufficient transmitter power to reach the distant station by transmitting on HIGH power and/or repositioning the vehicle with the whip antenna untied.

4. Check radio by attempting to communicate on an alternate frequency.

a. If communications are adequate on the alternate frequency, go to step 6.

b. If there are no communications on the alternate frequency, go to step 5.l

5. Check the transmitter for normal operation by attempting to communicate with another nearby station.

   a. If there is no output or if the output is low, then go to step 10.
   b. If the output power is within acceptable limits, go to step 6.

6. Check the antenna tuning circuits located in the antenna matching unit by having someone listen for the sound of relays operating when the frequency is changed.

   a. If the sound of relays operating is not heard, manually tune the MX-6707 to the proper frequency.

   b. If the sound of relays operating is heard, then go to step 7.

7. Make sure the antenna elements are tightly screwed together by turning off the transmitter and retightening the antenna sections.

8. Check that the antenna coax cable connectors are tight.

9. Inspect the coax cable for breaks or torn insulation.

   a. If a defective cable is found, follow these procedures:
      (1) Replace the defective cable in accordance with standard repair procedures.

      (2) Replace the defective cable with an acceptable replacement cable listed in para. 14-35.

      (3) Repair the cable in accordance with the procedures in para. 14-30.

   b. If a defective cable is not found, then follow the procedures indicated in step 10.

10. Replace the radio with a known operational radio. Operate radio.

   a. If communication has been restored, repair the radio in accordance with standard maintenance procedures.

   b. If the problem still exists, refer to the troubleshooting procedures in TM 11- 5820-401-12.

14-11. OBSERVABLE SYMPTOM: RADIO DOES NOT WORK IN "NEW SQUELCH "ON

Detailed Assessment Steps:

1. Verify that the distant station is transmitting with the squelch switch in the NEW ON position by setting your squelch to NEW OFF and telling the distant station to place his squelch in NEW ON.

2. Verify that the distant station is too far away for squelch operation by trying to communicate with the distant station in the NEW ON squelch position.

3. Make sure the antenna system is properly connected.

4. Make sure the antenna system is properly orientated by untying the whip antenna and/or by repositioning the vehicle.
5. heck the antenna tuning circuits located in the antenna matching unit by having someone listen for the sound of relays operating when the frequency is changed.
   a. If the sound of relays operating is not heard, manually tune the MX-6707 to the proper frequency.
   b. If the problem still exists, go to step 6.

6. Replace the radio with a known operational radio.

   a. If communication has been restored, repair the radio in accordance with standard maintenance procedures.
   b. If the problem still exists, refer to the troubleshooting procedures in TM II- 5820-401-12.

14-12. OBSERVABLE SYMPTOM: THE AUXILLIARY RECEIVER IS NOT OPERATING PROPERLY
Detailed Assessment Steps:

1. Verify that the aux receiver is firmly connected to its mount by loosening the receiver. Move the receiver forward. Line up the guide pins and push the aux receiver firmly back into place. Tighten the damps.
2. Verify that the aux receiver circuit breaker has not been tripped by turning the aux receiver power switch to OFF and then back to ON RESET.
3. Check that the cables are connected properly and are in good condition.
   a. If a defective cable is found, follow the procedures listed below:
      (1) Replace the defective cable in accordance with standard repair procedures.
(2) Replace the defective cables with an acceptable replacement cable listed in para. 14-35.

(3) Repair the cable in accordance with the procedures in para. 14-30 or the electrical chapter.

b. If the problem still exists, go to step 4.

4. Check that the aux receiver tuning controls are set correctly by attempting to receive a signal from a transmitter operating on a different frequency. Retune the aux receiver to the assigned frequency.

a. If the problem no longer exists, no further actions are necessary.

b. If the problem still exists, go to step 5.

5. Replace the aux receiver with a known operational aux receiver.

a. If communication has been restored, repair the receiver using standard maintenance procedures.

b. If the problem still exists, follow the troubleshooting procedures in TM 11- 5820-401-12.

14-13. OBSERVABLE SYMPTOM: THE KY-57 (KY-38) SPEECH SECURITY SYSTEM DOES NOT HAVE POWER

Detailed Assessment Steps:

1. Make sure the circuit breaker has not been tripped by turning off the KY-57 (KY- 38) power switch and then turning it back to ON.

2. Make sure the KY-57 (KY-38) is securely mounted by loosening the clamps and moving the KY-57 (KY-38) forward. Line up the guide pins and slide the KY-57 (KY-38) firmly back into the mount. Tighten the clamps.

3. Check that cables are connected properly.

NOTE

Do not attempt to repair any cables. Repair might breach security.

4. Check cables for damaged or torn insulation.

a. If a defective cable is found, follow the procedures listed below:

(1) Replace the defective cable in accordance with standard repair procedures.

(2) Replace the defective cable with an acceptable replacement cable listed in para. 14-35.

b. If the problem still exists, go to step 5.

5. Replace KY-57 (KY-38) with a known operational KY-57 (KY-38).
   a. If the problem no longer exists, repair the KY-57 (KY-38) using standard maintenance procedures.

   b. If the problem still exists, refer to the troubleshooting procedures in TM 11- 5810-256-OP-4.

14-14. OBSERVABLE SYMPTOM: UNABLE TO COMMUNICATE USING THE KY-57

Detailed Assessment Steps:

1. Check the KY-57 (KY-38) system by attempting to communicate in the PT (plain text) mode with a distant station.
   a. If PT communication is not possible, refer to paragraph 14-8.

   b. If PT communication is possible, go to step 2.

2. Make sure the proper code is being used by zeroing the KY-57 (KY-38) and then resetting it with the proper code. (Refer to applicable Communications-Electronic's Operation Instructions (CEOI).)

3. Attempt to communicate with a different distant station to make sure the proper code settings are being used.
   a. If communication is restored, attempt to notify the original distant station in PT that he is using improper code.

   b. If communication is not established, go to step 4.

4. Make sure the proper pre-operating procedures are being used. (Refer to TM 11- 581 0-256-OP-4.)
5. Make sure the KY-57 (KY-38) system is properly installed by checking all cables.
6. Replace the KY-57 (KY-38) with a known operational KY-57 (KY-38).

   a. If communication has been restored, repair the KY-57 using standard maintenance procedures.

   b. If communication has not been restored, refer to the troubleshooting procedures in TM 11-581-256-OP-4.

SECTION IV. Expedient Repair Procedures

14-15. GENERAL: This section contains expedient repair procedures to restore radio and/or intercommunications needed to complete the mission.

14-16. PROCEDURAL INDEX.

WARNING

Do not touch bare wires on expedient antennas with the radio keyed. You could get burned and/or shocked.

CAUTION

Field expedient antennas are fragile and will not take much abuse. The continued use of expedient antennas may result in damage to receiver/transmitter.

The index below is provided as a quick reference to locate specific problems or repair procedures. In the event that the specific repair does not appear to be contained in this section, refer to paragraph 14-5 or the electrical chapter.

14-17. METALLIC WHIP ANTENNA BROKEN

General Information:

This procedure gives splicing instructions for the repair of a metallic whip antenna if all pieces of the broken antenna are available.

Limitations:

• Slight reduction in reception and transmission range

Personnel/Time Required:

• I soldier
• 15 minutes

Materials/Tools

• Stick, dry, 4 to 6-inch length
• Wire, copper or cable, stripped telephone, WD-1/TT, 1-foot length

Other Options:

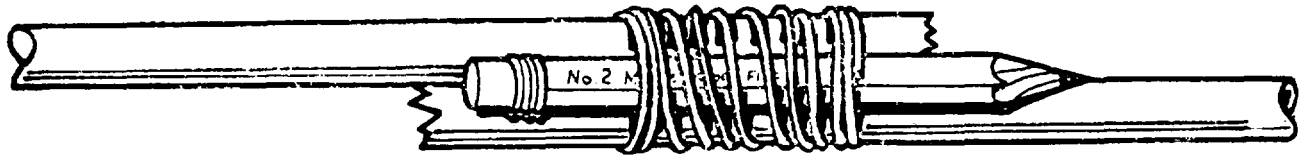
• Replace antenna with:
1. Field expedient antenna (Refer to para. 14-18 or 14-19.)
2. Field expedient ground plane antenna (Refer to para. 14-21.)

Procedural Steps:

1. Scrape off the paint 3 to 6 inches from the broken ends of the antenna with sand, rocks, metal, sandpaper, or a knife. Wipe scraped areas clean.

2. Overlay the cleaned ends. Place a dry stick on top of the overlaid ends and wrap tightly together with wire.

3. If time and equipment are available, solder the connection.



METALLIC WHIP ANTENNA SPLICE

4. Record the BDAR action taken. When the mission is completed, as soon as practicable, repair vehicle using standard maintenance procedures.

14-18. METALLIC WHIP ANTENNA REPLACEMENT

General Information:
This procedure gives instructions for the construction of a field expedient antenna if no other antenna is available.

Limitations
• Slight reduction in reception and transmission range

Personnel/Time Required:
• I soldier
• 15 minutes

Material Tools:
• Pole, wooden or stick, 10-foot length
• Tape, electrical, string or rope
• Wire, copper or cable, telephone, WD-1/TT, 10-foot length

Other Options:
• Repair broken metallic whip antenna (refer to para. 14-17).
• Field expedient replacement antenna (refer to para. 14-19).
• Field expedient ground plane antenna (refer to para. 14-21).

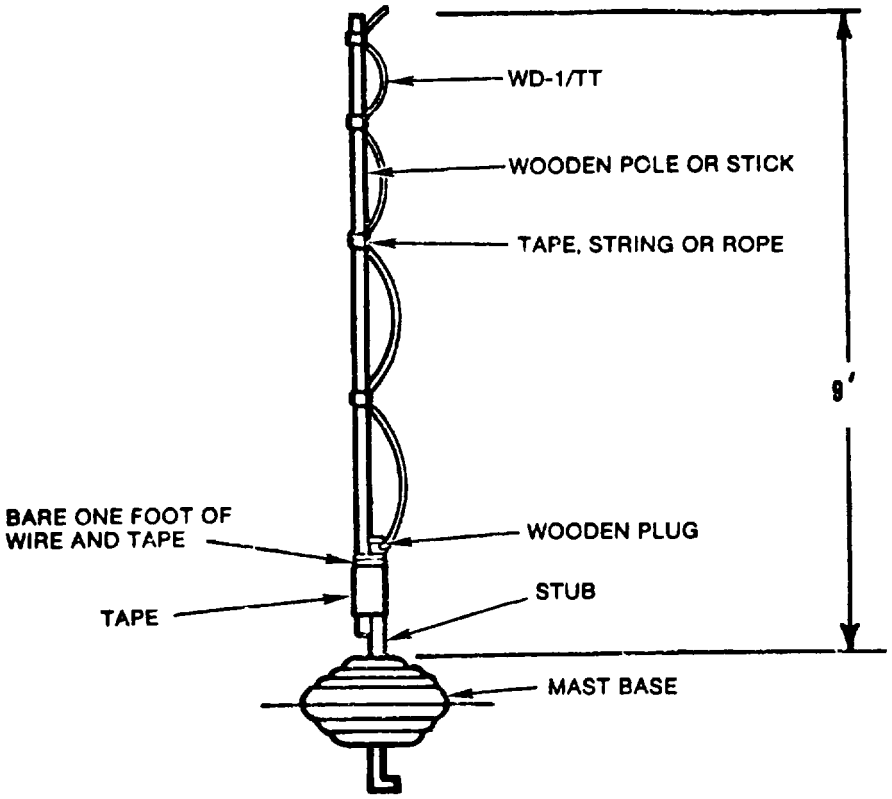
Procedural Steps:
1. Scrape the paint from the top two or three inches of the antenna stub.
2. Attach nine feet of copper wire or telephone cable along the length of the pole with tape. Scrape the insulation from the remaining one foot of wire.

NOTE
Total length of wire and antenna stub should not exceed nine feet.

3. Hold the pole along side the remaining section and base of the antenna. Wrap the bare one foot section of wire tightly around the scraped portion of the broken antenna and wooden pole.

4. Lay the short end of the bare wire on top of the stub. Push wire into the stub hole and jam in place with a wooden peg. Tape peg to stub.

Procedural Steps (Cont)



5. Record the BDAR action taken. When mission is completed, as soon as practical repair vehicle using standard maintenance procedures.

14-19. METALLIC WHIP ANTENNA REPLACEMENT; LONG WIRE ANTENNA

General Information:
This procedure gives instructions for the construction of a long wire antenna for use with the auxiliary receiver if the auxiliary antenna is broken or has been diverted for use with the receiver/transmitter.

Limitations:
• Cannot be used for transmission
• Reduction in reception
Personnel/Time Required:
• I soldier
• 5 minutes
Material/Tools:
• Cable, telephone, WD-1/TT 8-foot length
• Tape, electrical
Other Options:
• Repair broken metallic whip antenna (Refer to para. 14-17.)
• Field expedient metallic whip antenna. (Refer to para. 14-18.)
• Field expedient ground plane antenna. (Refer to para. 14-21.)

Procedural Steps:

CAUTION

Do not use this antenna for transmission. It could damage the radio equipment.

1. Strip approximately two inches of insulation from both leads on one end of the telephone cable.

2. Attach one bare lead to a screw on the R-442 auxiliary receiver.

3. Attach the other bare lead to the center of the antenna connection on the receiver by bending the wire double and jamming it into the hole.
4. Tape or tie the wire to the antenna connector to prevent it from being pulled or vibrated out of the hole.

5. Throw the loose end of the wire out the loader's hatch.

6. Record the BDAR action taken. When the mission is completed, as soon as practicable, repair vehicle using standard maintenance procedures.

14-20. FIBERGLASS WHIP ANTENNA REPLACEMENT

General Information
Since it is not practical to splint a broken fiberglass whip, this procedure gives instructions for construction of a field expedient antenna if no other antenna is available.

Limitations:
• Loader's hatch cannot be completely closed
• May result in degraded performance

Personnel/Time Required:
• 1 soldier
• 30 minutes

Materials/Tools:
• Cable, coaxial, RG-8 (NSN 6145-00-161-0887) or RG-58 (NSN 6145-00-161-0908), 20- foot length
• Pencil, nail or sharp stick
• Pole, wooden or stick, 10-foot length
• Rope
• Tape, electrical

Other Options:
• Utilize the R-442 auxiliary receiver metallic whip antenna by exchanging coaxial cables between receiver/transmitter.
• Replace antenna with field expedient ground plane antenna. (Refer to para. 14-21.)
Procedural Steps:

1. Measure off and mark but do not cut five feet of coaxial cable.

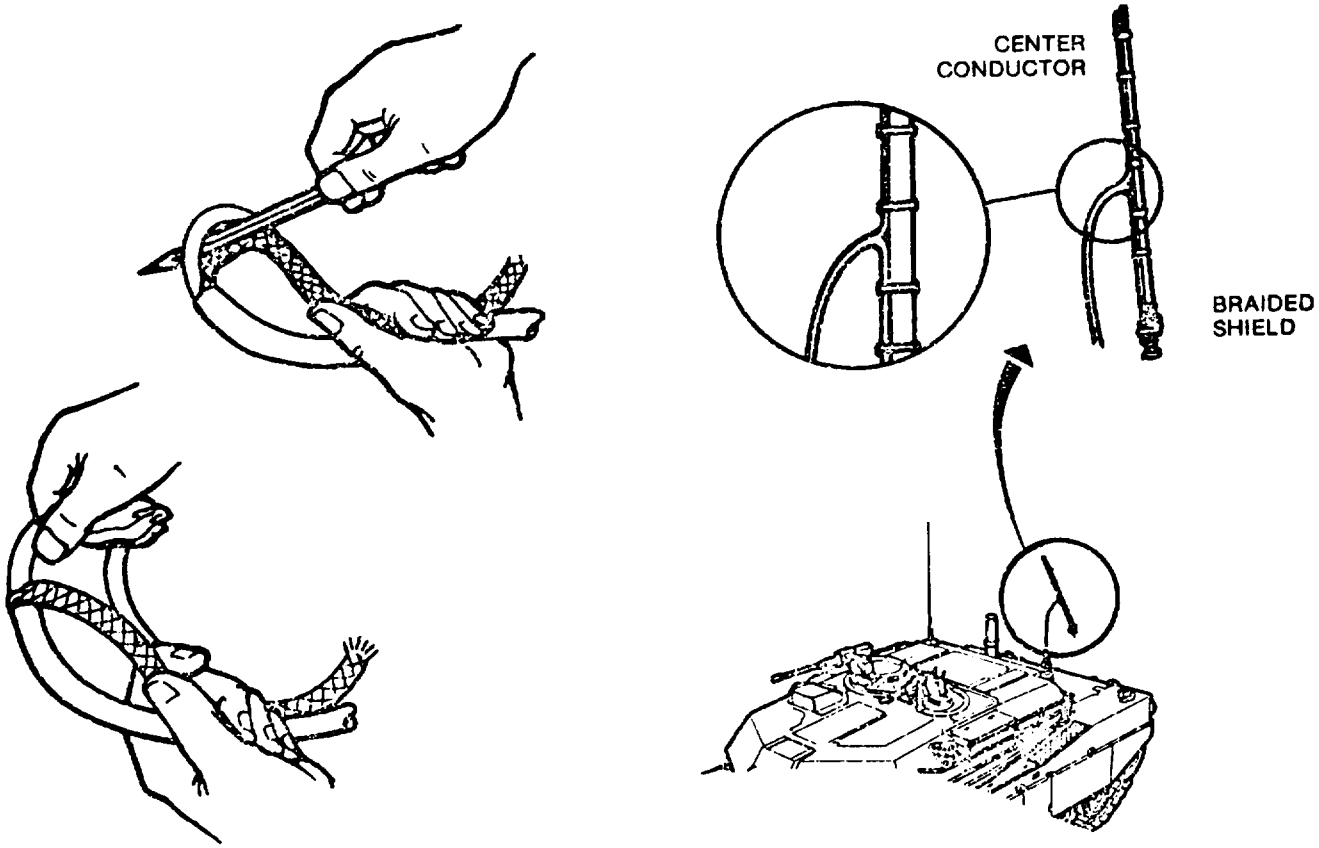
2. In one foot steps, strip the outer insulation from the cable to expose the braided shield wire. Use care so that the shield wire is not cut.

3. Bend the cable into a loop, holding it with one hand. Using a pencil or nail, and as close to the remaining insulation as possible, carefully separate the braided shield from the insulated center conductor.

4. Work the pencil or nail between the shield wire and center conductor to form a hole. While keeping the loop formed, place a finger in the hole and slowly pull the center conductor out of the shield.

5. Tape the center conductor to the top portion and the braided shield to the bottom portion of a ten-foot pole. Tape as necessary to hold cable securely in place.

Procedural Steps - Continued:



6. Fasten pole to antenna base with rope or tape.

7. Feed remaining coaxial cable through loader's hatch to the radio.

8. If there is a BNC connector (twist type lock) on the cable, attach it to the radio antenna connector. If not, do as follows:

a. Carefully strip the outer insulation of the coaxial cable to expose enough braided shield to reach a screw near the antenna connector on the radio case.
b. Use a pencil or nail and carefully separate the braided shield from around the center conductor. Twist into a pigtail.
c. Strip the inner insulation to expose enough center conductor to push into the antenna connector.
d. Wedge the center conductor into the antenna connector and attach the pigtail to a screw on the radio case.

9. Record the BDAR action taken. When the mission is completed, as soon as practicable, repair vehicle using standard maintenance procedures.

14-21. GROUND PLANE FIELD EXPEDIENT ONE-QUARTER WAVE ANTENNA

General Information:
This procedure gives instructions for construction of a one-quarter wave ground plane antenna which can be used for transmission and reception. This antenna has the capability of increasing the range of FM radios.

Limitations:
• Can only be used on a stationary vehicle and when a tree is available for suspension of the antenna

Personnel/Time Required:
• I soldier
• 30 minutes

Materials/Tools:
• Cable, l-roll, telephone, WD-I/TT
• Insulators (e.g., glass, plastic, leather, nylon, etc.) (Five required)
• Rope
• Sticks or branches, 3-foot length, (three required)

Other Options:
• Repair broken metallic whip antenna. (Refer to para. 14-17.)
• Field expedient metallic whip antenna. (Refer to para. 14-18.)
• Field expedient replacement of fiberglass antenna. (Refer to para. 14-20.)
• For reception only, field expedient auxiliary antenna. (Refer to para. 14-19.)

Procedural Steps:

1. Determine the length of wire needed for the radiating element of a one-quarter wave antenna using the following formula:

Length (feet) = 234 divided by frequency (MEGAHERTZ)
or
Length (meters) = 71.37 divided by frequency (MEGAHERTZ)

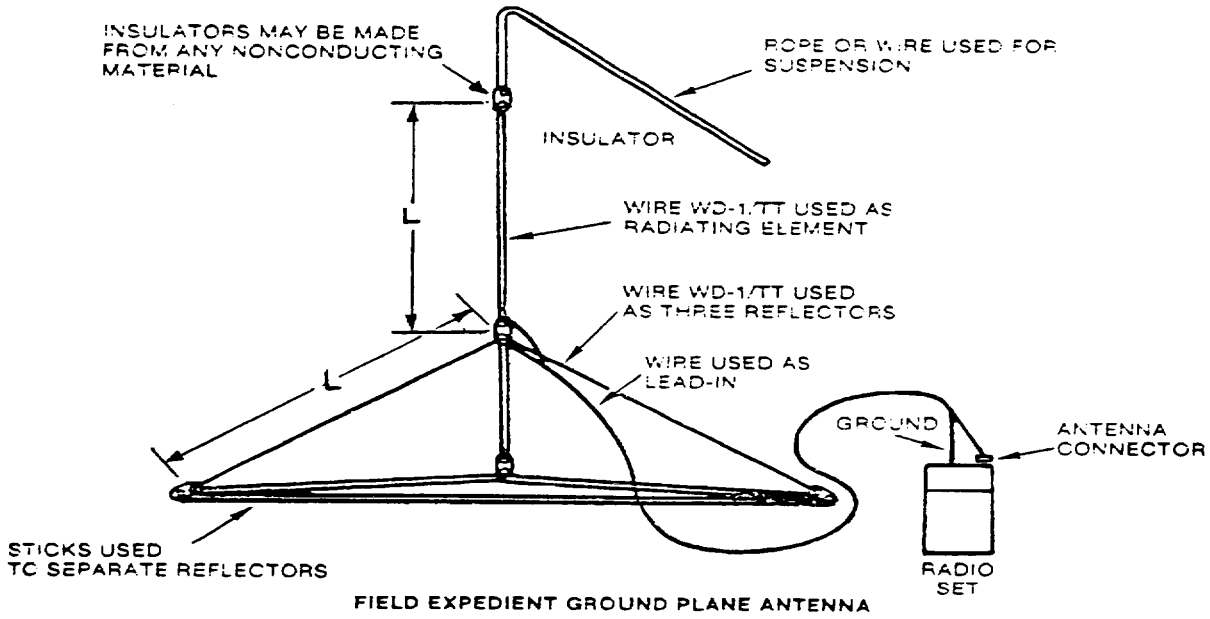
Example- A radiating element for a frequency of 50 MHZ:

L (feet) = 234 divided by 50 MHZ = 4.68 feet
or
L (meters) = 71.37 divided by 50 MHZ = 1.43 meters

Procedural Steps (Cont

2. Cut the required length from telephone wire.

3. Cut three reflector elements approximately the same length as the radiating element. Strip the insulation from one end of the three reflectors. Twist together and connect to an insulator.



