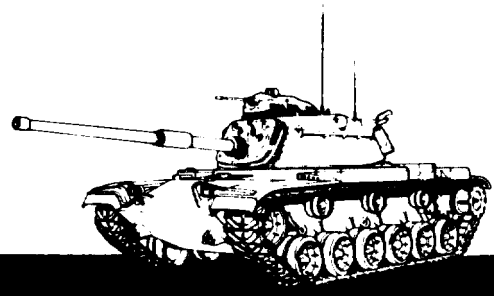
TM 9-2350-273-BD

TECHNICAL MANUAL

OPERATORS, ORGANIZATIONAL,
DIRECT SUPPORT AND
GENERAL SUPPORT MAINTENANCE



BATTLEFIELD DAMAGE ASSESSMENT AND REPAIR

FOR

M 4 8 / M 6 0

S E R I E S

TANK, COMBAT
FULL-TRACKED
105-MM GUN

ITEM NSN
INSIDE FRONT COVER

HEADQUARTERS, DEPARTMENT OF THE ARMY

JANUARY 1984

CHANGE

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TECHNICAL MANUAL

OPERATORS, ORGANIZATIONAL DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE BATTLEFIELD DAMAGE ASSESSMENT AND REPAIR

for

M48/M60 COMBAT VEHICLES

TM 9-2350-273-BD, 31 January 1984 is changed as follows:

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WARNING

THIS TECHNICAL MANUAL CONTAINS NON-STANDARD 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.

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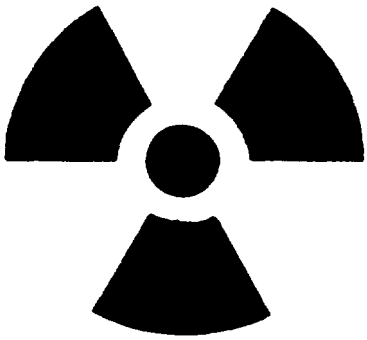

WARNING

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 arm 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.

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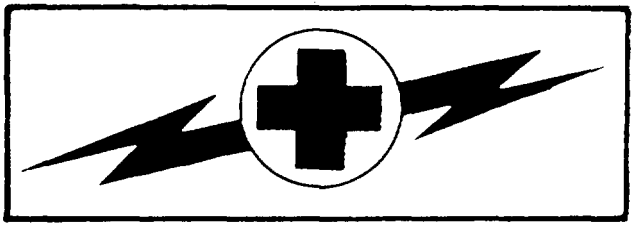

HIGH VOLTAGE

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

9-2350-273-BD

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D. C., 31 January 1984

OPERATOR'S, ORGANIZATIONAL DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE

BATTLEFIELD DAMAGE ASSESSMENT AND REPAIR for M48/M60 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.

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CHAPTER 11. COMMUNICATIONS SYSTEMS

APPENDIX A

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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 the M48/M60 Tank 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 self-recover. These repairs may be temporary and may not restore full performance capability.

1-2. scope.

a. This TM describes BDAR procedures applicable specifically to the M48/M60 tanks. Expedient repairs of a general nature applicable to systems or sub-systems common to more than one combat vehicle are covered in TM 9-2350-276-BD.

b. Many expedient repair techniques helpful in preparing a tank 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 can not be predicted nor are all effective field expedient repairs known. This TM provides guidelines for assessing and repairing battlefield failures of the M48/M60 tank 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 the M48/M60 tank. The commander must decide whether the risk of having one less tank 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 M48/M60 parts that serve a non-critical function elsewhere on the same tank 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 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 speciality. 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 tank can perform all its combat missions without endangering the life of the crew. To be FMC the tank 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 tank meets the minimum functional combat capability requirements. (See paragraph 1- 10.)

i. The term combat emergency capable means that the tank 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 tank if it is used. The commander must decide if these limitations are acceptable for that specific emergency situation.

j. The term self-recovery capble means that the tank 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 frorn 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 anyone 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 ensure that an adequate number of members of his organization, including supervisors, are trained in BDAR procedures applicable to his equipment. Each tank 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 M48/M60 Tanks 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 y and Operability (Operating Characteristics).

The Minimum Functional Combat Capability (MFCC) criteria for the M48/M60 Tanks are as follows:

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 road wheels 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.

1-1 L 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 tank to the combat ready condition required for continuation of the mission.

b. Battlefield damage repair kits consisting of essential tools, may be carried on-board each tank 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 tank 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 tank commander must make an initial out-of-action report to the platoon leader including these essentials:

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

(2) Location of tank.

(3) Firepower status.

(4) Mobility status.

(5) Manning status.

(6) Current and anticipated enemy action.

b. If communication capability is darn aged, the tank 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 tank to a covered or concealed position to prevent additional combat damage. This is the first priority. If the tank is not capable of self movement, use any vehicle, including other tanks to recover the vehicle or to get concealment. If this is not

possible, then the turret should at least be turned in the direction of engaging fires in order to limit damage and possibly return fire.

d. A 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 turret, either with a hand fire extinguisher or prepared to manually operate the turret fire extinguisher. A second crew member should be stationed outside the turret with the other fire extinguisher. He should also be prepared to manually actuate the engine compartment fire extinguisher.

f. A functional/operatlonal 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 tank 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 tank has been left unattended in the forward battle area, the immediate area of the tank should be checked for mines and the tank 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.

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

h. If the tank 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. 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 tank 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 tanks 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, TM DE, 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 an M48/M60 Tank, 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 tank 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 1. General

2-1. Scope

This chapter provides Guidelines to use to assess battlefield damage to the M48/60 tanks. 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 vehicles Technical Manuals (TM) and Lubrication Order (LO). This chapter explains how to use this manual to assess and fix battlefield damage that prevent the M48/60 tank from 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 standard 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 the standard 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 expendable supplies which are recommended for use to implement various BDAR repairs and interchangeable parts with the same NSN from other combat vehicles which maybe utilized for repairs on the M48/60 tank.

(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).

2-5. Assessment Process.

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

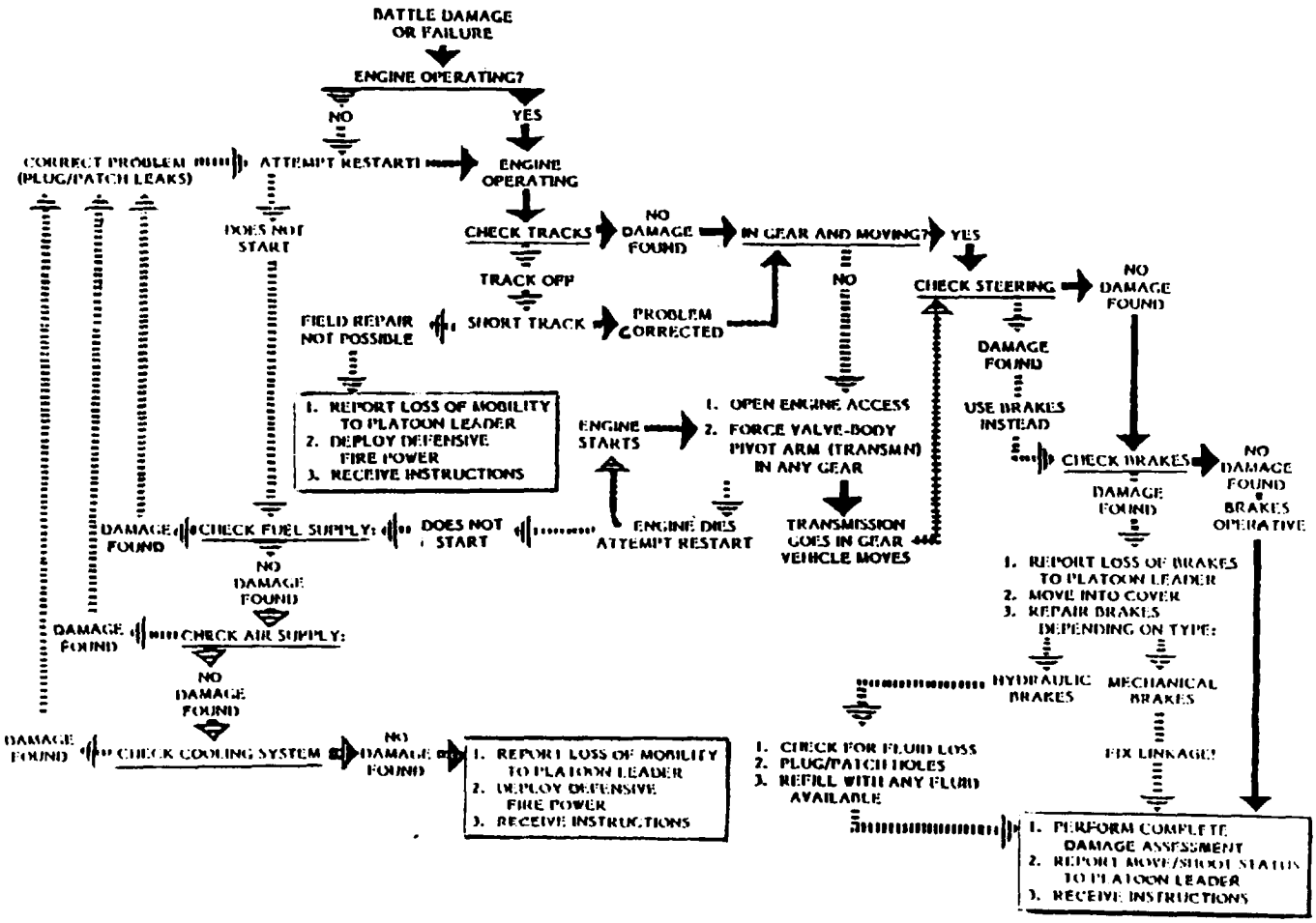


Figure 2-1. Battlefield Damage Assessment Process.

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 judgement 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,

(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, a vehicle develops a engine speed control problem. The overall vehicle assessment table directs the user to perform a number of visual and funtional checks, which will narrow down the number of areas possibly at fault. The overall vehicle assessment table provides references to chapter and/or sections.

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 . . . .

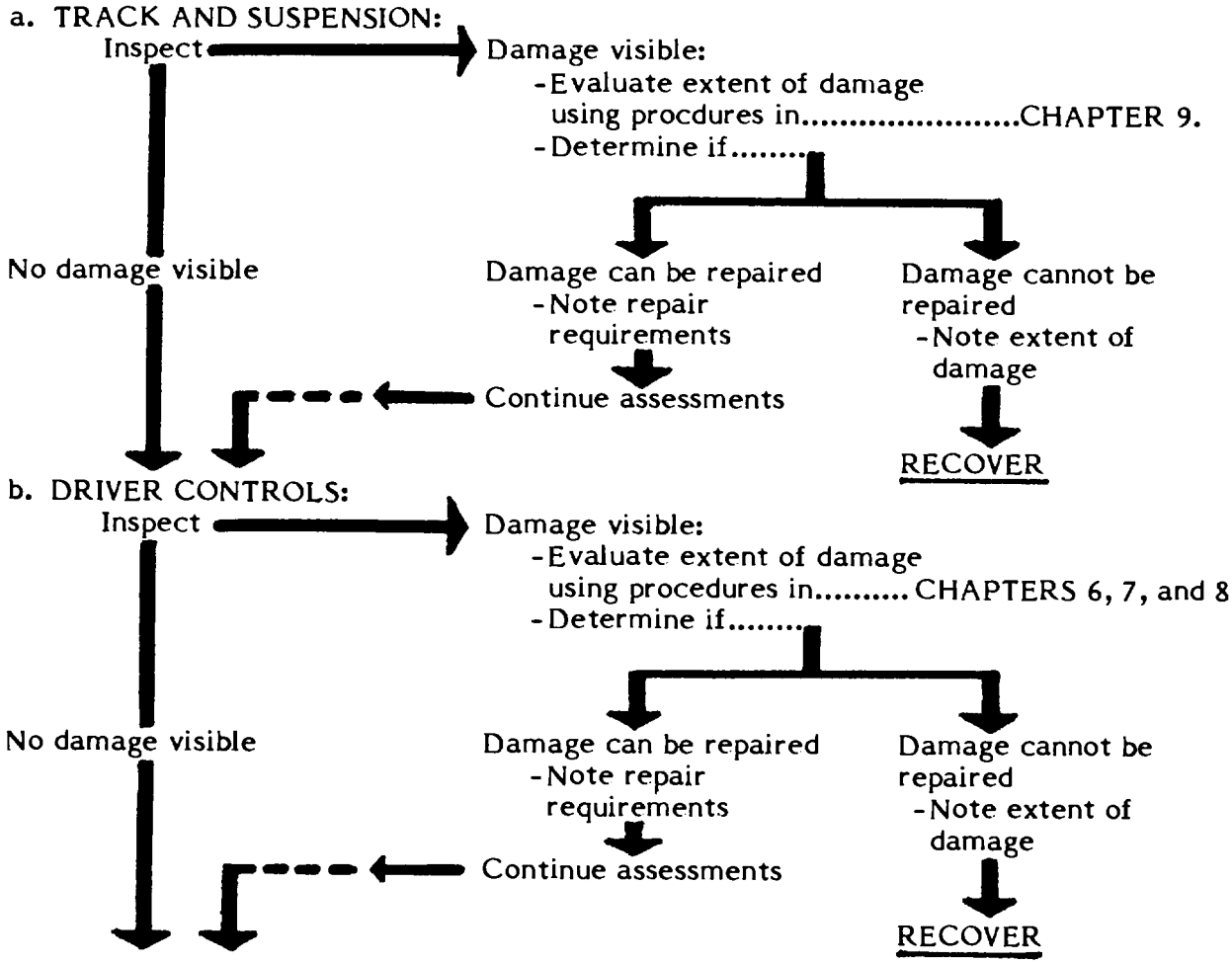


Table 2-1. Vehicle/System Assessment (Cont).

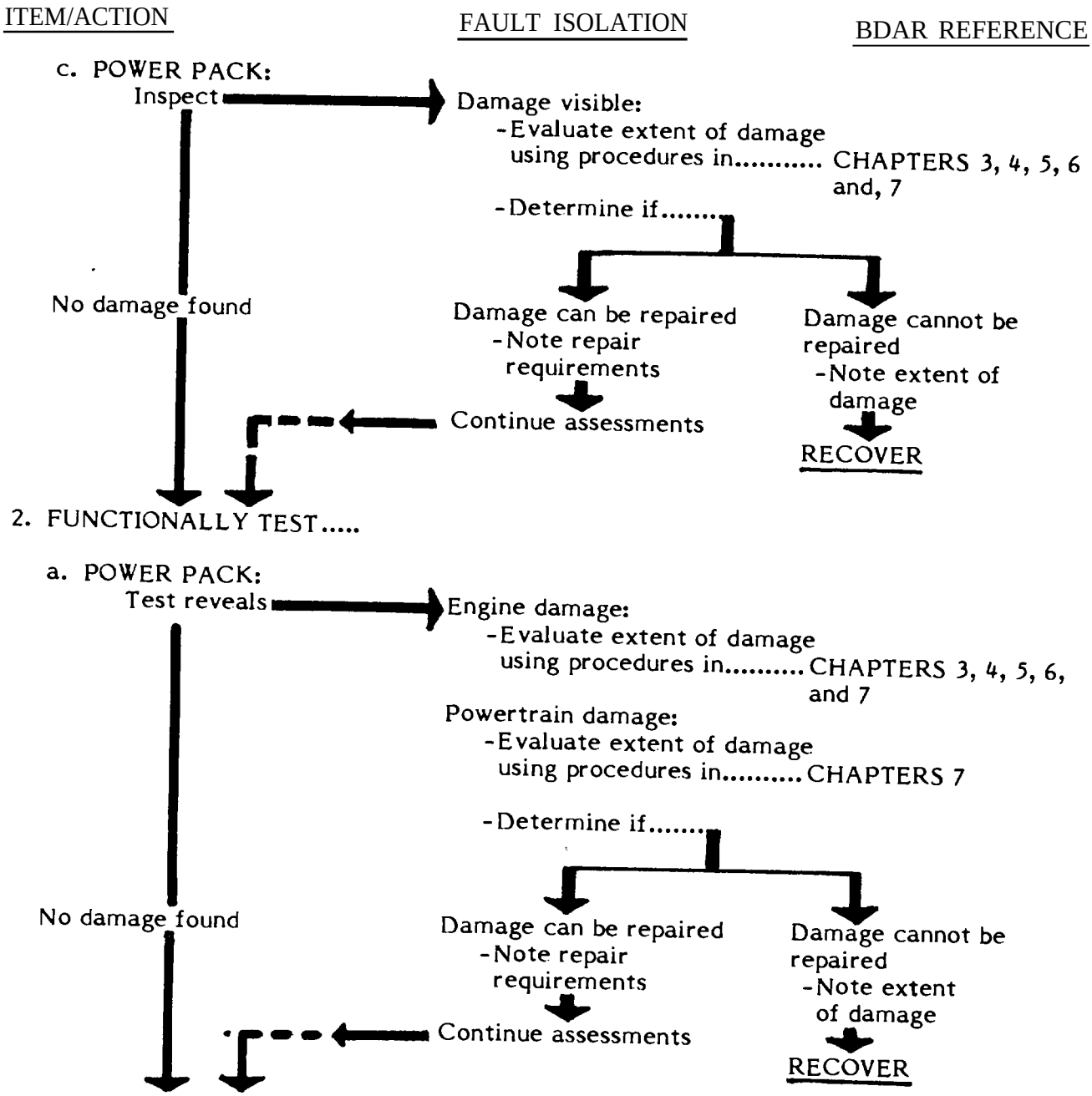
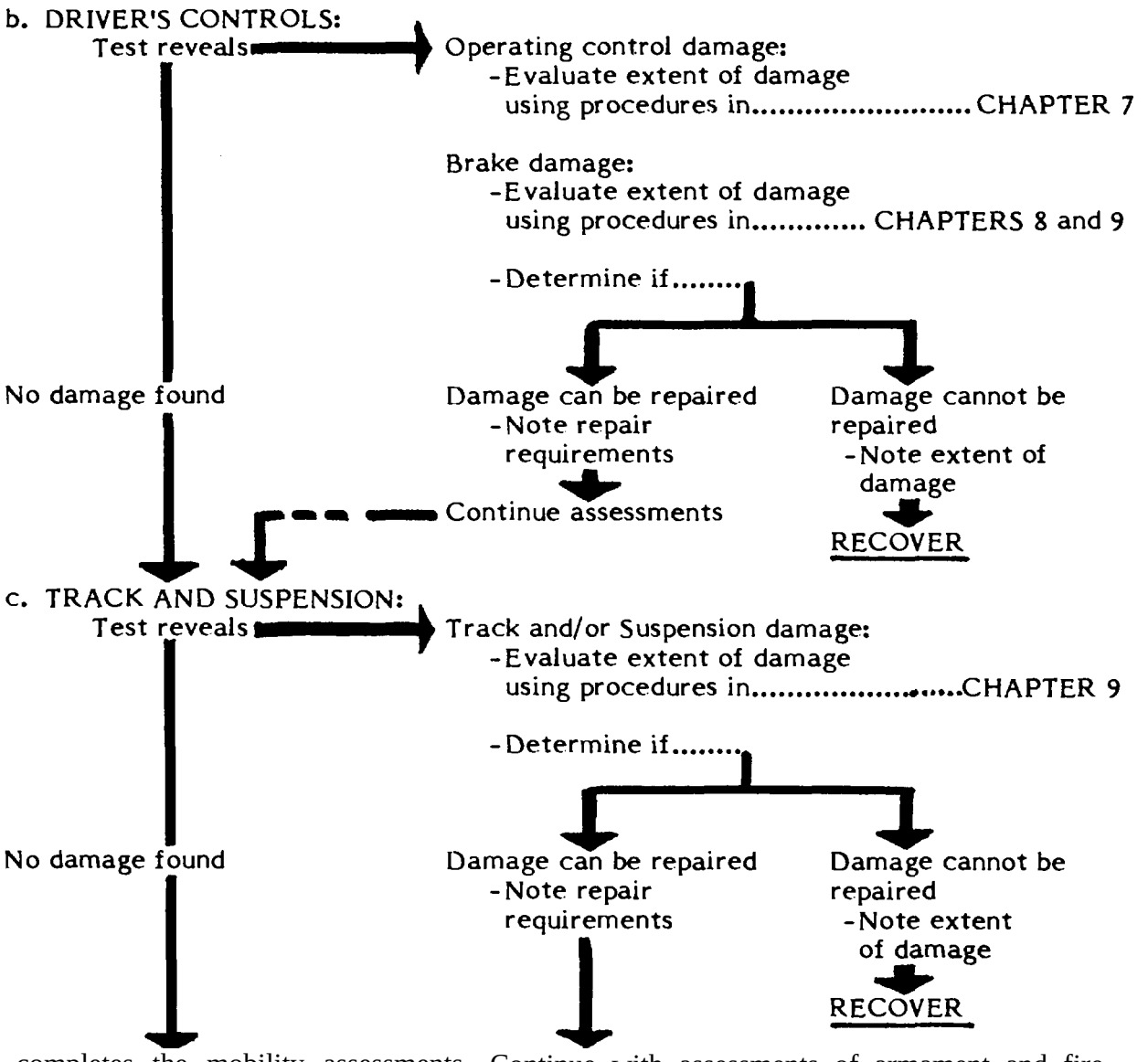


Table 2-1. Vehicle/System Assessment (Cont).



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 . . . . .

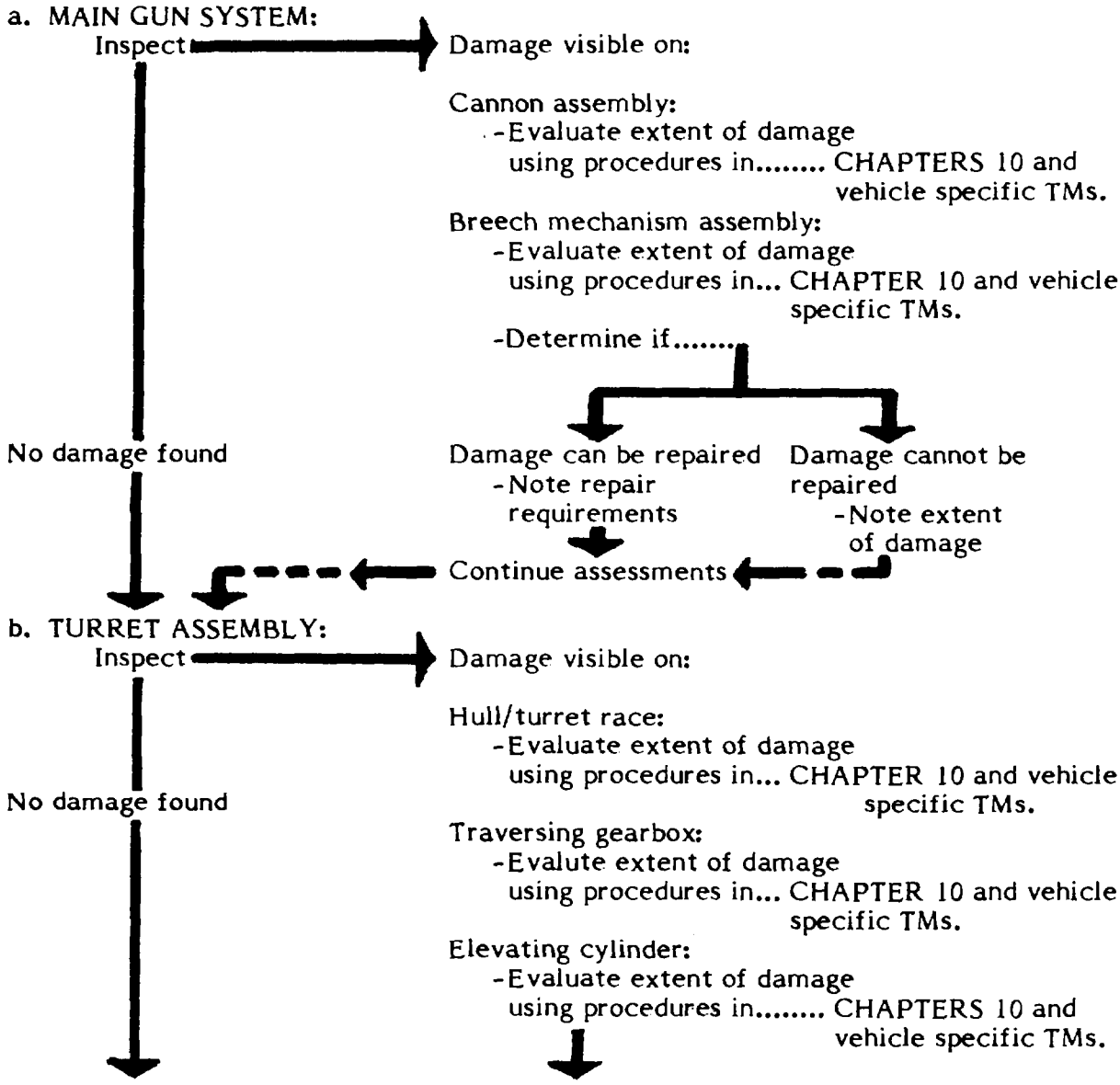


Table 2-1. Vehicle/System Assessment (Cont).

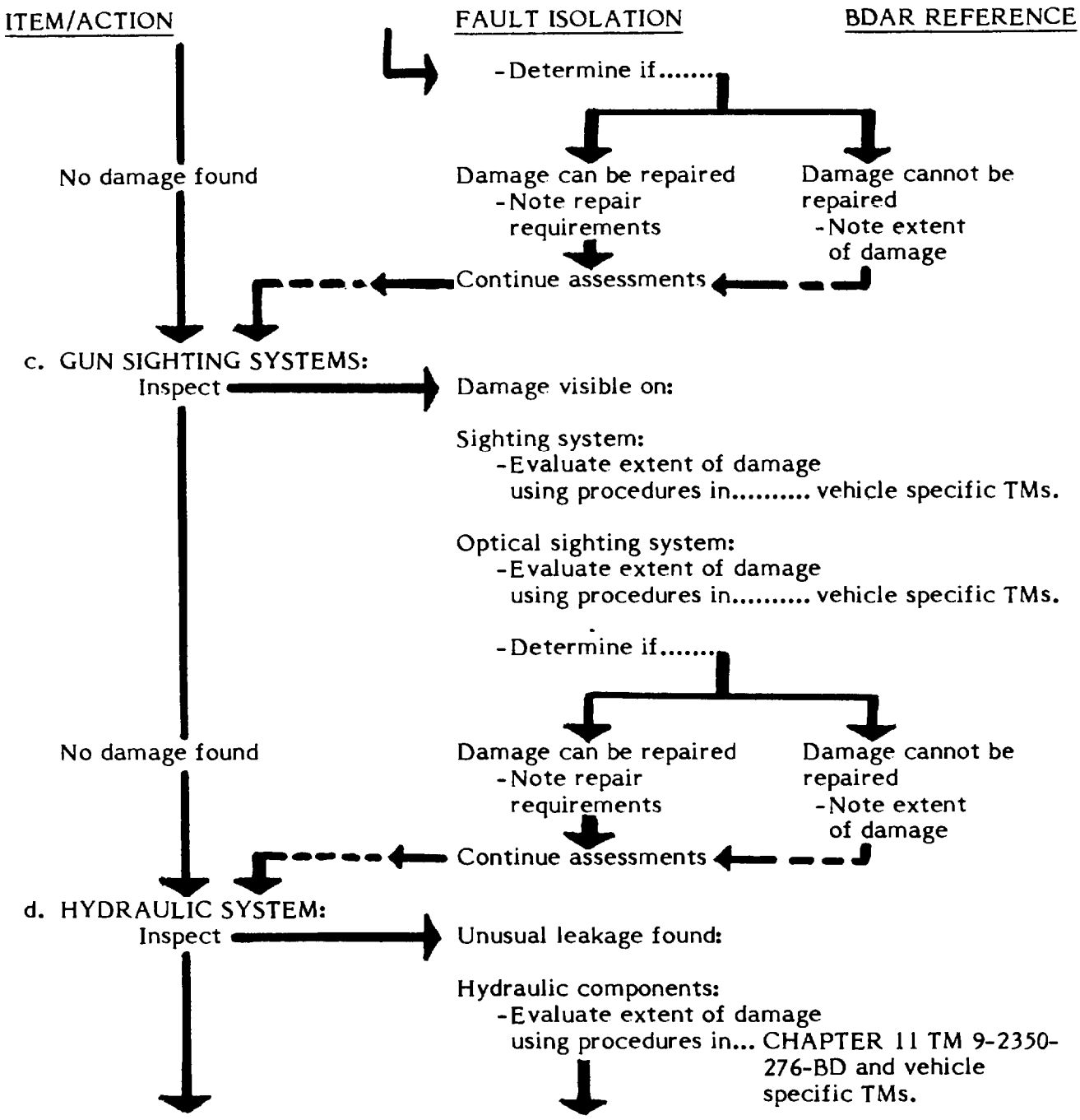


Table 2-1. Vehicle/System Assessment (Cont).

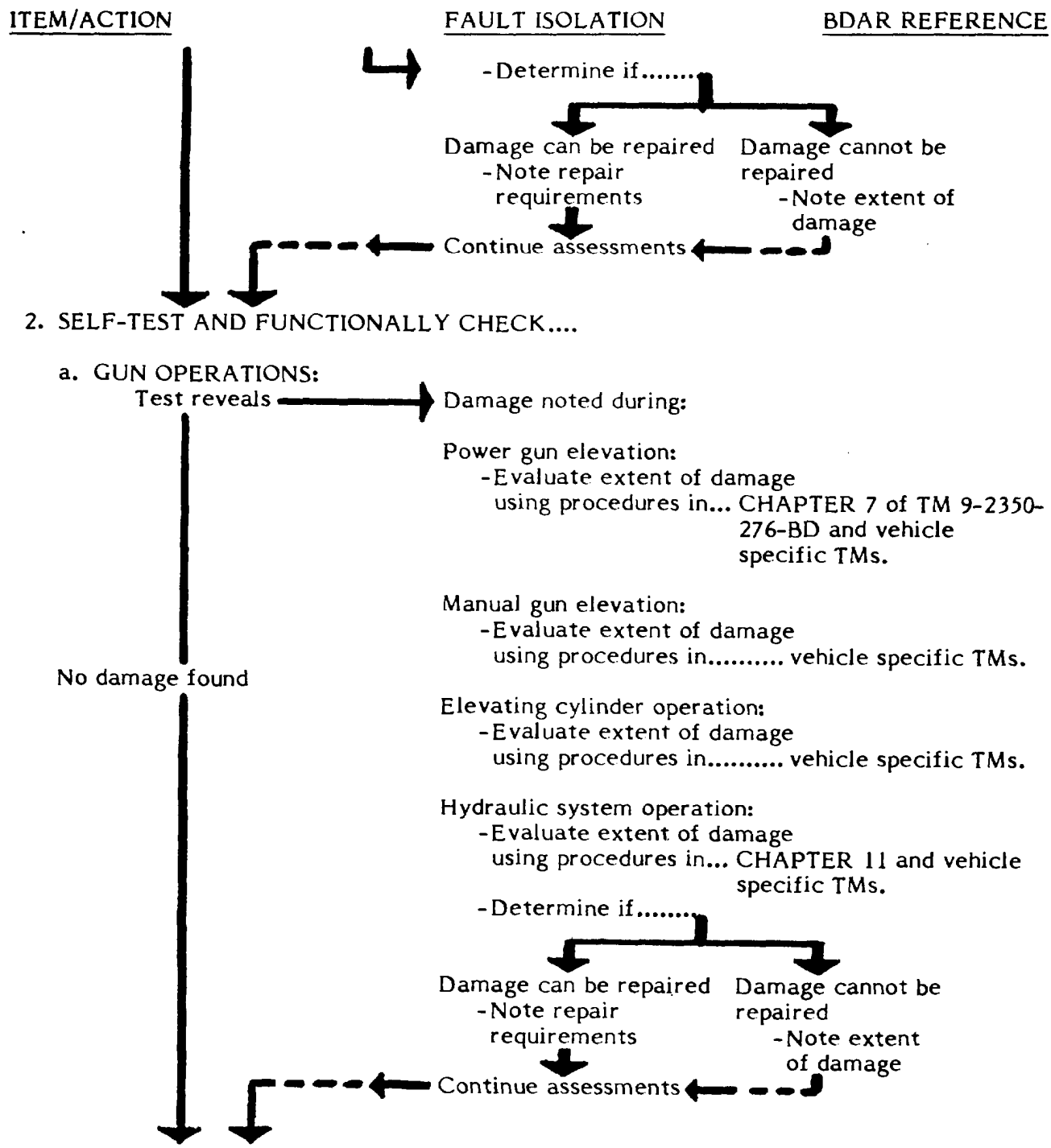


Table 2-1. Vehicle/System Assessment (Cont).

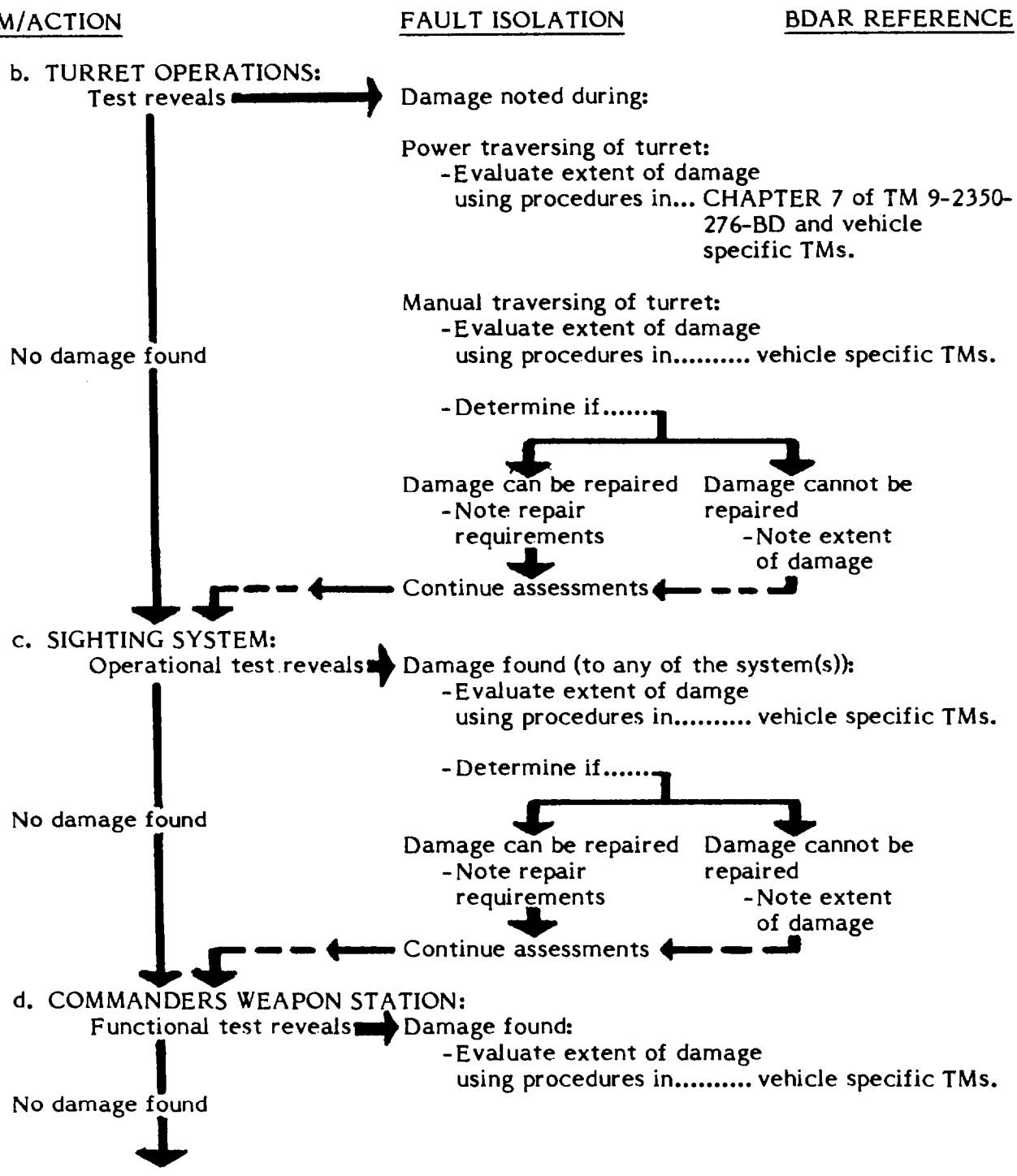
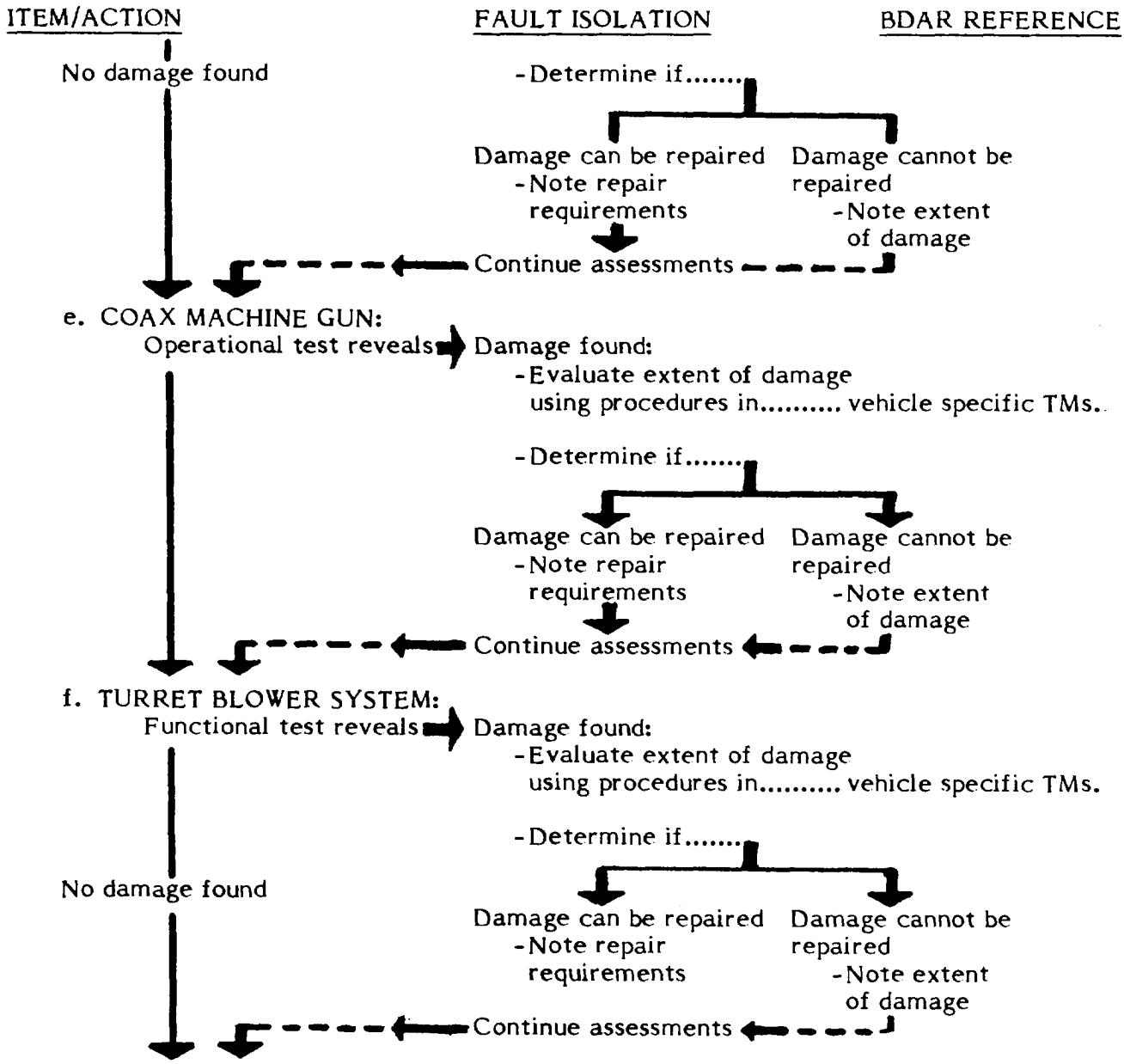


Table 2-1. Vehicle/System Assessment (Cont).



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:

Antenna(s):
- Evaluate extent of damage
  using procedures in . . . . CHAPTER 11

R. F. Cables:
- Evaluate extent of damage
  using procedures in . . . . CHAPTER 11

Radio mounts:
- Evaluate extent of damage
  using procedures in . . . . CHAPTER 11

No damage found ↓

Radio:
- Evaluate extent of damage
  using procedures in . . . . CHAPTER 11

Receiver:
- Evaluate extent of damage
  using procedures in . . . . CHAPTER 11

AM 1780 amplifier:
- Evaluate extent of damage
  using procedures in . . . . CHAPTER 11

Control boxes:
- Evaluate extent of damage
  using procedures i n . . . . . .CHAPTER 11

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

ITEM/ACTION	FAULT ISOLATION	BDAR REFERENCE
	CVC helmets: - Evaluate extent of damage	
No damage found	using procedures m	CHAPTER 11
	Speech security system: - Evaluate extent of damage	
	using procedures m	CHAPTER 11
	- Determine if..... Damage can be repaired - Note repair requirements Damage cannot be repaired - Note extent of damage	
	Continue assessments	

2. FUNCTIONAL TEST PRECONDITIONS . . . .

NOTE

Insure that no current-conducting wires will short out to each other or to ground, when power to equipment is turned on.

NOTE

Turn on power to each communication system as it is functionally tested.

3. SELF-TEST AND FUNCTIONAL CHECK . . . . .

a. RADIO:

Functional test reveals	Radio does not work - Evaluate cause of malfunction	
No damage found	using procedures in	CHAPTER 11

b. AUXILIARY RECEIVER:

Functional test reveals	Auxiliary receiver does not work - Evaluate cause of malfunction	
No damage found	using procedures in	CHAPTER 11

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

ITEM/ACTION	FAULT ISOLATION	BDAR REFERENCE
c. INTERCOMMUNICATIONS EQUIPMENT:		
Functional test reveals	Intercommunications equipment does not work - Evaluate cause of malfunction using procedures m	CHAPTER 11
No damage found		
d. SPEECH SECURITY SYSTEM:		
Functional test reveals	Speech security system does not work - Evaluate cause of malfunction using procedures m	CHAPTER 11
No damage found		
	-Determine if.....	
	Damage/malfunction can be repaired -Note cause and repair requirements	
	Damage cannot be repaired -Note cause and extent of damage	

This completes assessment of the communication systems. Summarize assessment findings, and prepare to report assessment findings in move/shoot/communicate order to commander for vehicle status/disposition determination.

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 (Cont'd)

SECTION III. Battlefield Damage Assessment/Repair Forms

2-9. 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.

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

. 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	Can Vehicle Be Repaired? Yes	No	Recovery Status	Yes	No
Move _____	☐	☐	☐	☐	Self Recover	☐	☐
Shoot _____	☐	☐			Can be Towed	☐	☐
Communicate _____	☐	☐			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 Indunction 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		

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		

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
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

3-1. General.

a. The M48/M60 Series tanks are powered by a V-12 air cooled, compression ignition, (diesel) turbosupercharged engine, AVDS-1790 2A or 2D. Engine damage can be detected by several different methods.

(1) abnormal oil pressure or temperature readings or warning lights,

(2) abnormal noises,

(3) abnormal amounts or coloration of exhaust smoke,

(4) sudden loss of power or excessive fuel consumption.

b. This chapter gives various expedient fixes which can restore the tanks mobility in event of engine system failure.

3-2. Assessment Procedure

a. Visually Inspect → Damage found to
- -Cooling System . . . . . Section III or 5
- -Fuel System . . . . . Section VI or Chapter 4

No apparent Damage found

- -Lubrication System . . . . . Section IV
- -Air Intake/Exhaust System Section III and IV

b. Attempt to Start → Will not Start
- -Check Fuel System . . . . . Section VI or Chapter 4
- -Check Air Intake/ Exhaust System . . . . . Section III and IV
- -Check Starting System . . . . . Chapter 6

Starts

c. Observe Operation → Damage Detected when Operating or system not WORKING

No Significant damage; Subsystems Work OK

-Mechanical Failures .....Section VII
-(Internal Engine Failures) ....Section VII
-Cooling System Failures.....Section V/Chapter 5
-Lubrication System Failures .....Section IV/Chapter 4

d. Evaluate Engine Performance

	Engine Assessment				
	Fully Mission Capable	Combat Capable	Combat Emergency Capable	Self Recovery Capable	Recover
-Power Output/Response Normal/Near normal	X	X	X		
-Power Output Degraded		X	X	X	
-Power Output Severely Degraded			X	X	
-No Power					X

3-3. BDAR Procedure Index. Para.

SECTION II. Engine Failure

3-4. General.

Basic engines in M48/M60 vehicles 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.

3-5. ENGINE INOPERATIVE, ENGINE INTERCHANGEABILITY

General Information:
Availability of engines may become restricted to those found in damaged vehicles. Basic engines from other vehicles can be modified or configurations rearranged to fit the vehicle needing the engine. The AVDS 1790 engine will fit M48A5, M60, M60A1, M60A3, or M88A1. The M88A1 powerpack has a model 1410 transmission, and M48/M60 vehicles have a model CD850 transmission. When engines are exchanged, the original transmission must be mated to the replacement engine.

Limitations:
l None.

Personnel/Time Required
l 3 soldiers.
l 6 hours.

Materials/Tools:
l Engine M48/M60 or M88A1.
l Lift device.

Other Options:
l Remove transmission/final drive connection 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.

Procedural Steps:

1. Remove powerpack.

2. If required, change transmission on powerpack.

3. Transfer needed bracketry, parts and hardware for a specific installation to the substitute engine.

   a. The 1790-2C engine w/650 AMP generator requires wiring harness 7722353 and 1165541.

   b. The 1790-2D engine w/300 AMP generator requires wiring harness 11682724 and 11672723.

4. Reinstall powerpack.

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

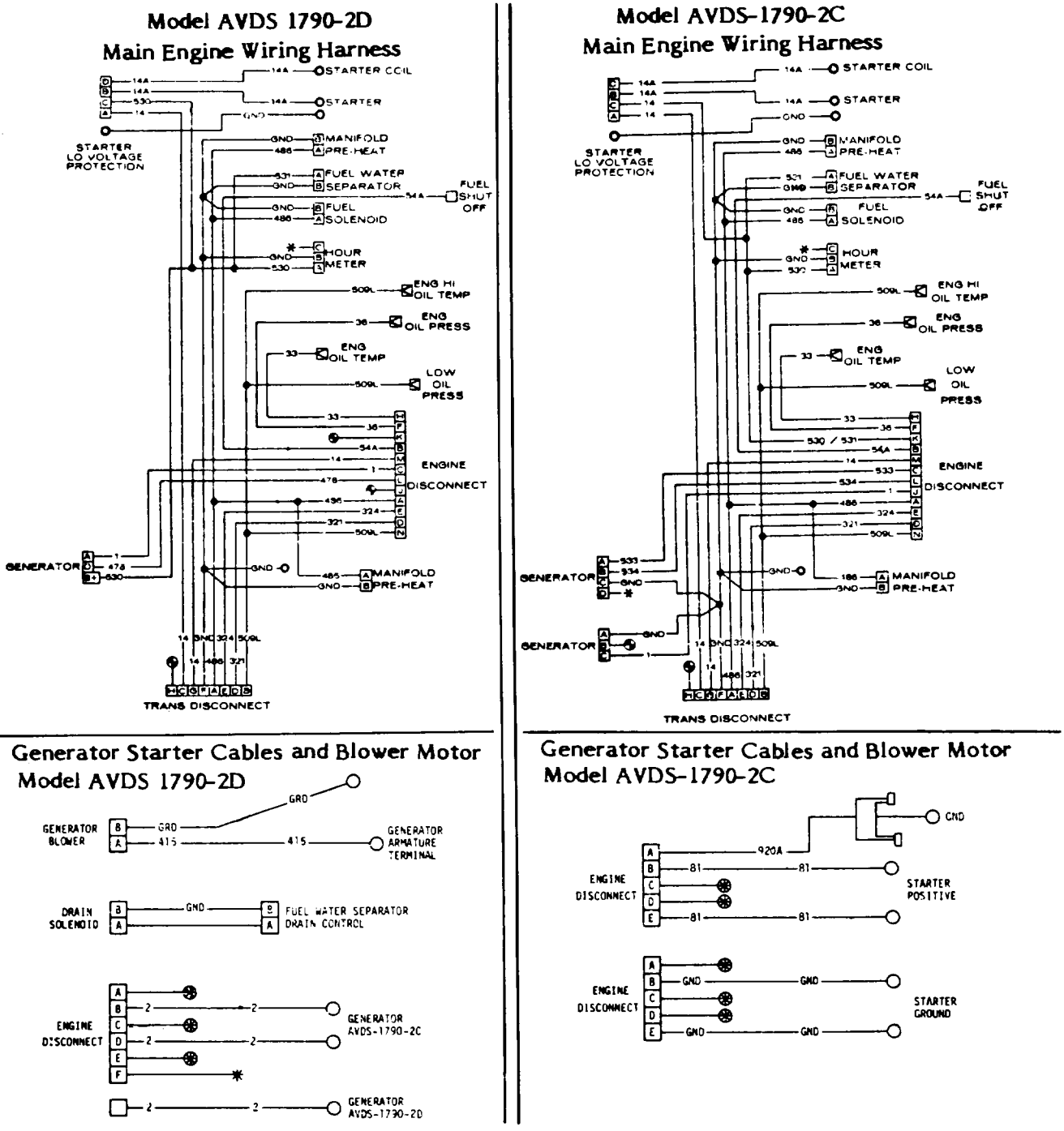


Figure 3-1

SECTION III. Engine Air Intake Systems

3-6. General.

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. Repairs to turbocharged air intake systems must be done with materials that do not block the air flow. The materials must be securely attached to prevent them from being sucked into the system up to the turbocharger inlet. The repairs must seal so that the air pressure is maintained from the turbocharger outlet to the intake manifold.

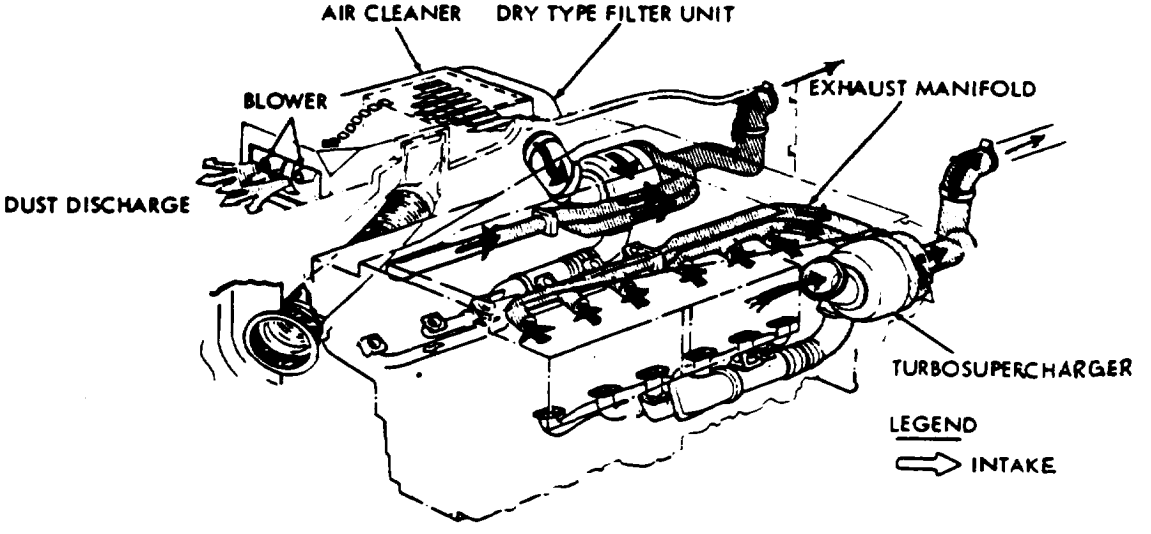


Figure 3-2. Engine Air Intake.

3-7. AIR CLEANER DAMAGED OR LEAKING

General Information
External location makes air cleaner vulnerable to damage. Dust ingestion will cause extensive internal engine wear. Holes or cracks in the air cleaner housing or ducting must be repaired or covered to keep dirt out of the air intake. Tape, auto body filler or any other available material should be used to seal the air intake system. If the air cleaner or ducting cannot be sealed they should be elimated using this procedure.