FIELD EXPEDIENT GROUND PLANE ANTENNA

4. Tie together three sticks, 3-feet in length, to form a triangular support for the lower end of the reflector elements.

5. Connect the lower end of the reflector elements and triangular support using three insulators.

6. Connect one end of the radiating element to the insulator at the upper end of the reflector elements. Make sure radiator does not touch the three reflectors.

7. Connect an insulator and a suspension rope or wire to the upper end of the radiating element. If wire is used for suspension, make sure suspension wire does not touch the radiator.

Procedural Steps (Cont);

8. Cut a piece of telephone cable long enough to reach from the radio to the desired height of the antenna.

9. Strip the insulation from one end of the two cable wires. Untwist the wires enough to splice one wire to a bare section of the radiating element and the other wire to a bare section of the reflectors.

10. Toss the suspension rope or wire over the limb of a tree, and pull the antenna up to the desired height.

11. Strip insulation from the other end of the two-wire cable. Untwist and connect one wire to a screw on the radio (ground) and the other wire to the center of the radio antenna connector.

12. If communications are not satisfactory, reverse the connections at the radio.

Record the BDAR action taken. When the mission is completed, as soon as practicable, repair vehicle using standard maintenance procedures.

14-22. INTERCOMMUNICATIONS SYSTEM FIELD EXPEDIENT

General Information:

This procedure gives instructions for constructing field expedient intercoms.

Limitations:
* If the AM-1780 is non-operational, the radio systems will not be usable through the intercom.
* If telephone cable WD-I/TT is routed to the driver's station, the turret cannot be traversed without cutting the cable.

Personnel/Time Required:
* 1 soldier
* 10 minutes

Materials Tools:
* One TA-312/PT or TA-I/PT field telephone for each station where requirement for intercom exists
* Cable, telephone, WD-I/TT, 10 to 15-foot length

Other Option:
* Replace with Soviet R-124 intercom. (Refer to paragraph 14-28).

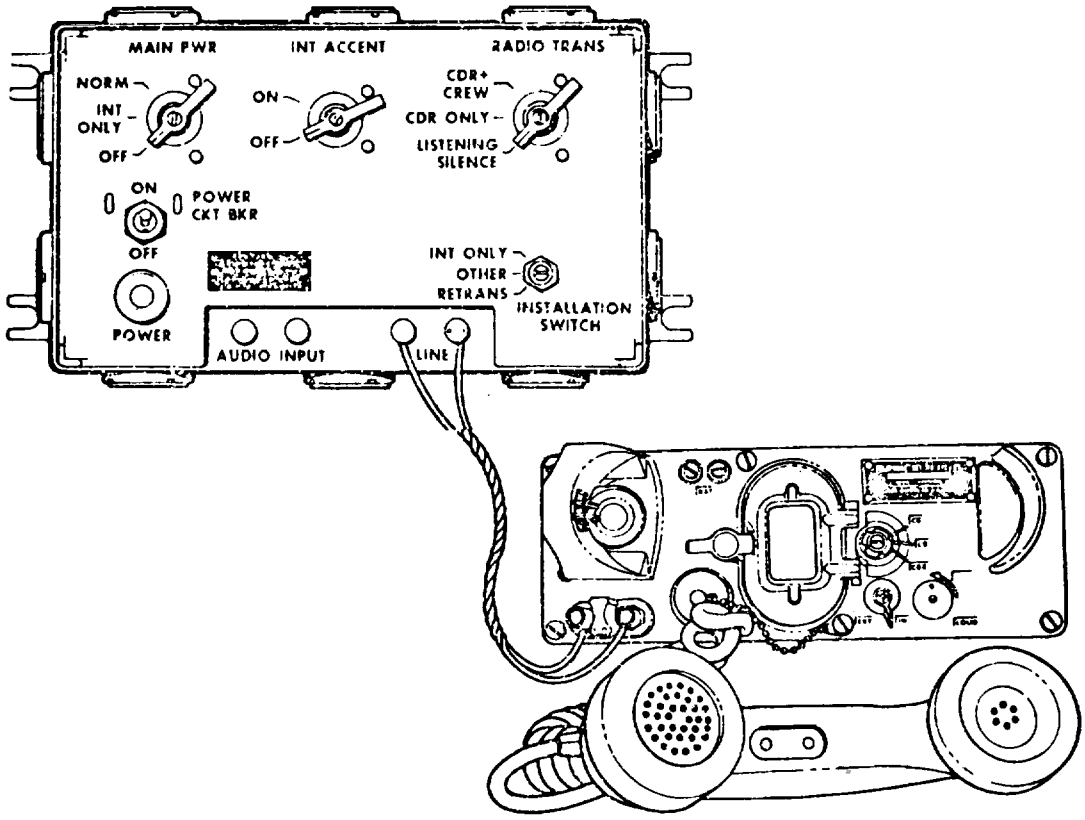
CAUTION

Do not crank or ring the field telephone because damage could occur to the AM-1780 and/or the entire AN/VIC-1 system.

Procedural Steps:

1. If one or more of the control boxes becomes inoperable but the AM-1780 is still operational, install TA-312 or TA-I field telephones at the station(s) where the bad control boxes are located and run field telephone wire back to the AM-1780. The WD1/TT should be hooked up on the "line" jacks of the AM1780.

2. If the AM-1780 is not operational, replace the entire intercom system with TA-312 or TA-I telephones and field telephone wire. Run the wire in a circle throughout the vehicle so that all telephones are connected to the same wire.



3. Record the BDAR action taken. When the mission is completed, as soon as practicable, repair vehicle using standard maintenance procedures.

14-23. RADIO SYSTEMS FIELD EXPEDIENT

General Information: There are no known methods of constructing a field expedient radio. It should be noted, however, that hand signals, signal flags, flashlights, telephones, and messengers can be used in place of a radio. Communications can be restored by substituting optional equipment identified below. It should also be noted that if the intercom is not fully operational and the radio is operational but will not work with the intercom, radio communications can be partially restored by connecting the CVC helmet or an H-189 handset directly to the radio. Further, if the receiver transmitter is damaged, the auxiliary receiver can be tuned to the proper frequency and used for reception only.

Limitations:
* Depending on extent of equipment damage or failure, partial to total loss of radio communications.

Personnel/Time Required:
*1 soldier
*30 minutes

Materials/Tools:
* Cable, telephone, WD-I/TT
* Field Telephone TA-312/PT, or TA-I/PT
* Flag set

Procedural Steps:

1. Substitute radio with:
a. AN/VRC-12 series on foreign equipment. (Refer to para. 14-25.)
b. Soviet equipment. (Refer to para. 14-26.)
c. Foreign Allied equipment. (Refer to para. 14-27.)

2. Record the BDAR action taken. When the mission is completed, as soon as practicable, repair vehicle using standard maintenance procedures.

14-24. FIELD EXPEDIENT RADIO MOUNT REPAIR.

General Information: Because of the configuration of plugs and jacks located on the mount and the way that the radio sets and mounts are mated, the fixes are very limited. Power and signal cables are routed in and out of the mount through cables and plugs and in turn with a plug and jack method to the radio. If any of those plugs and jacks are damaged, the only feasible alternative is to replace the mount.

Limitations:
* None

Personnel/Time Required:
*1 soldier
*45 minutes

Procedural Steps:

1. Turn off power to the radios.

2. Remove radio from damaged mount.

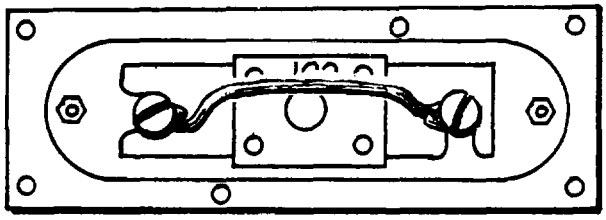
3. Carefully remove damaged mount from vehicle.

4. Remove all cables from damaged mount and note their positions.

5. Remove undamaged plugs from mount and reconnect them to the proper cables.

6. Check for blown fuse in mount. The fuse junction box is located on top of radio receptacle plug. Replace a blown fuse with a piece of solder or wire.

**FOR TEMPORARY FUSE
CONNECT LENGTH OF SOLDER
BETWEEN SCREWS**



MT-1029. Junction Box Cover

7. Turn power on.

8. Measure voltage on 3-21 (Power Cable) at terminals a (negative) and B (positive).

Voltage should be between 22 and 30 VDC.

9. Turn power off.

10. Attach radio receptacle plug to radio.

11. Strap or tie down radio to prevent falling.

12. Make sure radio is grounded by connecting a wire from a screw on the radio to any convenient screw or bolt on the vehicle.

13. Turn on power and radio. Check radio for power operation.

14. Record the BDAR action taken. When the mission is completed, as soon as practicable, repair the vehicle using standard maintenance procedures.

14-25. FOREIGN EQUIPMENT INTERCHANGEABILITY (AN/VRC- 12 SERIES)

General Information:

This procedure contains Interchangeability information to be used if standard radio components are not available.

Limitations:
* None

Personnel/Time Required:
*1 soldier
* 15 minutes

Materials/Tools:
* Component, radio, AN/VRC-12 series from foreign vehicle

Other Option(s)
* Field expedient radio systems. (Refer to para. 14-23.)
* Replace radio with:
    1. Soviet equipment. (Refer to para. 14-26.)
    2. Foreign Allied equipment. (Refer to para. 14-27.)

Procedural Steps:

1. The following foreign countries use the standard AN/VRC-12 series radio which can be installed in the US model tanks with no modifications required using standard procedures:

a. Belgium
b. Israel
c. Korea
d. Netherlands
e. Spain
f. Sweden

2. Record the BDAR action taken. When the mission is completed, as soon as practicable, repair vehicle using standard maintenance procedures.

14-26. FOREIGN EQUIPMENT INTERCHANGEABILITY (SOVIET RADIO R-123M)

General Information:
This procedure gives installation and operating instructions for the Soviet R-123M transceiver.

Limitations:
* This radio cannot be wired through the AN/VIC-1 intercom. Therefore, it can only be used by one man.

Personnel/Time Required:
*1 soldier
*1 hour
Materials/Tools:
* Wire, 4-conductor, 18-gauge 5-foot length or cable, telephone, WD-I/TT, 5-foot length, (two required) (cut back three steel strands of the two sections)
* Connector, UG-273
* Handset, H-189/GR, or standard CVC helmet
* Plate, Soviet chest
* Transceiver, Soviet, R-123M (with power supply)
* Wire, 2-conductor, 12-gauge (minimum size), 3-foot length
* Rope, 10-foot length
* Gun, soldering
* Solder, rosin-core

Other Options:
* Substitute radio with:
1. Foreign Allied equipment (Refer to para. 14-27).
2. Foreign AN/VRC-12 series equipment. (Refer to para. 14-25.)

Procedural Steps:

NOTE

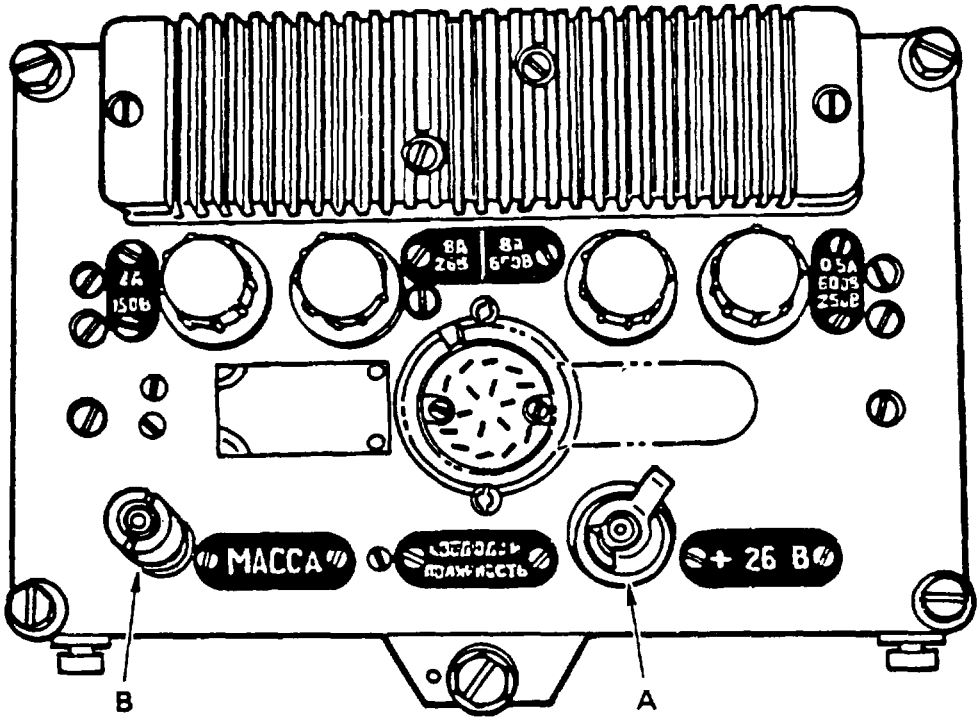
The AN/VIC-I intercom should not have the R-123M wired through it. For proper operation of the intercom while the R-123M is being used, set the INSTALLATION SWITCH on the AM-1780 to INT ONLY position.

1. Locate the power cable that runs from the turret wall to connection J-21 on the bottom of MT-1029. Remove the cable from the 3-21 connection. Without removing the connector from the cable, strip back and remove approximately four inches of the outer insulation. Stagger the splices, and scrape approximately 1/4 to 1/2-inch of the inner insulation off each of the four wires in the cable.

2. Use a jumper cable of at least 12-gauge wire, and attach both the red and the white wires in this power cable to the positive side of the Soviet power supply.
(Point A.)

3. Use another jumper cable of at least 12-gauge wire, and attach both the black and the green wires in this power cable to the negative side of the power supply. (Point B.)

Procedural Steps (Cont)



4. Install the R-123M onto the MT-1029, and tie down with rope or web sling.

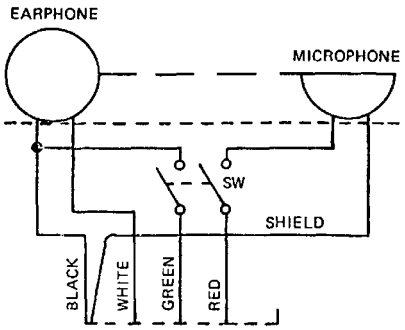
5. Remove the outer cover on the female end of the UG-273 connector to make it a male connector and insert it into the antenna connection point located on the right side of the R-123M immediately below the AHTEHHA sign. Attach the RF cable.

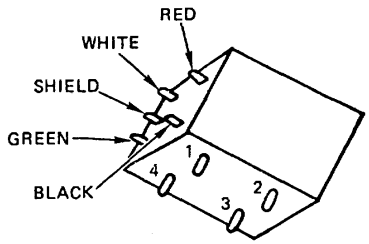
NOTE

* Frequency must be set manually on the MX6707. If possible use the auxiliary antenna.

* Use the four-conductor wire to hook up either a H-189 handset or a CVC helmet to the Soviet chest plate.

Procedural Steps (Cont):





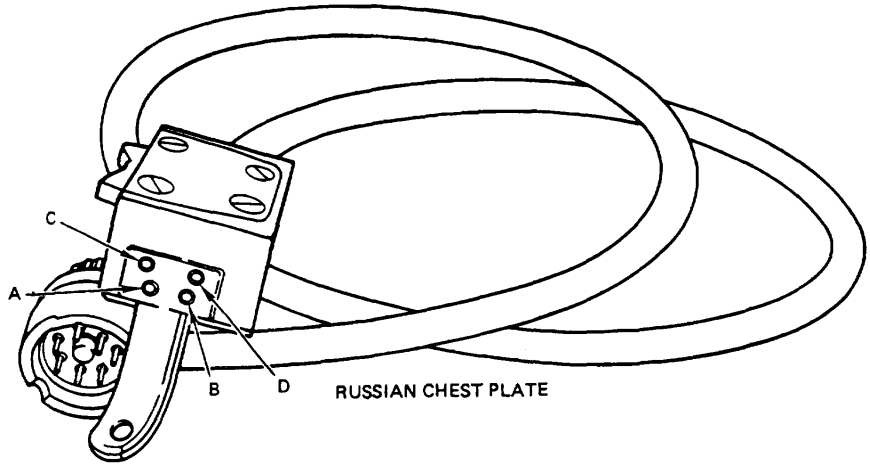
NOTE:
BOTTOM AND END VIEW OF SWITCH

6. H-189 Handset:

a. Insert and connect the four wires through the handset to the black, white, green, and red wire connections on the switch.

b. Hook the black wire to one of the inside jacks on the Soviet chest plate and the white wire to the other inside jack. (Points A and B.)

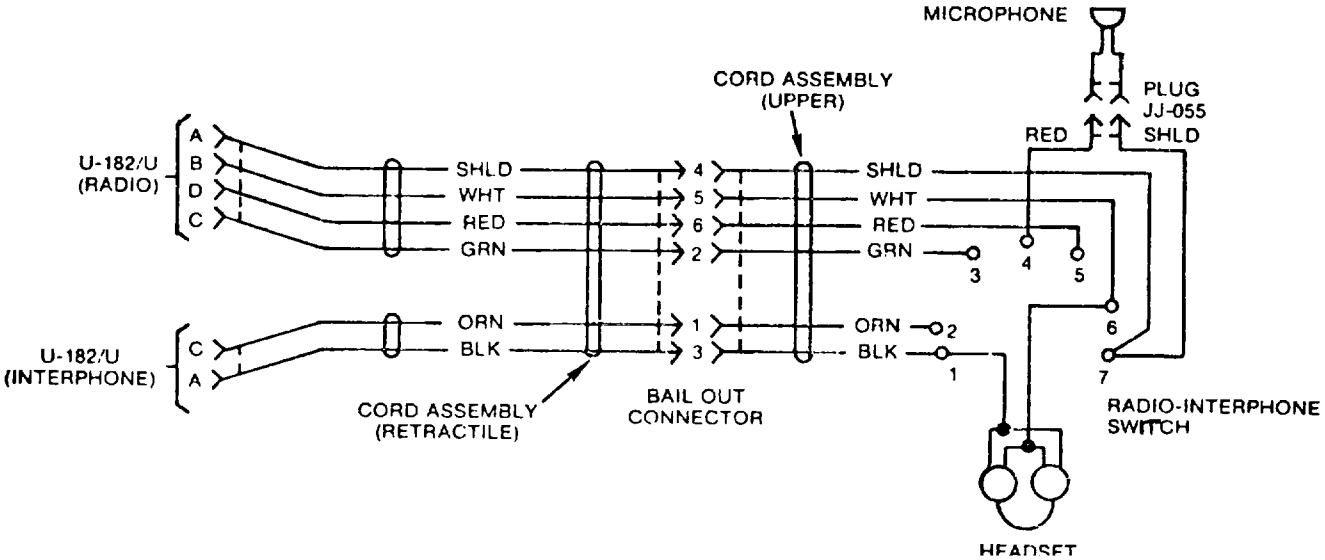
c. Hook the green wire connection to one of the outside jacks and the red wire to the other outside jack (points C and D).



Procedural Steps (Cont).

7. CVC Helmet:

a. Remove plastic earphone cushion and receiver retainer to gain access to the switch assembly.



CVC HELMET
(Headset-Microphone Kit MK- 1697.G. wiring diagram)

b. Connect four wires to white (switch position 6), black (1), shield (7), and red (4) wires.

c. Hook the white wire to one of the inside jacks on the Soviet chest plate and the black wire to the other inside jack (Points A and B on chest plate figure).

d. Hook the shield wire to one of the outside jacks and the red wire to the other outside jack. (Points C and D on chest plate figure).

e. Reassemble helmet. If you can receive but not transmit, reverse the red wire lead and shield wire lead on the two outside jacks.

8. Operating procedures for the Soviet R-123M Transceiver:

NOTE
Operating procedures and steps are keyed to the following figure.

a. Make sure the POWER SWITCH (23) and the DIAL LIGHT SWITCH (26) are in the off (down) position.

b. Set the MODE SELECTOR SWITCH (3) to the Simplex (left) position.

c. Make sure the ANTENNA LOADING CONTROL LOCKING NUT (8) is tightened (clockwise) until snug.

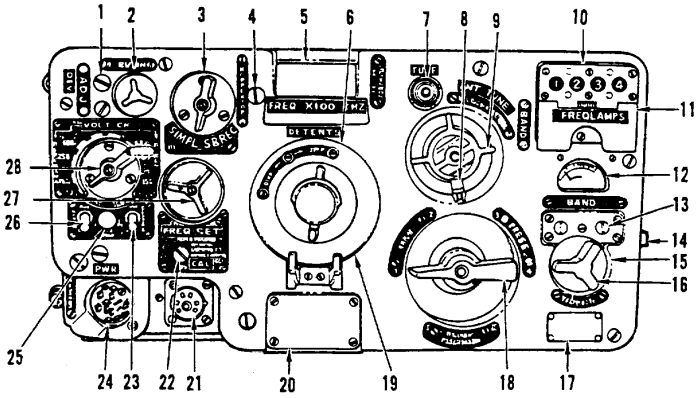
Procedural Steps (Cont).

d. Turn the SQUELCH CONTROL KNOB (2) counterclockwise (off).

e. Turn the VOLUME CONTROL KNOB (16) all the way clockwise.

f. Turn the VOLTAGE CHECK/OPERATE SWITCH (28) to the receiver circuits portion of the scale; 1,2B (approximately the one o'clock position).

g. Turn the power source on. The input voltage to the R-123M power supply should be 24 + 1 v D C for best operation.



1 DEVIATION ADJUSTMENT UNDER PLUG)
2 SOUELC, CONTROL KNOB
3 MODE SELECTOR SWITCH
4 INDEX L!IJE ADJUSTMENT (UNDER :LUG)
5 FREOJENCY DIAL VIEWING WINDOW
6 PRESET LOCKING SCREWS (UNDER COVER (19))
7 RF IND:ICATOR LAMP 1
8 ANTENNA LOADING CONTROL LOCKING NUT
9 ANTENNA LOADING CONTROL KNOB
10 PRESET CHANNEL INDICATOR
11 PRESET CHANNEL BAND SELECTOR (UNDER COVER)
12 INDICATOR METER
13 BAND INDICATOR
14 ANTENNA CONNECTOR LOCKING SCREW '
15 GROUND CONNECTOR
16 VOLUME CONTROL KNOB
17 DATAPLATE
18 PRESET CHANNEL,'CONTINUOUS TUNE SELECTOR SWITCH
19 PRESET LOCKING SCREW ACCESS COVER
20 OPERATING FREOUENCY CARD
21 INTERCOM CONNECTOR
22 CALIBRATIONADJUSTMENT (UNDER PLUG)
23 POWER SWITCH
24 POWERINPUTCONNECTOR
25 TONE CALL BUTTON
26 DIAL LIGHT SWITCH
27 FREOUENCY TUNING KNOB
SWITCH

h. Turn the POWER SWITCH (23) and the DIAL LIGHT SWITCH (26) to the on (up) position. At this time the FREQUENCY DIAL VIEWING WINDOW (5) and the INDICATOR METER (12) will light. After the tubes are heated, a rushing noise will be heard in the earphones. Adjust the VOLUME CONTROL KNOB (16) for the desired volume level.

Procedural Steps (Cont

i. heck the power supply in the receive mode by noting the reading on the INDICATOR METER (12) and turning the VOLTAGE CHECK/OPERATE SWITCH (28) clock wise to the 6,3B and the 150B positions. The needle on the INDICATOR METER (12) should be in the shaded portion of the scale for all readings. If not in the shaded portion, check the power supply for bad fuses and replace any bad ones.

CAUTION

The receiver and transmitter are tuned simultaneously.
Do not operate the transmitter without using an antenna or dummy load. Transmitting into an antenna base without connecting an antenna may damage the transmitter portion of the radio.

j. Check the power supply in the transmit mode by placing the VOLTAGE CHECK/OPERATE SWITCH (28) to the 1,2B position on the transmitter circuits portion of the scale (approximately the 7 o'clock position). The INDICATOR METER (12) should read in the shaded portion of the scale. If not in the shaded portion, check the power supply for bad fuses and replace any bad ones.

k. Place the VOLTAGE CHECK/OPERATE SWITCH (28) in the 150B position by rotating the switch clockwise. Momentarily place the chest plate switch and the CVC helmet or H-189 switch in the transmit position. Note the reading on the INDIATOR METER (12); it should be in the shaded portion of the scale. Release the switches.

l. Place the VOLTAGE CHECK/OPERATE SWITCH (28) alternately in the 250B and 600B positions by rotating the switch clockwise. To obtain an indication, it is necessary to momentarily depress the switches to transmit. Both the readings should be in the shaded portion of the scale.

m. Place the VOLTAGE CHECK/OPERATE SWITCH (28) in the operate #1 (PAbOTA 1) position.

n. Place the PRESET CHANNEL/CONTINUOUS TUNE SELECTOR SWITCH (18) in either the I or II position. Position I will be used if the desired operating frequency is between 20 and 35.75 MHz and position II will be selected if the desired operating frequency will be between 35.8 to 51.5 MHz. Band selections are also shown by the BAND INDICATOR (13) lights.

o. To calibrate the FREQUENCY DIAL, rotate the FREQUENCY TUNING KNOB (27) while looking into the FREQUENCY DIAL VIEWING WINDOW (5) and select the frequency listed below that is the closest to the desired operating frequency.

Band I:	22.050 MHz	28.350 MHz	34.650 MHz		
Band II:	36.225 MHz	40.950 MHz	42.525 MHz	45.675 MHz	48.825 MHz

The frequencies are noted on the frequency dial with an extended graduation line capped by an arrowhead.

Procedural Steps (Cont):

p. Set the MODE SELECTOR SWITCH (3) to the receive only (right) position.

q. Depress and hold the TONE CALL BUTTON (25). A tone should be heard in the earphones. Rotate the FREQUENCY TUNING KNOB (27) until a zero beat is obtained. While rotating the FREQUENCY TUNING KNOB (27) the tone should be heard to progress from a high pitch to a low pitch then to a high pitch again. The proper setting of the FREQUENCY TUNING KNOB (27) is the point at which the tone is at its lowest pitch or totally absent.

r. Note the relative positions of the index line and the frequency graduation line through the FREQUENCY DIAL VIEWING WINDOW (5). If the index line is within 1/5 of a frequency graduation (5 kHz), no adjustment of the index line is necessary .Proceed after releasing the TONE CALL BUTTON (25). If the index line is not within 1/5 of a graduation (5 kHz) the following adjustments must be made:

(1) Release the TONE CALL BUTTON (25). Using a screwdriver, remove the INDEX LINE ADJUSTMENT (4) plug.

NOTE

This adjustment is quite stiff. Care should be exercised to not change the frequency setting while adjusting the index line.

(2) Insert the screwdriver into the hole disclosed and contact the index line adjustment. Rotate the adjustment right or left until the index line exactly corresponds to the selected frequency graduation line.

(3) Replace the INDEX LINE ADJUSTMENT (4) plug.

(4) Check the setting by repeating steps (q) and (r). When no adjustment is required, proceed to the next step.

s. Return the MODE SELECTOR SWITCH (3) to the Simplex position (left).

t. Set the PRESET CHANNEL/CONTINUOUS TUNE SELECTOR SWITCH (18) to the preset #1 position.

u. Set the PRESET CHANNEL BAND SELECTOR (11) to correspond with the desired band. Frequencies between 20.0 and 35.75 MHZ are set on Band I (switch up); frequencies between 35.8 and 51.5 HMZ are set on Band II (switch down). Band selections are indicated by the BAND INDICATOR lights (13).

v. Open the PRESET LOCKING SCREW ACCESS COVER (19) on the front panel and loosen the PRESET LOCKING SCREW (6) marked "1" by turning the locking screw counterclockwsie until the slot is at right angles with the red circle. To release the preset locking screw, use the special key (not shown) attached to the case of the radio.

Procedural Steps (Cont):

w. Turn the FREQUENCY TUNING KNOB (27) to the desired frequency by aligning the desired frequency with the indicator line within the FREQUENCY DIAL VIEWING WINDOW (5). While holding the FREQUENCY TUNING KNOB (27) turn the PRESET LOCKING SCREW (6) clockwise with the special key until it is aligned with the red circle.

x. Loosen the ANTENNA LOADING CONTROL LOCKING NUT (8) two or three turns counterclockwise.

y. Put the chest plate switch in the transmit position and hold. Turn the ANTENNA LOADING CONTROL KNOB (9) for maximum deflection on the INDICATOR METER (12) and maximum brilliance on the RF INDICATOR LAMP (7).

NOTE

Several peaks will be noted on the indicator meter while loading the antenna. Tune to the maximum peak and to the maximum brilliance on the indicator lamp. For a more sensitive meter to help choose between peaks, turn the VOLTAGE CHECK/OPERATE SWITCH (28) to the operate #2 (PAbOTA 2) position. After determining the most advantageous loading position, return the VOLTAGE CHECK/OPERATE SWITCH (28) to the operate #1 (PAbOTA 1) position. Release the chest plate switch.

z. While holding the ANTENNA LOADING CONTROL KNOB (9), tighten the ANTENNA LOADING CONTROL LOCKING NUT (8). Check this step by depressing the chest plate switch to the transmit position. If the indication on the INDICATOR METER (12) is not the same as noted in step (y), loosen the ANTENNA LOADING CONTROL LOCKING NUT (8) and repeat step (y). If proper loading has been accomplished release the chest plate switch and proceed.

aa. Repeat steps (s) through (w) to preset frequencies on settings 2, 3, and 4.

NOTE

Only two frequencies can be preset on Band I and two more can be preset on Band II. Example: If the PRESET CHANNEL BAND SELECTOR (11) is set at Band I position for preset #1 and #2, only Band II frequencies can be selected for presets #3 and #4. Any combination of bands and presets may be used.

ab. You are now ready to operate in the preset mode. Any time you want to select a preset frequency, simply turn the PRESET CHANNEL/CONTINUOUS TUNE SELECTOR SWITCH (18) to the desired preset number.

Procedural Steps (Cont)

ac. To operate in the continuous tune mode, turn the PRESET CHANNEL/CONTINUOUS TUNE SELECTOR SWITCH(18) to the lower positions, labelled I and II. "I" corresponds to Band I frequencies and "II" corresponds to Band II frequencies.

ad. the FREQUENCY TUNING KNOB (27) to the desired frequency.

ae. Load the antenna by accomplishing steps (w) thru (z).

CAUTION

Observe a 1:3 transmit to receive ratio i.g., 3 minutes transmit to 9 minutes receive, to minimize the possibility of overheating the power supply and power output tubes.

af. You are now ready to operate in the continuous tune mode. The tuning controls are very sensitive; therefore, the continuous mode should not be selected if the radio is to be moved or subjected to vibrations.

9. Record the BDAR action taken. When the mission is completed, as soon as practicable, repair vehicle using standard maintenance procedures.

14-27. FOREIGN EQUIPMENT INTERCHANGEABILITY (ALLIED RADIOS)

General Information
This procedure contains general installation instructions for Allied radio equipment.

Limitations:
* Vary according to radio set but you can expect a decrease in operating range on some sets.
* You can expect not to be able to transmit and receive on all frequencies within the US. AN/VRC-12 frequency range.

Personnel/Time Required:
* 1 soldier
· Approximately one hour for each type of installation

Other Options:
* Replace with the AN/VRC-12 series of radio components from foreign vehicles. (Refer to para. 14-25.)
* Replace with Soviet radio R-123M. (Refer to para. 14-26.)

Procedural Steps:

1. Refer to table 14-1 for comparison purposes in determining limitations.

Procedural Steps (Cont):

Table 14-1. Allied Radios

Basic FM Radio & Country	Frequency Range (MHz)	Power Min (Watts)	Output Max	Bandwidth (kHz)	Range (km) Min	Max
AN/VRC-12	30 to 75.95	3	35	50	8	30
PRC-351/352 (UK)	30 to 75.95	4	20	25/50	8	16
SEM-35/25 (FRG)	26 to 69.95	0.15	15	50	8	30
RV-3/13/V (Italy)	26 to 71.95		15	50		30
TR-VP-113/213 (France)	26 to 71.95		15	50		30
TRC-570 (France)	26 to 71.95	2	30	25/50	15	40

NOTE

The Allied countries listed in the table have agreed to utilize the same connectors for cables within the radio system. All power cable connectors should be the same regardless of which country's radio is examined.

2. Remove the radio and its accompanying mount from the foreign vehicle. Note which cable connector supplies power to the mount.

3. Remove the radio and its accompanying mount from your vehicle. Note that the power cable is J-21.

4. Install the foreign vehicle radio and mount in the place vacated by the U.S. AN/VRC-12.

5. Install the cable that previously ran to 3-21 in the connector socket for input power on the foreign radio mount.

6. If the foreign vehicle had an intercom system, hook up the cable that runs between 3-22 on the U.S. radio mount and J-501 on the AM-1780. This cable must be connected to the same connections to which the foreign vehicle intercom master control box was connected to.

7. Be sure to take one foreign vehicle CVC helmet for use in case the U.S. CVC -helmet will not adapt to the front of the foreign radio. Prior to using the foreign CVC helmet at the radio face, attempt to operate the radio through the AM-1780. If the AM-1780 does not key the foreign radio then there is a wiring difference and the foreign CVC helmet can be connected directly to the microphone connector on the front face of the foreign radio.

Procedural Steps (Cont)

8. Record the BDAR taken. When the mission is completed, as soon as practicable, repair vehicle using standard maintenance procedures.

14-28. FOREIGN EQUIPMENT INTERCHANGEABILITY (SOVIET INTERCOM R-124)

General Information
This procedure gives installation and operating instructions for the Soviet R-124 intercom.

Limitations:
* The AN/VRC-12 series radio cannot be wired through this intercom. Therefore, the radio can only be operated by one man.

Personnel/Time Required:
* 1 soldier
* 1 hour

Materials/Tools:
* Handset, H-189/6R, (each chest plate), or standard CVC helmet
* Intercom, Soviet, R-124
* Plate, chest, Soviet (one for each control box)
* Tape, electrical
* Wire, 4-conductor, 18-gauge, 5foot length or cable, telephone, WD-1/TT, 5foot length (two required)
* Wire 2-concor 12-gauge 3 foot length
* Gun, soldering
* Solder, rosin-core

Other Options
* Field expedient intercom (refer to para. 14-22).

Procedural Steps:

NOTE

All wires in the R-124 interconnecting cables are soldered directly to the internal connecting points in the individual boxes. Use care in removal/installation. Do not disconnect individual boxes unless absolutely necessary.

1. Remove the R-124 from Soviet vehicle and install in U.S. vehicle.

2. Wire the H-189/GR handset or CVC helmet using the procedures listed in para. 14-26.

NOTE

Power is obtained in the same manner as listed in step I of para. 14-26.

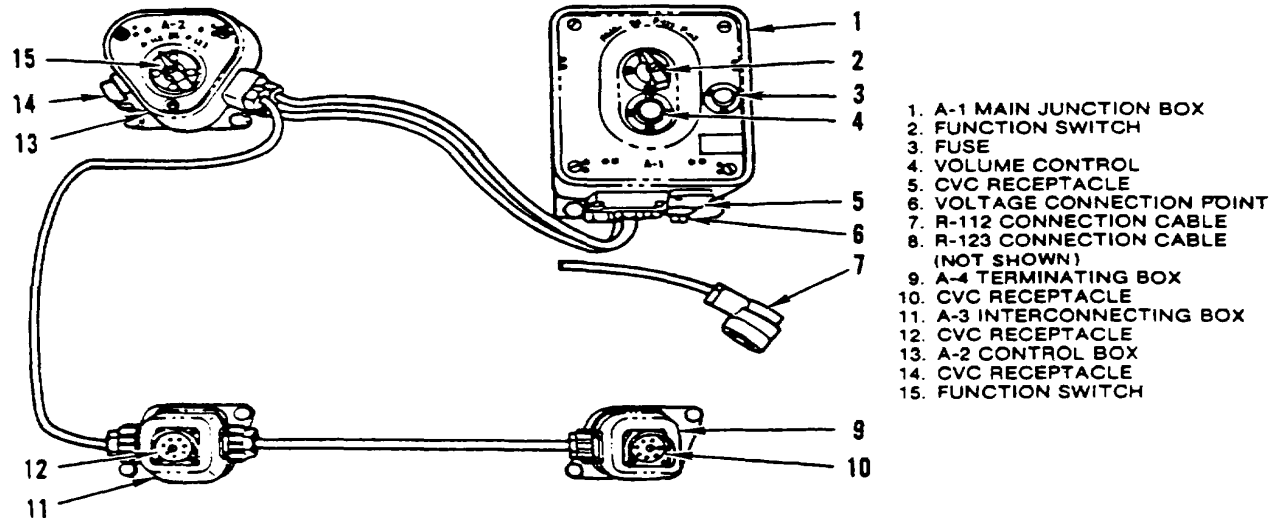
3. Attach the red and white wires from the power cable to the black terminal on the bottom of the A-I box of the R-124. Attach the black and green wires from the power cable to the ground strap on the A-I box. See position 6 in the illustration on the following page.

Procedural Steps (Cont)

4. Operating procedures for the R-124.

NOTE

Operating procedures are keyed to the intercom.



a. Connect the CVC helmet to the chest plate switch. Connect the chest plate switch to any of the R-124 receptacles (5, 10, 12, or 14 in the intercom figure).

b. Set FUNCTION SWITCH (2) and FUNCTION SWITCH (15) to the intercom BC position. (Both function switches must be in the BC position to allow all four boxes access to intercom.)

c. Adjust VOLUME CONTROL (4) for desired audio level in the headsets.

5. Record the BDAR action taken. When the mission is completed, as soon as practicable, repair tank using standard maintenance procedures.

14-29. COAXIAL CABLE REPAIR

General Information:
This procedure gives instructions and identifies materials recommended for repair of coaxial or other shielded cables when standard replacement parts are not available.

Limitations:
* None

Personnel/Time Required:
* 1 soldier
* 20 minutes

Materials/Tools:
* See illustrations in this procedure for materials required.

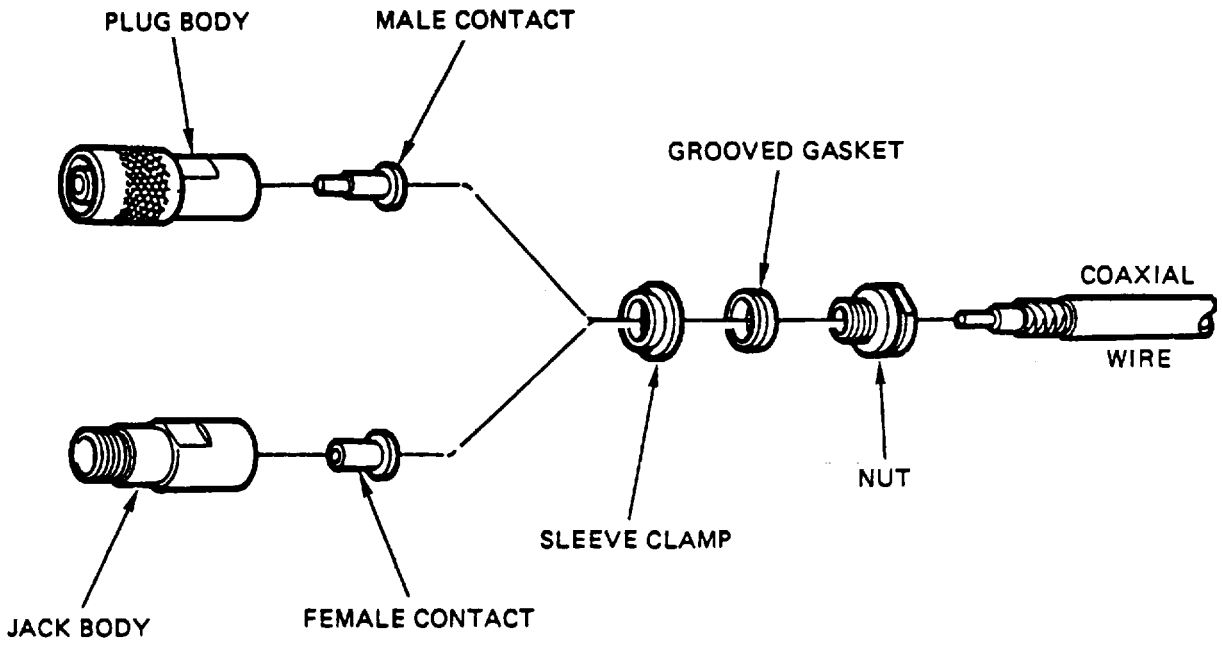
Other Option:
* See shielded cable repair procedures in electrical chapter.

Procedural Steps:

NOTE

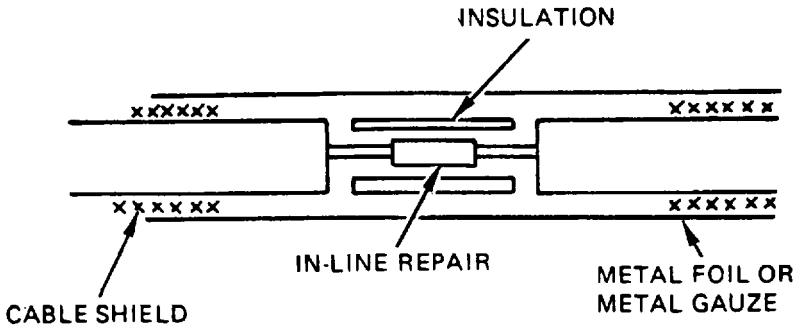
Do not attempt to repair broken or damaged coaxial cables unless absolutely necessary. Replace the entire cable whenever possible.

1. If replacement is not practical, install a matching plug and jack of the proper size and type for splicing the damaged or broken part.



Procedural Steps (Cont):

2. Alternate repair to coaxial cables: Damage to coaxial cable shields or the center conductors can be repaired using the same methods as any other shielded wire repair. Insure that this repair is sufficiently insulated to prevent the center conductor from shorting to the shield. The shielding may be restored by several methods. One such method is illustrated below.



a. Remove 1/2 inch of insulation from the shielding and join the severed ends of the shielding together by wrapping a conductive material over the repair. Some suitable materials are tubular copper braid, metal gauze, conductive foil from gum wrappers, cigarette packages or common kitchen foil.

b. Remove one inch of insulation, unravel exposed shielding, and twist into pigtails. Join the pigtails by splicing in a piece of insulated wire. Insulate the entire repair when using either method of repair.

3. Record the BDAR action taken. When the mission is complete, as soon as practicable, repair vehicle using standard maintenance procedures.

14-30. INTERCOMMUNICATIONS CABLE REPAIR

General Information: This procedure gives methods for connecting broken wires in multiple wire cables such as the CX-4723 intercommunications cables.

Limitations: * None
Personnel/Time Required:
* I soldier ·
*5-10 minutes per individual wire

Materials/Tools
* Knife
* Tape
* Soldering iron
* Solder, rosin-core

Other Option:
* See other methods for splicing wires and cables in the electrical chapter.

Procedural Steps:

1. Turn off power or unplug cable at both ends if possible or at end nearest the damaged area.

2. Peel back outside insulation about 3 inches on each side of damaged area.

3. Identify wires with broken insulation only and those with actual separated wires.

4. Tape those with broken insulation but with wire intact.

5. Cut clean ends on broken wires.

6. Strip insulation back 1/2 inch.

7. Matching color coding on wires, twist together, solder if possible, or tighten with pliers if available.

8. Bend twisted wires back along length of wire.

9. Tape repaired wire with length of tape.

10. When all wires are repaired, tape around entire bundle and try to seal insulation ends peeled back in Step 2.

11. Plug cable back into equipment, turn on power, and test.

12. Record BDAR action taken, when the mission is complete, as soon as practicable, repair vehicle using standard maintenance procedures.

14-31. CABLES ARE TOO SHORT: BDAR INSTALLATION

General Information:

This procedure gives methods for connecting two or more cables together to make the desired cable length. This procedure is for CX-4723 cable. Other types of cables can be extended using similar methods.

Limitations:
* Preferred method- none
* Alternate methods - possible lowered volume

Personnel/Time Required:
* 1 soldier
* 20 minutes

Materials/Tools:
* Preferred method:

Box, control, C-10456 or C-2298 VRC
* Alternate method:

Gun, soldering
Solder, rosin-core

Other Options:
* See other methods for splicing cables in electrical chapter.

* The preferred method uses a junction box such as a C-2298 control box between two CX-4723 cables.

* Another method is fabricating a junction by removing the J-801 and J-804 connectors from a C-2298 control box. Solder jumper wires between the corresponding connector pins. Insulate the jumper wires and the rear of the connectors.