Limitations:
- Degraded air intake efficiency

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

Materials/Took
- Clean rags
- Cloth
- Burlap
- Fine mesh screen wire

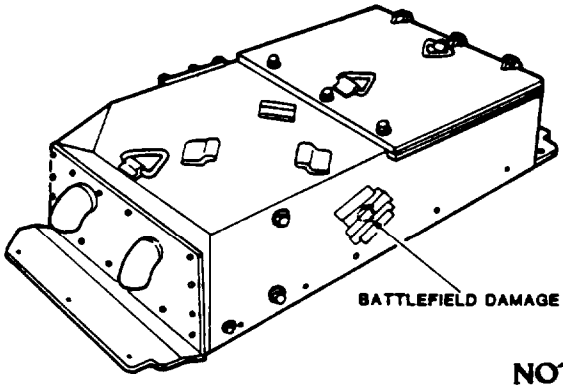
Other Options:
- Operate for short time periods

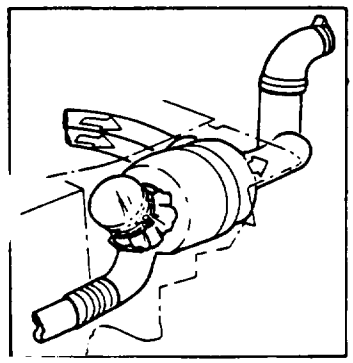
of time without air filtration system.

Procedural Steps:

1. Gain access to air inlet by opening top deck grille doors.

2. Remove air inlet hoses, (right and left), if both air cleaners are damaged.





NOTE

The denser the material, the more it restricts air intake, thus reducing engine power output.

3. Place cloth or screen wire over air inlet as shown. Secure material with air intake hose clamps or wire to prevent engine from sucking material into engine.

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

SECTION IV. Engine Exhaust Systems

3-8. General.

The engine exhaust system is the exhaust manifold, header pipes, muffler and other exhaust ducts. Since these engines are turbocharged, the exhaust gases are also routed through the turbocharger.

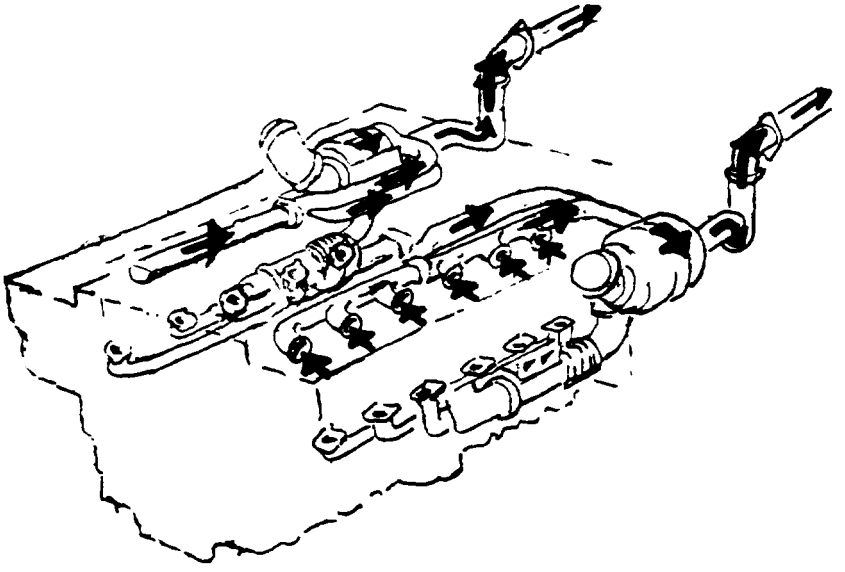


Fig 3-3. M48/M60 Exhaust Systems.

3-9. EXHAUST SYSTEM DAMAGE

General Information:

To repair holes or cracks in the exhaust system, cans or similar metal items can be cut and bent to cover holes. A source for the large clamps needed is the generator air ducting system of a nonrepairable vehicle. Air ducting is needed to cool the generator/alternator. Avoid using the clamp from the tank under repair because if the cooling is disabled, the generator/alternator could be damaged.

Limitations:

o Some loss of power at high operating speeds. Generator/Alternator damage if cooling duct is incomplete.

Personnel/Time Required

o 2 soldiers
o less than 2 hours

Materials/Tools:
- Generator air ducting clamps

Other Options:
- Use welder to repair holes in exhaust system.

Procedural Step:

1. Remove top deck.

2. Locate hose clamp on vehicle that can be removed and is large enough in diameter to fit manifold.

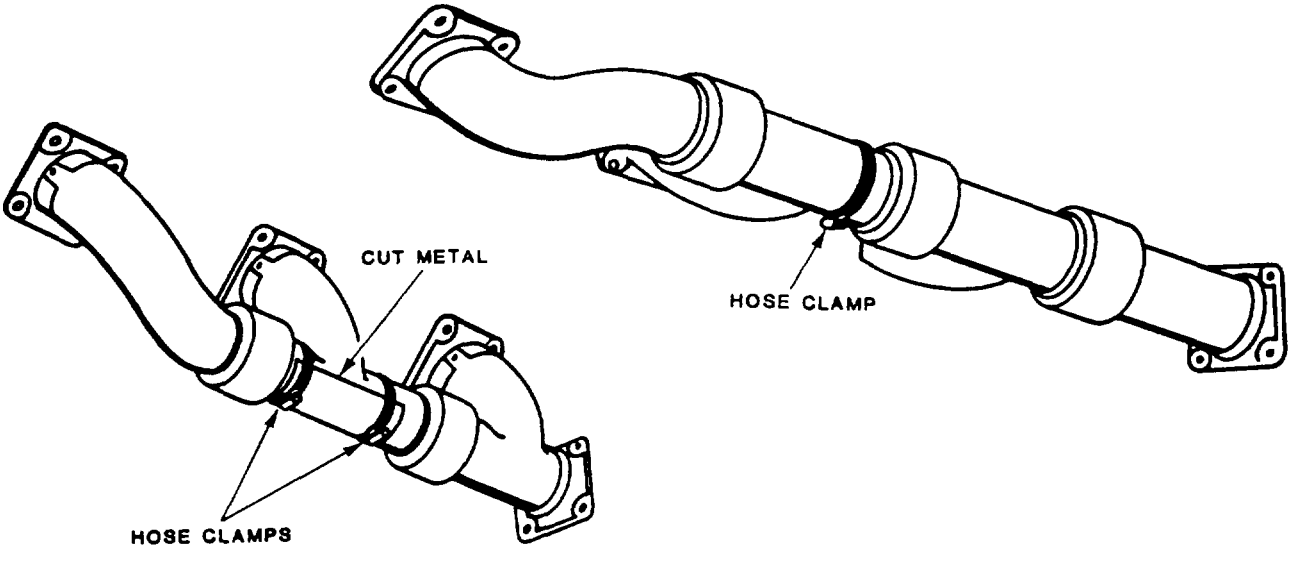
3. Cut can or other metal at least 1/4 inch larger than hole in manifold. Bend metal to fit curve of manifold.

4. When hole is 1/2 inch or less in diameter one hose clamp can be placed around manifold and clamp tightened over the hole.

5. When hole is 1/2 to 1 inch in diameter, cut metal can to a size just larger than the hole. Place metal over the hole and secure with one or two hose clamps.

6. When hole is larger than 1 inch, cut metal can to a size just larger than the hole. Place metal over the hole and secure with two or more hose clamps.

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



SECTION V. Engine Lubrication Systems

3-10. General.

Engine lubrication is essential for all components. However, crankshaft bearings and diesel engine piston crowns are critical components. 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 shorten the engine life.

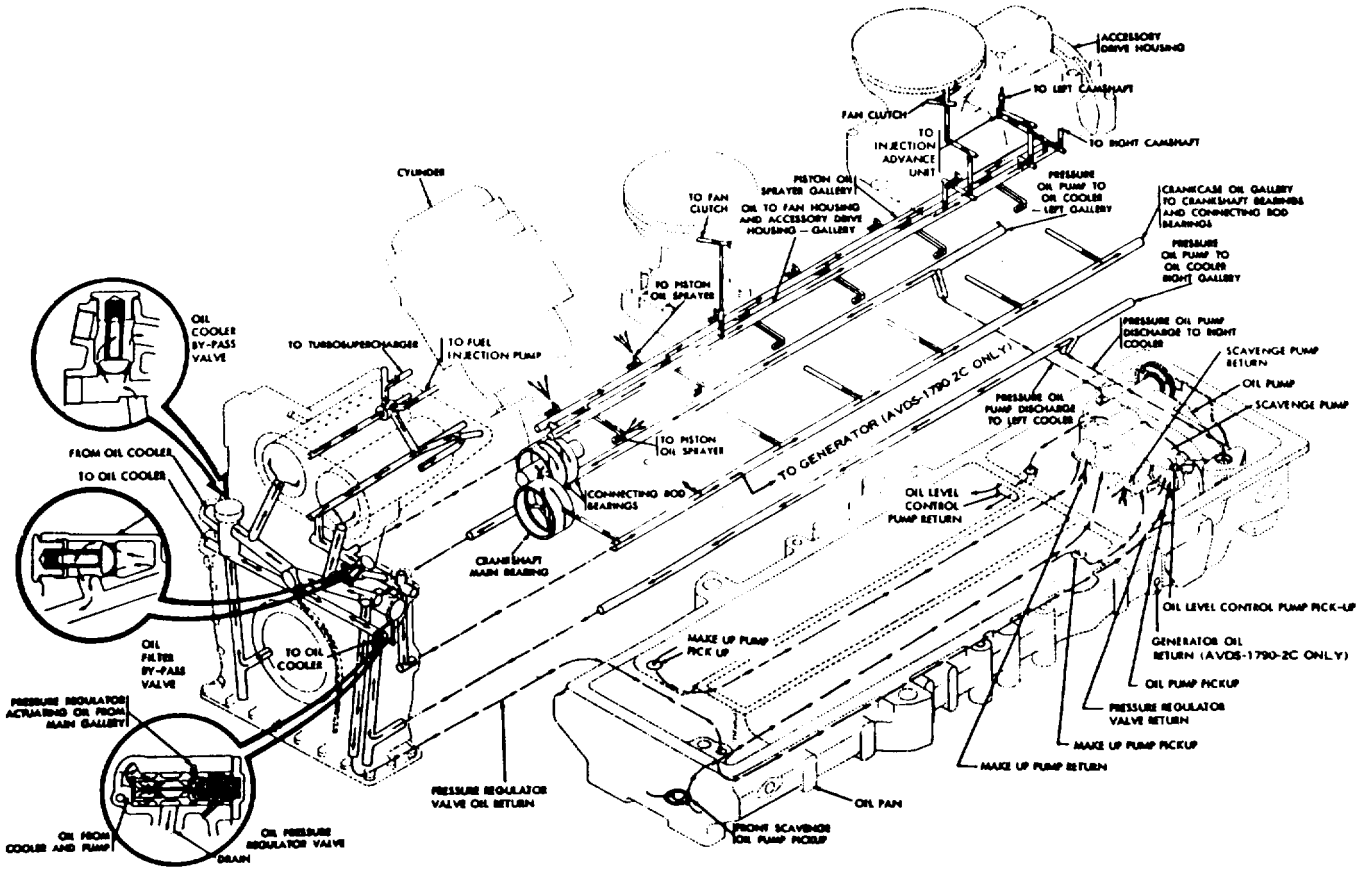


Fig 3-3. M48/M60 Engine Lubrication Systems.

3-11. PUMP FAILURE, LUBRICATION SYSTEM

General Information:

Oil pump fails to supply sufficient lubricant to the engine. Low or no reading on the oil pressure gage while engine is running.

Limitations:
- Short moves at low speed only

Personnel/Time Required:
- 1 soldier
- 30 minutes

Materials/Tools:
- Engine oil

NOTE

Transmission oil, other type vehicle oil or diesel fuel may be used when engine oil is not available.

Procedural Steps:

CAUTION

Use this procedure only in extreme emergency and operate the vehicle for short periods of time and at low speeds. The valve train parts will not be lubricated.

1. Check oil level.

2. Obtain enough engine oil to overfill crankcase by 3 or 4 quarts. New oil or used oil may be used.

3. Overfill the crankcase. The crankshaft will be submerged in oil and as it rotates it will splash the lubricant over the main engine parts.

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

3-12. OIL LEVEL LOW

General Information:
Oil level low in the engine crankcase. Substitute lubricants may be used to raise oil level. Oils other than those designed for use in engines will provide only limited lubrication. Driver must employ caution and operate the vehicle at lower revolutions per minute (RPM) (1600) to prevent damage. Diesel fuel is a thin oil and provides only limited lubrication. Do not dilute the lubrication oil more than approximately 3 parts diesel fuel to 1 part engine oil except in extreme emergencies. Drive slower to prevent damage to the engine. If the engine oil is supplemented with any oil other than that given in the LO, it will be necessary to change the engine oil and filters as soon as possible.

Limitations:
● Reduced lubrication will limit engine life.

Personnel/Time Required:
● 1 soldier
● 10 minutes

Materials/Tools:
● Cooking oil
● Diesel fuel
● Hydraulic fluid
● Used oil

Other Options:
● Drain oil from transmission or a hydraulic system and add oil to engine crankcase to bring oil level to at least the ADD OIL mark on gage.

WARNING

Do not mix gasoline with lubricating oil. Gasoline provides no lubrication and could cause an explosion in the crankcase or create a fire hazard.

Procedural Steps:

1. Fill the engine crankcase at least to the ADD OIL mark with any available lubricating oil.

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

3-13. OIL COOLER DAMAGE

General Information:
Abnormal oil pressure due to a plugged or damaged oil cooler. Operating engine without oil cooling will cause engine overheating leading to engine failure.

Limitations:
● Self recovery is possible but requires slow speed operation, monitoring of oil temperatures and frequent stops for engine cooling.

Personnel/Time Required
● **3** soldiers
● 3 hrs

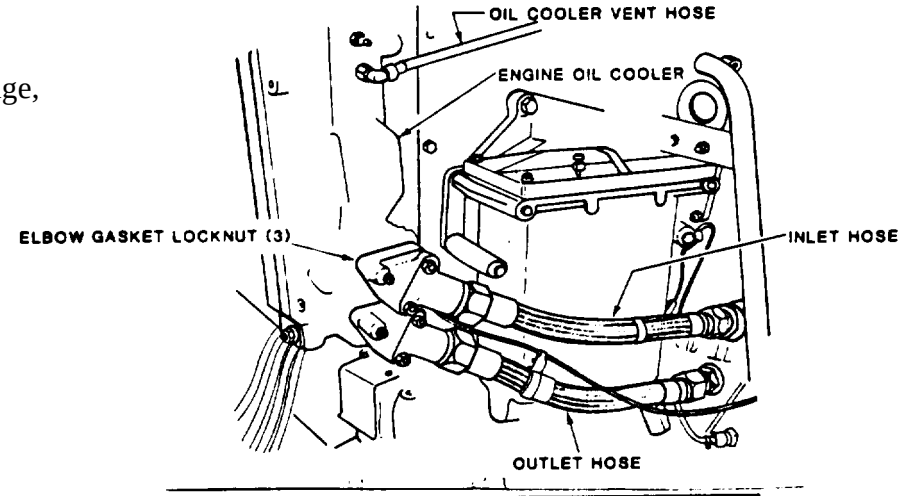
Other Options:
● Continue operations; monitor oil temperature and level.

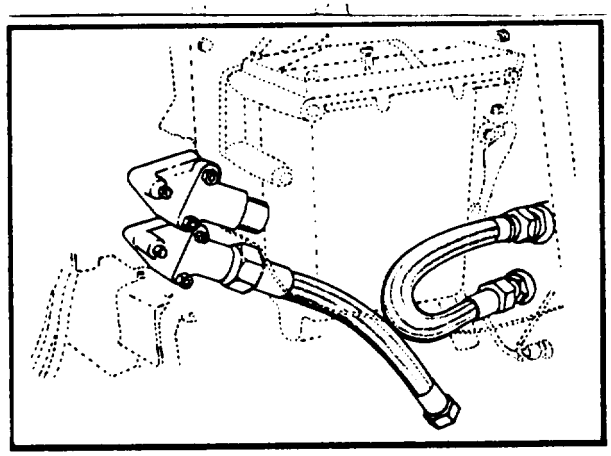
Procedural Steps:

1. Depending on damage, disconnect either inlet or outlet oil cooler line from engine.

2. Disconnect the other line from cooler and connect to engine.

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





SECTION VI. Engine Fuel Systems

3-14. General.

The engine fuel system provides the pressurized fuel needed for proper operation of a compression ignition engine. An electrical fuel pump provides fuel to the fuel injection pump which distributes high-pressure fuel pulses to the 12 injectors. The pulse is timed to the compression stroke of the piston in each cylinder. Fuel is injected into the cylinders in the proper quantities to ensure complete combustion. The engine houses a water separator assembly which is equipped with an automatic dump sensor. As water contacts the sensor the system will drain the contaminated fuel. Three fuel filters reside the separator ensure that water or other contaminants do not enter the fuel injection circuit.

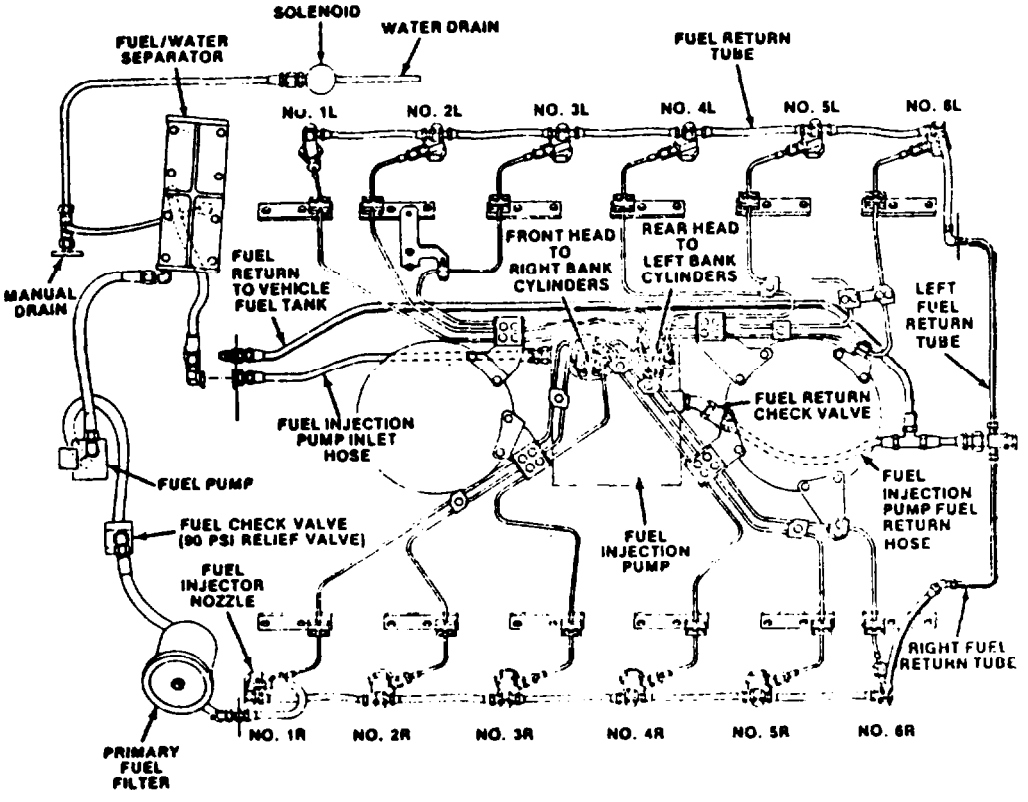


Fig 3-4. Engine fuel system.

3-15. THROTTLE LINKAGE BROKEN

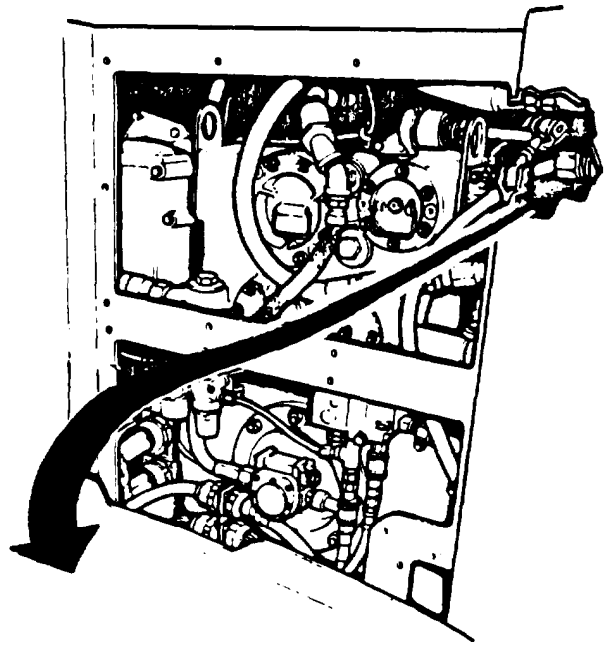
General Information
Engine power cannot be controlled.

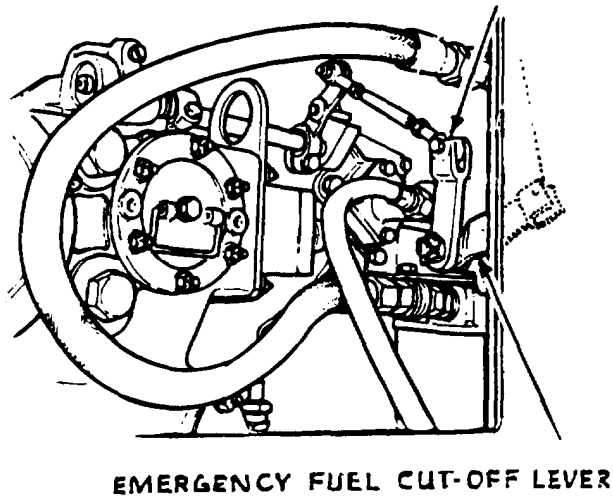
Limitations:
- Degraded vehicle control; no engine shut-off

Personnel/Time Required:
- 1 soldier
- 45-60 minutes

Materials/Tools:
- Wire (electrical wire, WD-1 communications wire, or any similar material)

Other Options:
- Weld or splint broken linkage.
- If throttle linkage is not available, route flexible wire from engine fuel control to a soldier in the turret or on rear deck to control acceleration.





Procedural Steps:

WARNING

With throttle wired open, vehicle will jump forward or backward when placed in gear. This could cause injury to personnel in or around vehicle.

1. Gain access to fuel control linkage.

2. Inspect throttle linkage to determine damage.

3. Disconnect the engine fuel control rod from the engine fuel control lever and then reconnect it to the emergency fuel shut-off lever.

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

SECTION VII. Engine Structure And Internal Components

3-16. General.

Engine internal components are not easy BDAR fixes because of the tolerances and balances necessary to contain the pressure and forces of the burning fuel, and the need for mechanical integrity of the reciprocating, rotating parts. The best repair for internal engine components is replacement parts from the supply system.

a. It is possible, however, to mix and match parts from two or more damaged engines to reassemble one good engine with used parts. For example, if one engine has a damaged cylinder set or top end, the good cylinder/head set can be matched with a good, used short block to build a serviceable spare.

b. Certain internal engine component failures such as cam followers or rocker arm shaft galling may be ignored. Other failures, such as broken rings and galled pistons will result in engine destruction if the vehicle is operated.

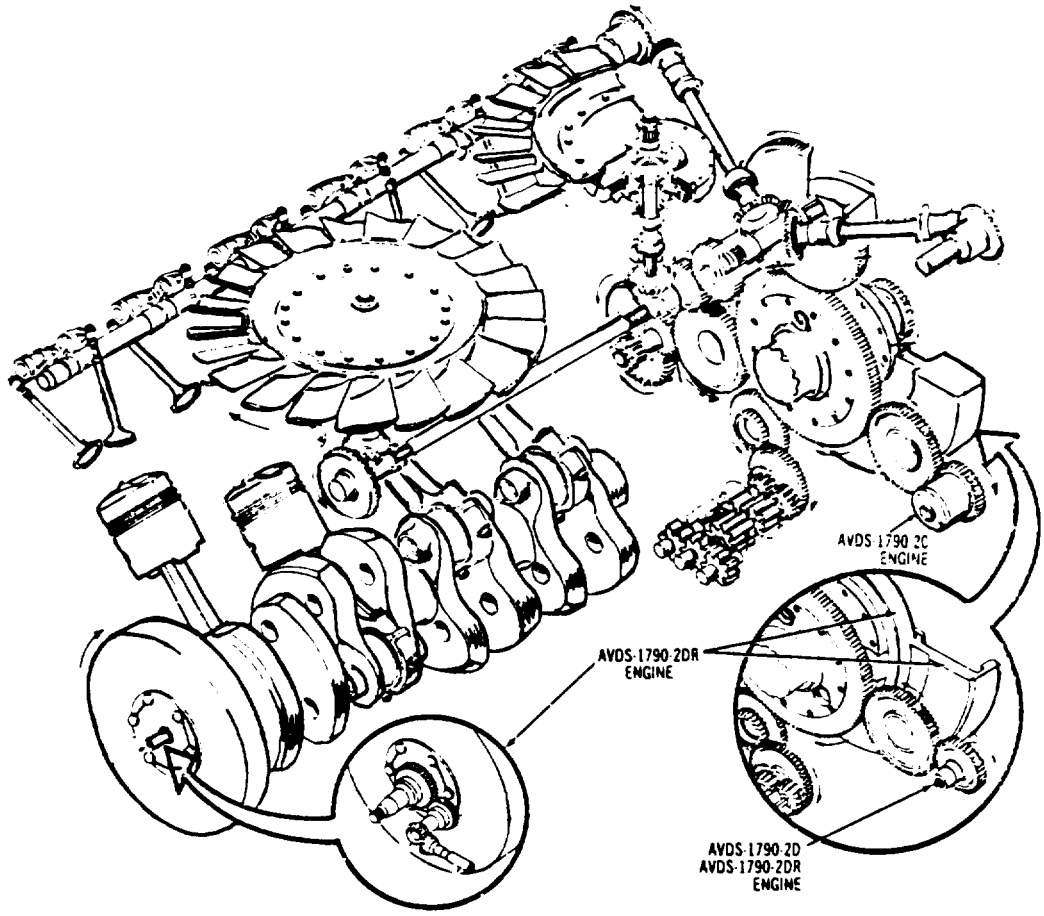


Fig. 3-6. Typical Engine Mechanical Construction - Combat Vehicles

3-17. ENGINE/TRANSMISSION HOUSING DAMAGE

General Information:
Small cracks or holes may develop in a cylinder block or transmission housing due to vibrations or severe shock forces like mine explosions. Any battle damage to the power pack should be assessed by the MT.