* A less desirable method is to remove one connector from each cable and splice the corresponding wires from the two cables together. Insulate the splice.

Record the BDAR action taken. When the mission is complete, as soon as practicable, repair vehicle using standard maintenance procedures.

14-32. ISOLATION OF NON-ESSENTIAL SYSTEMS (GENERAL)

General Information:
This procedure lists general guidelines for the isolation of non-essential systems.

Limitations:
* Varies depending on which system is isolated

Personnel/Time Required:
* 1 soldier
· 5-30 minutes

Materials/Tools:
* Crimpon end caps, electrical tape or other insulating material

Other Options:

* Insulate/isolate non-essential wiring or cabling with crimp-on end caps, tape, or any other insulating material. Secure wires to some structure and tag them for rapid identification.

* Any intercom control box can be considered non-essential if one is willing to operate without it. Disconnect the cable leading to that particular control box at AM1780 and consider using field expedient means for intercom. Also, consider switching control boxes and/or cables within the vehicle to provide intercom at the desired points.

For repairs of this type, existing cabling can be rerouted if the original cables have been damaged.

Record the BDAR action taken. When the mission is complete, as soon as practicable, repair vehicle using standard maintenance procedures.

14-33. ISOLATION OF NON-ESSENTIAL SYSTEMS (VOLTAGE SUPPRESSORS)

General Information:

This procedure gives instructions for the isolation and by-passing of both the MK 2096 and the MX-7777/MX-7778 Transient Voltage Suppressers.

Limitations:

*Possible loss of all communications

Personnel/Time Required:
* 1 soldier
* 5-10 minutes

Procedural Steps:

CAUTION

Without the transient voltage suppresser in the circuit, voltage spikes will be routed through the communications equipment and damage could occur. By-pass the suppresser only as a last resort.

1. Removal of MK-2096 transient voltage suppressor:

    a. Locate the MK-2096 under the radio mount.

    b. Unscrew the MK-2096 from the connector.

    c. The MK-2096 is now removed from the circuit,

Procedural Steps (Cont

2. Removal of MX-7777/MX-7778 transient voltage suppresser:

a. Locate the MX-7777/MX-7778 in the vicinity of the driver's compartment.

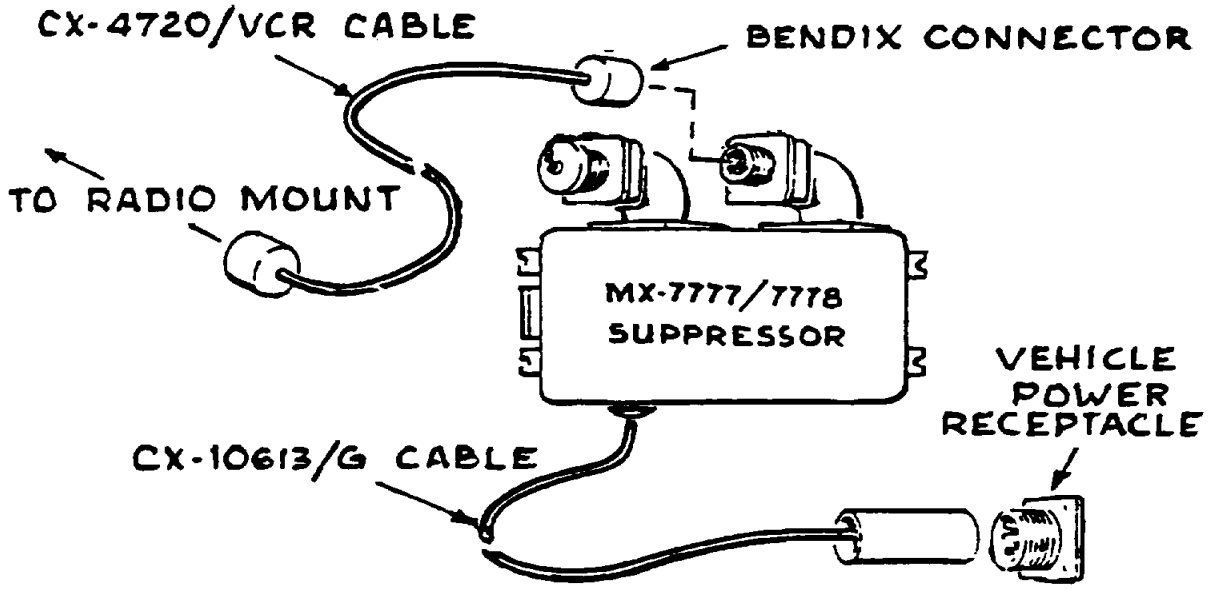
b. Remove the CX 10613/G cable which runs between the vehicle power receptacle and the rear of the voltage suppresser.

c. Remove the Bendix connector which is attached to one of two possible plugs on the top of the suppressor.

d. Plug this Bendix connector directly into vehicle power receptacle.

e. The suppressor is now out of the circuit.

Record the BDAR action taken. When the mission is complete, as soon as practicable, repair vehicle using standard maintenance procedures.



14-34. FIELD EXPEDIENT RADIO REMOTE

General Information
This procedure gives instructions for the construction of a field expedient remote to replace the AN/GRA-39 if it is inoperative.

Limitations:
* None

Personnel/Time Required:

* 1 soldier
* 60-90 minutes

Materials/Tools:
* 680 Ohm Resistor
* 47 Ohm Resistor
* 5000 Ohm Variable Potentiometer
* H-144/U Handset (only cord and plug used)
* M-80 Microphone (only cord and plug used)
* K-1 Relay (28 VDC) (NSN: 5945-0-951-6458)
* BA4386/U Battery (NSN: 6135-00-926-8322)
* TA-312/PT Field Telephones (two each)
* Electrical tape
* 18-24 Gauge wire
· Soldering iron and solder
* Wire strippers
* Multimeter or continuity tester
* Knife
* WD-I/TT field wire (as needed)

Procedural Steps:

1. Build the prototype radio remote unit from the schematic using the following steps:

a. Locate the R-3 potentiometer, K-1 relay, and BA4386/U battery. Tape the three components solidly together.
b. Cut the cords from the H-144/U handset and the M-80 microphone.

Procedural Steps (Cont)

NOTE:
Cut as close to the handset and microphone as possible so a long cord and the plug will be intact.

c. Strip 6 inches of outer insulation off the cut end of each of the cords, being careful not to cut the inner wires.

d. Strip 1/2 inch of insulation off the end of each of the exposed wires.

e. Use the multimeter or continuity tester to match the wires with the pins in the plug using referenced letters.

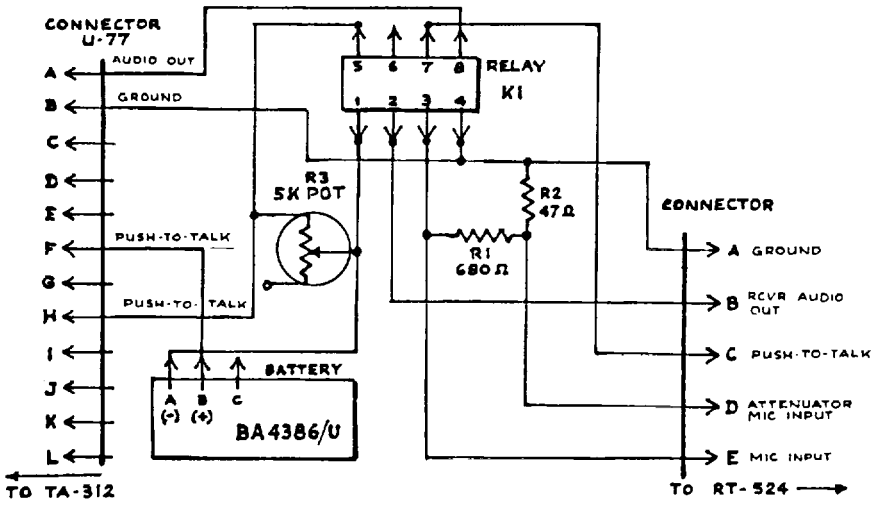
f. Solder the two resistors.

g. Solder the wires to points referenced.

h. Solder the remaining wires using the 18-24 gauge wire.

NOTE

When connecting the wires to the battery plug, ensure they are connected as shown. Pin 6 on K-I relay is not used. Pin C on battery connector is not used. Pins C, D, E, G, I, K, J, and L on the U-77 connectors are not used.



Procedural Steps (Cont)

2. Plug the 5-pin connector into the RT-524 jack marked RETRANSMIT R/W.

3. Plug the 10-pin connector into the receptable on the Number 2 TA-312.

4. Cut the required length of WD-1/TT Field Wire (up to 15 miles).

5. Connect one end of the wires to line jacks I and 2 of TA-312 Number 2 and the other end to line jacks 1 and 2 of TA-312 Number 1.

6. Set the selector switch S1 on both telephones to LB to enable DC switching from the push-to-talk switch.

7. Connect the DC plug from the remote unit into the BA4386/U battery.

8. Turn on all power.

9. Adjust the 5K ohm potentiometer so that the K-1 relay in the remote unit energizes when the press-to-talk switch on TA-312 Number is pressed.

10. Once this setting is found, the potentiometer should be backed off slightly to minimize battery drain.

11. Check all connections and test.

12. Record BDAR action taken. When the mission is complete, as soon as practicable, repair the vehicle using standard maintenance procedures.

14-35. GENERAL INTERCHANGEABILITY INFORMATION

General Information:
Repairs made to combat damaged equipment should be the same as repairs made during the normal maintenance posture. However, due to the extreme nature of damage that might be found in combat-damaged equipment, normal maintenance procedures might not be sufficient. In the interest of rapidly repairing damage to communications system in this situation, it will often be faster to exchange some components rather than repair them. The following is a partial listing of interchangeable parts for the AN/VIC-1 and the AN/VRC-12 as installed in most common tracked vehicles on the battlefield. It is provided as a guide only and is not necessarily a complete listing of all components from other vehicles that could be substituted. Further assistance can be obtained by studying the cording diagrams located in paragraph 14-36. This table considers only US equipment. For information on foreign equipment Interchangeability, refer to paragraph 14-25 through 14-28. Any component that has been replaced should be turned in for repair through the normal channels and thereby returned to the inventory. When time permits, route all replaced cables to conform to the original configuration. If haste is essential, route replaced cables as necessary and secure them where possible to prevent damage to the cables.

EQUIPMENT INTERCHANGEABILITY LISTING (CONT)

Nomenclature	Description	Compatible Component	Compatible Vehicle	Notes
1 ANTENNAS				
AS-1729	N/A	AS-1729	All with radio	2
AS- 1729 Antenna	N/A Receiver	Auxiliary	All with Aux.	1
AT-1095	Top Element	AT-1095	All with radio	2
AT-1730	Bottom Element	AS-1730	All with radio	2
Auxiliary Antenna	N/A	AT-1095	All with radio	2
Auxiliary Antenna Antenna	N/A Receiver	Auxiliary	All with Aux	2
MS-II116A Receiver	Bottom Element MS-I 116A		All with Aux	2
MS-I 17A Receiver	Middle Element	MS-I 17A	All with Aux	2
MS-118A Receiver	Top Element	MS-I 18A	All with Aux	2
MX-6707	Matching unit	AT-912	Some with radio	3
AT-912	Matching unit	MX-6707	Most with radio	3
AB-15 Receiver	Mast Base	AB-558	Most with Aux	2
AB-558 Receiver	Mast Base	AB-15	Most with Aux	2

EQUIPMENT INTERCHANGEABILITY LISTING (CONT)

	Nomenclature	Description	Compatible Component	Compatible Vehicle	Notes
2	INTERCOM				
	AM-1780	Amplifier	AM-1780	All w/AN/VIC-1	2
	C-2296	Outside Control Box	C-2296 AVLB, MAB	M60, M551	2
	C-2297	Drivers Control Box	C-2297 AVLB, MAB	M60, M551	2
	C-2298	Member Control Box	C-10456	M1, M2, M3	2
	C-2298	Member Control Box	C-2298	All w/AN/VIC/I	2
	C-2742	Frequency Selector Box	C-2742	All w/RT-246	2
	C-10456	Control Box	C-10456	MI, M2, M3	2
	C-10456	Control Box	C-2298	All w/AN/VIC-l	1,7
3	CABLES				
	CG-1773	4’10"	CG-1773	M113, M88	2,5
	CG-1773	5’0"	CG-1773	M151, M2, M3	2,5
	CG-1773	6’0"	CG-1773	M60, M578	2,5
	CG-1773	6’6"	CG-1773	M561	2,5
	CG-1773	7’0"	CG-1773	M60, M151	2,5
	CG-1773	8’0"	CG-1773	AVLB, M2, M3	2,5
	CX-4720	2’0"	CX-4720	MAB, M561	2,5
	CX-4720	3’0"	CX-4720	M151, M561	2,5
	CX-4720	4’0"	CX-4720	M113	2,5

EQUIPMENT INTERCHANGEABILITY LISTING (CONT)

Nomenclature	Description	Compatible Component	Compatible Vehicle	Notes
CX-4720	8’0"	CX-4720	M110	2,5
CX-4720	10’0"	CX-4720	AVLB	2,5
CX-4721	2’6"	CX-4721	M551	2,5
CX-4721	3’0"	CX-4721	M113, M151 M1, M561	2,5
CX-4722	4’0"	CX-4721	M2, M3	2,5
CX-4722	3’0"	CX-4722	M113	2,5
CX-4722	4’0"	CX-4722	M88	2,5
CX-4722	5’0"	CX-4722	M2, M3	2,5
CX-4722	6’0"	CX-4722	M60, M561	2,5
CX-4722	7’0"	CX-4722	M151, M578	2,5
CX-4722	8’0"	CX-4722	M2, M3	2,5
CX-4722	20’0"	CX-4722	M901	2,5
CX-4723	2’0"	CX-4723	M551, M561 MAB	2,5
CX-4723	3’0"	CX-4723	M60, M551 M2, M3, MAB	2,5
CX-4723	4’0"	CX-4723	M901, M109	2,5
CX-4723	4’6"	CX-4723	M561 MI, M2, M3, M88	2,5
CX-4723	5’0"	CX-4723	M113, M901, M561, M551, M577, AVLB	2,5
CX-4723	6’0"	CX-4723	AVLB	2,5

EQUIPMENT INTERCHANGEABILITY LISTING (CONT)

Nomenclature	Description	Compatible Component	Compatible Vehicle	Notes
CX-4723	7’0"	CX-4723	M1, M2 M3, M110	2, 5,
CX-4723	8’0"	CX-4723	M2, M88, M110 M151, MAB	2, 5
CX-4723	9’0"	CX-4723	M60, M88, M113, M577, M578, M901	2, 5
CX-4723	10’0"	CX-4723	M60, MAB M88, M578	2, 5
CX-4723	12’0"	CX-4723	M3	2, 5
CX-4723	13’0"	CX-4723	M88	2, 5
CX-4723	14’0"	CX-4723	M551	2, 5
CX-4723	15’0"	CX-4723	M2, M109	2, 5
CX-4723	16’0"	CX-4723	M60, M901	2, 5
CX-4723	18’0"	CX-4723	M110	2, 5
CX-4723	20’0"	CX-4723	M1, M60	2, 5
CX-4723	21’0"	CX-4723	M1	2, 5
CX-7058	2’0"	CX-7058	M60	2, 5
CX-7058	4’0"	CX-7058	M561	2, 5
CX-7058	5’0"	CX-7058	M113	2, 5
CX-7058	8’0"	CX-7058	M1, M551	2, 5
CX-7058	9’0"	CX-7058	M551	2, 5
CX-7059	9’0"	CX-7059	M60	2, 5

EQUIPMENT INTERCHANGEABILITY LISTING (CONT)

Nomenclature	Description	Compatible Component	Compatible Vehicle	Notes
CX-7059	10’0"	CX-7059	M151	2, 5
CX-7059	22’0"	CX-7059	M1	2, 5
CX-7060	1’6"	CX-7060	M1, M60	2, 5
CX-7060	2’0"	CX-7060	M60	2, 5
CX-7060	3’0"	CX-7060	M2, M3, M60, M110, M578	2, 5
CX-7060	4’0"	CX-7060	M1, M2, M60	2, 5
CX-7060	6’0"	CX-7060	M110	2, 5
CX-7060	9’0"	CX-7060	M2, M3	2, 5
CX-7060	14’0"	CX-7060	M3, M578	2, 5
CX-8650	Y Cord	CX-8650	A11 w/AN/VIC-1	2, 6
CX-9640	1’6"	CX-9640	M109	2, 5
CX-9640	2’6"	CX-9640	M109	2, 5
CX-13089	2’1"	CX-13089	M109	2, 5
CX-13089	3’0"	CX-13089	M88	2, 5
CX-13089	7’0"	CX-13089	M2, M3	2, 5
CX-13089	10’0"	CX-13089	M578	2, 5
B-4005084	8’0"	B-4005084	M1	2, 5
B-4005084	8’0"	CG-1773	AVLB, M2, M3	2, 5
B-4005084	14’0"	B-4005084	M1	2, 5
SC-D-690731	7’0"	SC-D-690731	M1	2, 5
SC-D-866546	7’0"	SC-D-866546	M1	2, 5

EQUIPMENT INTERCHANGEABILITY LISTING (CONT)

Nomenclature	Description	Compatible Component	Compatible Vehicle	Notes
SC-D-866547	10’0"	SC-D-866-547	M1	2, 5
SC-D-866551	8’2"	SC-D-866551	M1	2, 5
4. CVC HELMETS				
CVC	MK-1039	DH-132	Most with AN/VIC-1	2, 6
DH-132	MK-1697	CVC	Older Vehicles w/AN/VIC-1	2, 6
5. MOUNTS				
MT-1029	Radio	MT-1029	All with radio	2, 8
MT-1898	Aux Receiver	MT-1898	All with Aux. Receiver	2, 8
MT-3823	KY-38	MT-3823	All w/KY-38	2
MT-4626	KY-57	MT-4626	All w/KY-57	2
AM-2060	RTB-841	AM-2060	All w/RT841	2
6. RADIO EQUIPMENT				
RT-246	Receiver Transmitter	RT-246, RT-524, RT-841	All with radio	2, 9
RT-524	Receiver Transmitter	RT-246, RT-524, RT-841	All with radio	2, 9
RT-841	Receiver Transmitter	RT-246, RT-524, RT-841	All with radio	2, 9
R-442	Auxiliary Receiver	R-442	All with Aux Receiver	2, 9

EQUIPMENT INTERCHANGEABILITY LISTING (CONT)

	Nomenclature	Description	Compatible Component	Compatible Vehicle	Notes
7	TRANSIENT VOLTAGE SUPPRESSORS				
	MK-2096	Mini-Suppressor	MK-2096	M1, M2, M3	2
	MX-7777, MX-7778	Suppressor	MK-2096 MX-7778 MX-7777	All w/AN/VIC-1	2
8	SPEECH SECURITY EQUIPMENT				
	AM-4979	Amplifier	AM-4979	M113	2
	J-2731	Distribution Box	J-2731	M113, M60 M577, M578, M88	2
	J-3024	Interconnecting Box	J-3024	M88, M113, M577, M578, M60	2
	KY-38	SSE	KY-38	All w/KY-38	2
	KY-57	SSE	KY-57	All w/KY-57	2
	Z-ACD( )	Power Unit	Z-ACD( )	All w/KY-38	2
9	SSE CABLES FOR KY-38				
	CX-10475	1’7"	CX-10475	M60	2, 5
	CX-10475	4’0"	CX-10475	M113, M88, M577, M578	2, 5
	CX-10475	10’0"	CX-10475	M113	2, 5
	CX-10539	4’0"	CX-10539	M113, M48, M577	2, 5
	CX-10539	6’0"	CX-10539	M113, M60	2, 5
	CX-11996	6’0" x 3’0"	CX-11996	M88	2, 5
	CX-11996	12’0" x 3’0"	CX-11996	M48, M60	2, 5

EQUIPMENT INTERCHANGEABILITY LISTING (CONT)

Nomenclature	Description	Compatible Component	Compatible Vehicle	Notes
CX-11996	14’0" x 3’0"	CX-11996	M60, M113	2, 5
CX-11996	10’0" x 5’0"	CX-11996	M577, M578, M113	2, 5
CX-12126	5’0"	CX-12126	M113	2, 5
CX-12126	8’0"	CX-12126	M113	2, 5
CX-12195	4’0"	CX-12195	M578, M88 M113, M577	2, 5
CX-12195	6’0"	CX 12195	M113, M48	2, 5
CX-12195	10’0"	CX-12195	M60	2, 5
CX-12925	6’0"	CX-12925	M113	2, 5
Power Cable	Y	Power Cable	All w/KY-38	2

NOTES

NOTE #1 - System is slightly degraded. Replace with original component as soon as possible.

NOTE #2 - No degradation. Continue normal mission.

NOTE #3 - No degradation, electronically compatible; however, adapter bracket may have to be locally fabricated as AT-912 may not bolt into same holes. Also, antenna element AT-1096 must be used in lieu of antenna element AS-1730.

NOTE #4 - This precludes usage of RT-524 and should not be done unless RT-524 is inoperative.

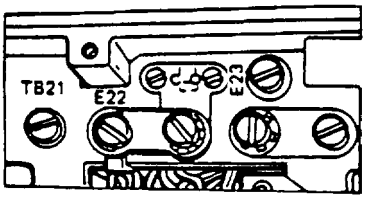
NOTE #5 - Any cable with the same number can be substituted if it is of an equal length to or longer than the cable being replaced. Most of the time a shorter cable can also be used by routing it in the most direct path between components. Additionally, two shorter cables can be spliced together to attain the desired length.

NOTES (Cont):

NOTE #6 - Ensure the connector compatability. If the older type CVC helmet is substituted for the DH-132 series helmet then the cord assembly CX-8650 B/GR must also be exchanged with the CVC-helmet.

NOTE #7 - This exchange will remove the capability to key the intercom or radio by any means other than by the switch located on the CVC helmet.

NOTE #8 - If the mount is from any vehicle other than a vehicle with the AN-VIC-1 intercom then the "Pivot terminal link" must be in position as shown



NOTE #9 - If the R/T or aux receiver is from a vehicle not utilizing speech security equipment then the X-mode position switch may have to be changed. Turn your R/T ON and see below procedures.

A Set the R/T SQUELCH control on OLD ON.

B Remove the cover from the X-MODE receptable, if the CALL light comes on, the switch is in X-MODE, **BUT** if the CALL light does not come on, the switch is in NORMAL. Organizational or higher maintenance should then:

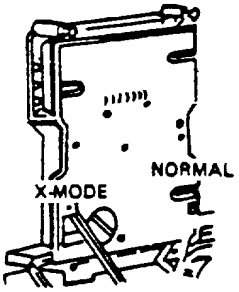
C Remove R/T from ount, turn R/T upside down.

D Remove bottom cover from R/T.

E Loosen assembly A4000 captive screws.

F Raise assembly A4000 and lock brace.

G Turn X-MODE-NORMAL switch to X-MODE.



H Be sure leaf springs are equally curved.

I Lower assembly A4000 and tighten captive screws,

J Be sure assembly hinge pin is pushed all the way in.

K Replace bottom cover of R/T.

L Replace R/T on to mount.

NOTE (Cont):

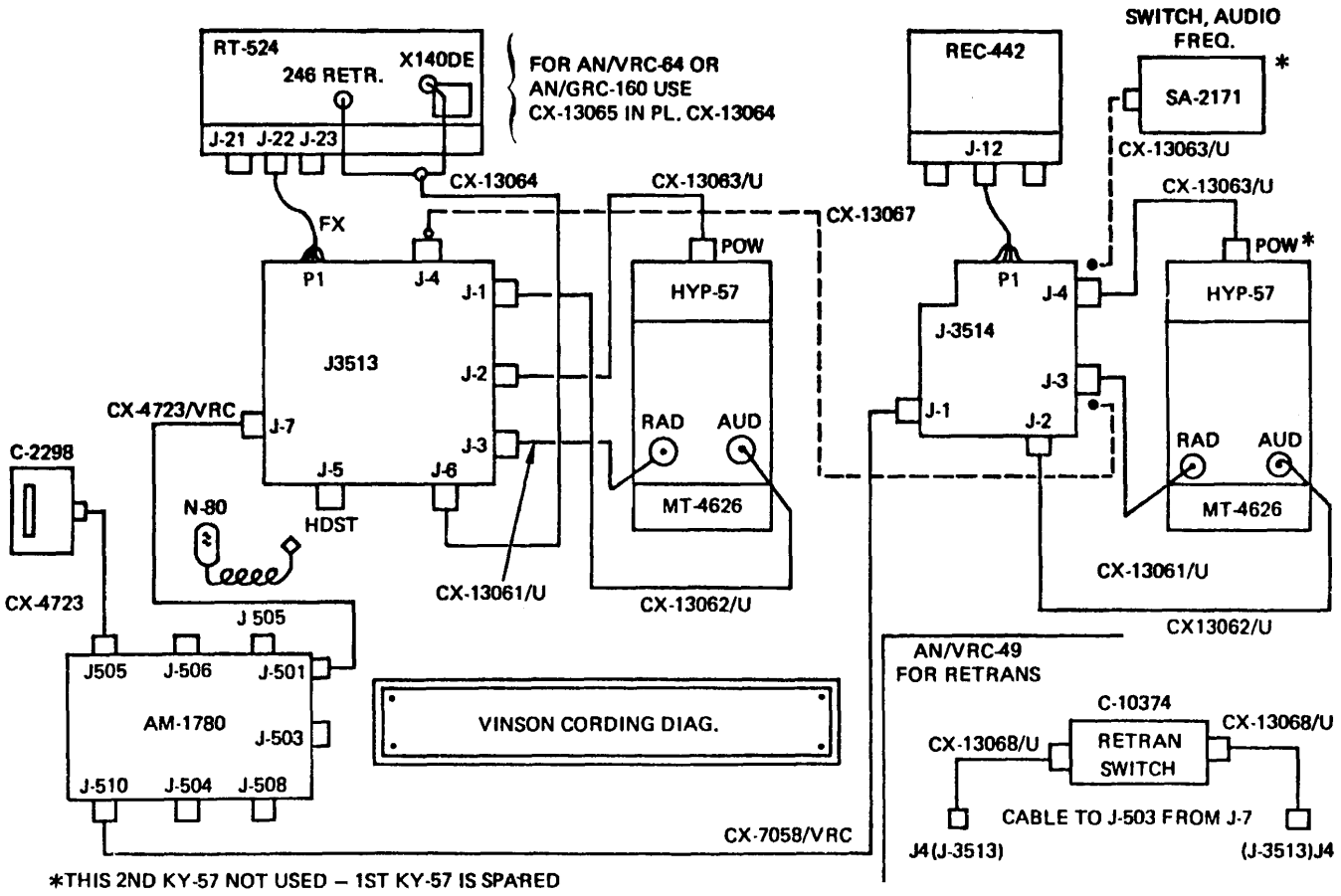
If the AUX receiver is to be used in the X-MODE communications hookup, it must be opened up and its switch set to X-MODE.
The AUX receiver switch must be placed in NORMAL after you are through with the X-MODE hook-up.

NOTE #10 - Loss of automatic channel selection if RT-246 is being used.

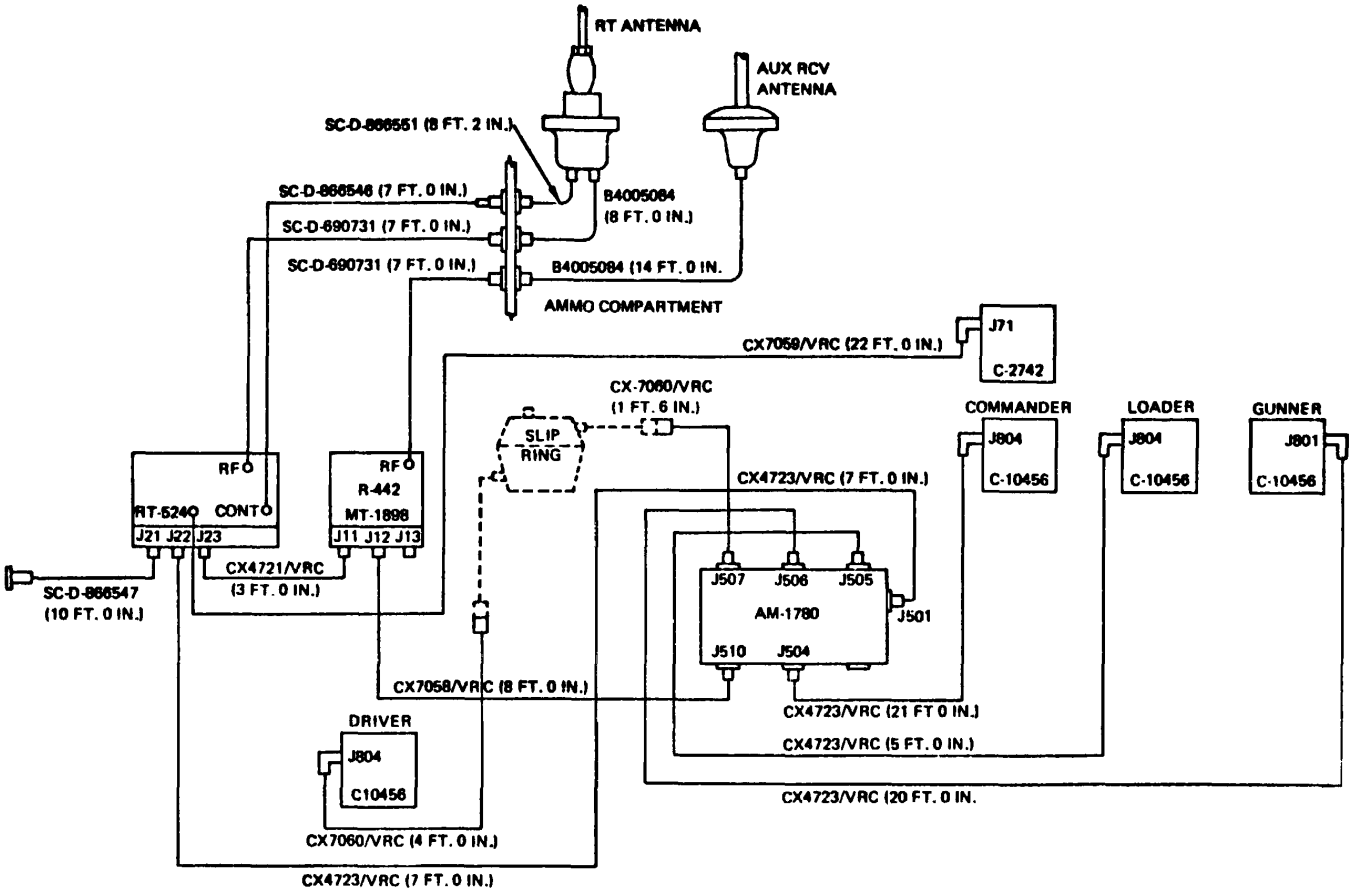
Section V. Common Vehicle Cording Diagrams

14-36. GENERAL.

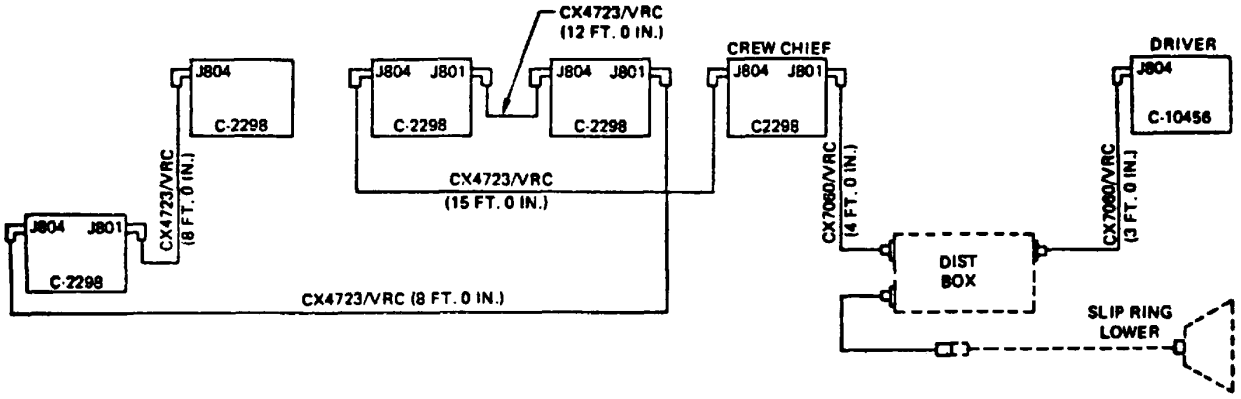
Cording diagrams for common U.S. vehicles on the battlefield have been provided in this section to aid in identifying components and cables that are interchangeable. These diagrams also assist in identifying cables without having to trace them throughout the vehicle.



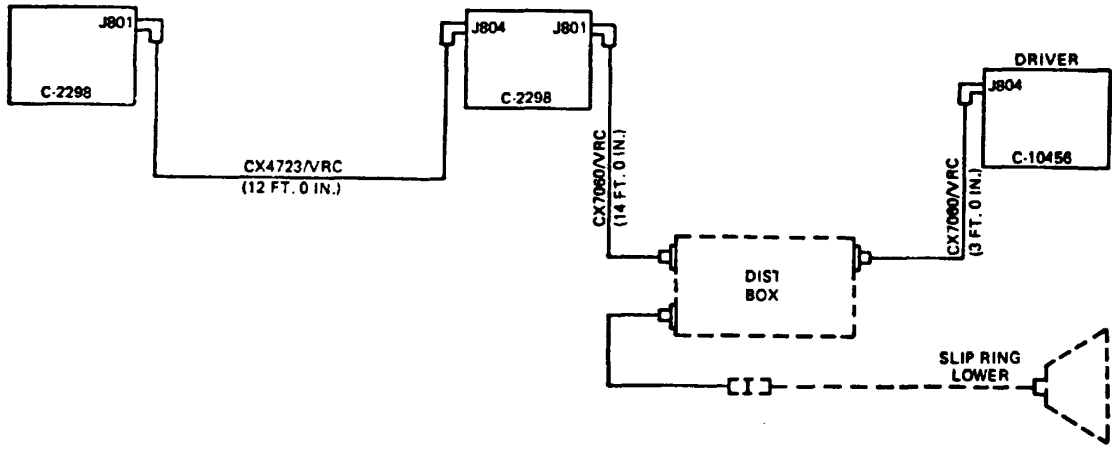
KY-57 General Configuration



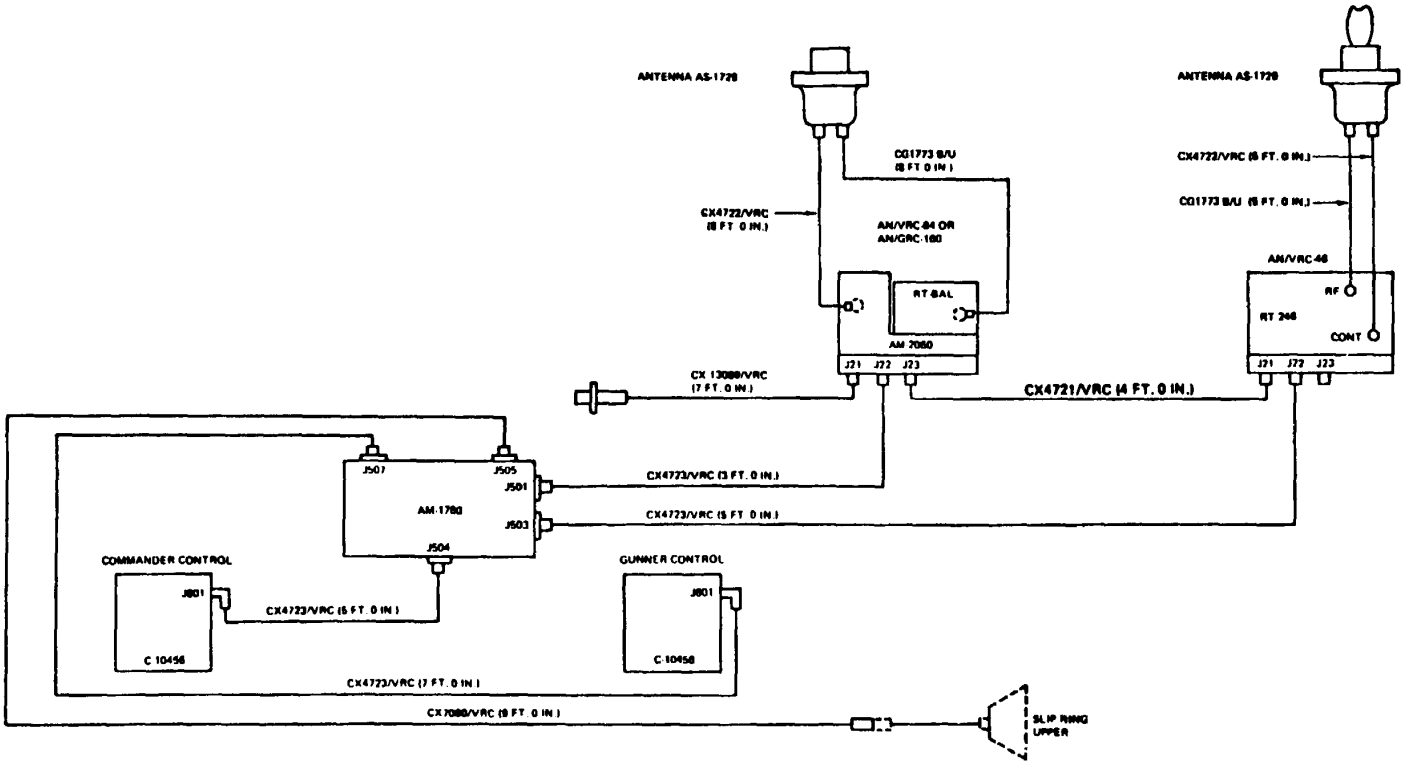
AN/VIC-1 and AN/VRC-12 in M1 Tank



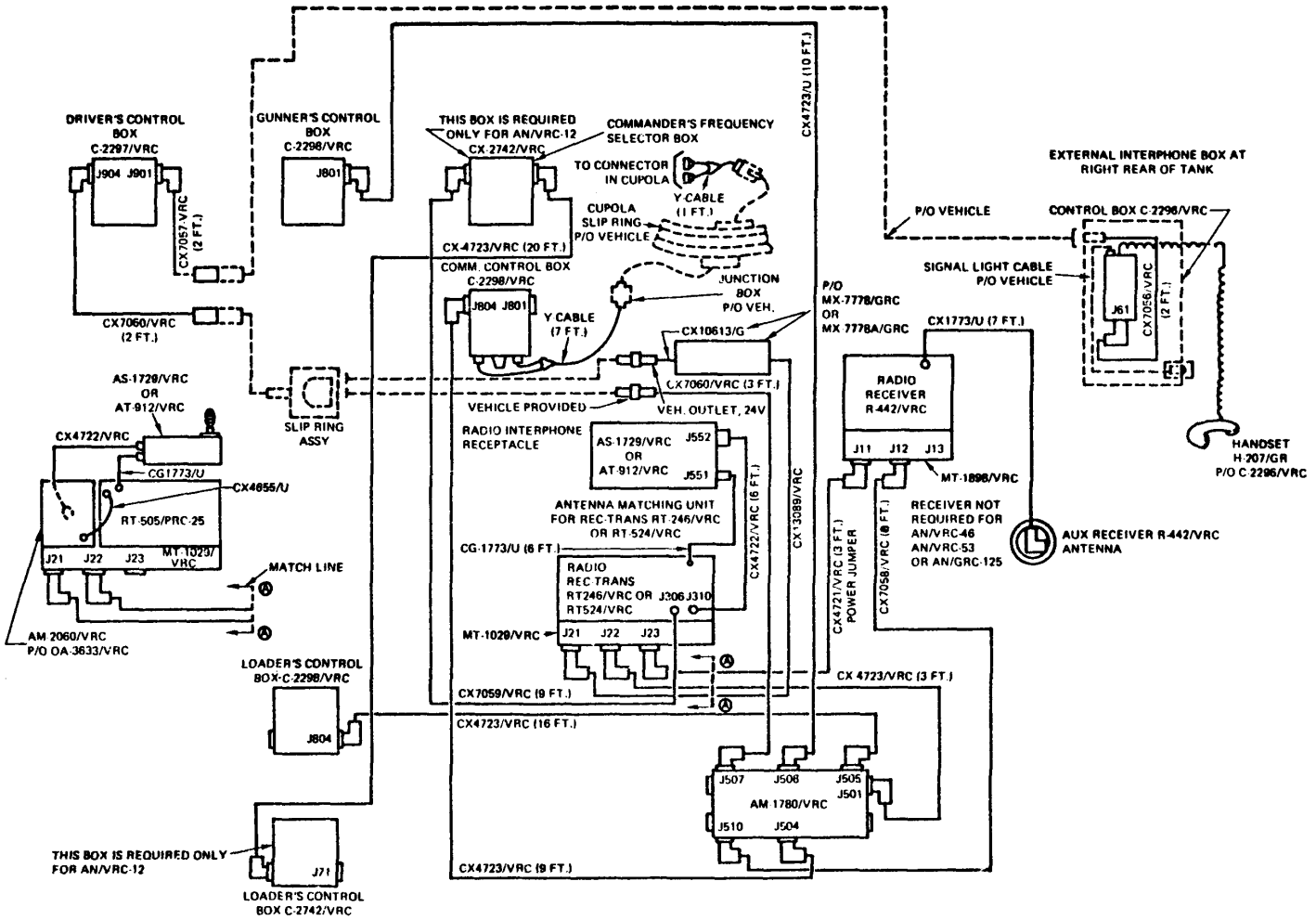
AN/VRC-46, AN/VRC-64, or Two AN/GRC-160's with AN/VIC-1 in M2 (chassis)



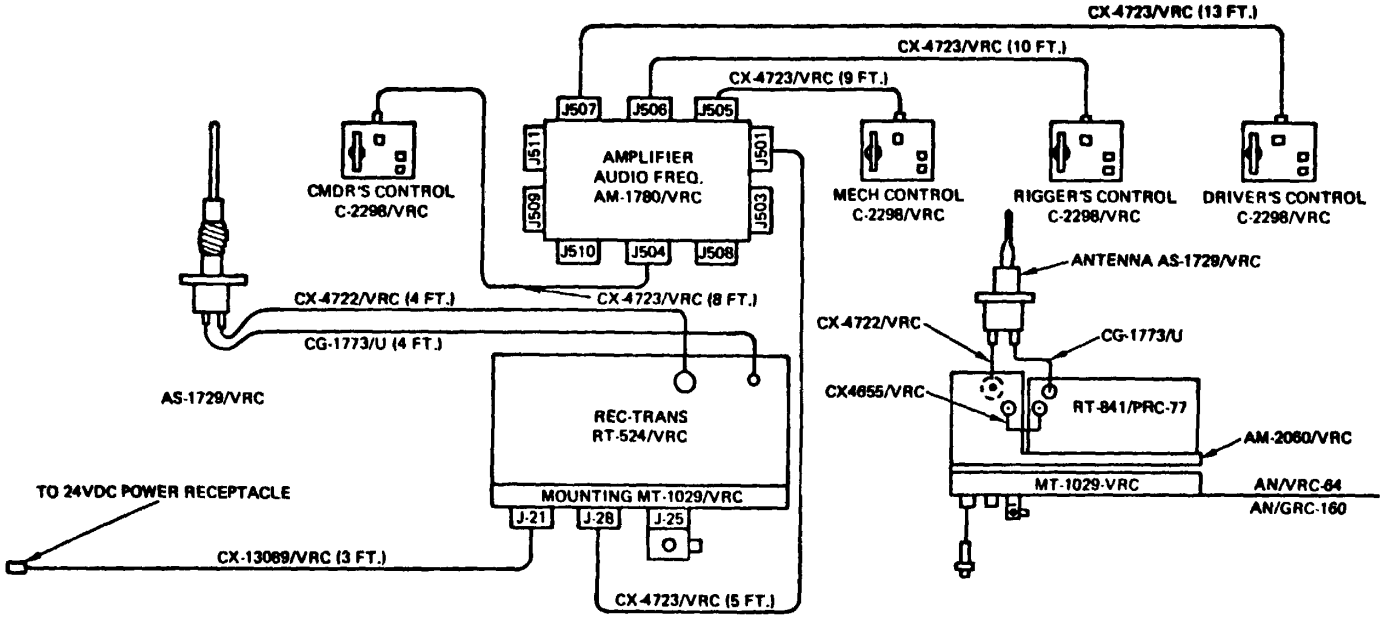
AN/VRC-46, AN/VRC-64, or Two AN/GRC-160's with AN/VIC-1 in M3 (chassis)