Limitations:
- Degraded reliability

Personnel/Time Required:
- 3 soldiers
- 12-24 hours

Materials/Tools:
- Oxy-Acetylene torch for brazing
- Bulk issue fiberglass or epoxy kit
- TIG or MIG welding gun for aluminum
- Permatex, any grade
- Lift capability

Other Options:
- Continue operations.

Procedural Steps:

1. Remove power pack when required.

2. Clean damaged area.

3. Fill small cracks or holes in low stress areas either with permatex, fiberglass, or epoxy.

4. Many cracks and holes in stress areas can be repaired by a TIG or MIG welding gun for aluminum, but precautions must be taken to prevent the housing from warping. Iron castings can be brazed using an oxy-acetylene torch.

5. Re-install power pack.

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

CHAPTER 4

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

4-1. General.

The fuel is stored in aluminum fuel tanks located on each side of the powerpack. Each fuel tank has an electric fuel pump to provide fuel to the engine. The fuel is routed through aluminum and steel fuel lines to a paper element fuel filter and then through steel reinforced rubber hoses to another electrical fuel pump on the engine. The engine can draw fuel without the in tank fuel pumps operating but they are needed as a back up system to provide the fuel requirement of the AVDS 1790 engine.

4-2. Assessment Procedure

a. Visually inspect → Damage found to:

-fuel tank; ..... go to Section II
-fuel line; ..... go to Section IV
-fuel filters; ..... go to Section V

No apparent damage found

b. Check for impurities in the fuel by draining the fuel filters.

c. Attempt to Operate → Damage found to:

-tanks or lines ..... go to Section II or IV
-pump or pump ..... go to Section III
-fuel filters or filters ..... go to Section V

Fuel System delivers fuel and does not leak

d. Observe Operation → Damage found to or substandard operation noted on:

-pumps; ..... go to Section III
-fuel filters; ..... go to Section V

No apparent damage found

e. Evaluate system performance:

FUEL SYSTEM ASSESSMENT

	Fully Mission Capable	Combat Capable	Combat Emergency Capable	Self Recovery Capable	Recover
-Output adequate	X	X	X		
-Output degraded		X	X	X	
-Output severely degraded			X	X	
-No output			X		X

4-3. BDAR Procedure Index

SECTION II. Fuel Storage Systems.

4-4. General.

Fuel is stored in enclosed aluminum containers. Fuel tanks are susceptible to contamination from dirt, water or other impurities. The fuel tanks are susceptible to corrosion which may result in leaks. Purging a contaminated fuel system and repairing leaks are the prime BDAR solutions. The tank is particularly susceptible to cracks.

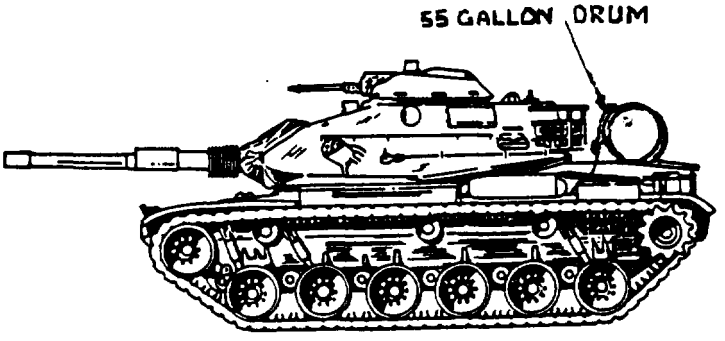
&5. FUEL TANK SUBSTITUTE

General Information

Fuel tank is damaged beyond immediate repair, a temporary tank may be used. Any suitable container, such as a 5-gallon gas or oil can, a 55 gallon drum, etc, can be secured to the outside of the vehicle in a position above the engine.

Limitations:

- Turret traversing will be limited.
- Frequent refueling required.



Personnel/Required:

- 2 soldiers
- 1 to 1-1/2 hours

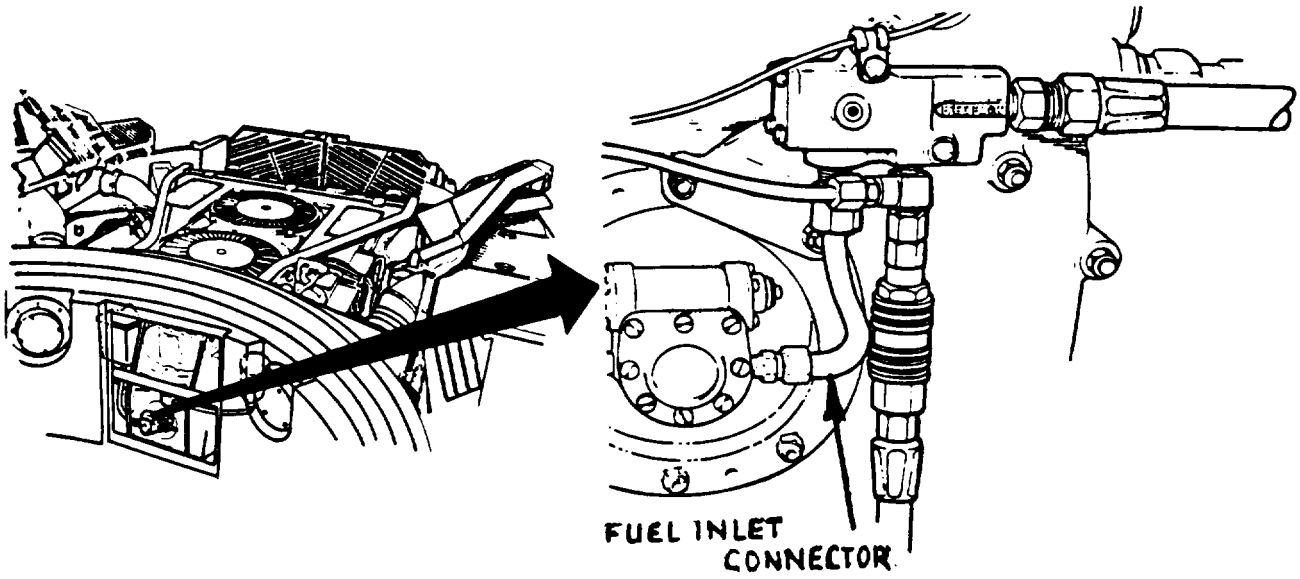
Materials/Tools:

- Rubber fuel line
- Wood blocks
- Rope or straps

Procedural Steps:

1. Secure container on outside of tank using wood blocks and rope.
2. Obtain fuel line or hose and secure it to the container.
3. Gain access to the engine mechanical fuel pumps.
4. Disconnect the fuel line at the fuel inlet connector as shown.
5. Connect the fuel line from the container to the fuel inlet connection.
6. Fill the container with fuel and purge the air from the fuel line, tighten connection.

7. Tie or block the engine access doors to protect the fuel line from damage.



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

SECTION III. Fuel Pumps

4-6. General .
Engine will not start, no fuel to injector pump. The in-tank fuel pumps are generally interchangeable between combat vehicles. The difference is in the bracketry used to mount the pump in the fuel tanks. The electrical pump unit can be removed and used on the brackets to fit the M48/M60 series tank.

4-7. FUEL PUMP ON-TANK) INOPERATIVE

General Information:
Engine will not start, no fuel to injector pump. Install a substitute fuel pump. The in-tank fuel pumps are generally interchangeable between combat vehicles.

Limitations:
- None

Personnel/Time Required:
- 2 soldiers
- 3 hours

Materials/Tools:
- In-tank fuel pump from any of the following
  - 2-1/2 ton truck
  - 5 ton truck
  - M109/Ml 10 SP Howitzer
  - M 1 tank

Other Options:
l Use the heater's fuel pump to provide fuel to the engine.

Procedural Steps:

NOTE

If engine stops, check fuel valve to assure valve is in "BOTH" position. If fuel flow valve is in "BOTH" position, both pumps have failed. Only one fuel pump is needed to supply fuel to the engine with fuel flow valve in "BOTH" postion.

1. Gain access to left or right engine compartment (in-tank) fuel pump mounting cover assembly that has defective fuel pump.

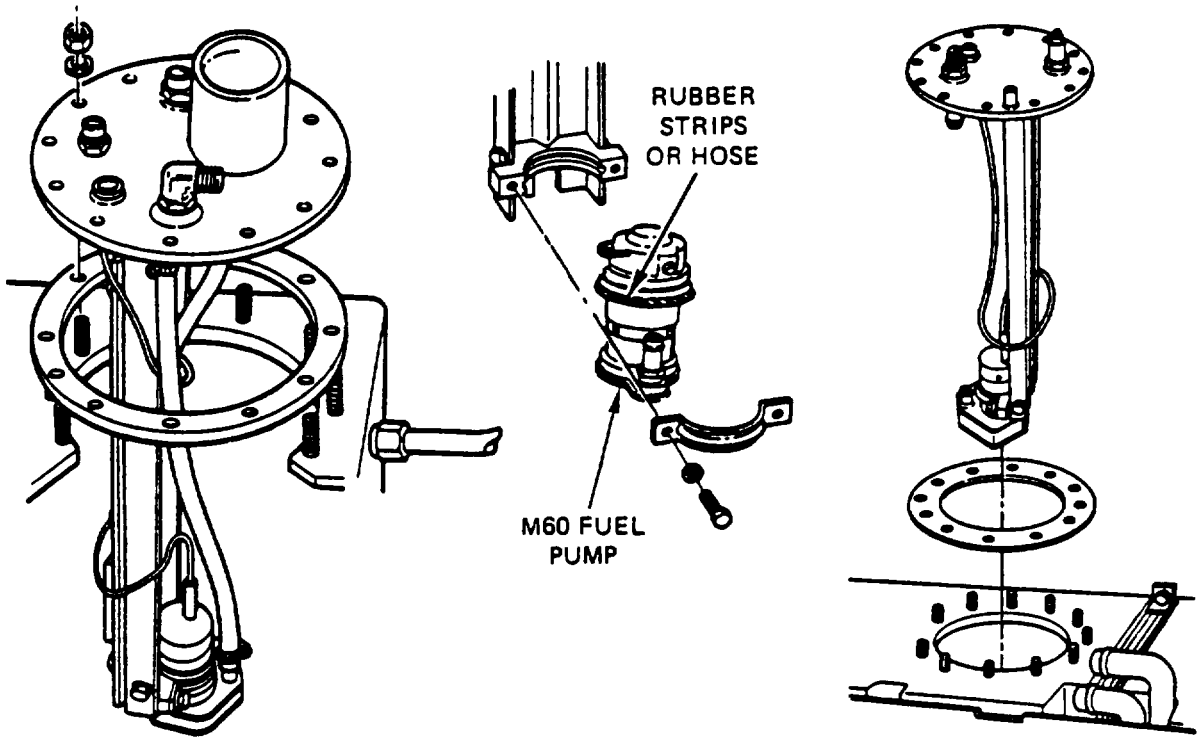
2. Remove fuel pump cover assembly with attached defective fuel pump. Remove defective pump from cover assembly.

Procedural Steps(Cont'd)

3. Wrap rubber strips or hose around substitute fuel pump body so that it will be tightly secured when installed.

4. Install substitute fuel pump in cover assembly.

5. Obtain a fuel pump connector and cable. Connect fuel pump to connector.



6. Splice fuel pump cable and red wire from cover assembly cable together. Insulate connector with shrink tubing.

7. Attach black wire from cover assembly cable to ground terminal on fuel pump.

8. Install cover and pump assembly to fuel tank.

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

SECTION IV. Fuel Lines And Valves

4-8. General.

Any fix which will stop leaks or by-pass a blocked line is acceptable. Metal and rubber line repairs are covered in TM 9-2350-276-BD.

4-9. FUEL LINE FROZEN

General Information:
Engine will not start because of frozen fuel lines. Diesel fuel may accumulate water by condensation causing a freezing problem during cold weather. Fuel tanks should be checked for water.

Limitations:
- None

Personnel/Time Required:
- 2 soldiers
- 30 to 60 minutes

Materials/Tools:
- Air duct tubing

Other Options:
- Use a Herman Nelson heater to warm the lines.
- Use another vehicle's exhaust to heat the lines.

Procedural Steps:

1. Disconnect heater air duct tubing at personnel heater.

2. Route a long duct or connect a series of short ducts long enough to reach the frozen area.

3. Start personnel heater and heat the frozen lines.

4. Attempt to start engine,

5. After the engine starts, purge water from fuel system.

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

Section V. Fuel Filters

4-10. General.

There are 2 filter devices in the fuel system. The primary filter is on the engine and 3 filter elements are in the fuel water separator also on the engine. The filters must be periodical y drained to prevent water or dirt from entering the engine fuel system.

4-11. FUEL FILTER CLOGGED OR FROZEN

General Information

Clogged or frozen fuel filters will stop the flow of fuel to the injector pump. Lack of fuel will stop the engine from running or if frozen will prevent the engine from starting. Clogged filters must be repaired or by-passed and frozen filters must be thawed.

Limitations:

- Unfiltered fuel if filters are bypassed.

Personnel/Time Required:

- 1 soldier
- 60 minutes

Materials/Tool*

- None

Other Options

- For frozen filters, heat with the personnel heater air ducted to the engine compartment or heat with another vehicle's exhaust.

- For clogged filters, remove filter element.

Procedural Steps:

1. Gain access to the fuel filters.

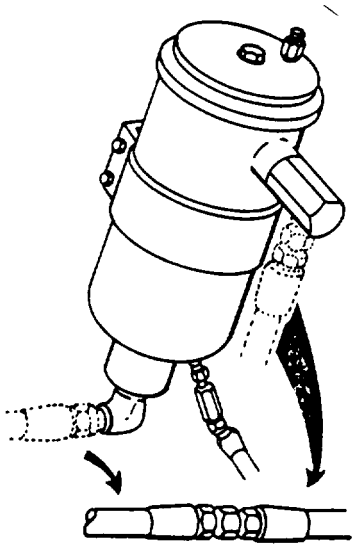
2. Clean away all grease and oil from filter connectors.

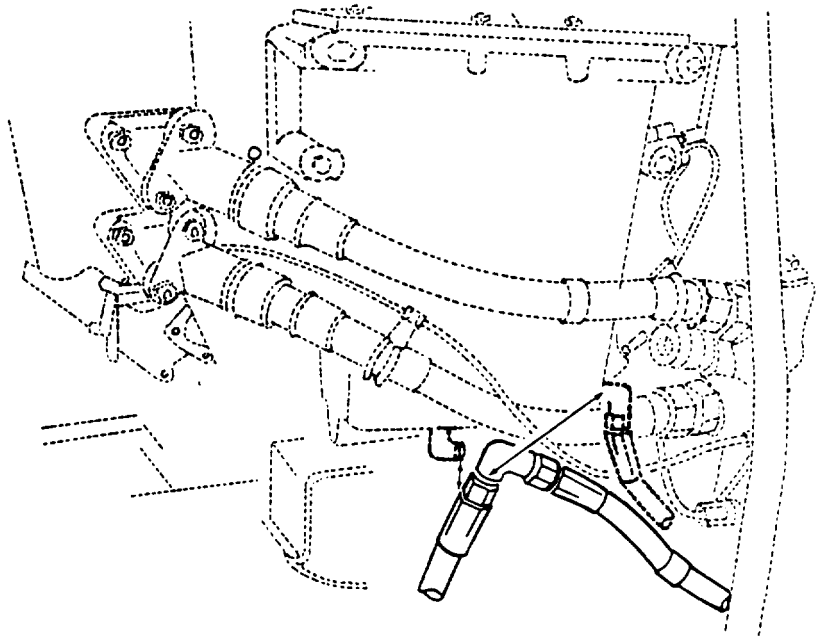
3. Drain the fuel lines and filter canisters.

4. Check for fuel leakage, tighten connections if required. Purge fuel lines; if the failure is not corrected, go to step 5.

5. Primary filter may be by-passed by disconnecting lines from filter and connecting them together as shown.

Procedural Steps (Conf'd)





6. The secondary filter may be by-passed by disconnecting the main injector supply line from the filter and connecting it directly to fuel pump line using the existing elbow .

7. Check for fuel leakage after by-passing the filter.

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

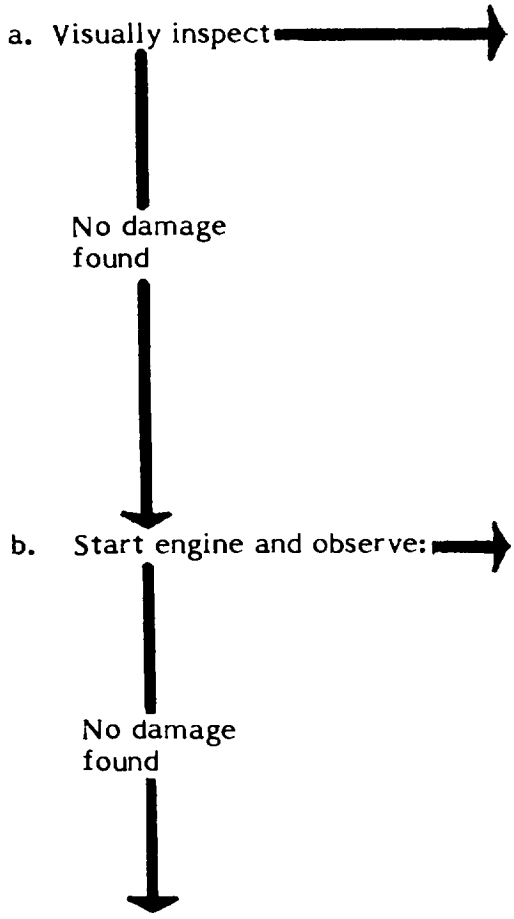
CHAPTER 5
COOLING SYSTEM

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

5-1. General. Cooling system problems may be indicated by a variety of faults. Typically the driver's indicator panel will show overheating. However, sporadic overheating or constant high temperature may indicate an impending major cooling system problem.

5-2. Assessment Procedure



Damage found to:

-fans; . . . . . go to Para 5-4

-fan drive; . . . . . go to Para 5-4

-shrouds; . . . . . go to TM 9-2350-276-BD

-ducts; . . . . . go to TM 9-2350-276-BD

-engine . . . .go to TM 9-2350-276-BD compartment covers;

-engine . . . .go to TM 9-2350-276-BD compartment seals;

Damage found to:

-fan air intake; . . go to Para 5-4

-fan drive; . . . . . go to Para 5-4

-engine . . . .go to TM 9-2350-276-BD compartment covers;

-engine . . . .go to TM 9-2350-276-BD compartment seals;

c. Evaluate system performance:

	COOLING SYSTEM ASSESSMENT				
	Fully Mission Capable	Combat Capable	Combat Emergency Capable	Self-Recovery Capable	Recover
-Cooling normal/ near normal	X	X	X		
-Cooling degraded		X	X	X	
-Cooling severely degraded			X[1]		X[1]
-No cooling			X[1]		X[1]

Note 1

Careful operation under these conditions will not damage the engine if it is operated only to reposition or move the vehicle under light acceleration for short periods of time. The engine oil temperature must be allowed to cool to under 200°F between operations.

5-3. BDAR Procedure Index.

SECTION II. BDAR Procedures

5-4.. COOLING FAN FAILURE

General Information:
The AVDS-1790 engine utilizes two cooling fans. The fan at the front of the engine primarily cools the engine oil coolers. The rear fan cools the transmission oil coolers. A damaged fan should be replaced. However, the transmission can function much longer at a higher temperature than the engine. The rear fan can be installed on the front drive. However, the rear fan drive must not be disabled because it drives the engine fuel injector pump. Fans from AVDS-1790 series engines are interchangeable on the M48A5, M60, M60A1, M60A3, and M88A1 vehicles. If a fan is defective operate at low speeds and monitor power pack oil temperatures.

Limitation:
- Reduced mobility

Personnel/Time Required:
- 2 to 3 soldiers
- Less than 2 hours

Materials/Tools:
- Replacement fan, or rear fan
- Spacer, fan hub sleeve, NSN 4910-00-795-7952

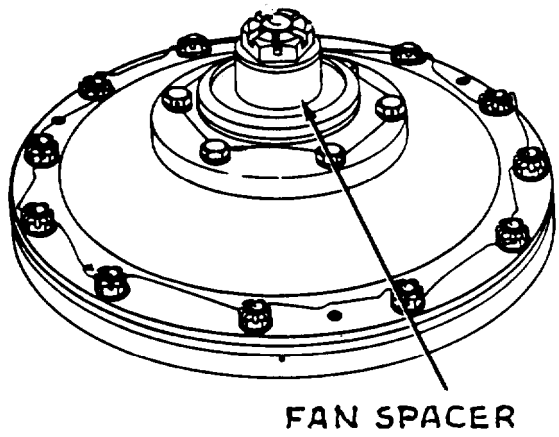
Procedural Steps:

1. Remove rear deck.

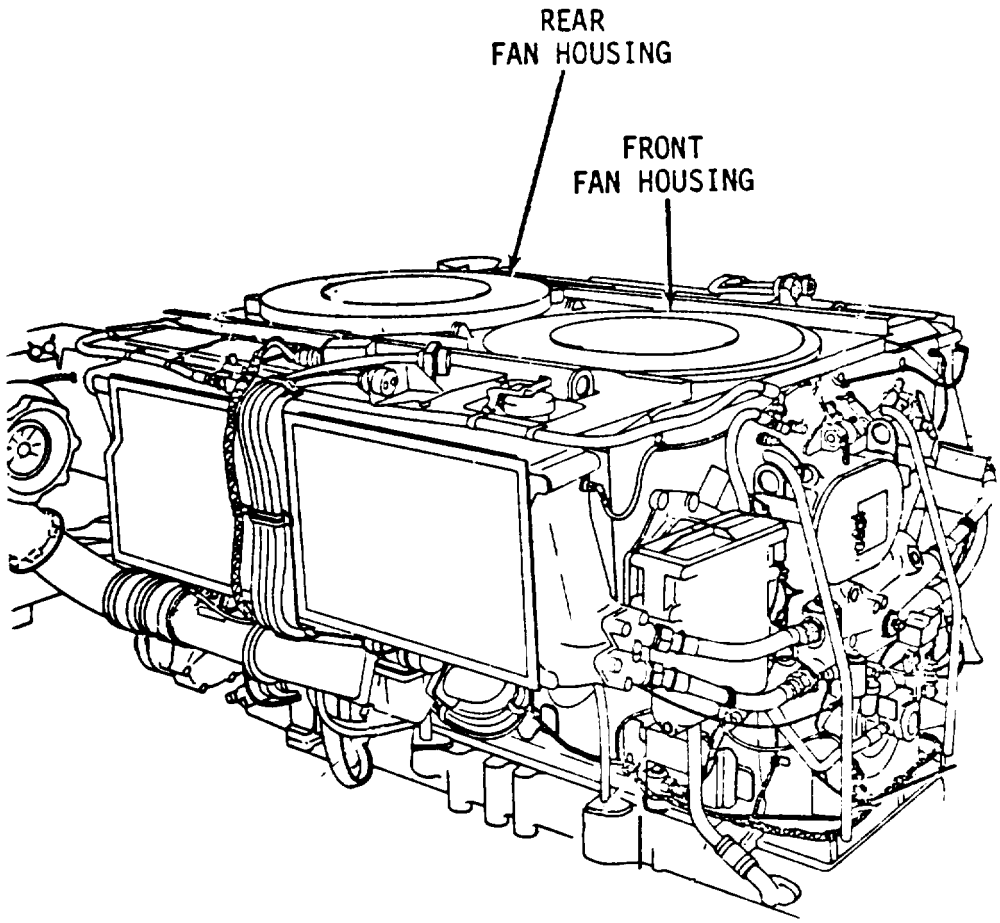
2. Remove defective fan assembly.

3. When replacement fan is not available, replace the front fan with rear fan. The overflow of air from front fan will help cool the transmission.

4. Install the fan spacer in place of the removed fan.



Procedural Steps (Cont'd)



5. Reinstall rear deck.

6. When both fan assemblies are defective, the vehicle must be recovered.

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

CHAPTER 6
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

6-1. General.
The electrical system is a 24-volt direct current power supply. Storage is provided by six 12-volt batteries located to the rear of the driver under the turret basket floor. Recharging is provided by either a 650 AMP oil cooled alternator or a 300 AMP air cooled AC generator. A slave receptacle is provided for emergency power should the vehicle's power fail. The starter is a 24 vDC electric motor protected by a neutral safety switch which prevents starter operation unless the transmission is in neutral. Circuit protection is provided by circuit breakers. When tripped, the circuit breakers will automatically reset as they cool down.

6-2. Assessment Procedure

a. Visually inspect → damage found to:

-batteries; . . . . . go to TM 9-2350-276-BD
-cables; . . . . . go to Section II
-wiring, ... go to Section II
-circuit breakers; . . . . . go to TM 9-2350-276-BD
-voltage regulator . . . . . go to Section III
-alternator; . . . . . go to Section III

No damage found ↓

b. Start engine and observe →

-alternator output function; . . . . . go to Section III
-voltage regulator function . . . . . go to Section III
-circuit breakers . . . . . go to TM 9-2350-276-BD

No damage or trouble found ↓

c. 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	
-Charging system works marginally		X	X	X	
-Charging system does not work			X	X	X

6-3. BDAR Procedure Index.

SECTION II. General Electrical Repair

6-4. General.

Electrical repairs fall into several categories.

a. By-passing a switch or system.

b. Substituting with a like item or lower powered item.

c. Isolating a circuit.

The priority of the function, available tools and parts will dictate the type of repair to be attempted. General electrical repair procedures are given in TM 9-2350-276-BD. Electrical components which are interchangeable may be found in Appendix A or the following sections of this chapter.

SECTION 111. Motors, Starters, Alternators

6-5. General.

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

6-6. ALTERNATOR INTERCHANGEABILITY

General Information:
Alternator failure will degrade the vehicle's combat operations. Emergency usage on battery power is only operation possible, but will require frequent recharging from another vehicle or an outside power source. The alternator should be replaced.

Limitations:
- None

Personnel/Time Required:
- 2 soldiers
- 4 hours

Materials/Tools:
- Cannibalized alternator
- Corresponding regulator

Other Options:
- Vehicle can be driven without alternator

Procedural Steps:

1. Remove power pack.

2. Obtain alternator from another vehicle or unserviceable engine.

3. Examine the replacement alternator to determine if it is an exact replacement. If the exact replacement cannot be found, the AVDS 1790-2D alternator can be interchanged with the AVDS 1790-2C alternator.

NOTE

Interchanging alternators requires the exchange of engine wiring harnesses 7722353 and 1165541 (AVDS 1790-2C) with 11682724 and 11672723 (AVDS 1790-2D). The voltage regulator must also be changed if changing the wiring harnesses and alternator (See figure 3- 1).