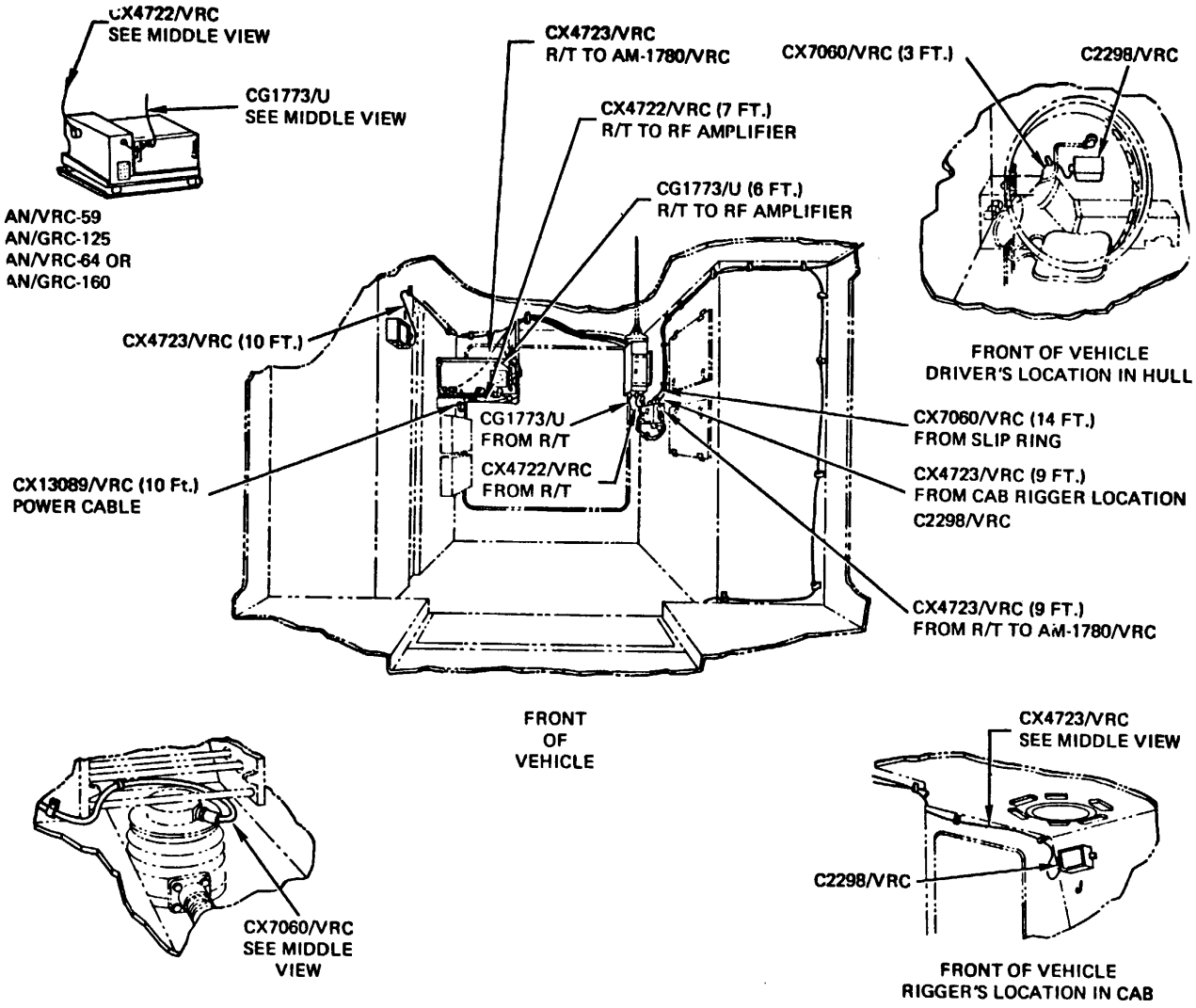
AN/VRC-46, AN/VRC-64, or Two AN/GRC-160's with AN/VIC-1 in M2 and M3 (Turret)



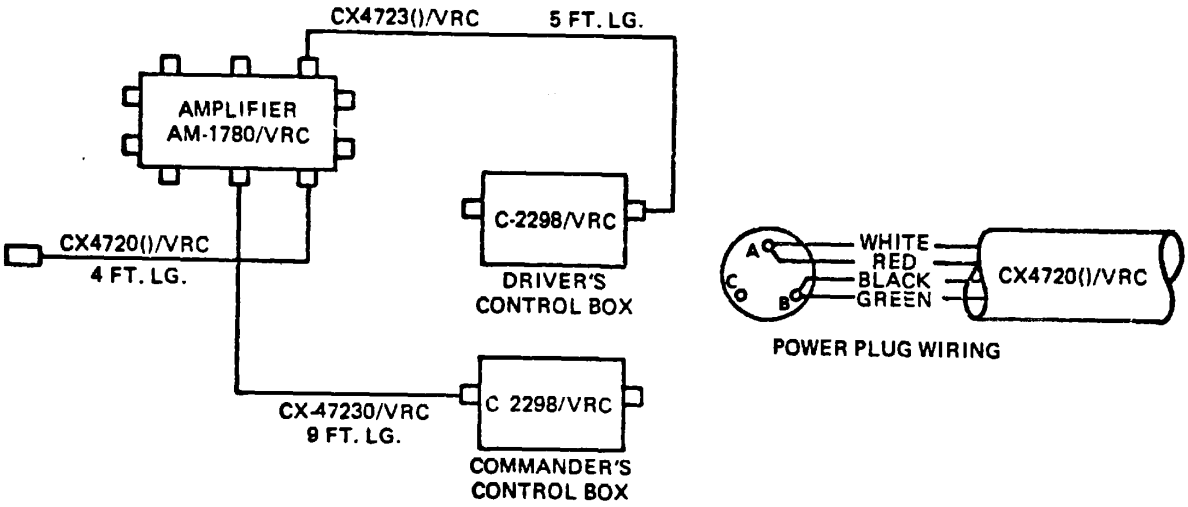
AN/VIC-1 and AN/VRC-12 in M60A1 Tank



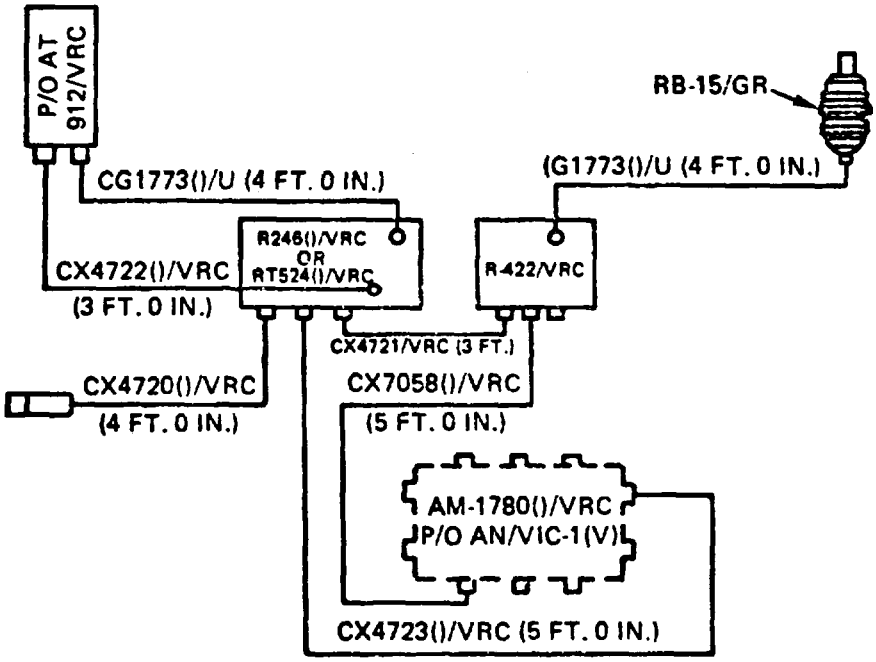
AN/VRC-46, AN/VRC-64, or AN/GRC-160 with AN/VIC-1 in M88A1



AN/VRC-46, AN/VRC-53, AN/GRC-125, AN/VRC-64, OR AN/GRC-160 and AN/VIC-1 in M578

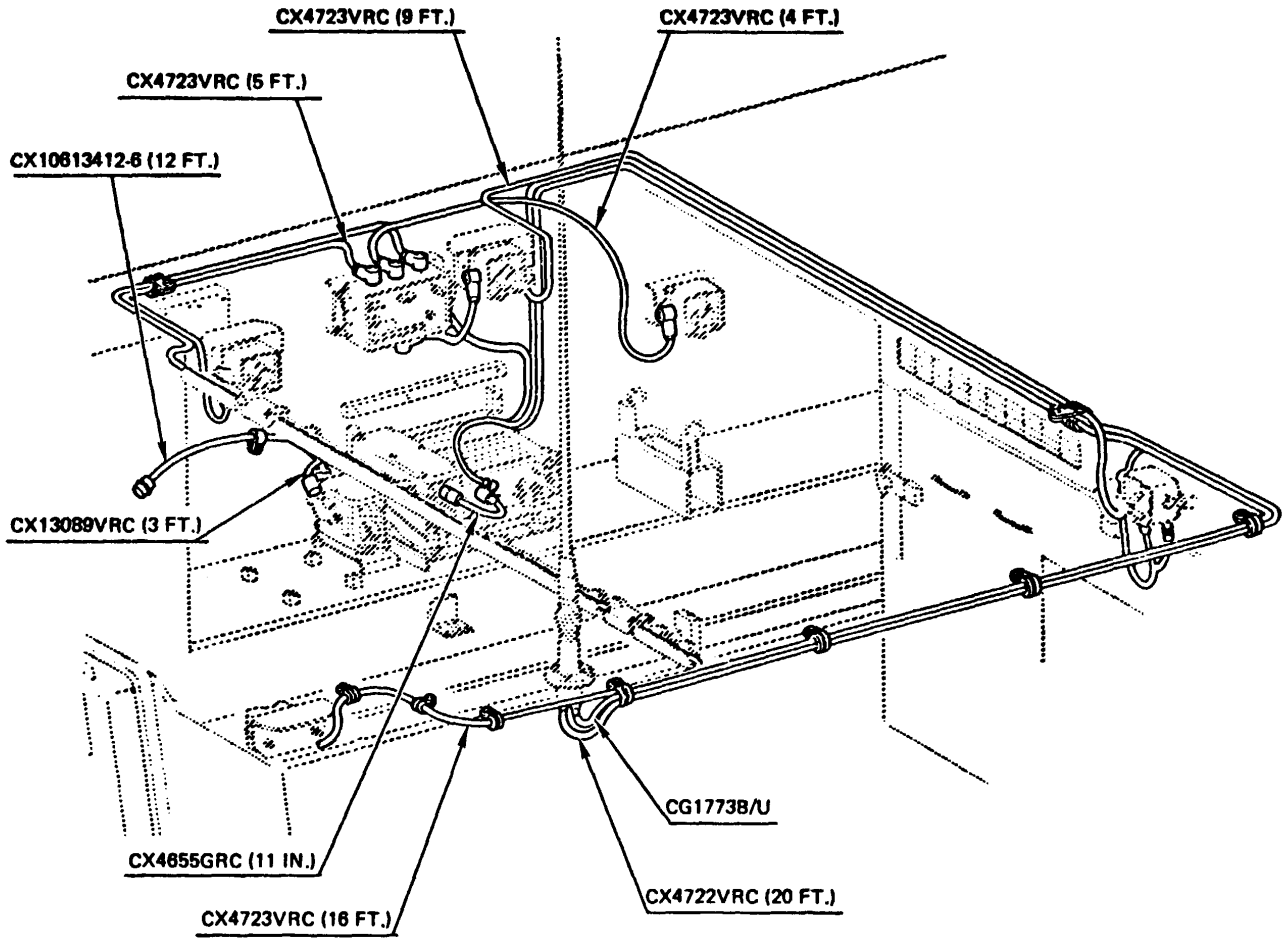


AN/VIC-1 in M113 and M577

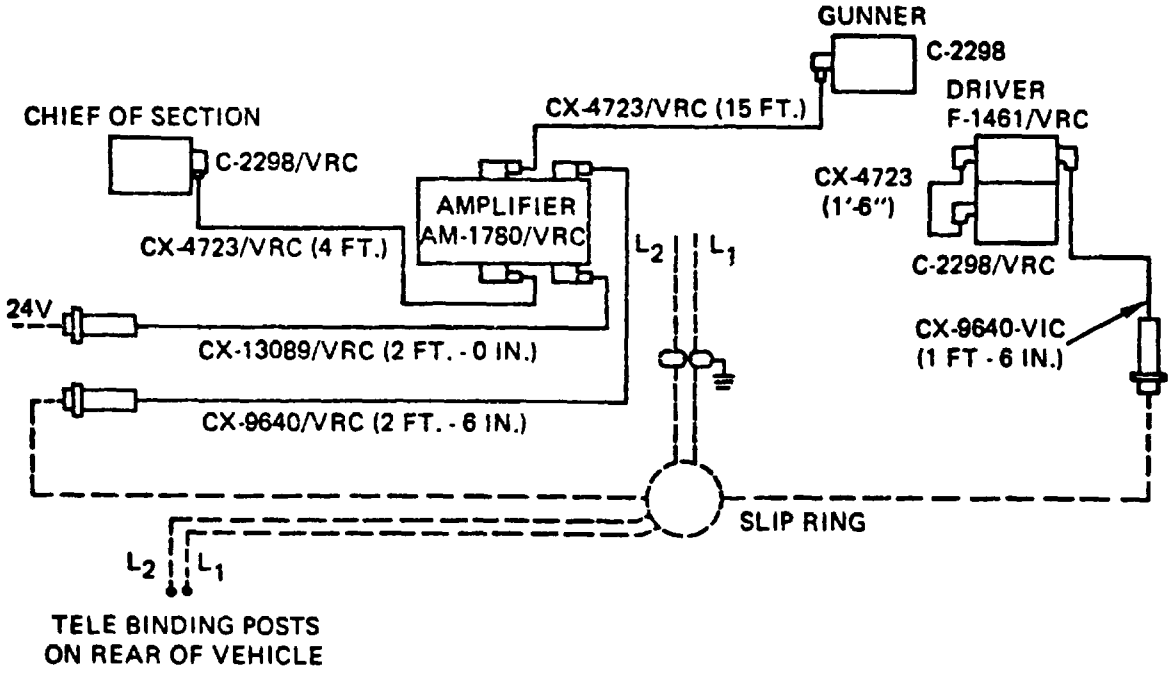


(CORDS MUST ENTER AM-1780( )/VRC AS SHOWN)

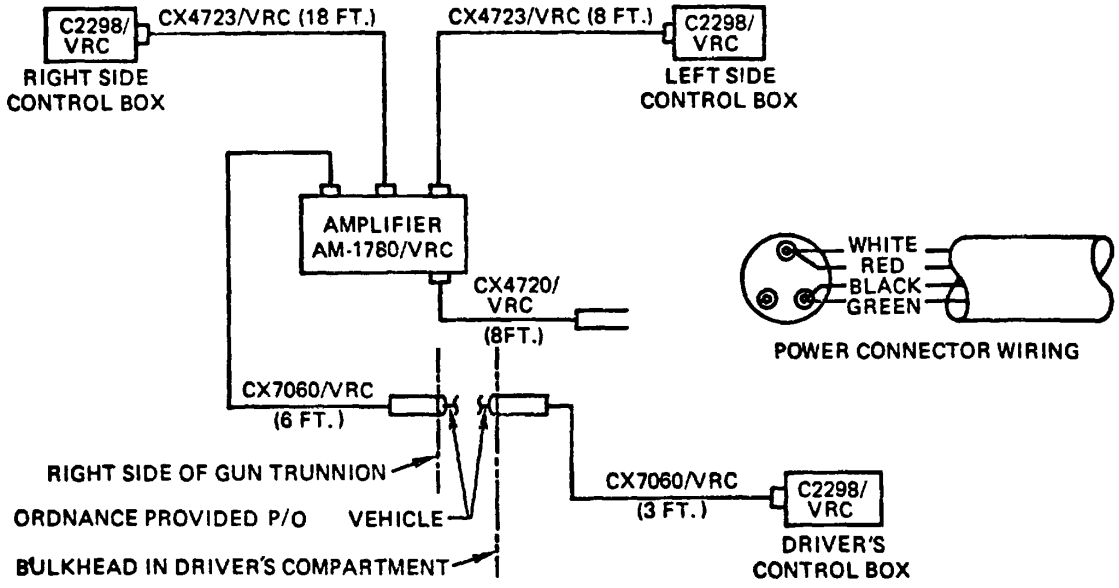
AN/VRC-12 in M113 Family



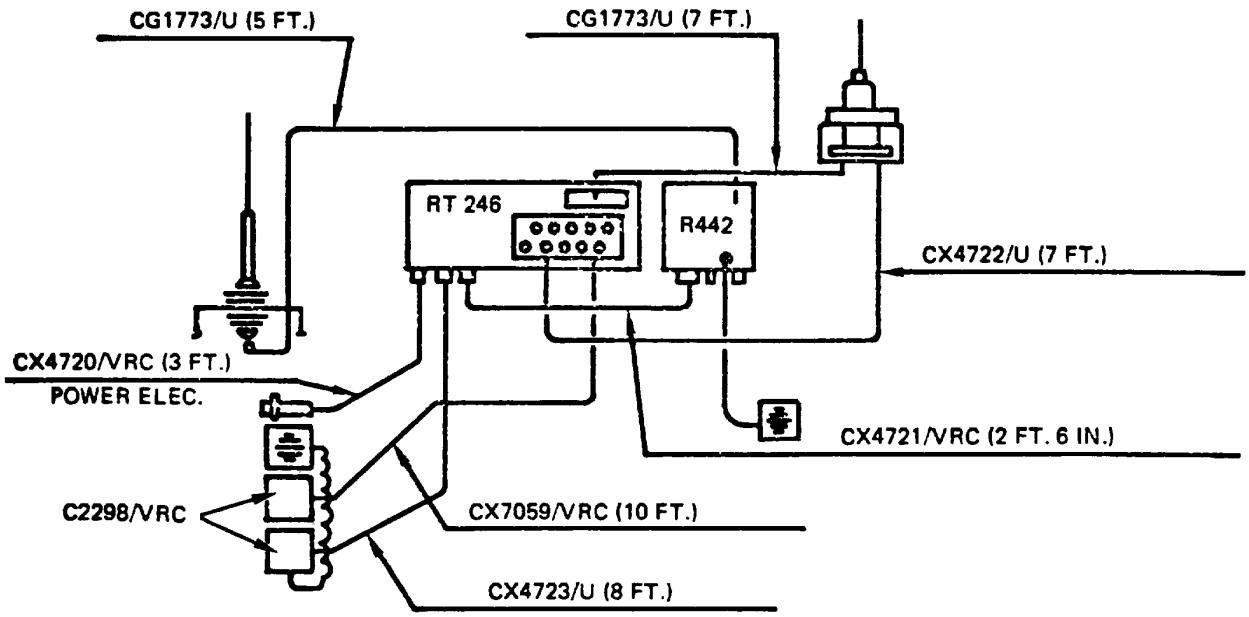
AN/GRC-160 and AN/VIC-1 in Improved TOW Vehicle M901



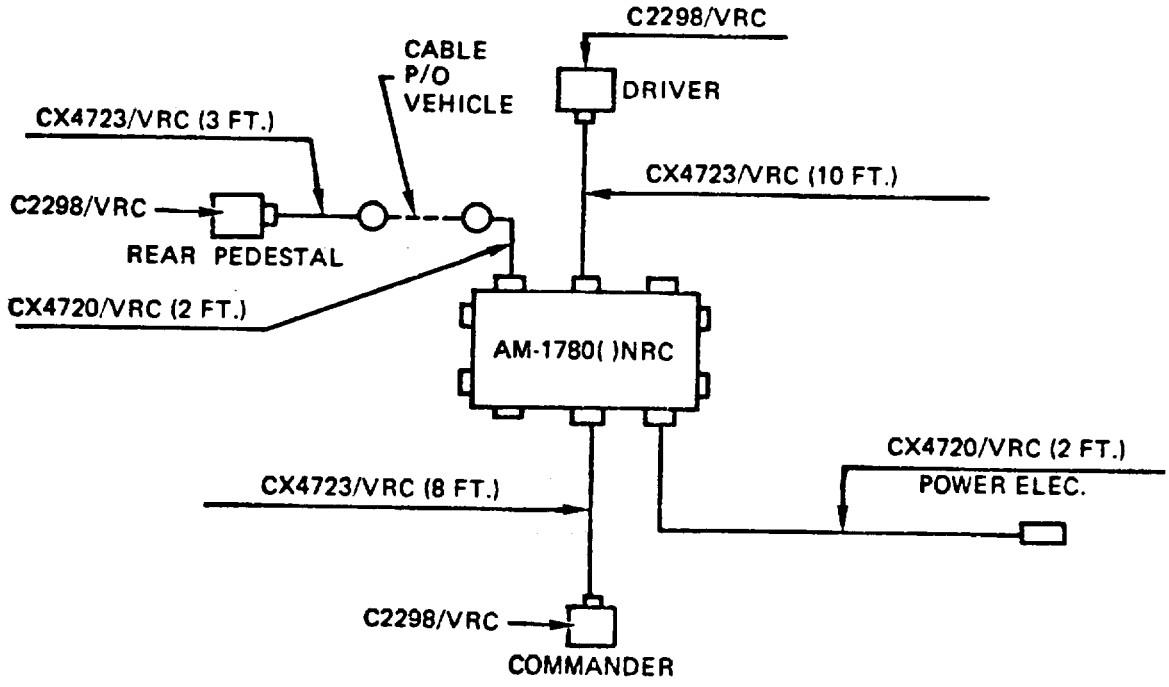
AN/VIC-1 in M109A2 and M109A3



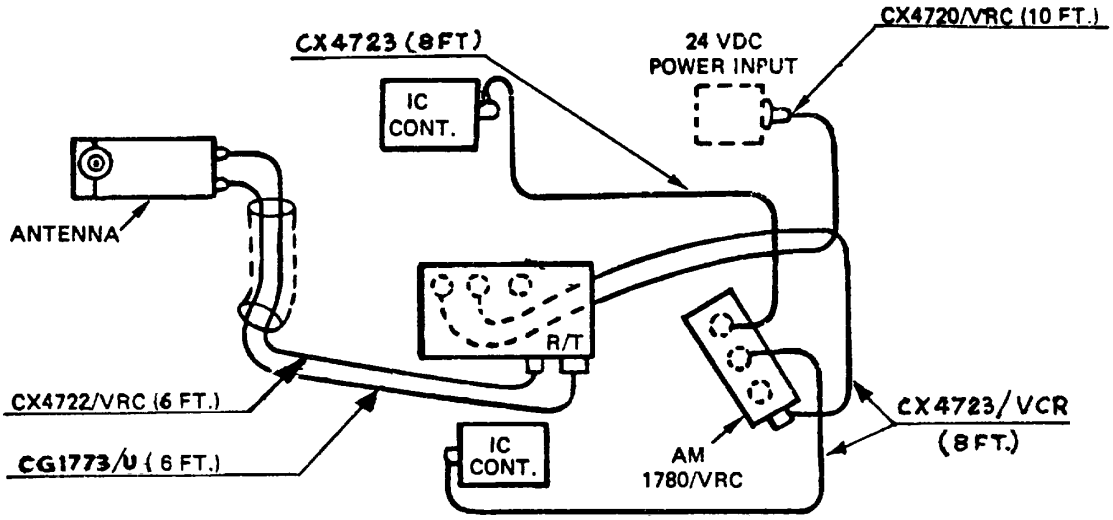
AN/VIC-1 in M107 and M110



AN/VRC-12 in 1/4-ton Truck, M151A1

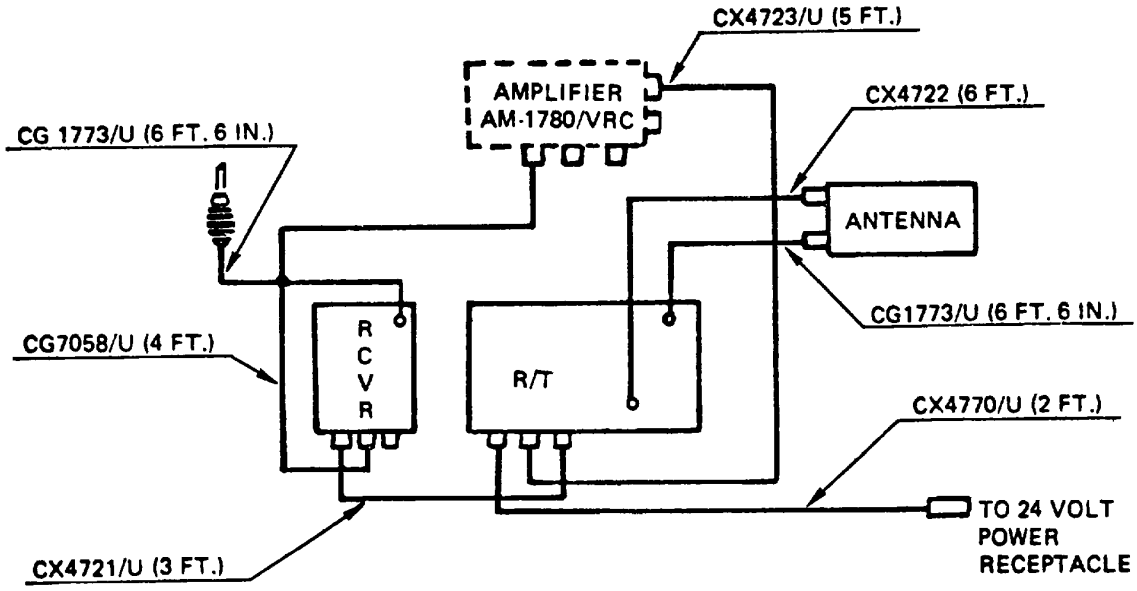


AN/VIC-1 in Mobile Floating Assault Bridge/Ferry

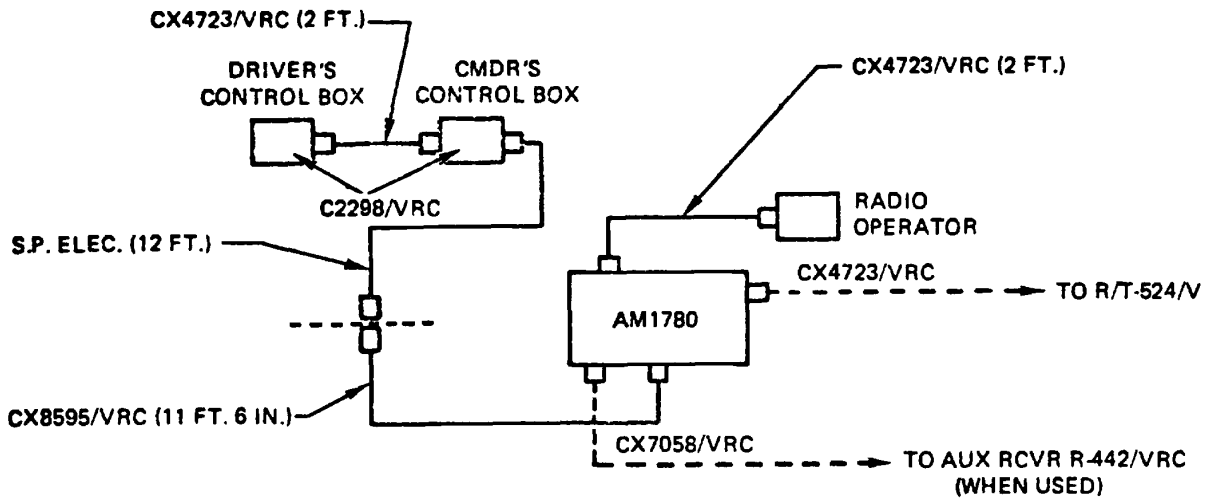


NOTE: THERE IS A 40 FT. AUDIO EXTENSION CABLE AND RF CABLE BETWEEN THE MX-707 AND THE R/T.

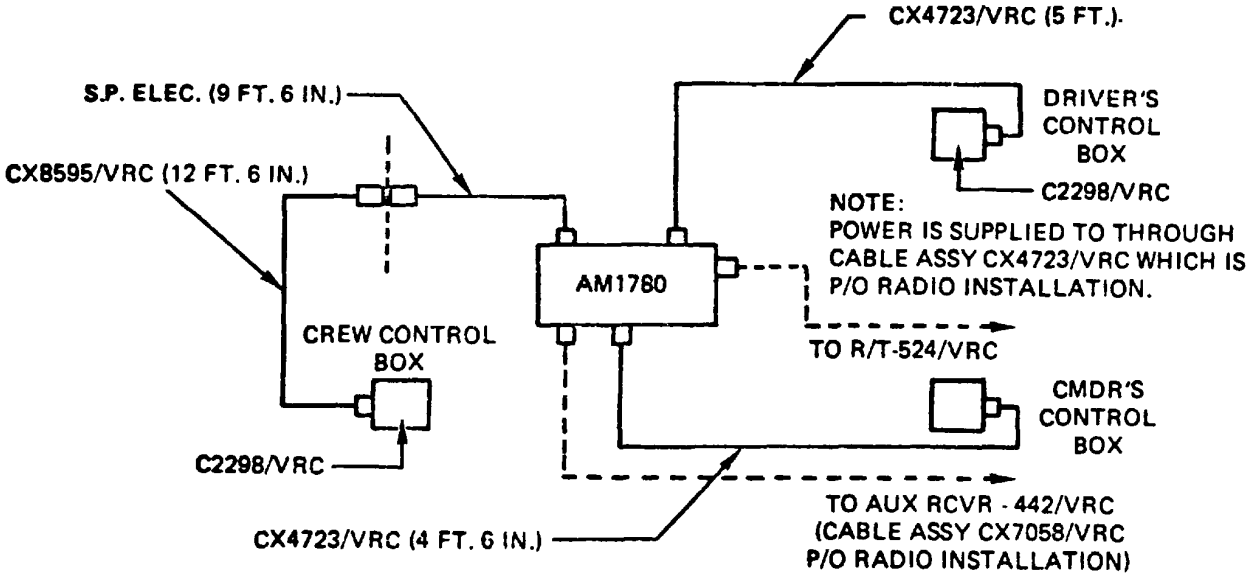
AN/VRC-12 and AN/VIC-1 in AVLB (M60 Chassis)



AN/VRC-12 or AN/VRC-47 in M561



AN/VIC-1 in M561 Commo Vehicle, Radio Sets in Rear



AN/VIC-1 in M561 Commo Vehicle, Radio Sets in Cab

APPENDIX A

ALTERNATE SOURCES OF SUPPLY

**BDAR FIXES SHALL BE USED ONLY IN COMBAT
AT THE DISCRETION OF THE COMMANDER
AND SHALL BE REPAIRED BY STANDARD MAINTENANCE PROCEDURES
AS SOON AS PRACTICABLE AFTER THE MISSION IS COMPLETED.**

SECTION I. General.

A-1. General.

This appendix lists alternate sources of supply to include foreign ownership of US combat vehicles and expendable supplies which may be utilized for repairs on this vehicle.

SECTION II. Foreign Ownership of US Weapons Systems

A-2. General.

Repair parts are expected to be in short supply. Parts may be available from other nations involved in the immediate combat areas. Friendly nations owning US weapons systems may have stocks of repair parts or equipment available for cannibalization. The following tables identify nations owning American combat vehicles.

Table A-1.

North American and Europe

	Tank M60/M48 Family	M113 FOV	S.P. How M110	S.P. How M109	S.P. How M108	S.P. How M107	Lance
Austria	X			X			
Belgium		X	X	X	X		X
Britian			X			X	X
Canada		X		X			
Denmark		X		X			
Fed Rep Ger	X	X	X	X		X	X
Greece	X	X	X	X			X
Italy	X	X		X			X
Netherlands		X	X	X		X	X
Norway	X	X		X			
Portugal	X	X		X			
Spain	X	X	X	X	X	X	
Turkey	X	X	X				
Switzerland		X		X			

Table A-2.

Asia

	Tank M60/M48 Family	M113 FOV	S.P. How M110	S.P. How M109	S.P. How M108	S.P. How M107	Lance
Japan			X				
New Zealand		X					
Pakistan	X	X		X			
Philippines		X					
Singapore		X					
South Korea	X	X	X	X		X	
Taiwan	X	X	X	X	X		
Thailand	X	X					
Viet Nam	X	X	X	X		X	

Table A-3.

Africa and Middle East

	Tank M60/M48 Family	M113 FOV	S.P. How M110	S.P. How M109	S.P. How M108	S.P. How M107	Lance
Egypt	X	X					
Ethopia		X		X			
Iran	X	X	X	X			
Israel	X	X		X		X	X
Jordan	X	X	X	X			
Kuwait		X					
Lebanon	X	X					
Libya		X		X			
Morocco	X	X		X			
North Yeman	X	X					
Oman	X						
Saudia Arabia	X	X	X				
Sudan	X	X					
Tunisia	X	X					
Zaire		X					

SECTION III. Expendable Supplies

A-3. General.

This appendix lists items recommended for the support of combat vehicles in a combat environment. The lists include expendable supplies and materials which may be used to expedite BDAR repairs in a combat situation. The items listed may be required for Battlefield Damage Assessment and Repair at maintenance levels from crew through DS.

The column marked "Level" indicates the maintenance level at which it is recommended these items be stocked or carried. The unit commander may modify the items in the list and the maintenance levels carrying the items, based on current mission requirements and recent operational experience.

The items marked "C" (Crew) are recommended to be carried on the vehicle for use in combat emergencies at the discretion of the unit commander. Those items marked "MT" are recommended to be carried be each Battlefield Damage Assessment and Repair Maintenance Team (MT). Some of these items may already be available at organizational maintenance, however, additional items will be required to stock each MT. Those items marked "O" are recommended to be stocked at organizational level and those marked "MST" are recommended to be carried by the DS Maintenance Support Team (MST).

EXPENDABLE SUPPLIES

ITEM NUMBER	LEVEL	NSN	DESCRIPTION	U/I
1	0	8040-00-831-3403	Adhesive, epoxy 1 pt	kt
2	0	8040-00-828-7385	Adhesive/Sealant, silicone rubber, GE RTV 103	tu
3	0	8040-00-738-6429	Adhesive, epoxy	kt
4	MT	5999-00-661-0416	Cap, electrical: crimp style	pkg
5	C	8030-00-159-5032	Cement, epoxy, devcon F-2	kt
6	C	4730-00-289-5909	Clamp, hose: 3/8 in. to 1 in.	ea
7	C	4730-00-908-3193	Clamp, hose: 1 1/16 in. to 2 in.	ea
8	C	5350-00-192-5047	Cloth, abrasive: al-oxide 1/09 in. w, 11 in. lg (50 sheets)	pkg
9	MT	5315-00-598-5916	Cotter pin assortment	At
10	MT	5940-00-296-5326	Ferrule, electrical: wristlock type 22-14 wire size (10 in pkg)	pkg
11	0	5330-00-291-1605	Gasket, cork, 1/32 in.	sh
12	0	5330-00-171-9134	Gasket, cork, 3/16 in.	sh
13	C	5330-00-467-3615	Gasket, material, 1/32 in. (w.o.g. resistant)	sh
14	C	5330-00-223-5845	Gasket, material, 1/64 in. (w.o.g. resistant)	sh
15	0	5330-00-467-3615	Gasket, material, 1/32 in. (w.o.g. resistant)	sh

EXPENDABLE SUPPLIES (Cont)

ITEM NUMBER	LEVEL	NSN	DESCRIPTION	U/I
16	0	4720-00-623-9178	Hose, non-metallic, 1/4 in. ID	ft
17	0	4720-00-169-5112	Hose, non-metallic, 1/2 in. ID	ft
18	0	4720-00-288-9873	Hose, non-metallic, 3/4 in. ID	ft
19	0	8010-00-515-2487	Lacquer, insulating, electrical	pt
20	0	5310-00-297-3751	Nut Assortment	at
21	MT	5330-00-966-8657	Packing Assortment (O-rings)	ea
22	0	9650-00-264-5050	Pig Lead, 5 lb	lb
23	0	5410-00-793-2021	Repair Kit, electronic equipment shelter (fiberglass)	ea
24	C	4020-00-968-1352	Rope, polypropylene (600 ft roll)	roll
25	MT	5320-01-004-0238	Rivet, pop, steel, SB4-2, 1/8 in. dia 1/8 in. lg (quantity 100)	hd
26	MT	5320-01-028-6621	Rivet, pop, steel, SB4-4, 1/4 in. dia 1/4 in. lg (quantity 50)	box
27	MT	5320-00-510-7823	Rivet, pop, aluminum, AB-2A 1/8 in. dia 1/8 in. lg	ea
28	MT	5320-00-408-6073	Rivet, pop, aluminum, AB6-2A 3/16 in. dia 1/8 in. lg	hd
29	MT	8030-00-656-1426	Sealing Compound, gasket, non-hardening	Pt
30	0	5335-00-054-5273	Screen Wire Mesh 60 in. x 150 ft	roll

EXPENDABLE SUPPLIES (Cont)

ITEM NUMBER	LEVEL	NSN	DESCRIPTION	U/I
31	0	8030-00-935-1083	Sealant, asphalt base, 8-lb	can
32	0	8030-00-965-2004	Sealant, synthetic rubber 1 pt	kt
33	0	8030-00-881-5238	Sealant and Puttying Compound Kit: kit no. 3 qt	kt
34	MT	5305-00-275-4073	Set Screw Assortment	at
35	MT	5940-00-840-0139	Splice, conductor: crimp style, wire size 10	ea
36	MT	5940-00-500-8723	Splice, conductor: crimp style, wire size 10	ea
37	C	5975-00-451-5001	Strap, tiedown (nlyon)	hd
38	MT	5820-00-783-9035	Strap, clamp, perforated	ft
39	C	9905-000-537-8957	Tag, blank, white	bd
40	C	8030-00-889-3535	Tape, anti-seizing pipe plug, teflon, 1/2 in. wide	ea
41	MT	5970-00-543-1005	Tape, electrical	roll
42	C	7510-00-802-8311	Tape, filament-reinforced: 3/4 in., 50 yd roll	roll
43	MT	5940-00813-0698	Terminal, lug: crimp style, stud sz 6, wire sz, 22-18	ea
44	MT	5940-00-577-3711	Terminal, lug: crimp style stud sz 10, wire sz 22-18	hd
45	MT	5940-00-283-5280	Terminal, lug: crimp style, stud sz 6, wire sz 16-14	ea
46	MT	5940-00-143-4780	Terminal, lug: crimp style stud sz 10, wire sz 16-14	ea

EXPENDABLE SUPPLIES (Cont)

ITEM NUMBER	LEVEL	NSN	DESCRIPTION	U/I
47	MT	5940-00-143-4794	Terminal, lug: crimp style, stud sz 10, unspec	ea
48	MT	5940-00-804-9185	Terminal, quick disconnect, wire sz 18	pkg
49	Mt	5940-00-804-9184	Terminal, quick disconnect, wire sz 14-16	pr
50	MT	5970--00-815-1295	Tubing, shrink, 1/4 in.	ft
51	MT	5970-00-812-2967	Tubing, shrink, 1 in.	ft
52	MT	5970-00-812-2968	Tubing, shrink, 1/6 in.	ft
53	MT	5970-00-812-2969	Tubing, shrink, 1/8 in.	ft
54	MT	5310-00-209-2312	Washer, lock, assortment	at
55	MT	5310-00-275-4290	Washer, flat, assortment	at
56	C	6145-00-152-6499	Wire, wire sz 14	ft
57	C	6145-00-435-8613	Wire, wire size 18	ft
58	MT	5315-00-271-4251	Woodruff Key Assortment	at

APPENDIX B
SPECIAL AND FABRICATED TOOLS

**BDAR FIXES SHALL BE USED ONLY IN COMBAT
AT THE DISCRETION OF THE COMMANDER
AND SHALL BE REPAIRED BY STANDARD MAINTENANCE PROCEDURES
AS SOON AS PRACTICABLE AFTER THE MISSION IS COMPLETED.**

SECTION I. General

B-1. Scope.

This appendix lists items recommended for the support of the vehicle in a combat environment. The items listed may be required for Battlefield Damage Assessment and Repair at maintenance levels from crew through DS. Also listed are expedient tools for performing BDAR repairs using non-standard equipment.

SECTION II. Tools

B-2. General.

Tools listed in this appendix will enhance crew members and mechanics at all levels to accomplish Battlefield Damage and Assessment repairs in a more expedient manner. Some tools listed may already be on hand in the unit.

The column marked "Level" indicates the maintenance level at which it is recommended these items be stocked or carried. The unit commander may modify the items in the list and the maintenance levels carrying the items, based on current mission requirements and recent operational experience.

The items marked "C" (Crew) are recommended to be carried on the vehicle for use in combat emergencies at the discretion of the unit commander. Those items marked "MT" are recommended to be carried by each Battlefield Damage Assessment and Repair Maintenance Team (MT). Some of these items may already be available at organizational maintenance, however, additional items will be required to stock each MT. Those items marked "O" are recommended to be stocked at organizational and those marked "MST" are recommended to be carried by the DS maintenance support teams (MST).

TOOLS

ITEM NUMBER	LEVEL	NSN	DESCRIPTION
1	C	5110-00-277-4591	Blade, hand hacksaw: 24 teeth per in., 10 in.
2	C	5110-00-927-1063	Blade, hacksaw, flat (tungsten)
3	MT	5120-00-203-6431	Clamp, C: 6 in (2 required)
4	MT	5120-00-278-2423	Crimping Tool: terminal, hand w/cutting pin, stripper
5	MT	5120-00-278-6520	Cutter, tubing, close quarters
6	C	5120-00-227-8074	Extension, socket wrench: 1/2 in. sq dr 10 in lg
7	C	5110-00-241-9153 5110-00-241-9156	File, hand: half rnd 10 in.
8	C	5110-00-234-6559	File, hand: rnd style
9	C	5110-00-289-9657	Frame, hand hacksaw, 10 in and 12 in blade accommodated
10	O	4940-00-561-1002	Gun, thermal: PN 8031088
11	C	5110-00-263-0349	Handle, file
12	C	5110-00-240-5943	Knife, pocket: w/clevis, screwdriver, wire scraper and cutting blade
13	C	5120-00-221-1536	Knife, putty
14	C		Lifter, roadwheel arm
15	C	5120-00-239-8251	Pliers: linemans w/side cutter, 8 in.
16	C	5120-00-247-5177	Pliers: lrnd nose w/cutter, 6 in.

TOOLS (Cont)

ITEM NUMBER	LEVEL	NSN	DESCRIPTION
17	C	5120-00-278-0352	Pliers, slip joint: angle nose, multiple tongue and groove, 10 in.
18	C	5120-00-624-8065	Pliers, slip joint: conduit w/o hdl, w/removable plastic inserts, 9 in lg
19	C	5120-00-293-0448	Punch, aligning: 3/16 in pt, 8 in. lg, 3/8 in dia
20	C	5120-00-595-9531	Punch, aligning: 1/4 in pt, 12 in lg
21	C	5120-00-242-5966	Punch, drive pin: 1/8 in.
22	0	4931-01-119-7103	Repair Kit, electrical connector: PN 12285360
23	MT	5120-00-017-2849	Riveter: blind, hand
24	C	5120-00-234-8913	Screwdriver, cross tip: No 2
25	C	5120-00-221-7063	Scriber, machinists: double point
26	C	5120-000-237-0982	Socket, socket wrench, 1/2 sq dr, 12 pt opening, regular length, 3/8 in.
27	C	5120-00-189-7924	Socket, socket wrench, 1/2 sq dr, 12 pt opening, regular length, 7/16 in,
28	C	5120-00-237-0984	Socket, socket wrench, 1/2 sq dr, 12 pt opening, regular length, 1/2 in.
29	C	5120-00-189-7932	Socket, socket wrench, 1/2 sq dr, 12 pt opening, regular length, 9/16 in.
30	C	5120-00-189-7946	Socket, socket wrench, 1/2 sq dr, 12 pt opening, regular length, 5/8 in.
31	C	5120-00-235-5870	Socket, socket wrench, 1/2 sq dr, 12 pt opening, regular length, 11/16 in.
32	C	5120-00-189-7985	Socket, socket wrench, 1/2 sq dr, 12 pt opening, regular length, 3/4 in.

TOOLS (Cont)

ITEM NUMBER	LEVEL	NSN	DESCRIPTION
33	C	5120-00-189-7933	Socket, socket wrench, 1/2 sq dr, 12 pt opening, regular length, 13/16 in.
34	C	5120-00-189-7934	Socket, socket wrench, 1/2 sq dr, 12 pt opening, regular length, 7/8 in.
35	C	5120-00-189-7935	Socket, socket wrench, 1/2 sq dr, 12 pt opening, regular length, 15/16 in.
36	C	5120-00-189-7927	Socket, socket wrench, 1/2 sq dr, 12 pt opening, regular length, I in.
37	C	5120-00-242-3349	Socket, deepwell, 1/2 in dr, 3/4 in.
38	MT	5110-00-803-6339	Splitting Tool, nut, 7/8 in cap
39	MT	6625-01-102-6878	TA-1 Continuity and Test Probe Kit: PN 12303622
40	C	5140-00-498-8772	Tool Box, portable: steel w/removable tray 21 inlg, 8-1/2 in w, 7-3/8 in h
41	MT	5120-01-128-5511	Tool Set, supplement, organizational: PN 12310894
42	C		Web Strap Assembly, adjustable: PN 12273481
43	C	5120-01-121-4981	Wrench, plug, straight bar hex: PN 12284998
44	C	5120-00-240-5328	Wrench, adjustable: 8 in.
45	C	5120-00-277-4244	Wrench, pliers: straight jaw, 8-1/2 in.
46	C	5120-00-148-7917	Wrench Set, combination box with open end, 12 components, 5/16 in. - in.
47	C	5120-00-148-7918	Wrench Set, open end, fixed, 6 components 3/16 in - 1-1/16 in.