Interchanging alternators also requires the installation or removal of oil cooled alternator cooler hoses or air cooling ductwork. Utilize as many parts as possible from the same source.

Procedural Steps (Cont'd)

4. Re-install power pack.

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

6-7. EMERGENCY TOW STARTING , AT REDUCED SPEED

General Information:
Loss of electrical power or starter failure in degraded towing environments will prevent normal tow start operations. The vehicle can be tow-started at speeds as low as 10 mph.

Limitations
- None

.
Personnel/Time Required:
- 3 soldiers
- 30 minutes

Materials/Tools:
- Tank or other vehicle capable of towing the tank to 10 MPH minimum
- Tow cables

Procedural Steps:

CAUTION

Equipment damage may result if the right steer is not released promptly after engine starts. Failure to release right steer control will apply excessive pressure on steering system causing oversteer of vehicle when engine is started.

1. Connect the disabled vehicle front to rear of tow vehicle with tow cables.

2. Bring vehicle speed to 10 MPH minimum.

WARNING

If the right steer is not released promptly, personnel may be injured by being jerked against the vehicle or by flying objects caused by violent vehicle movement.

3. Shift the towed tank into the lowest forward gear and apply hard right steer. The hard right steer will double the transmission pump rate and crank the engine fast enough to start.

Procedural Steps (Cont'd)

4. As soon as the engine starts, release the right steer.

5. Stop vehicles and disconnect tow cables or tow bar.

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

6-8. STARTER FAILURE

General Information
Starter will not operate. Replace starter with cannibalized starter from M48A5, M60A1, M60A3, M88A1, AVLB or CEV.

Limitations:
- None

Personnel/Time Required:
- 3 soldiers
- 3-4 hours

Materials/Tools:
- Starter
- Lift capability

Other Option:
- Tow Start

Procedural Steps:.

1. Remove power pack.

2. Remove defective starter.

3. Install the new or used starter cannibalized from one of the vehicles with an AVDS-1790 engine.

4. Re-install power pack.

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

6-9. ENGINE STARTER WILL NOT ENERGIZE, DEFECTIVE NEUTRAL SAFETY SWITCH

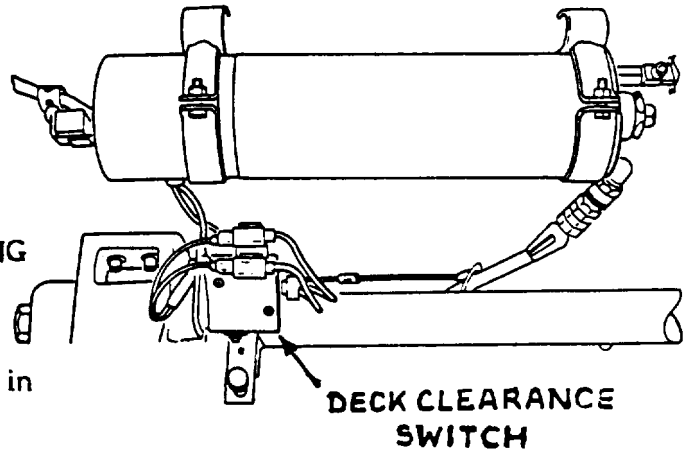
General Information:
If the engine starter will not energize because the neutral safety switch is defective; the neutral safety switch can be replaced with the rear deck clearance switch.

Limitations
- Equipment fail-safe system neutralized when deck clearance switch is removed.

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

Materials/Tools:
- Safety switch or deck clearance switch
- Tape

Other Options:



WARNING

The vehicle will start in any gear when the neutral safety switch has been by-passed. Accidental starts may cause death to personnal in front of vehicle.

l By-pass the neutral safety switch by removing the two wires at the switch and connecting the wires together.

Procedure Steps:

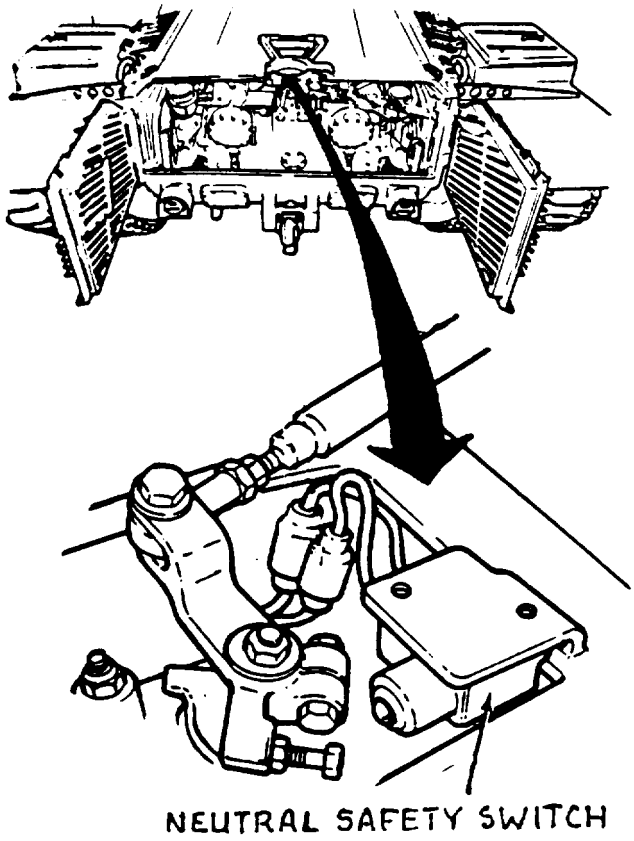
1. Remove defective safety switch.

2. Install another neutral safety switch or replace it with the deck clearance switch if a switch is not available.

CAUTION

Operation of vehicle without a deck clearance switch could cause equipment damage.

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



SECTION IV. Turret Power

6-10. TURRET, NO HYDRAULIC POWER

General Information:
The turret hydraulic power is needed to operate the turret. The manual back-up system can be used without the main hydraulic power being functional but the operation would be seriously degraded. The stabilization system will be inoperative. This procedure will give a method to power up the hydraulic system.

Limitations
- None

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

Materials/Tools
- Multimeter
- Tape
- Soldering iron

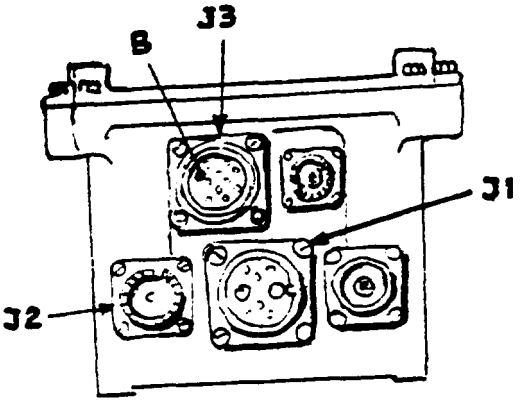
Assessment Steps:

1. Turn MASTER power switch ON.

2. Check that ELEV/TRAV power indicator light lights.

    a. If yes, go to step 13.
    b. If no, go to step 3.

3. Turn MASTER power switch OFF.



Assessment Steps (Cont'd)

4. Disconnect turret power cable at turret power relay box, connector 31.

5. Turn MASTER power switch ON.

6. Check for power at turret power cable connector.

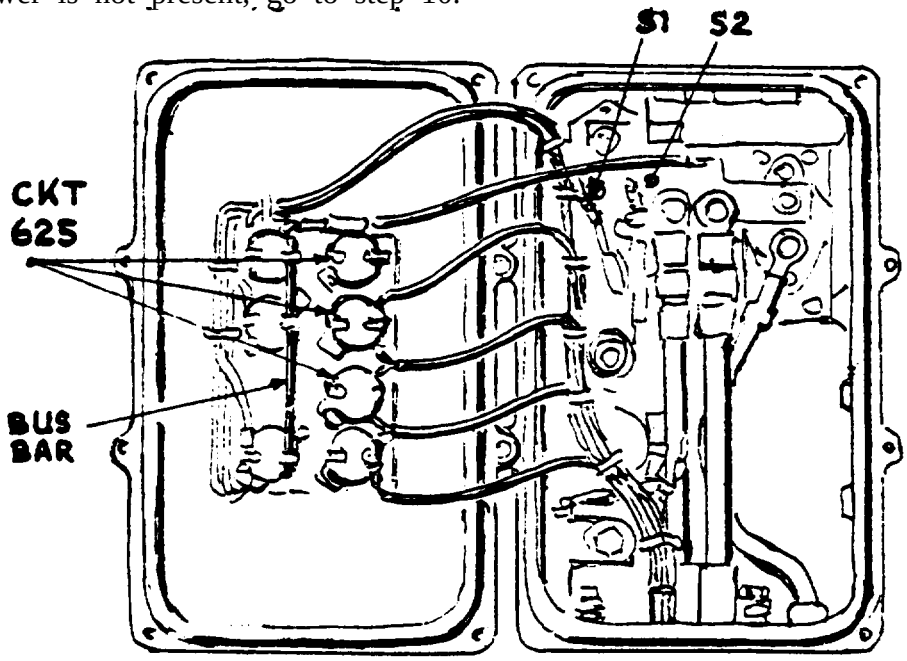
   a. If power is present, go to step 7.
   b. If power is not present, repair turret power cable.

7. Reconnect turret power cable.

8. Disconnect turret control wiring harness from connector J3.

9. Check for power at socket B of connector J3 on the turret relay box.

   a. If power is present, go to step 13.
   b. If power is not present, go to step 10.

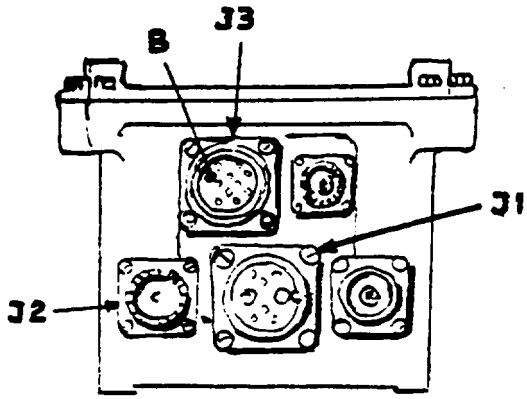


10. Remove cover of turret power relay box.

11. Remove wire (CKT 625) from circuit breaker.

12. Connect this wire to circuit breaker bus bar using existing screw.

Assessment Steps (Cont'd)

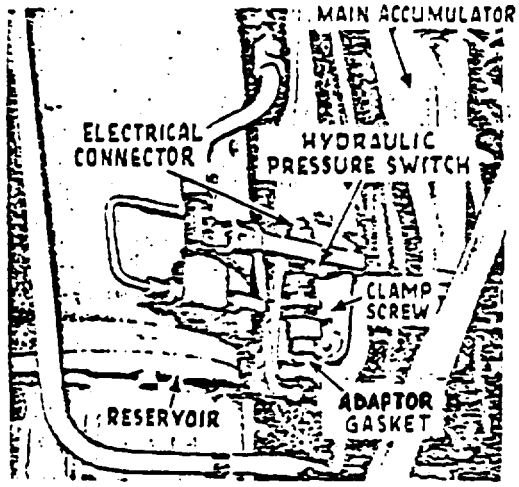


13. Remove hydraulic pump motor cable from connector J2 on turret power relay box.

14. Check for power at connector J2.

    a. If power is present, repair the hydraulic pump motor or use manual back-up system.
    b. If power is not present, go to step 15.

15. Reconnect hydraulic pump motor cable.



Assessment Steps (Cont'd)

16. Disconnect pressure switch connector.

17. Check for power at socket A.

a. If power is present, go to step 18.
b. If power is not present, repair turret control wiring harness or use manual back-up system.

18. Using ohms scale check pressure gauge (pressure below 1225 psi).

19. Check for continuity through pressure switch.

a. If present, go to procedural step 1.
b. If not present, replace pressure switch or use manual power.

Procedural Steps

1. Remove cover from turret power relay box.

2. Check continuity of power control circuit breaker across bus bars and across wire terminals S1 and S2.

a. If present at both checks, replace power relay or use manual power.
b. If not present, go to step 3.

3. Remove one leg of power lead (CKT 100) from bus bar.

4. Connect to bus bar between defective circuit breaker and power relay.

5. Remove wire from terminal S1 and connect to terminal S2 using existing screw.

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

CHAPTER 7

POWERTRAIN/STEERING

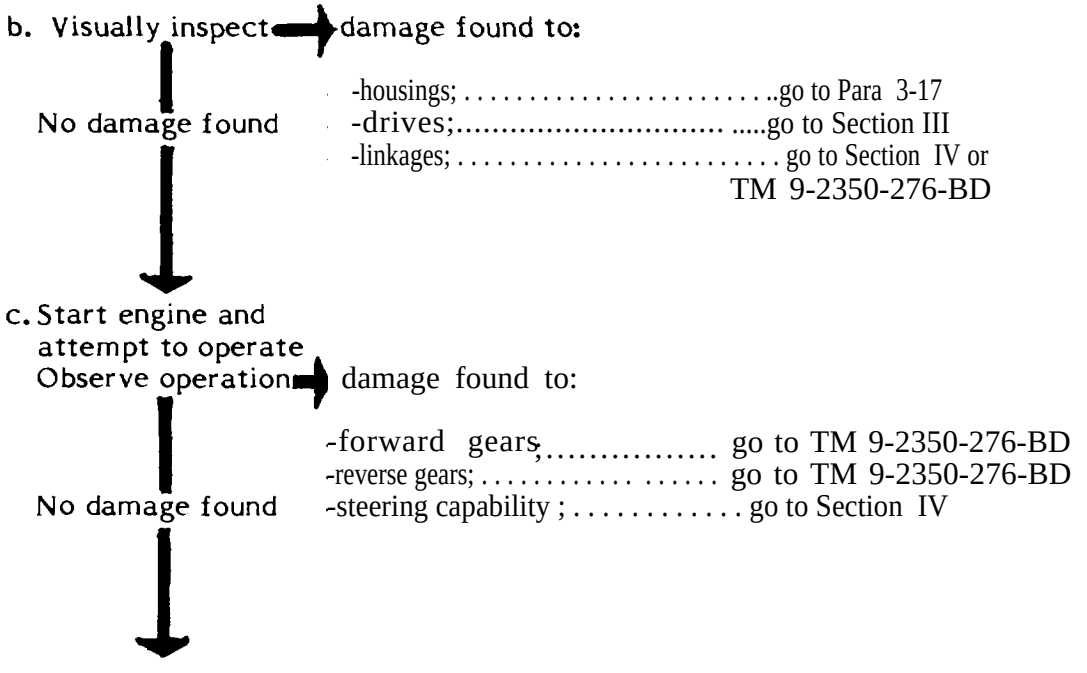
BDAR FIXES SHALL BE USED ONLY IN COMBAT
AT THE DISCRETION OF THE COMMANDER
AND SHALL BE REPAIRED By STANDARD MAINTENANCE PROCEDURES
AS SOON AS PRACTICABLE AFTER THE MISSION IS COMPLETED.

SECTION I. General

7-1. General.
The powertrain consists of a CD850-6A two-speed forward, one-speed reverse, automatic transmission which delivers power to two final drives to drive the tracks. The CD850 transmission houses the steering mechanisms and brake bands. The transmission provides the tank with a neutral steer capability which allows it to turn in its own radius by driving one track forward and the other in reverse.

7-2. Assessment Procedure.

a. Pre-conditions: Vehicle brakes should be in working condition. The vehicle engine must run to assess the powertrain using this procedure.



Assessment Procedure Cont.

d. Check Powertrain/steering performance:

	POWERTRAIN/STEERING ASSESSMENT				
	Fully Mission Capable	Combat Capable	Combat Emergency Capable	Self Recovery Capable	Recover
-All gears and steering	X	X	X		
-Reverse, one forward gear and steering		X	X	X	
-One gear only and steering			X	X	X
-One gear only; no steering			X[1]	X	X
-No gears, no steering			X[1]		X

Note 1

Use as towed platform or stationary gunumount.

7-3. BDAR Procedure Index:

SECTION II. Transmission

7-4. TRANSMISSION SLIPPAGE

General Information
When the transmission is slipping, the engine overspeeds relative to vehicle movement. The procedure below is the only known battlefield expedient that can be performed on the transmission in less than 2 hours to correct transmission slippage. The transmission converter pressure must be raised to above 60 psi for transmission to operate. Draining and replacing transmission oil with OE 30 or OE 50 oil will not correct transmission slippage caused by pump or disk wear.

Limitations
- Potentially short transmission service life.

Personnel/Time Required:
- 2 soldiers
- 2 hours

Materials/Tool:
- Steel washer; minimum l/2-inch inside diameter, maximum l-inch outside diameter.

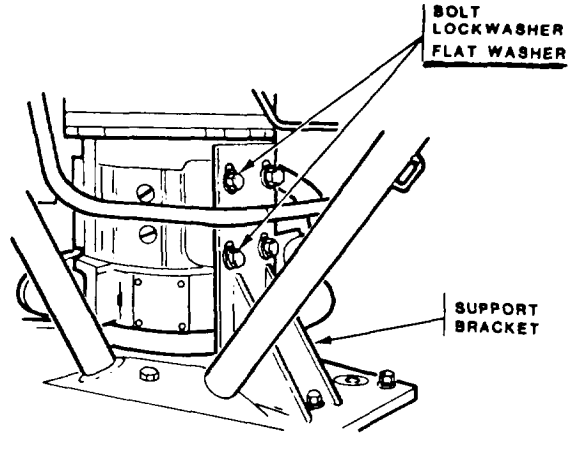
Procedural Steps:

NOTE

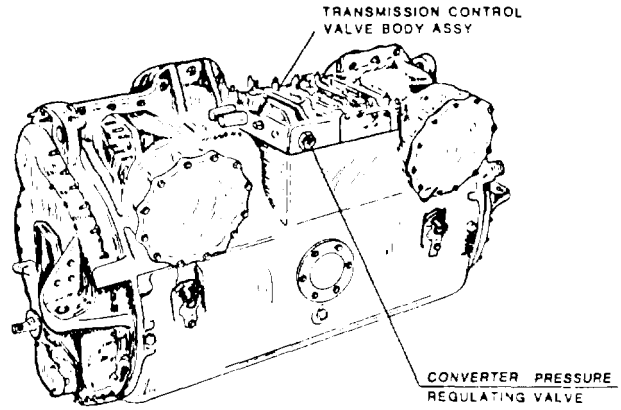
This procedure will increase the pressure to the converter approximately 10 psi per washer and raise the converter pressure above 60 psi. Transmission will not operate if pressure is below 60 psi.

1. Remove two flat washers from hydraulic power pack side mount. Re-install bolts and lock washers in side mount.

2. Gain access valve body.



Procedural Steps (Cont'd)

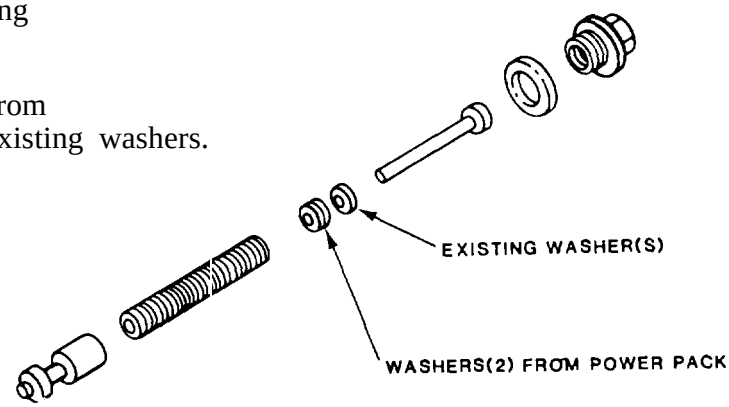


3. Remove cap frorn converter control valve located on side of valve body.

4. Pull out piston and spring inside valve body.

5. Remove the spring but leave existing washers on piston.

6. Install the two washers, removed from hydraulic power pack, on top of the existing washers.



7. Re-install spring on piston and place the large diameter end of piston in the cap.

8. Insert the piston and cap into the valve body and re-tighten the cap.

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

SECTION III. Final Drive

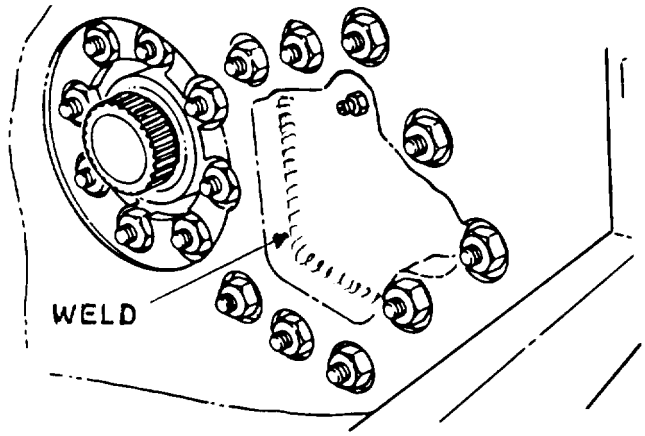
7-5. FINAL DRIVE MOUNTING STUDS BROKEN OR SHEARED

General Information:
Loose final drive mounting studs can cause the final drive to work loose and shear the studs. Severe damage to the transmission, final drive and/or track may result if the damage is not repaired promptly.

Limitations:
- Option 1: None with a complete set of replacement studs; if less then a complete set, degraded mobility.
- Option 2: Welded repair requires periodic inspection.

Personnel/Time Required:
- 2 soldiers
- 4 hours per final drive

Materials/Tools:
- Replacement stud(s)
- Welding equipment
- Lift capability



Procedural Steps:

Option 1

1. Break track and remove sprocket and hub assembly from final drive.

2. Remove broken/sheared studs from final drive.

3. Install replacement bolts or studs (use every other stud from the opposite final drive if required).

4. Re-install sprocket and hub assembly.

5. Reconnect track and adjust tension.

Option 2.

1. Break track and remove sprocket and hub assembly from final drive.

2. Ensure that the final drive housing is seated to the hull, and weld the final drive housing to the hull.

3. Re-install sprocket and hub assembly.

Procedural Steps (Cont'd)

4. Reconnect track and adjust tension.

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

SECTION IV. Steering Systems

7-6. STEERING LINKAGE FAILURE

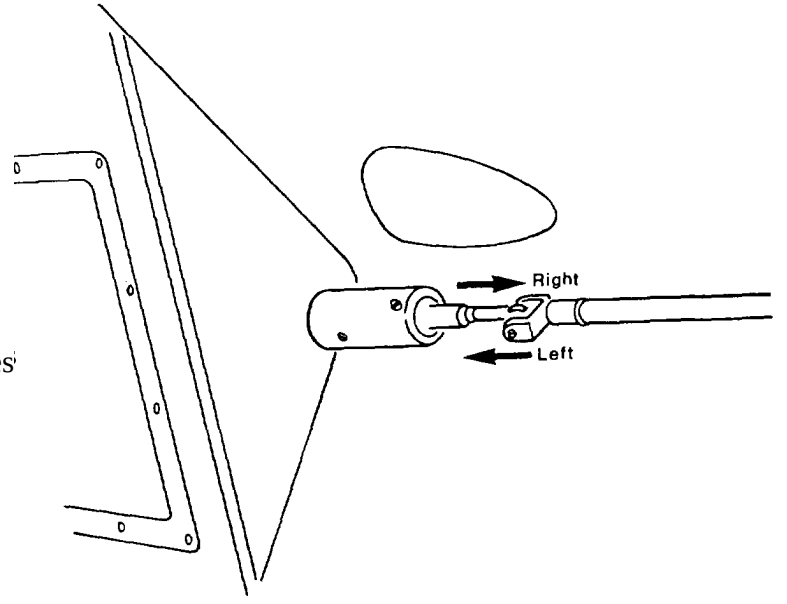
General Information
Unable to control vehicle, no steering capabilities. Steer the vehicle by manually operating the push rods.

Limitations:
- Degraded mobility

Personnel/Time Required
- 2 soldiers
- 30 minutes

Materials/Tool:
- Cannibalized linkage assembly

Other Options:
- Weld or splint linkage using procedures for linkage repair in TM 9-2350-276-BD.



Procedural Steps:

WARNING

Do not move turret while manually steering the vehicle. Turret movement could result in severe injury or death.

1. To steer vehicle with broken linkage, station a crew member on the left side of turret for access to the linkage.

   b. Push the steering rod to the rear to turn the vehicle left.

   b. Pull the steering rod forward to turn the vehicle right.

2. Maintain communications with the driver by intercom for instructions.

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

CHAPTER 8

BRAKES

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 vehicle service brake is a hydromechanical system. A master cylinder and two slave cylinders are used to apply the brake bands-inside the transmission and stop the tank. The steering system uses braking action to steer the tank by applying braking action to one side or the other. This allows the steering to be used to stop the tank should the hydraulic brake system fail. The parking brake has mechanical linkage to the transmission which locks the transmission in a braked condition.

8-2. Assessment Procedure

a. Assessment Preconditions: Before testing the vehicle brakes, clear the immediate area or, if in a restricted area, restrain 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.

b. Check fluid level.

c. Visually inspect → Damage found to;

-pedal and linkage; . . . .go to TM 9-2350-276-BD
-hydraulic lines; ..... go to TM 9-2350-276-BD
-brake cylinders; . . . . . go to Section II

No Damage found

d. Start or tow the vehicle up a slight grade and check brake operation effectiveness → Damage found to:

-no stopping power; . . . . go to Section II

-pulling or other erratic action; . . . . . go to Section II or TM 9-2350-276-BD

-parking brakes; . . . . . go to Section II

No Damage found

d. Evaluate performance

	BRAKE ASSESSMENT				
	Mission Capable	Fully Combat Capable	Combat Emergency Capable	Self Recovery	Recover
-Brakes normal	X	X	X	X	
-Brakes degraded		X	X	X	
-Brakes severely degraded			X	X	X
-No brakes			X	X	X

8-3. BDAR Procedure Index

SECTION II. Brake BDAR

8-4. General.

The service brakes are actuated by a master cylinder and two slave cylinders. Cylinder leakage and internal corrosion are the most common modes of failure. Several methods are available to regain the use of the brakes if repair parts are not available.

8-5. BRAKE MASTER CYLINDER FAILURE

General Information

Master cylinder failure will degrade the stopping capability of the tank. The master cylinder should be replaced with a new or substitute item. A 5-ton truck master cylinder is physically the same on the outside. The internal fluid return ports are different but the bore diameter is the same. The piston cups are the same as those on M48/M60.

Limitations

- None

Personnel/Time Required

- 1 soldier
- 2 hours

Materials/Took

- Repair kit for master cylinder
- A 5-ton truck master cylinder

Other Options

- Disassemble master cylinder and clean.
- Use hills to slow or stop tank.
- Brush against other objects, trees, earth banks, to slow or stop the tank.
- Use neutral and steer to brake the vehicle.