SECTION III. Test Equipment

B-3. FIELD EXPEDIENT TEST EQUIPMENT

General Information:

Sometimes, in the process of assessing the battlefield damage, it is necessary to make voltage and resistance measurements to determine where the fault is. Standard test equipment (voltmeter, ohmmeter, SWR meter, etc.) should be used whenever possible. If standard test equipment is not available, field expedient equipment can be fabricated using parts commonly found on the vehicle and in the forward maintenance areas. The following paragraph provides fabrication instructions for making a voltmeter, ohmmeter, and RF transmitter output tester.

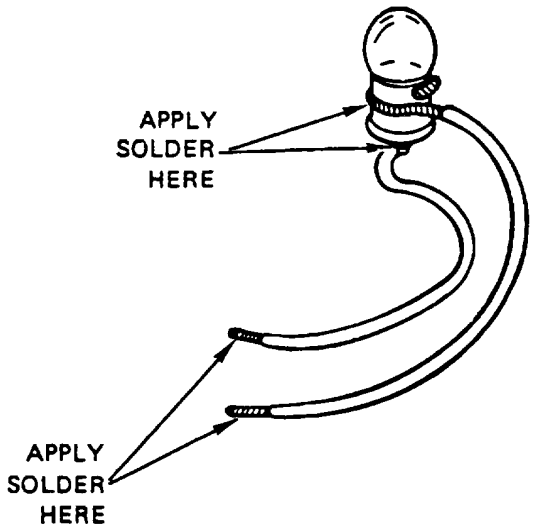
NOTE

Accurate measurements are not available. These are Go - No-Go meters.

1. Making a Voltmeter.

A voltmeter can be made from a light bulb and two pieces of wire.

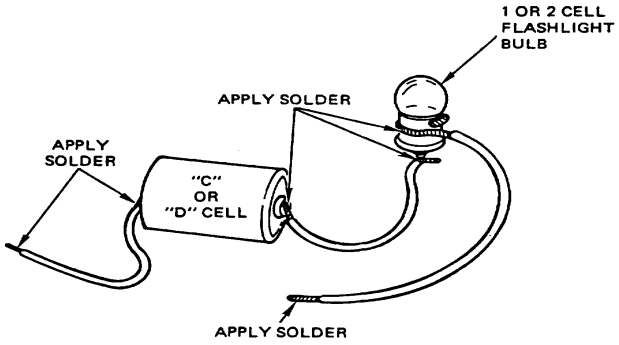
The pieces of wire can be connected to the case and center terminal of the bulb by means of solder, twisting, or simply holding the wire ends against the bulb (see illustration). The voltage rating of the bulb should be close to the value of the expected voltage being measured. For voltages in the 18 to 30 vdc range, any light bulb on the driver's master panel, driver's instrument panel, gunner's panel, commander's panel, or gunner's primary sight can be used. For voltages of 5 vdc or less a two-battery cell flashlight bulb can be used. The presence of voltage will cause the bulb to glow. Polarity of dc voltage does not have to be observed; even ac voltage can be measured. Twist exposed wire ends together and apply solder, if available, and solder. Touch tooltage source when ready to make measurement.



FIELD EXPEDIENT TEST EQUIPMENT (CONT)

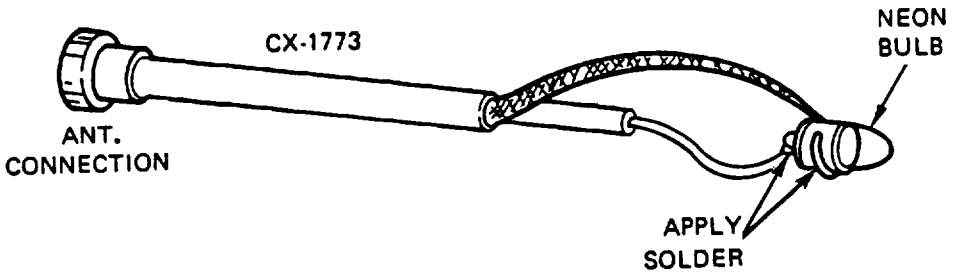
2. Making an Ohmmeter (continuity tester).

An ohmmeter can be made from a flashlight bulb, flashlight battery, and three pieces of wire. When the free ends of the wires are touched to a circuit where continuity (or a short) exists, the bulb will glow. If a two-cell flashlight bulb is used with only one battery, the bulb will glow with one-half its normal brilliance.



3. Making an RF Transmitter Output Tester.

This device is used to determine if the radio is sending a signal to the antenna.



a. An RF transmitter output tester can be made from a neon light bulb and a piece of CG-1773 RF cable. Solder the bulb to the cable as shown in the illustration. Connect the cable to the ANT connection on the front of the radio. When the radio is keyed, the bulb will glow if RF power is present at the antenna connection (this does not verify transmitter frequency accuracy).

b. Another way to check for transmitter output is to hold a common (wood) lead pencil tip l/F-inch to 1/8-inch from the ANT connection. If RF power is present, a yellowish-white arc will jump from the connector to the pencil tip when the radio is keyed.

Section IV. Welding Expedients

B-4. CONTROLLED AMPERAGE

General Information:

Battlefield repairs requiring welding can be done by using the auxiliary generator (Little Joe) from the M88 or generator recovery vehicle if a regular welder is not available.

Limitations:
Possible degraded armor protection

Materials/Tools:
Auxiliary generator (24 vdc)
Control unit from a welder or similar control
Welders helmet and gloves
Welding rod, coat hangers, or barbed wire
Heavy gauge cable (2.0 gauge or larger)
Vise grips or clamps
Fuel line

Personnel/Time Required:
2 soldier
1-2 hours

Other Options:
Use uncontrolled amperage
Weld using vehicle battery power
Procedural Steps:

1. Remove auxiliary generator from M88 recovery vehicle and place close to area to be welded. Connect heavy gauge cables to (+) and (-) output posts. Also connect control unit to (+) and (-) output posts. Tighten terminal securely.

2. Connect negative (-) cable to tank hull with clamp close to area to be welded. Connect welding rod to positive (+) cable with vise grips. Insulate vise grips with gloves, rags, or several layers of dry paper.

WARNING

Use welder's helmet to protect eyes and face from arc. Do not touch exposed cable or vise grips with bare hands; metal gets very hot. Do not perform this task in rain or on wet ground because of electrical shock hazard.

Procedural Steps (Cont):

3. Start auxiliary generator, strike arc, and weld. Set control unit for amperage level required by the thickness of the metal.

4. Record the BDAR action taken. When the mission is completed, as soon as practicable, repair vehicle using standard maintenance procedures.

B-5. UNCONTROLLED AMPERAGE

General Information:

Battlefield repairs requiring welding can be accomplished by using auxiliary generator (Little Joe) from M88 recovery vehicle or a generator if a regular welder is not available. Welding will be difficult without amperage control.

Limitations:
Possible degraded armor protection

Personnel/Time Required:
2 soldiers
1-3 hours

Materials/Tools:
Auxiliary generator (24 vdc)
Heavy gauge cable (2.0 gauge minimum)
Vise grips or clamps
Fuel line
Welder helmet and gloves
Welding rod, coat hangers, or barbed wire

Other Options:
Weld using the vehicle battery power

Procedural Steps:

1. Remove auxiliary generator from M88 recovery vehicle and place close to area to be welded. Connect heavy gauge cables (+) and (-) output posts and tighten securely.

2. Connect negative (-) cable to vehicle hull with clamp close to area to be welded. Connect welding rod to positive (+) cable with vise grip and insulate area against heat with gloves, rags, or several layers of dry paper.

Procedural Steps (Cont):

WARNING

Use welder's helmet to protect eyes and face from arc. Do not touch exposed cable or vise grips with bare hands; metal will get very hot. Do not perform this task in rain or on wet ground because of possible electric shock hazard.

3. Start auxiliary generator, strike arc, and weld. Use small diameter welding rod for thin metal; use large welding rod for thick metal. Continue to weld until repair is satisfactory.

4. Record the BDAR action taken. When the mission is completed, as soon as practicable, repair vehicle using standard maintenance procedures.

Section V. Containers

B-6. IMPROVISED CONTAINER

General Information:
Many repairs require the draining of the fluid systems (fuel, coolants, or oils). An improvised container can be used to catch the fluids.

Limitations:
None

Personnel/Time Required:
2 soldiers
20-30 minutes

Materials/Tools:
Large plastic sheet
Poncho
Tarpalin

Procedural Steps:

1. Dig a basin large enough to hold liquid.

2. Line the hole with a liner to hold the fluids.

3. Drive the vehicle over the hole.

4. Drain the liquid.

5. Dip the liquid from the hole using a steel helmet, can or canteen cup.

6. Record the BDAR action taken. When the mission is completed, as soon as practicable, repair the vehicle using standard maintenance procedures.

APPENDIX C
POL SUBSTITUTES

**BDAR FIXES SHALL BE USED ONLY IN COMBAT
AT THE DISCRETION OF THE COMMANDER
AND SHALL BE REPAIRED BY STANDARD MAINTENANCE PROCEDURES
AS SOON AS PRACTICABLE AFTER THE MISSION IS COMPLETED.**

Section I. General

C-1. General.

a. POL products available within the US and NATO military supply systems, commercial products and, captured products may be acceptable substitutes for POL shortages. Some POL will be destructive if used. This appendix provides tables on how to blend or mix good fuels with poor or non-fuels to increase the available quantity of fuel. This appendix also presents information on lubricants and hydraulic fluids. The tables divide POL products into three categories as follows:

Primary. The correct product for the system.

Alternate. A product that closely matches the primary but will result in reduced performance. Using the alternate POL will have no effect on the durability of the system. There are no restrictions on the duration of use.

Emergency or Expedient. A product that can be used for a short period of time only. These products are a last resort only and will result in a both significant reduction in performance and in serious harm to the system with continued use.

b. POL products are usually identified by NSNs or part numbers which identify the product, however, specification numbers and product names may also be a means of identifying the product. Guidance provided is keyed to specification numbers, product names, application (automotive, aviation, marine), and the type of user (military, commercial and foreign).

c. NATO products can usually be assumed to be direct replacements for US Military products, but there are some products which do not meet the same user applications. The American Society of Testing and Measurements (ASTM) specifications relate to commercial products found in the US.

d. This section will list a few elementary characteristics of importance, although you will have no means of measuring or predicting them. You can use the basic fuels, as provided, in order or priority. It will tell you how to mix one or more fluids to produce a usable fuel and finally tell how to remove or flush a fuel from the system.

e. Table C-1 identifies fuels or products that can be used as fuels. One of the best means to increase the available fuel is to use potential substitutes as extenders by mixing them with the primary fuels and not using them as the sole fuel source. This allows some products which could not ordinarily be burned (or pumped) to be used by diluting them. Because of the dangers of varying combustibility of fuels, increased by vaporization during filling, the blending process is very important. The most direct and expedient procedure to mix fuels is to add the two fuels at the same time from two separate fuel lines. If added directly to the vehicle fuel tanks as separate fuels there is not sufficient turbulence in filling or shaking by normal driving to provide a properly mixed fuel. In vehicles with more than one tank, you could end up with a distinct fuel type in each tank.

C-2. FUEL BLENDING.

a. In following the blending procedure it must be remembered that the basic fuel is the better of the two fuels and the extender is the poorer. The blending fuel is the extender. While you can use up to 50 percent (half and half) of the extender you should not use more than is needed to obtain the supply needed. Also, ensure a fuel tank or container is available to hold the quantity of fuel needed to perform the mixing operation.

b. Blending Procedure. The preferred location to accomplish blending is at a fuel dispensing site or in fuel dispensing vehicles that utilize their own pumps. The least desirable is using vehicle's fuel tanks. Blending in vehicle fuel tanks should only be done as a last resort because it is imprecise and time consuming.

(1) Blending in Fuel Dispensing Vehicles. Add the blending fuel to the fuel tank and mix by reconnecting the pump inlet hose to the vehicle and recirculating the fuel for a minimum of 15 minutes.

(2) Blending in 55 Gallon Drums. Add the blending fuel directly into a drum and mix by rolling the drum.

(3) Blending in Gravity Feed Tanks (Stationary) Not Equipped With Fuel Transfer Pumps. Blending fuel can be added manually or by using the pump and meter of a fuel dispensing vehicle. Add the blending fuel and mix by recirculating from the tank outlet to the tank truck pump inlet.

NOTE

Blending in the fuel tanks of using equipment and vehicles should be undertaken only as a last resort. Add both fuels to the fuel tank at the same time with dual nozzles, or from fuel cans.

c. If expedient fuels are not used completely during the operation, they should be drained or pumped out. Fill the vehicle fuel tanks with 10-15 gallons of an approved primary fuel and run the engine for at least 1/2 hour. Operate the engine under a load or drive the vehicle a sufficient distance to bring the engine up to operating temperature.

C-3. LUBRICANTS AND HYDRAULIC FLUIDS.

a. This section lists a few elementary characteristics of importance although there are no expedient means of measuring or predicting them. A list of basic fluids which can be used is provided in order or priority. Cautions on incompatible fluids are mentioned and a means suggested to flush the system.

b. Table C-2 provides a list of basic fluids which can be used as substitutes (alternate and expedient). It is structured around the vehicle lube order. Alternate products shown are NATO equivalents to the US specifications and can really be considered primary fluids. There are no corresponding ASTM designators. The expedients are emergency only substitutions. They may cause one of three problems either individually or in combination.

(1) They may not allow proper or efficient operations because of improper viscosity.

(2) They may cause high wear rate because of improper viscosity.

(3) They may cause seal damage or create deposits because of improper chemical composition.

c. There are no established time constraints on these expedients but the shorter the time used the better.

C-4. FLUSHING LUBRICANT AND HYDRAULIC SYSTEMS.

a. Expedient lubricant and hydraulic fluids must be removed as soon as possible, and the system cleaned and inspected.

b. For those systems using oils, flushing involves draining, refilling with the proper product, operating to insure complete circulation and when possible stable operating temperature (this usually means at least 1/2 hour), a redrain and refill. For the transmission and hydraulic system a second period of operations and a third drain and refill are needed. Installation of new filters is desirable. Filters must as a minimum be removed and cleaned. As a last resort only, operate without filters. While systems should not be disassembled to inspect seals, maintenance organizations should be prepared to replace seals that show signs of leaking. Organizations must observe seals on these systems during subsequent operations.

c. For systems using grease, it is normally necessary to disassemble the system and wash the parts, especially the bearings, in a suitable solvent. The parts are then wiped dry, inspected for wear and pitting, replaced if needed and repacked with the proper product.

SECTION II. Tables

TABLE C-1. FUELS AND SUBSTITUTE FUELS

(Listed in Order of Priority)

Primary Fuels

1. VV-F-800 (Diesel Fuels) (DF-1, DF-2, DF-A)
2. NATO-F-54 (Diesel Fuel, Military)
3. ASTM-D-975 (Automotive Diesel) (1-D & 2-D)
4. NATO - 58 (Kerosene)
5. ASTM-D3699 (Kerosene)
6. Any blend of the above.

Alternate Fuels

1. MIL-T-5624 (Aviation Turbine Fuel) (JP-4 & JP-5)*
2. NATO-F-40 (Aviation Turbine Fuel)
3. ASTM-D-1655 (Aviation Turbine Fuel) (Jet B)
4. NATO-F-44 (Aviation Turbine Fuel)
5. MIL-T-83133 (Aviation Turbine Fuel) (JP-4)
6. NATO-F-34 (Aviation Turbine Fuel)
7. ASTM-D-1655 (Aviation Turbine) (Jet A-l)
8. ASTM-D-2880 (Turbine Fuel) (O-GT, I-GT, 2-GT, 3-GT, 4-GT)
9. MIL-F-16884 (Marine Diesel) (DFM)
10. NATO-F-76 (Navy Distillate Fuel)
11. MIL-F-815 (Navy Distillates) (FO-1 & FO-2)
12. NATO-F-75 (Navy Distillate) (Low Pour Point)
13. ASTM-D-396 (Fuel Oil) (No. I & 2)

With Fuel Extenders (Blends up to half and half - 50 percent extender)

	Base	Extender
14.	Any Primary Fuel	Any Alternate Fuel
15.	Any Alternate Fuel	Any Alternate Fuel
16.	MIL-F-815	Any lighter primary or alternate
17.	NATO-F-76	Any lighter primary or alternate
18.	Any Diesel Fuel	PD-680 (Type I & II) (Dry Cleaning Solvent) ASTM-D-484 (K, I, II, III, IV) (D.C.S.) ASTM-D-235 (I thru IV) (Pet. Spirits)

*Better than a 50 percent chance these will have acceptable cetane.

TABLE C-1. FUELS AND SUBSTITUTE FUELS (Continued)

Expedient (Emergency) Fuel

Blends with other fuels or extenders (Note blend rates stated).

	Base	Extender
1.	Any Primary Fuel	Any Gasoline** - up to 50%
2.	Any Alternate Fuel	Any Gasoline II - up to 25%
3.	Any Primary Fuel	New engine oil - up to 50%
4.	Any Alternate Fuel	New engine oil - up to 75%
5.	Any Primary Fuel	Used engine oil Strained & filtered
6.	Any Alternate Fuel	Used engine oil through charcoal or cloth. Any significant quantity of water must be removed.

* *Gasolines

1. MIL-G-3056 (Motor Gasoline) (Combat)
2. NATO-F-46 (Auto Gasoline) (91 RON) (Military)
3. NATO-F-49 (Auto Gasoline) (95 RON) (Military)
4. NATO-F-50 (Auto Gasoline) (91 RON)
5. VV-G-1690 (Auto Gasoline)
6. ASTM-D-439 (Auto Gasoline) (Any Grade)
7. MIL-G-53006 (Auto Gasoline)
8. MIL-G-5572 (Aviation Gasoline) (100/130)
9. NATO-F-18 (Aviation Gasoline) (100/130)
10. ASTM-D-910 (Aviation Gasoline (100)
11. MIL-G-5572 (Aviation Gasoline) (115/145)
12. NATO-F-22 (Aviation Gasoline) (115/145)

Table C-2.
LUBRICATION SUBSTITUTES

Temp Range	LO Authorized			Alternates		
	Lube	US Specification	NATO Product	US Spec or Use Equiv NATO Prod	Soviet	Expedient
Above 32°F +40°F to -10°F to -65°F	OE/HDO-50 OE/HDO-30 OE/HDO-10 OEA	MIL-L-2104 MIL-L-2104 MIL-L-2104 MIL-L-46167	O-238/739 O-238/739 O-238/739 O-183	Any Hydraulic Oil	M8G1, M1091, M-8V, M10V M-8A, M10A AS-9, AS-10, AS-11 Below 0°F Soviet Products M6V, M6A, AS-3, AS-4, AS-5, AS-6	Commercial Heavy Transmission or any Hydraulic Fluid Turbine
Above 32°F +40°F to -10°F 0°F to -65°F	HB HB HBA	VV-B-680 VV-B-680 MIL-H-13910				
All	OHT	MIL-H-6083D	C-635	MIL-H-5606 (NATO H-515) MIL-H-46170 (NATO H-549)		Commercial Heavy Transmission Fluid
All	GAI	MIL-G-23827		MIL-G-10924		
Above 32°F +40±F to -10°F 0°F to -65°F	OE/HDO-10 OE/HDO-10 OEA	MIL-L-2104 MIL-L-2104 MIL-L-46167	O-238/739 O-238/739	Any Hydraulic Fluid	See Above	Cooking Oil Water
	OHA	MIL-H-5606	H-515	MIL-H-6083 MIL-H-46170		
Above 32°F +40°F to -10°F, 0°F to -65°F	GGP GGP GAA	MIL-G-23549 MIL-G-23549 MIL-G-10924	G-403	All C-2105	TS/ATIM-201 TS/ATIM-221 UNIINP-232 UNIINP-279 UNIINP-221 LITOL-24	
Above 30°F 40°F to -10°F,	GO 90 GO 80 GOS	MIL-L-2105 MIL-L-2105 MIL-L-10324	G-226 G-226	MIL-L-2104 OE 50 MIL-L-2104 OE 50 MIL-L-46167 OEA		

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THE METRIC SYSTEM AND EQUIVALENTS

'NEAR MEASURE

. Centimeter = 10 Millimeters = 0.01 Meters = 0.3937 Inches
1 Meter = 100 Centimeters = 1000 Millimeters = 39.37 Inches
1 Kilometer = 1000 Meters = 0.621 Miles

'VEIGHTS

Gram = 0.001 Kilograms = 1000 Milligrams = 0.035 Ounces
1 Kilogram = 1000 Grams = 2.2 lb.
1 Metric Ton = 1000 Kilograms = 1 Megagram = 1.1 Short Tons

LIQUID MEASURE

1 Milliliter = 0.001 Liters = 0.0338 Fluid Ounces
1 Liter = 1000 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 = 1000 Cu. Millimeters = 0.06 Cu. Inches
1 Cu. Meter = 1,000,000 Cu. Centimeters = 35.31 Cu. Feet

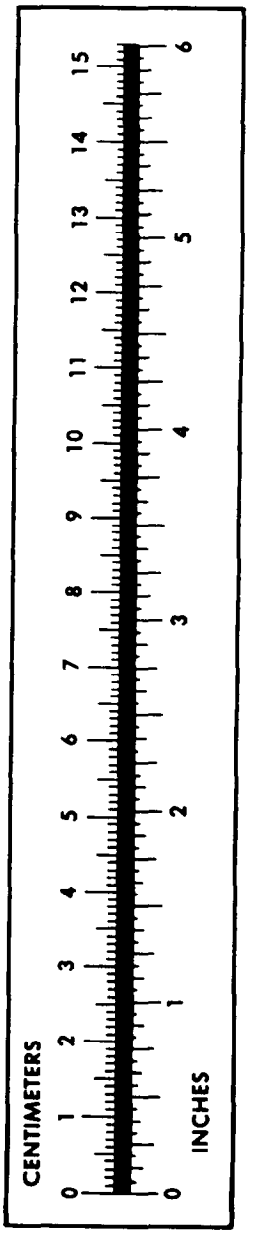
TEMPERATURE

5/9(°F - 32) = °C
212° Fahrenheit is evuivalent to 100° Celsius
90° Fahrenheit is equivalent to 32.2° Celsius
32° Fahrenheit is equivalent to 0° Celsius
9/5C° + 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
ıts	Liters	0.473
arts	Liters	0.946
allons	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
ers	Gallons	0.264
ms	Ounces	0.035
ograms	Pounds	2.205
Metric Tons	Short Tons	1.102
Newton-Meters	Pounds-Feet	0.738
Kilopascals	Pounds per Square Inch	0.145
lometers per Liter	Miles per Gallon	2.354
meters per Hour	Miles per Hour	0.621



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