Procedural Steps

NOTE

Bleed brake system after performing brake work.

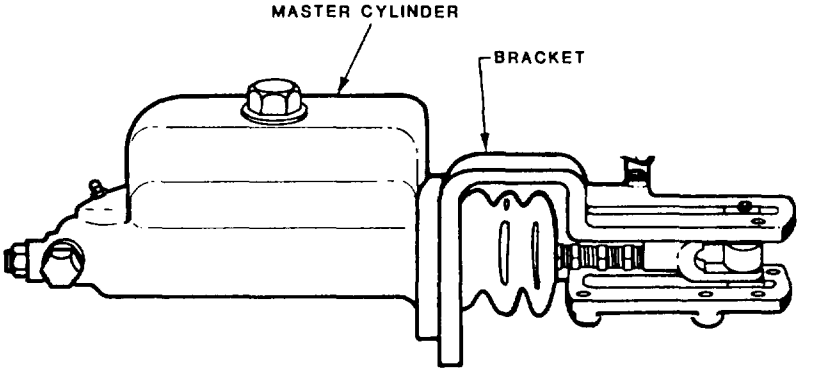
Option 1:

1. Remove unserviceable master cylinder.

2. Remove master cylinder from bracket.

3. Insert new cups into the master cylinder from a repair kit if one is available or use 5-ton master cylinder cups.

Procedural Steps (Cont'd)



4. Attach master cylinder to bracket and install in vehicle.

Option 2:

1. A 5-ton truck master cylinder is an alternate replacement.

2. Attach master cylinder to bracket and install in vehicle.

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

8-6. BRAKES LOCKED, LINKAGE JAMMED

General Information:
Vehicle will not move; engine stalls or bogs down when attempting to drive away. Brakes appear to be locked. Check the brake linkage for jamming or binding. If correcting the binding linkage does not free the brakes, the brake plates in the transmission have seized, and the transmission must be replaced.

Limitations
- No braking capability, use lowest range when going down-hill.
- Use chocks when parking *on* an incline.

Personnel/Time Required:
- 1 soldier
- 1 hour

Materials/Tools:
- Safety wire
- Communications wire
- Cord
- Boot lace
- String-like material

Other Options:
- If the brakes cannot be unlocked, disconnect the U-joints to recover the vehicle.

Procedural Steps:

1. Open rear grille doors.

2. Remove transmission shroud.

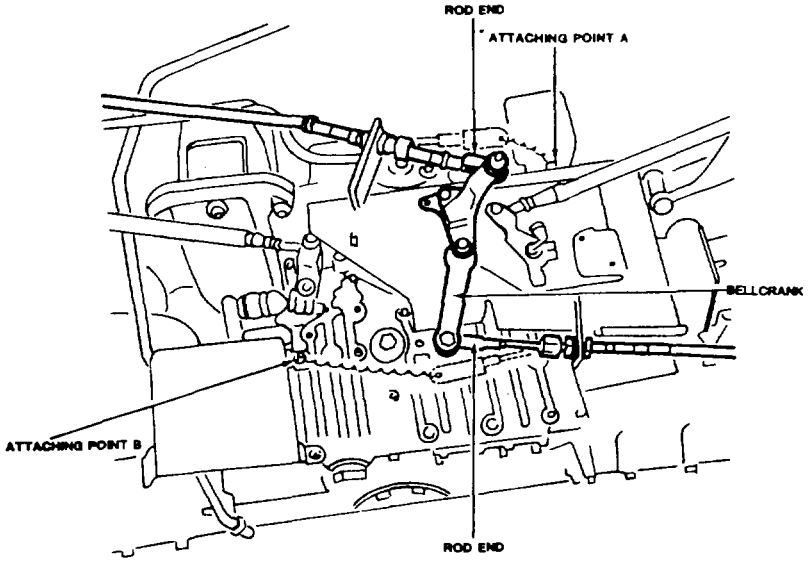
3. Remove cotter pins from bellcrank pins on left and right brake rods.

4. Remove pins from bellcrank, freeing the rods.

5. Pull brake rods out as far as possible (both right and left rods). Ensure that both left and right brakes are unlocked.

6. Secure brake control rods by tying string or wire to left rod end and hook to point "A" and right rod end hook to point "B" as shown .

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



8-7. BRAKE FLUID LEAKAGE AT TRANSMISSION SLAVE CYLINDER

General Information
Brake fluid leakage at transmission slave cylinder normally occurs at the fluid line connections. Leakage occurs from over-tightening the fitting and powerpack vibration.

Limitations:
- Limited braking if line is crimped

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

Materials/Tools:
- New or serviceable ring seal
- Spark plug gasket from gasoline engine
- Fine tooth file
- Hydraulic fluid, fuel, oil, or alcohol

Other Options:

CAUTION

Braking capability will be severely altered if slave cylinder fluid supply line is crimped. Braking capability will not be available for that side of vehicle. This will cause vehicle to steer to one side when braking.

l If slave cylinder cannot be repaired, crimp the fluid supply line so fluid will not leak.

Procedural Steps:

1. Gain access to leaking slave cylinder.

2. Remove slave cylinder.

3. Clean, file or scrape uneven spots on ring seal to a smooth mating surface for re-installation; See figure 1, item 1.

4. Re-install the slave cylinder using a new or used ring seal. A used ring-seal may be installed if reclamation procedures in step 3 have been accomplished. A spark plug seal from gasoline engine may be used as a ring seal.

5. Fill brake system with fluid. Use hydraulic fluid, fuel, oil, or alcohol when brake fluid is not available. Water may be used in above-freezing temperature.

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

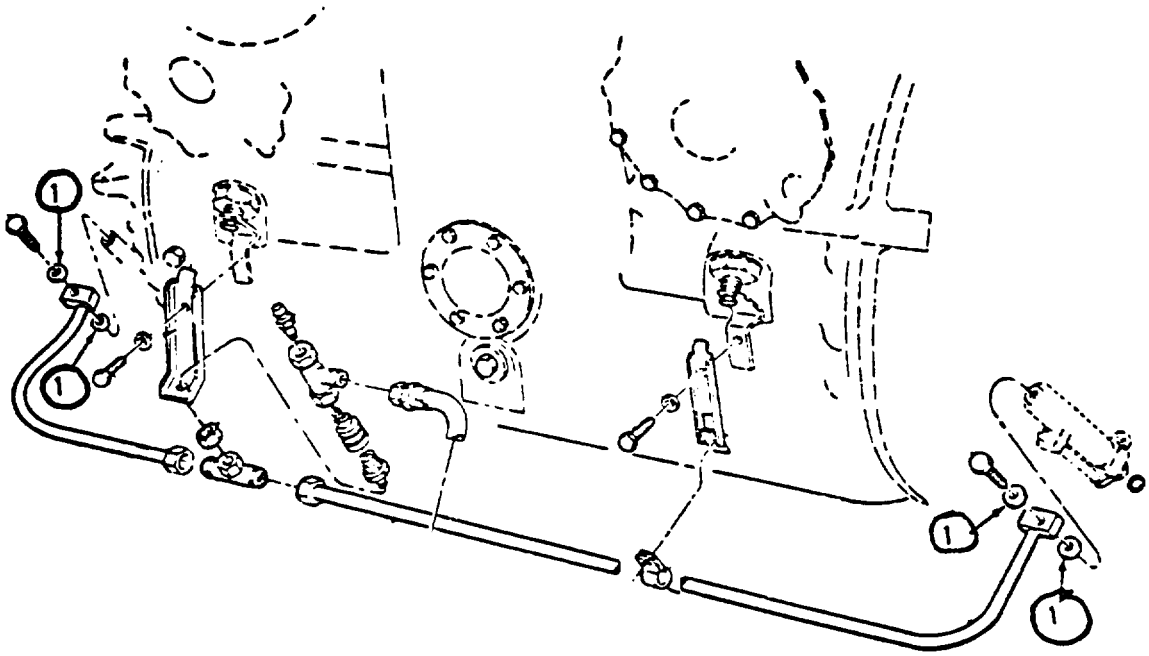


Figure 1. Brake lines.

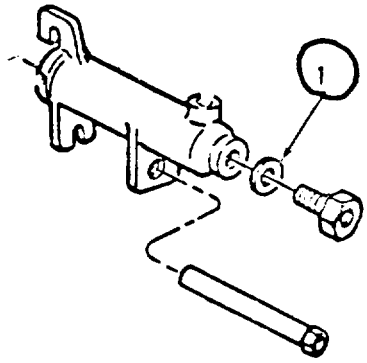


Figure 2. Slave cylinder.

CHAPTER 9
TRACK AND SUSPENSION

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

9-1. General.

a. When track or suspension components are damaged, the tank can operate by eliminating some positions. Maintaining a tight track and uniform ground pressure will be a problem. As more roadwheels, arms, and torsion bars are damaged, there is less to support the vehicle load. This will result in reduced ground clearance and heavier loading on remaining components. The crew of the tank must control the speeds, limit the agility of movement and select smoother terrain if the tactical situation permits. Imbalance and mismatch from side to side will not only cause a control problem for the driver, but will consume engine power and directly affect the top speed of the vehicle.

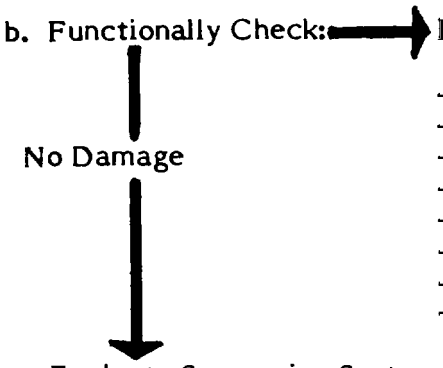
b. Many items within the suspension assembly are identical regardless of position, but some have minor differences from left to right and front to rear. In an emergency situation, these parts can be used as a substitute despite the fact they carry a different NSN.

9-2. Assessment Procedure.

a. Visually Inspect: → Damage found to

No Damage ↓

- Track; ..... go to Section II
- Roadwheels; ..... go to Section III
- Drive Sprockets; ..... go to Section III
- Support Rollers; ..... go to Section IV
- Roadwheel Arms; ..... go to Section IV
- Idler Assemble ..... go to Section II
- Shock Absorbers; ..... go to Section IV



	Fully Mission Capable	Combat Capable	Combat Emergency Capable	Self Recovery Capable	Recover
-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

9-3 BDAR Procedure Index

SECTION II. Track

9-4. General.

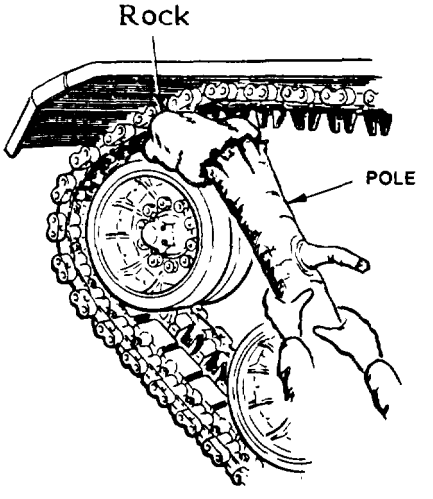
a. The steel grousers are exposed when the rubber blocks are badly worn, chunked or missing. This will not keep a vehicle from operating. Worn rubber on either the roadwheel or the track block is not important. Steel on steel operation is possible; however, it will create more noise and will be inefficient, thus reducing operating range.

b. Inspect the track and when extreme rubber wear is apparent check for cracking or splintering of the steel components.

9-5. TRACK PARTIALLY THROWN

General Information
Vehicle movement is limited, or track will require breaking in order for it to be reinstalled.

Limitations
- None



Personnel/Time Required
- 3 soldiers
- 30 minutes

Materials/Tools
- Spare track shoe
- Wedging material, such as block of wood, etc
- Long pole, wood, metal or similar material
- Tanker's bar

Procedural Steps:

WARNING

Wedging material may be thrown violently by the track pressure. This could cause injury or death to personnel.

1. Locate wedging material.

2. Loosen track tension.

3. Place wedging material on top of compensating idler wheel, between wheel and track as shown.

Procedural Steps (Cont'd)

4. Hold wedging material in place with pole.

5. Move vehicle slowly so wedging material will move with the wheel and lift track off wheel.

6. Using tanker's bar, pry track in place. If tanker's bar is not available, move vehicle back and forth about a foot. Track should straighten itself out. Lateral steering may be applied to put a side load on the track.

7. Remove wedging material and readjust track tension.

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

9-6. TRACK WEDGE LOST

General Information:
The wedge holds the end connector on the track shoe pins. If the end connector comes off, the track will come apart. Close inspection is required to find a missing wedge. Perform this procedure only if a replacement wedge cannot be found.

Limitations
- None

Personnel/Time Required
- 2 soldiers
- 30 minutes

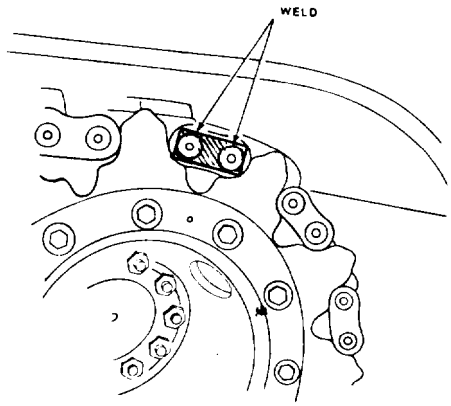
Materials/Tools
- Welding equipment
- 3/4 Inch bar steel stock or equivalent

Procedural Steps:

Option 1:

1. Drive end connectors in place with hammer.

2. Weld bar stock to end of track shoe pins as shown.



Option 2:

1. Release track tension.

2. Remove one track shoe.

Procedural Steps (Cont'd)

3. Use end connector from existing shoes to reconnect the shortened track.

4. Readjust track tension.

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

9-7. Center Guides.

a. Every other guide can be missing and the vehicle will be functional. However, high speed or hard turns in soft or sandy soils, might throw the track. Several missing guides not located together will have no effect on vehicle operation. This applies also to guides that are badly worn or that have a tooth broken off. The base or hub of the center guide must be present even if the tooth is broken off. The center guide is part of the structure of the track. If this is missing, the track pin could bend and break.

b. Inspect to ensure that the bases or hubs of broken or badly worn center guides are present. Alternate the serviceable replacements when some guide bases are cracked or broken.

9-8. TRACTION INADEQUATE

General Information:
The vehicle may slip on ice, snow, and mud. The center guides may be modified and reversed to improve traction.

Limitations:
- None

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

Materials/Tools:
- Cutting torch
- hacksaw
- ruler

Procedural Steps:

CAUTION

Guide prongs must be cut off 1- 1/4 inches to prevent damage to fenders and air cleaners.

1. Remove every fifth centerguide from track.

2. Cut 1-1/4 inches from each prong Of guides.

3. Install modified centerguides with prongs extending from outer perimeter of track.

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

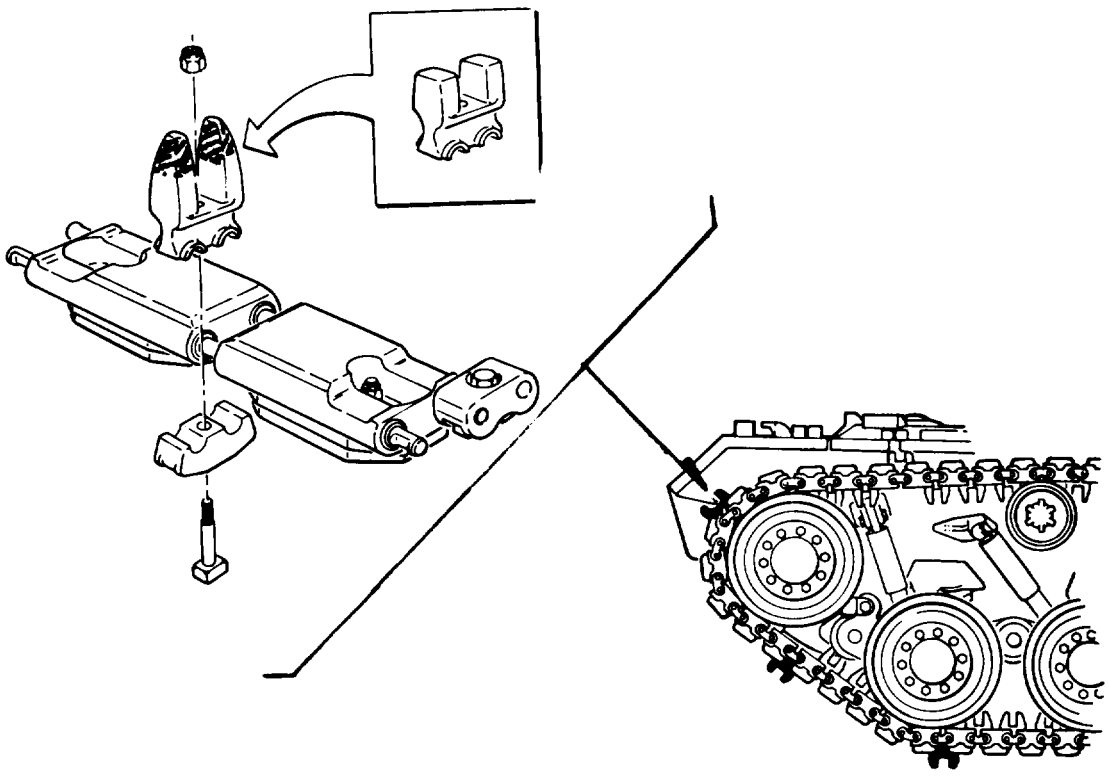


Figure 1. Slippage on Ice, Snow, and Mud.

SECTION III. Drive and Road Wheels

9-9. General.

a. There is little that can be done to repair a sprocket that has sustained damage. However, if the hub is intact, there may be some things done that can make it functional.

b. Usually, the sprocket must be replaced with a new or cannibalized item. The vehicle cannot operate with either the inner or outer sprocket missing on a side, but it can function with one or several non-consecutive teeth missing from the sprocket. Operations should be limited to low-speed, gradual turns.

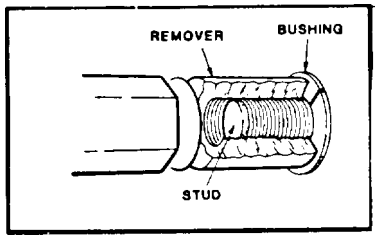
9-10. DRIVE SPROCKET HUB SHEARED OFF

General Information
Loose sprocket hub because of sheared sprocket hub studs can be repaired following this procedure. Operating with improperly tightened sprocket studs can cause shearing of studs. Vehicle cannot be propelled when one drivetrain is inoperative.

Limitation
- None

Personnel/Time Required
- 4 soldiers
- 3 hours

Materials/Tools:
- Arc welding equipment



Procedural Steps:

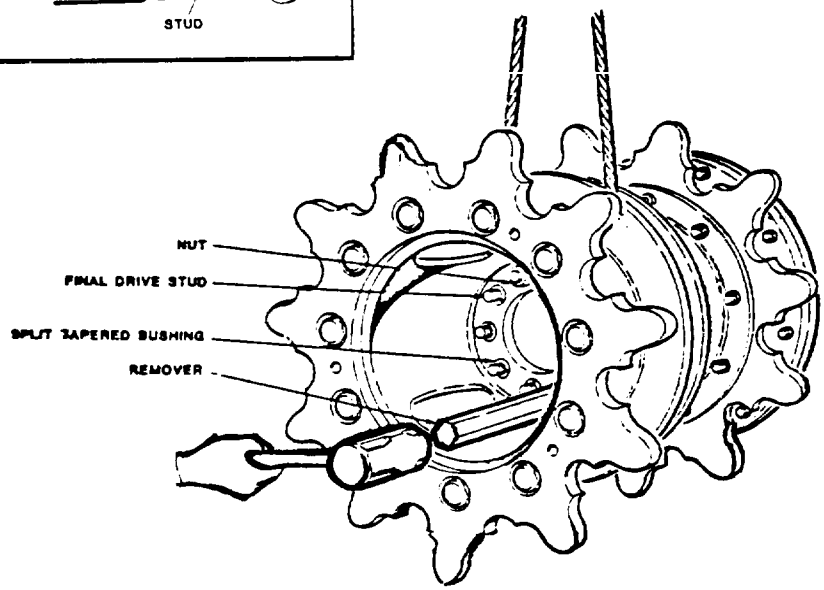
1. Break track.

2. Remove drive sprocket as shown.

3. Attempt to remove broken studs.

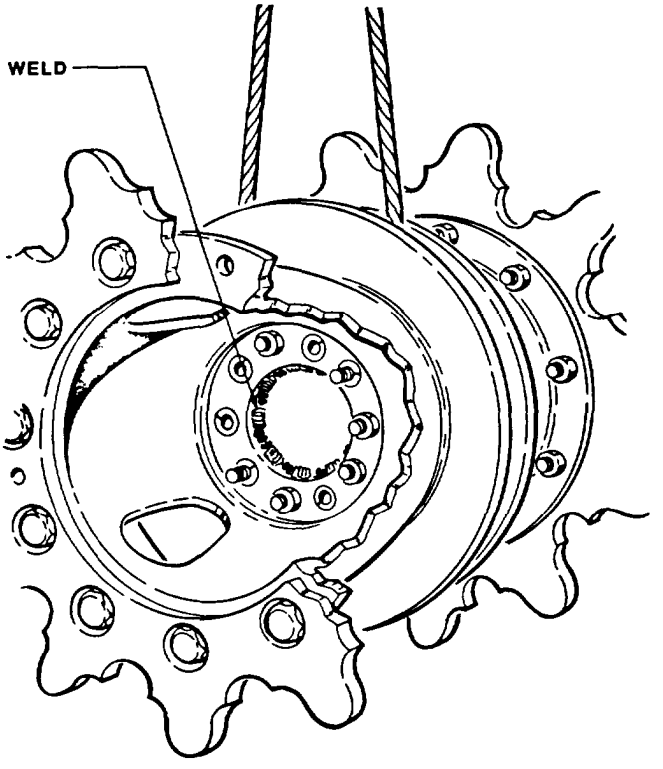
4. If hub is damaged, remove a hub from another damaged vehicle.

5. If new studs are available, replace studs and install hub.



6. If studs are not available, or old studs cannot be removed. Weld the hub on as shown.

7. Use the remaining parts of studs to align hub to final drive and weld in place with a continuous bead.



8. Reinstall track assembly.

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

9-11. SUPPORT ROLLER DAMAGED

a. Return rollers keep the track from sagging as it moves from the sprocket to the idler and are necessary to keep the track from being thrown caused by hitting the hull center section. With no rollers, tank operation should be restricted to self evacuation.

b. Return roller damage that would provide jagged edges which could snag the track must be corrected. A roller that will not turn is less of a problem than a bare stub shaft which would catch the track and break or throw it. F-or rollers that will not turn, disassemble and clean. The bearings may be damaged and need replacing.

If the roller is broken attempt to turn so that the smoothest segment is up and provides a sliding surface for the track. Weld the bearing and roller hub in this position so they will not turn.

Other Options:
l When the roller is totally missing or cannot be made to provide a smooth sliding surface, it will be necessary to cut off the hub with a torch.

9-12. ROADWHEELS.

a. Operating with less than the standard number of roadwheels will do two things; One, it imposes heavier loads and therefore increased wear, but this will not be measurable over several battlefield days. Second, it will reduce the number of "slots" available for center guides and alinement of the track. Assuming that only roadwheels have been lost and all arms are functioning, it is better to operate with single wheels in some positions than to leave a position completely blank. Two rules should be followed First, if possible, do not put two single wheel positions next to one another. Second, when single wheels must be consecutive, make them alternating single inner and single outer.

b. Wear plates are desirable but not critical. Missing wear plates will significantly shorten the life of a wheel but a wheel should still last several battlefield days.

c. At least two roadwheels bolts can be missing in non-consecutive positions.

9-13. ROADWHEEL/HUB DAMAGE

General Information: The tank cannot operate if specific roadwheels are damaged. The M48/M60 tank can be operated in a degraded mode if it is equipped on both sides with a rear sprocket, an idler wheel, a center or a front and rear track support, roadwheels 1 and 6, and two other nonadjacent roadwheels such as 2 and 4 or 3 and 5. All suspension system components can be replaced, if the bearing seats in the hull are serviceable. If a roadwheel in a required location is damaged, it may be replaced with an undamaged roadwheel taken from a position where a roadwheel is not essential. All roadwheels are interchangeable. Vehicles are still operable if all rubber on wheels and track supports are lost; however, the track must be adjusted to compensate.

Limitation=
- Degraded mobility

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

Materials/Tools:
- Length of pipe
- Bar steel
- Four inch diameter wood

Other Option:
- The M1 tank roadwheel will mount on the M48/M60 series vehicle roadwheel hub. M 1 tank roadwheels must be mounted in pairs on M48/M60 series tanks as they are smaller in diameter.

Procedural Steps:

1. Inspect to see which roadwheels are damaged.

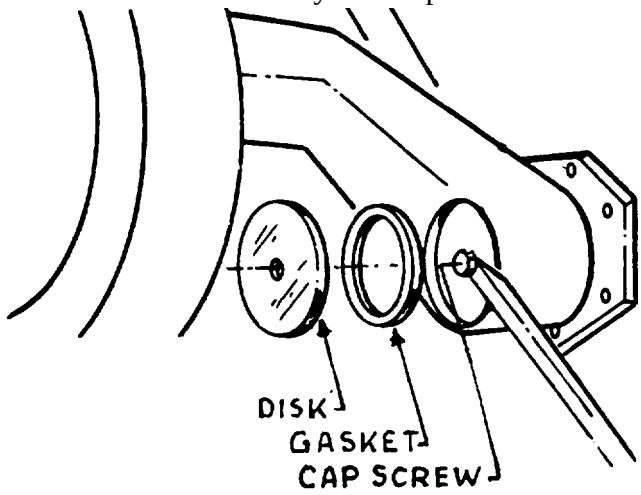
Procedural Steps (Cont'd)

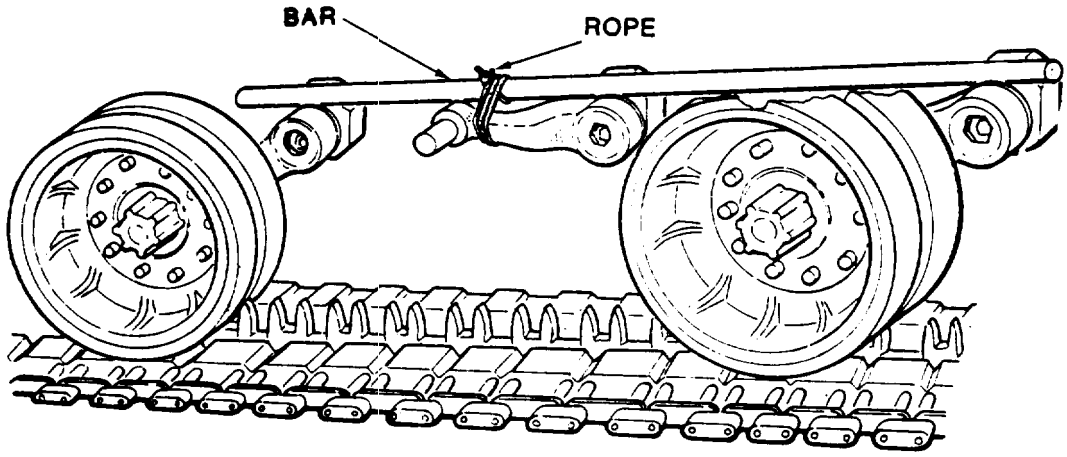
z. As an alternative to removing complete roadwheel arm assembly, the roadwheel arm can be tied up out of the way.

3. To tie a roadwheel arm up, remove torsion bar.

4. Position the vehicle across a ditch narrow enough to permit the front and rear roadwheels to support the weight of the vehicle and deep enough to permit the track to sag away from the defective roadwheel. If a ditch is not available, a trench can be dug. The vehicle in this position will allow the roadwheel assembly to drop and remove the stress on the torsion bar.

5. Remove the torsion bar by removing its capscrew and end plug, replace capscrew in torsion bar, and pry behind the capscrew head with a tanker's crowbar as shown.





6. Reposition the vehicle on level ground and remove the roadwheel. Lay a six-foot length of pipe across two torsion bar support housings, and tie the roadwheel arm in the raised position to the six foot pipe, steel bar, or 4 x 4 board, with rope or chain as shown.

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

SECTION IV. Suspension Components

9-14. General.

a. When a roadwheel and arm assembly has been damaged or the hull is damaged so that the roadwheel and arm won't work, it may be necessary to disable this assembly so that it will not interfere with the operation of the track or other roadwheel positions. This can be done by positioning the vehicle across a ditch narrow enough to permit the front and rear roadwheels to support the weight of the vehicle, and deep enough to permit the track to sag away from the defective roadwheel. If a ditch is not available, a trench or hole can be dug. The roadwheel position can be disabled.

b. Idler, No. 1 and No. 6 roadwheel positions are essential for M48/M60 mobility. If these positions are damaged, the vehicle cannot be operated and must be recovered.

9-15. POSITION 2, 3, 4, OR 5 MISSING OR DAMAGED.

General Information

a. These positions are interchangeable among themselves except that torsion bars have a pretwist adaptable to one side only. The vehicle can operate with one, two or even three of these missing. If three positions are unserviceable, they should not be adjacent positions.

b. Inspect for broken or damaged parts and check for oil leaks, and signs of overheating. Abnormal leakage may be tolerated. It may be necessary to disassemble the roadwheel position components to determine the problem. Do not disassemble unless bearing or journal damage is suspected.

(1) Determine which suspension positions must be replaced or eliminated. Clear damaged parts by removing, bending or tying up, so that there is nothing to interfere with the function of the track or suspension. If necessary, remove parts with a cutting torch.

(2) Using procedures in the maintenance manual, remove, replace, or interchange the desired suspension elements. More care must be used than in the routine procedure to replace seals and gaskets, because you have to re-use them. It should be expected that there will be oil or grease leaks during this operation. Check oil level frequently.

(3) Re-assemble the track if it has been broken.

NOTE

The use of a torsion bar from the opposite side should be considered a last possible choice. The bar will have a very short life. It must be replaced as soon as possible and should be discarded.

(4) Retension track.

(5) Plug open holes.

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

9-16. COMPENSATING IDLER ARM BROKEN

General Information
The compensating idler arm is required to maintain track tension. Short tracking on M48/M60 vehicle is not possible. Replacement from another vehicle is the only option available. Units are interchangeable between M48A5, M60A1, M60A3 and M88A1. The M60A3 unit is made of a stronger alloy and has a different part number, but it will fit on the other vehicles; bushing and sleeves are the same part numbers.

9-17. SUSPENSION SYSTEM INTERCHANGEABILITY

General Information
Damage to track and suspension components will remove or seriously hinder the tanks mobility and proper repair parts may not be available through the supply system.

Limitations
- Possible degraded stability

Personnel/Time Required
- 2-3 soldiers
- 1-4 hours

Procedural Steps:

1. Break track and remove damaged components.

Procedural Steps (Cont):

2. Cannibalized serviceable components, track, roadwheels, hubs, roadwheel arms, sprockets, and hubs from any of the following vehicles:

a. M60 Series.

b. M48A5.

c. M88A1.

d. CEV 728.

e. AVLB.

NOTE

Some components have different part numbers but will interchange with M60/M48 components.

3. Roadwheels may be used from the M 1 tank but must be used in pairs due to the smaller outside diameter.

4. Clean and lubricate replacement components.

5. Install components on the damaged tank.

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

9-18. ROADWHEEL ARM DAMAGED

General Information
If the roadwheel arm assembly has been damaged beyond use and the roadwheels are missing, the remaining part of the roadwheel arm could interfere with the track. Number one or number six must be in position.

Limitations:
- Reduced stability

Personnel/Time Required:
- 2 soldiers
- 2-4 hours

Materials/Tool:
- Welding equipment

Other Options
- Weld broken or damaged arm

Procedural Steps:

1. Release track tension.

2. Remove damaged components.

3. If roadwheel arm is not in a critical position, tie it UP to eliminate interfering with the track.

4. If the roadwheel arm is damaged in a critical position, remove a roadwheel arm from a non-critical position and install it in the critical position.

NOTE

Replacement arms without shock absorber mounts can be used in positions normally equipped with shock absorbers. Vehicle stability will be greatly decreased.

5. If the roadwheel arm used is from 3, 4, or 5 position and is being used to replace 1, 2, or 6 position, cut the shock strut attachment from the damaged arm and weld it to the replacement arm.

6. Reconnect and tension track.

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

9-19. ROADWHEEL ARM HOUSING BOLTS SHEARED

General Information
The roadwheel arm housing can be damaged by travel over desert or rocky terrain or mine damage.

Limitations:
- None, if all bolts are installed
- Degraded mobility if all bolts are not available

Personnel/Time Required
- 3 soldiers
- 2 hours

Materials/Tools:
- Bolts for roadwheel arm (if needed)
- Roadwheel arm housing (if damaged)
- Welding equipment

Other Options:
- Remove the roadwheel arm, plug holes and continue operations.

Procedural Steps:

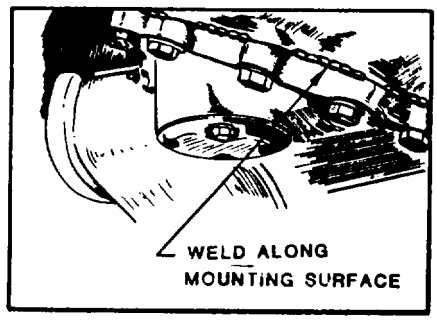
1. Remove sheared bolts, if possible.

2. If roadwheel arm is damaged, cannibalize arm from another damaged vehicle.

3. If sheared bolts have been removed, re-install housing using serviceable bolts.

NOTE

Limited operation is possible with every other bolt on roadwheel arm mount missing.



4. If broken bolts cannot be removed, line up new housing with bolt holes and weld in place.

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

9-20. TORSION BARS

a. Torsion bars have a pretwist which gives them a directional spring action. If they are used in the wrong direction, they unwind and become a spring with zero spring rate. The tank may lean or squat, especially if more than one torsion bar is broken.

Procedural Steps (Cont'd)

b. It is most desirable to have torsion bars in positions 1, 2, and 7. Positions 4 and 5 are least critical.

c. Torsion tube covers protect the torsion bars from rust and physical scratching or notching which could shorten the life of the bar. In a combat emergency, the covers are not necessary to the operation of the vehicle.

9-21. SHOCK ABSORBERS

Shock absorbers stabilize the vehicle. The vehicle can function without one or more of the shock absorbers but the ride and gun stabilization will be degraded and will get increasingly worse. The shock absorber depends on the oil with which it is filled for both, damping and lubrication. The indication of a defective shock absorber will be a significant loss of oil or feeling cold to the touch.

CHAPTER 10

ARMAMENT AND FIRE CONTROL SYSTEM

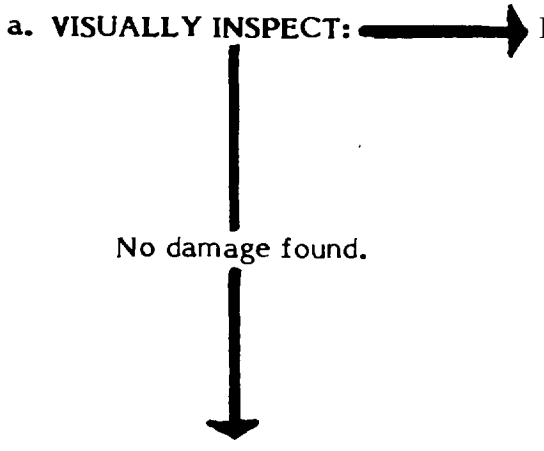
BDAR FIXES SHALL BE USED 0NLY IN COMBAT
AT THE DISCRETION OF THE COMMANDER
AND SHALL BE REPAIRED BY STANDARD MAINTENANCE PROCEDURES
AS SOON AS PRACTICABLE AFTER THE MISSION IS COMPLETED.

SECTION I. General

10-1. General.

Armament and fire control systems are two classes of equipment. Fire control systems are essentially aids to improve the accuracy and 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 overcome armament system failures. Fire control systems because of their complexity do not lend themselves to BDAR procedures. Refer to the standard TIM for fire control repairs.

10-2. Assessment Procedure



-cannon assembly; . . . . . go to para 10-4 thru 10-9.
-sighting system; . . . . . go to specific maintenance TM
-hull Turret Race; . . . . go to para 10-10
-breech assembly; . . . . . go to para 10-6
-traversing gear box;. go to normal maintenance TM
-elevation cylinder; . . . . go to specific maintenance TM
-hydraulic system; . . . . go to TM 9-2350 -276-BD

b. SELF-TEST AND FUNCTIONALLY CHECK → Damage found to:

No damage found

-gun elevation/ traversing system ....go to specific maintenance TMs

-m ain gun power; ..... go to Para 10-9

-sighting sytem ..... go to spcific maintenance TMs

-Commander's weapons station; ..... go to Para 10-15

-coax machine gun ....go to specific maintenance TMs

-turret blower system; ..... go to TM 9-2350-276-BD

c. 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	

10-3. BDAR Procedure Index. Para

WARNING

Parts of the electrical harness system carries a 300 AMP current potential, which could cause serious accidental injuries. Disconnect battery ground terminals when making connections.

CAUTION

When arc welding on turret, ground welding equipment to turret only. When arc welding on hull, ground welding equipment to hull only. Parts of slipring and bearing race can be damaged from high currents conducted between hull and turret if welding equipment is not grounded correctly.

SECTION II. Armament BDAR

10-4. GUN TUBE IS UNSERVICEABLE; RECOVERY VEHICLE NOT AVAILABLE

General Information
This procedure gives instructions for replacing a main gun tube by using another tank rather than a recovery vehicle to hoist the main gun tube.

Limitation
- None

Personnel/Time Required
- 3 soldiers
- 2 hours

Materials/Tool*
- Cargo strap (or rope, or cable) capable of withstanding approximately 2500 pounds.
- Sling capable of withstanding approximately 2500 pounds.
- An operable (M 1, or M48/M60).
- Stiff wire (such as a piece cut from a coat hanger) approximately 7 inches long (or 1-1/2 inch MS90728 screw and two flat washers).
- Wood block approximately 2 feet long.
- Two guide ropes.
- Gun tube wrench (if wrench is not available, it is possible to turn the tube using a rope or cargo strap and a tanker bar or 2 x 4 wood board).

Other Options:
- Fabricate an A-frame or use a strong tree and vehicle with winch.

Procedural Steps:

CAUTION

The gun tube outer shell can be damaged during handling operations if it is not removed.

1. Remove operable tank's front gun tube outer shell if applicable.

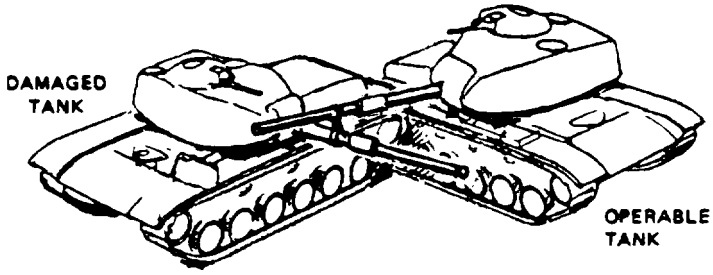
2. Remove damaged tank's front and rear gun tubes outer shells, if applicable and bore evacuator.

3. Raise operable tank’s main gun to fully elevated position.

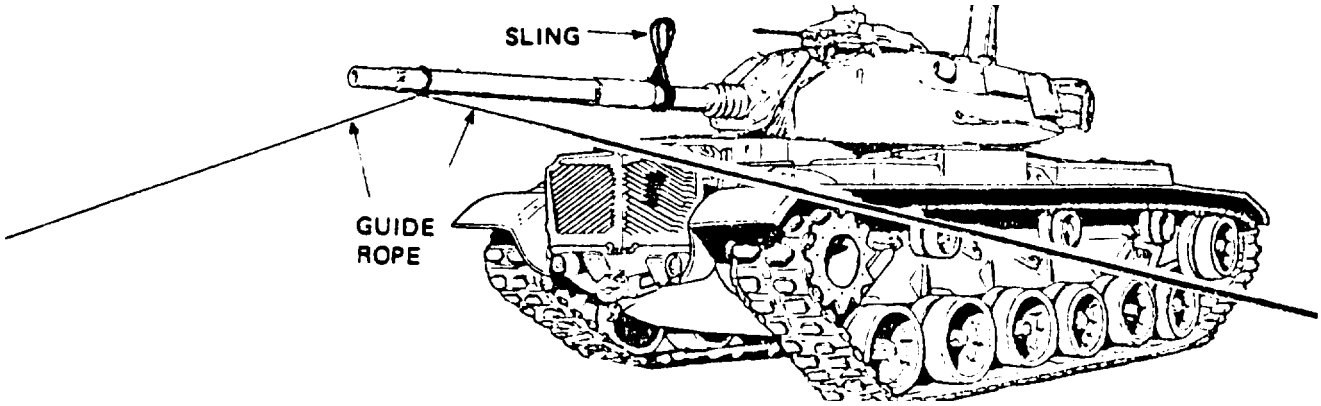
4. Position damaged tank’s main gun slightly below zero degrees elevation.

Procedural Steps (Cont'd)

5. Drive both tanks into place and traverse turrets so that operable tank's main gun is in lifting position over damaged tank's main gun.



6. Install sling on damaged gun at center of balance mark, lower operable tank gun and tie two guide ropes to gun tube near muzzle.



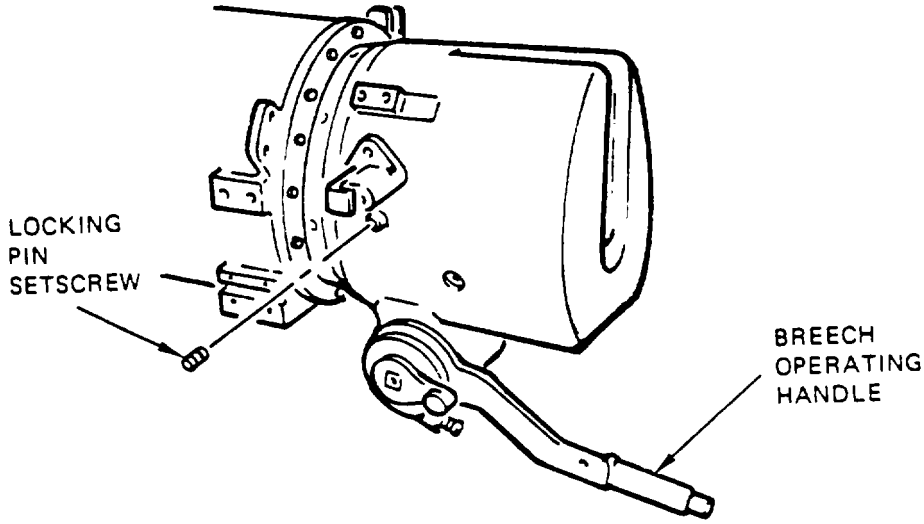
7. Lower operable tanks gun and attach sling to operable tank's hoisting gun with cargo strap, rope or cable.

8. Elevate operable tank's gun to take slack out of sling.

WARNING

Handle is under spring tension until breechblock is opened all the way and is locked in place. If you let go of handle before it is all the way down, it can hit you and cause injury.

9. Move breech operating handle all the way down until there is no more spring tension.

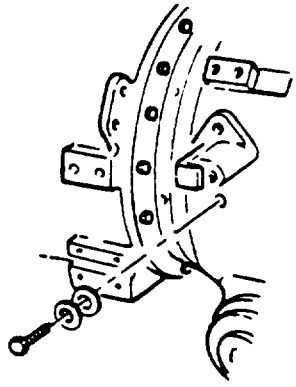


10. Remove locking pin setscrew.

NOTE

If proper size screw is not available, use a stiff wire bent to form a slight hook in ‘one end to pull out locking pin.

11. Insert a 1-1/2 inch long screw, 3/8-16 NC, through two flat washers and into gun tube locking pin.

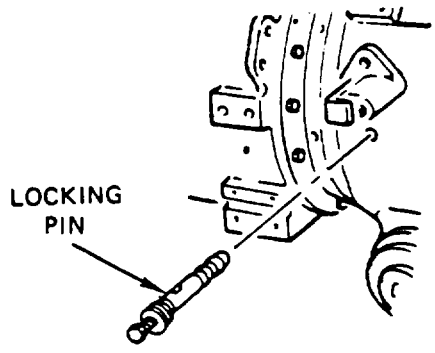


12. Pull on screw to remove locking pin.

13. Turn gun tube counterclockwise approximate y one-eighth turn.

14. Grasp two guide ropes to steady the gun during removal.

15. Remove damaged gun tube by alternate y traversing, elevating and lowering the hoisting gun (manually).



NOTE

Steps 16 through 27 are concerned with installation of replacement main gun.

16. Install sling on replacement gun tube at center of balance mark.

Procedural Steps (Cont'd)

17. Tie two guide ropes to replacement gun tube near muzzle.

18. Attach sling to hoisting gun with cargo strap, rope, or cable.

19. Elevate hoisting gun to take slack out of sling.

20. Grasp two guide ropes to steady the gun during installation.

21. Install replacement gun tube in tank by alternate y traversing, elevating and lowering the hoisting gun (manually).

22. Turn gun tube clockwise approximately one-eighth turn.

23. Install locking pin in breech and secure with locking pin setscrew.

24. Remove sling and cargo strap from gun tubes.

25. Install hoisting tank's front gun tube (outer shell).

26. Install replacement gun's front and rear gun tubes (outer shells) and bore evacuator chamber.

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

10-5. BORE EVACUATOR DAMAGED

General Information
As a round is propelled through the gun tube, gas pressure is forced inside the bore evacuator. As the round leaves the tube, bore evacuator pressure rushes out behind the round, exhausting excessive smoke and fumes. If the evacuator is damaged or leaks, this pressure is lost, causing excessive smoke and fumes to enter the turret as the breech block opens. This procedure repairs puncture damage to the bore evacuator. Smoke fumes limit the crews capabilities to operate inside the turret.

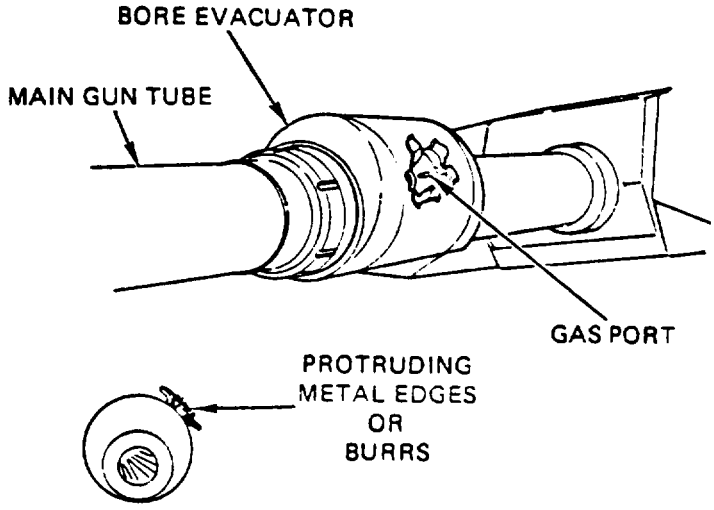
Limitations:
- None

Personnel/Time Required:
- 1 soldier
- 1 hour

Materials/Tools:
- Welding equipment
- Sheet metal, l/4-inch thick (size dependent on damage)

Other Options:
● Open turret hatches and turn on turret blower. Fire main gun as necessary.

Procedural Steps:



Option 1: Welded patch repair.

1. Use acetylene torch to cut and remove any burrs or protruding metal edges from damaged bore evacuator.

2. Clean any blocked gas ports, if accessible.

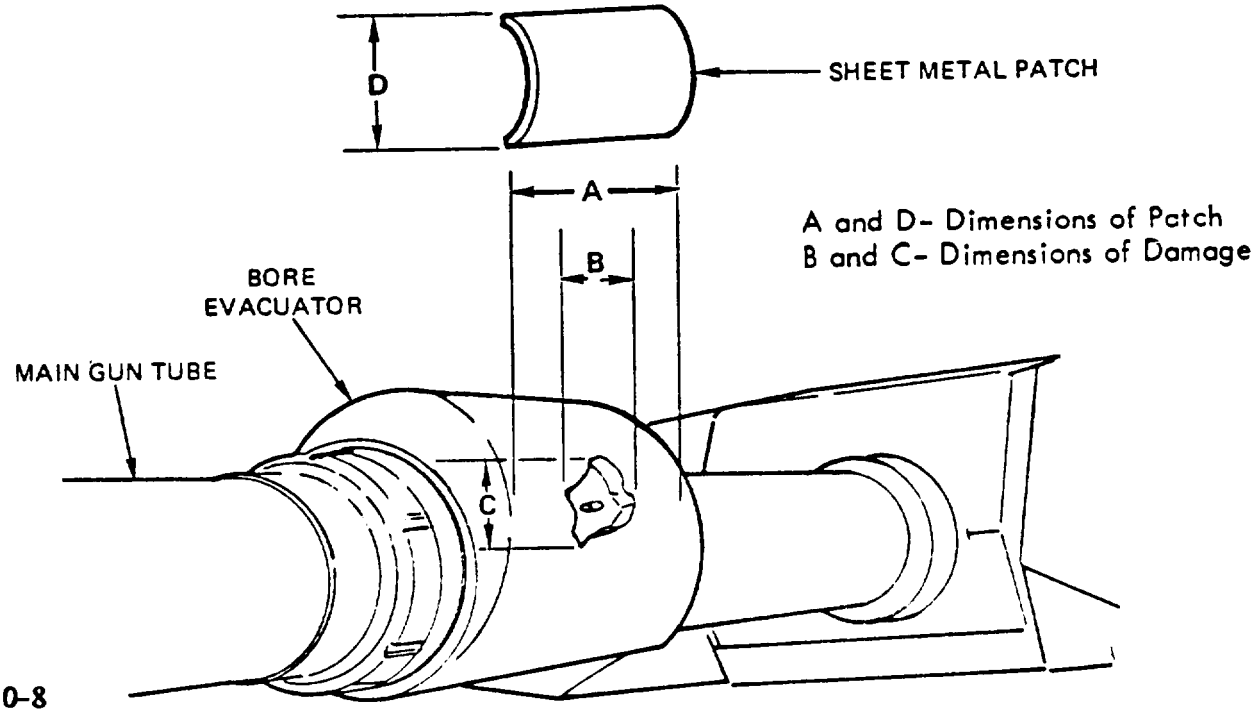
3. Measure and record dimensions of damaged area.

4. Use acetylene torch to cut a patch from sheet metal 1/4 - to l/2-inch larger than damaged area.

5. Shape patch to fit curve of bore evacuator.

6. Wire brush bath mating surfaces.

7. Set and secure patch in place over damaged area.



Procedural Steps (Cont'd)

CAUTION

When arc welding on turret, ground welding equipment to turret only. Parts of slip ring and race bearings can be damaged from high currents conducted between hull and turret if welding equipment is not grounded correctly.

CAUTION

Disconnect electrical connectors from laser rangefinder before arc welding anywhere on tank. Rangefinder can be damaged by electrical current caused during arc welding.

8. Use gas or arc to weld a continuous bead around the patch. Check weld for cracks or openings, and repair if necessary.

Option 2: Fabricated clamp repair.

Limitations:
- None

Personnel/Time Required:
- 1 soldier
- 1 hour

Materials/Tools:
- Acetylene torch
- Asbestos paper or other suitable fire resistant material
- Grinder
- Hexagon head nuts, 3/8-inch (as required)
- Lockwashers (as required)
- Machine screws, 3/8-inch x l-inch (as required)
- Sheet metal, l/4-inch thick, about 21-inches long and wide enough to overlap damage.

Procedural Steps:

1. Use acetylene torch and grinder to cut and remove any burrs or protruding metal edges that may affect air-tight seal.

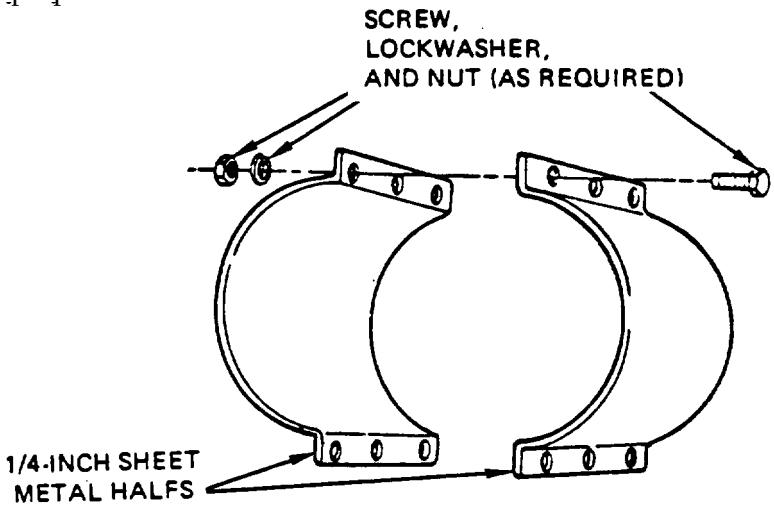
2. Clean any blocked gas ports, if accessible.

3. Measure and record dimensions of damaged area.

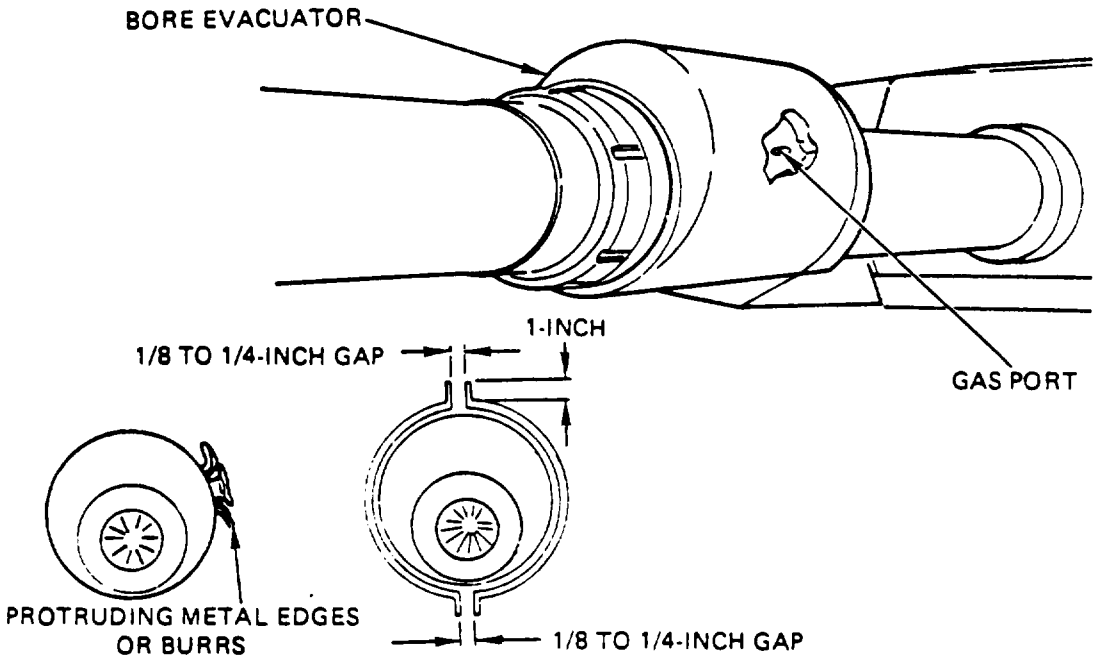
Procedural Step (Cont'd)

NOTE

If damage is extensive, clamp should be made same width as bore evacuator to ensure a proper seal.



4. Use acetylene torch to cut two 10-1/2 inch long metal strips at least l-inch wider than damaged area.



Procedural Steps (Cont'd)

5. Shape each metal band to fit curve of bore evacuator. When metal bands are placed around bore evacuator, a gap between 1/8 to l/4-inch should exist between halves (see illustration).

6. Remove bands from bore evacuator and line inside surface of each band with asbestos paper or some other suitable fire resistant material.

7. Drill 3/8-inch evenly spaced holes in each end of both bands (see illustration).

8. Set bands in place over damaged area.

9. Secure bands against bore evacuator with screws, nuts, and lockwashers.

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

10-6. BREECH BLOCK WILL NOT CLOSE, CLOSING SPRING BROKEN

General Information
If the breech-closing mechanism fails to function as a result of broken leaf springs, function can be restored by repositioning broken spring leafs.

Limitations:
- Increased stress on remaining unbroken springs.

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

Materials/Tools:
- Replacement leaf springs

Other Options
- Use replacement leaf springs or entire leaf spring assembly from an M1 tank.

Procedural Steps:

1. Remove breech closing mechanism from breech spring assembly.

Procedural Steps (Cont):

2. Remove leaf spring assembly from closing mechanism assembly by driving the retaining pins from each end.

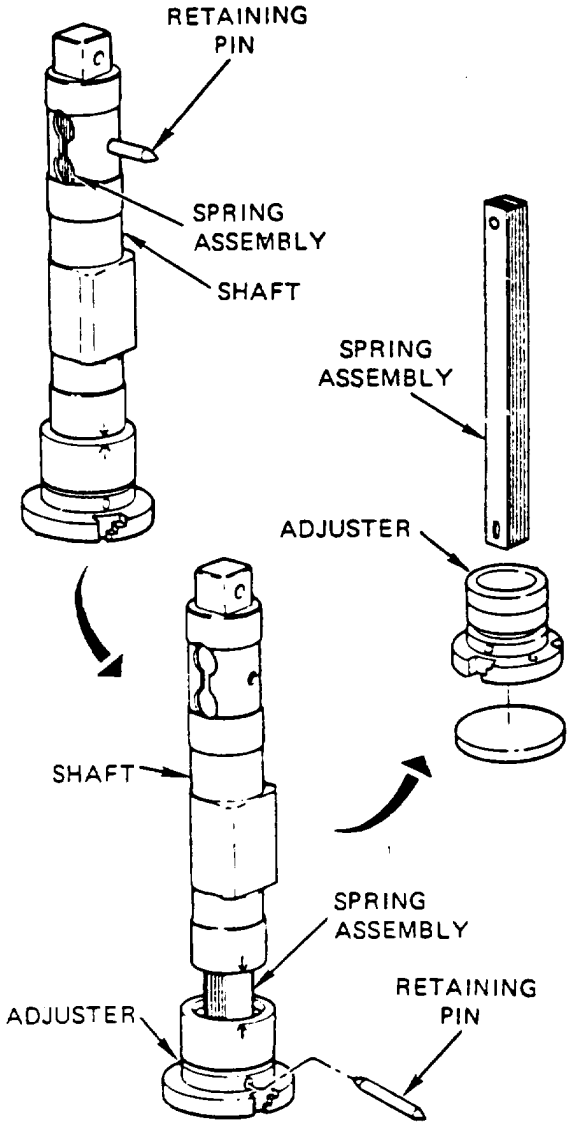
3. Reassemble springs, placing as many unbroken springs as possible between broken springs.

4. Install leaf spring assembly and retaining pins in breech closing mechanism.

5. Install breech closing mechanism in breech spring assembly.

6. Adjust spring tension by turning spring tension adjuster toward breech end of main gun with spanner wrench until click is heard.

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



10-7. GUN DOES NOT FIRE; GUN DOES NOT RETURN TO "BATTERY"

General Information:
If the main gun does not return to "battery" after firing, the firing circuit will be open causing a failure to fire from any trigger, switch, or position.

Limitations:

Personnel/Time Required:
- 2 soldier
- 4-10 minutes

Materials/Tools:
- Rex. cable. or strap approximately 40 feet long.
- Wood block (2" x 4"- 12 inches long).

WARNING

Do not circumvent the safety features when the main gun is 'lout-of-battery". Causing the main gun to fire when "out-of-battery" could result in equipment damage and injury to personnel.

Procedural Steps:

1. Traverse turret so main gun is forward over driver's compartment.

2. Lock turret.

CAUTION

Do not force gun 'tout-of-battery" more than 12 inches. Components may be damaged.

3. Select a tree or another tank and drive to a point where main gun tube just touches obstacle.

4. Drive tank very slowly forward to force main gun "out-of-battery" 4 to 6 inches.

5. Reverse tank and quickly back tank away from obstacle.

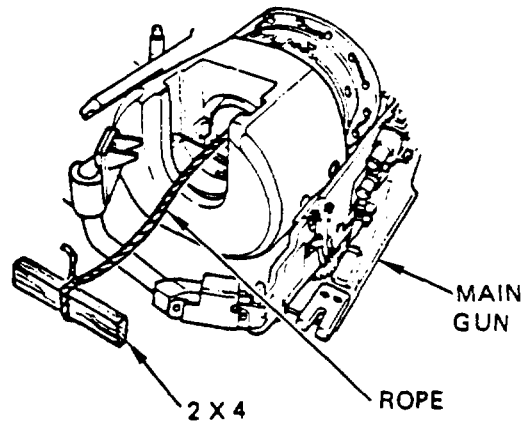
6. If main gun returns to "battery" position, continue mission. If not, do steps 7 through 11.

7. Guide rope down bore of main gun and out through breech as shown on the next page.

8. Inside turret, tie rope to 2 x 4. Place 2 x 4 against breech of main gun.

9. Outside tank, tie rope to solid object such as a tank or tree.

10. Very slowly back-up tank until main gun moves to "in-battery" position.



Procedural Steps (Cont'd)

CAUTION

Cease firing if length of recoil is excessive or if recoil action is irregular.

11. Clear bore of main gun.

12. Repeat the recoil exercise (steps 1 through 6).

WARNING

If the gun does not return to battery, do not fire the weapon. The weapon will be destroyed causing equipment damage and personnel injuries or cleat h.

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

10-8. GUN WILL NOT FIRE; HARD-WIRE BLASTING MACHINE TO MAIN GUN

General Information:
If all other methods to fire the main gun fail, the blasting machine can be wired directly to the main gun primer to fire the main gun.

Limitations:
- Safety circuits are bypassed

Personnel/Time Required:
- 1 soldier
- 15 minutes

Material/Tools:
- Knife
- Tape

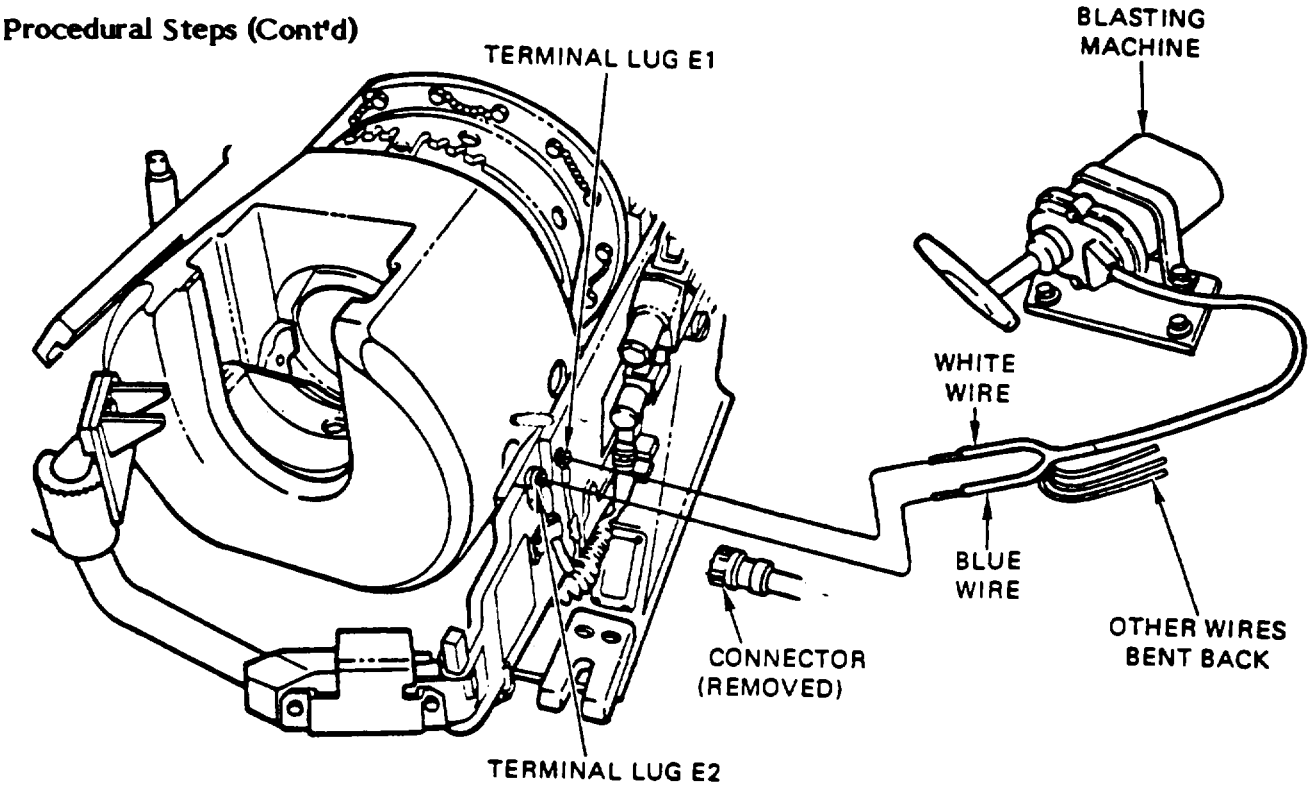
Other Options:
- Use magneto-type field-phone
- Refer to para. 10-9, main gun inoperative; electrical power loss procedure

Procedural Steps:

1. Cut connector off blasting machine cable.

2. Remove cable from cable clamps.

Procedural Steps (Cont'd)



3. Strip approximately one inch of insulation from white and blue wires.

4. Secure white wire to terminal E 1 on main gun primer.

5. Secure blue wire to terminal E2 on main gun primer.

6. Bend other wires out of the way and tape (to insulate) the other wire ends.

7. Crank blasting machine handle two to four times to fire main gun.

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

10-9. MAIN GUN INOPERATIVE; ELECTRICAL POWER LOSS

General Information
Main gun will not fire from any switch or position. Magneto from telephone set or field telephone produces enough voltage to fire gun manually.

Limitations
- Only commander or gunner can fire the main gun.

Personnel/Time Required:
- 1 soldier
- 20-30 minutes

Materials/Tools:
- TA- 1/PT telephone set
- TA-312/PT field telephone
- wire strippers or knife

Other Options:
- Hard wire blasting machine to gun.

Procedural Steps:

1. Remove wires from blasting machine.

2. Strip wires back one-half inch.

3. Connect wires to field telephone in place of blasting machine.

4. Use hand crank on field telephone to generate voltage needed to fire main gun. Do not touch the wires when cranking the telephone set.

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

10-10. TURRET INTERCHANGEABILITY

General Information:
Turret is damaged beyond repair. Turrets can be exchanged from one system's chassis to another with modifications.

Limitations:
- NBC equipment might not be operational.

Personnel/Time Required:
- 3 soldiers
- 10-18 hours

Materials/Tool:
- Replacement turret
- Cutting torch or saw
- M88A1 VTR or 20-ton crane`
- Turret stand
- Slip ring shim or similar material
- Drill

Procedural Steps:

1. Remove damaged turret.

2. To install M48A5 turret on M60 series tank chassis: (See table 10-1 for interchangeability.)

a. Modify M48A5 turret platform to accept M60 series tank slip ring.

(1) Use cutting torch or saw to cut M48A5 platform slip ring hole to the size of M60 series tank platform slip ring hole.

(2) Use new or used slip ring shims or similar material to raise slip ring high enough (approximately one-half to two inches) to accept the shorter M48A5 turret.

b. Install turret and connect all connections.

3. To install M60 series turret on M48A5 chassis: (See table 10-1 for interchangeability.)

a. Change platform legs. Use shorter legs from damaged M48A5 turret on the M60 series turret.

b. After short legs are installed, adjust turret power pack to correct height or redrill mounting brackets for new position.

c. Install turret on chassis.

d. Make all connections.

4. Check all fluid connections for leakage and electrical connections for proper operation.

INTERCHANGEABILITY TABLE 10-1

TURRET	CHASSIS M48A5	CHASSIS M60A1	CHASSIS M60A3
M48A5	No rework	Step 2	Step 2
1M60A1	Step 3	No rework	No rework
M60A3	Step 3	No rework	No rework

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

10-11. GUN MOUNT INTERCHANGEABILITY

General Information
Gun mount is damaged. The M68 gun mounts are interchangeable on the M48A5, M60A1, and British L7A1 tanks.

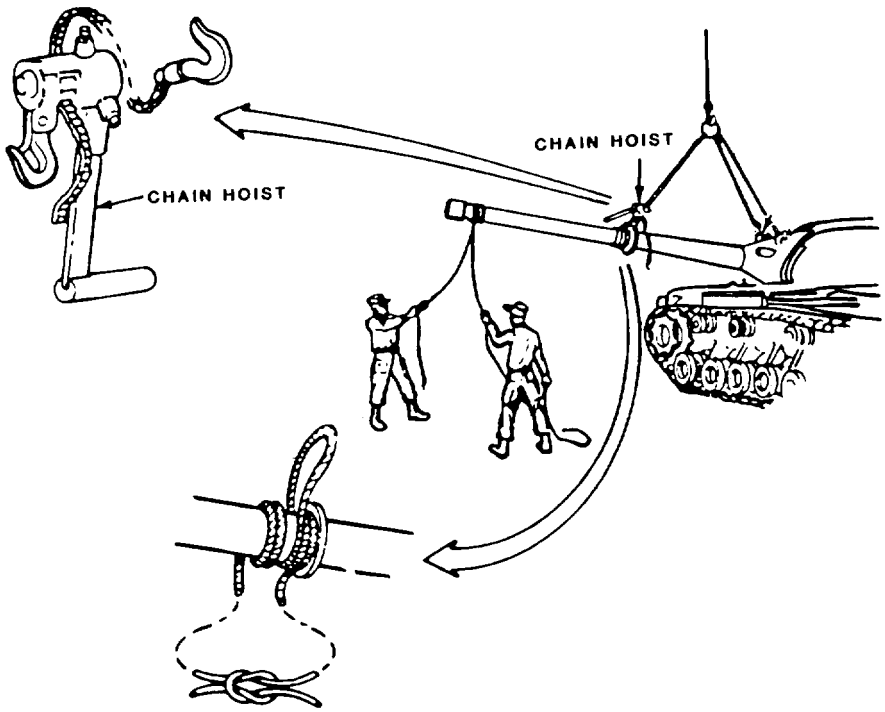
Limitations:
- None

Personnel/Time Required:
- 3 soldiers
- 4 hours

Materials/Tools:
- Lift capability
- Replacement gun mount
- 2 point sling
- Chain hoist

Procedural Steps:

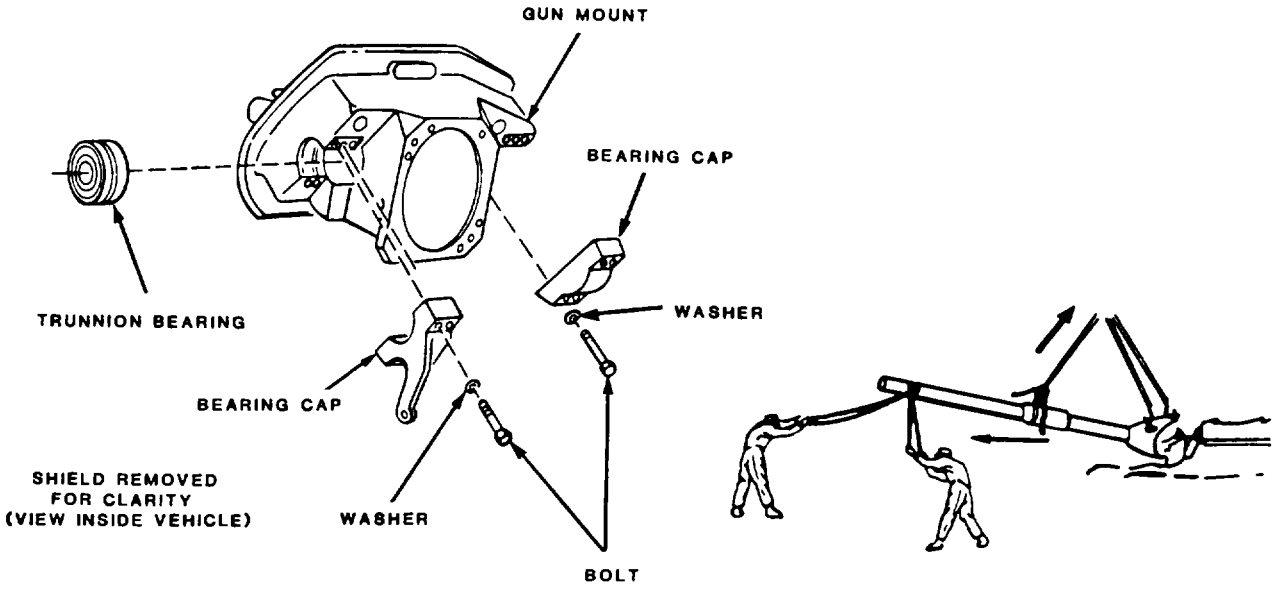
1. Obtain a gun mount from another vehicle.



2. Attach boom from wrecker to gun mount and attach chain hoist as shown.

Procedural Steps (Cont'd)

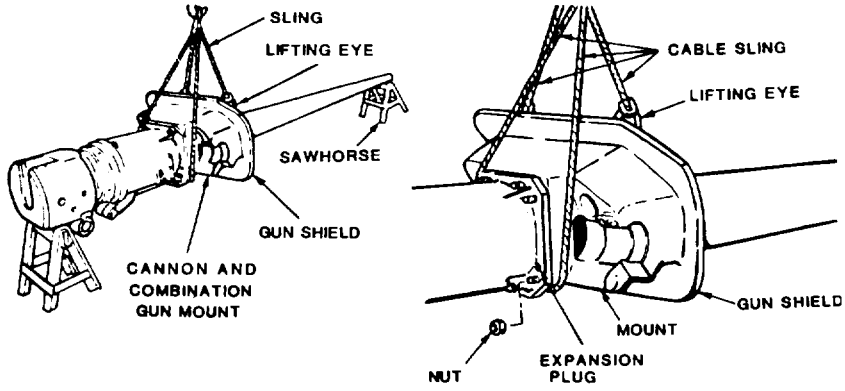
3. Disconnect elevating mechanism.



4. Remove trunnion bearings as shown.

5. Using chain hoist, lift tube to clear trunnion and remove gun assembly.

6. Unbolt and remove gun mount.



7. Install gun mount on gun tube assembly.

Procedural Steps (Cont'd)

8. Using boom, lift gun mount and tube assembly and re-install into turret.

9. Re-install trunnion bearings.

10. Reconnect elevating mechanism.

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

10-12. GUN TUBE INTERCHANGEABILITY

General Information:
Gun tube is damaged and requires replacement. The 105MM gun tubes are interchangeable on the M48A5, M60A1, M60A3,M1, the British L7A1 and the German L7A3 Tanks.

Limitations:
- None

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

Materials/Tools:
- Lift capability

Procedural Steps:

1. Remove heat shields, if applicable.

2. Attach block and tackle or boom from wrecker, to bottom of tube.

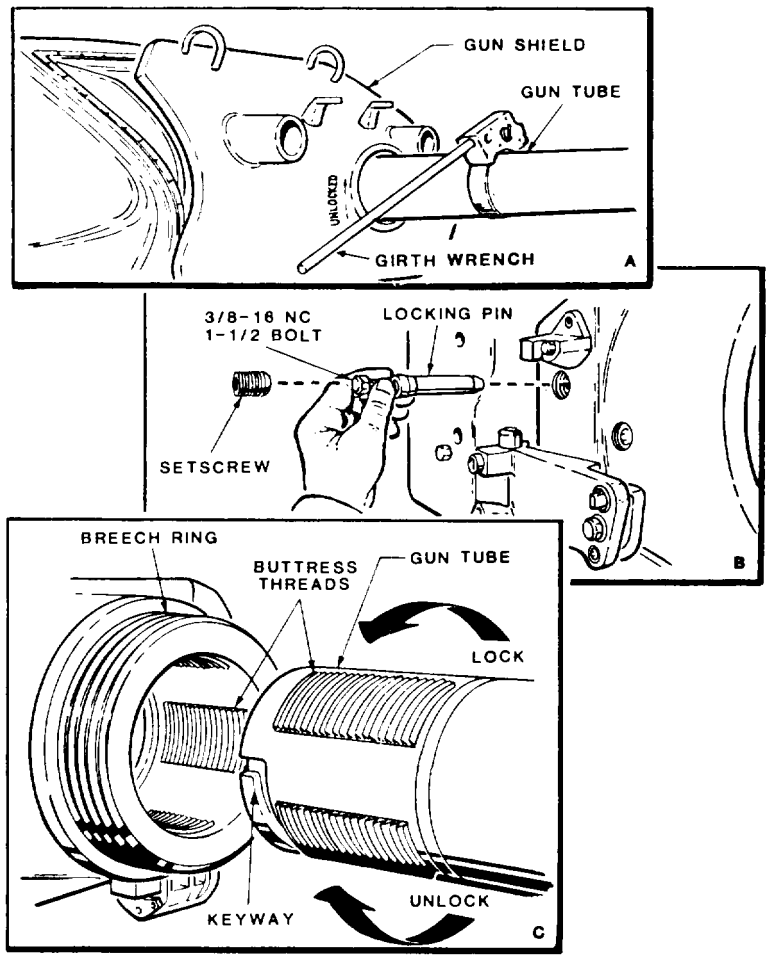
3. Remove pin holding gun tube in place.

4. Using girth wrench, turn gun tube one-eight turn counterclockwise or to unlock-position mark on shield.

5. Attach guide ropes to end of tube.

6. Remove tube assembly.

7. Insert replacement gun tube into shield assembly.



Procedural Steps (Cont'd)

8. Using girth wrench, turn tube clockwise one-eight turn or to lock position mark on shield.

9. Replace holding pin.

10. Reinstall heat shields.

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

10-13. TURRET POWER PACK DAMAGE

General Information
A hole can be cut in the turret floor to reduce the time required (normally 4 hours) to replace a damaged or inoperative turret power pack.

Limitations:
- None

Personnel/Time Required:
- 2 soldiers
- 1 hour

Materials/Tools:
- Acetylene torch
- Wood blocks
- Replacement motor

Procedural Steps:

1. Traverse the turret so that the power pack is not over the battery compartment.

WARNING

Ensure area to be cut is free of grease, oil and hydraulic fluid by flushing with water. Hydraulic fluid is extremely flammable and may cause serious injury to personnel if ignited.

2. Using a torch cut a hole in the turret floor slightly larger than the power pack motor, directly below power pack.

3. Replace damaged or failed motor by using the following procedures:

a. Turn turret to driver's access. This is the only position where the motor can be removed.

b. Place wood blocks under motor to support it.

Procedural Steps (Cont'd)

c. Remove the four bolts that hold motor to pump mount.

d. Remove four bolts that hold motor to power pack.

e. Remove blocks and lower motor into hole cut in basket floor.

4. Install motor.

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

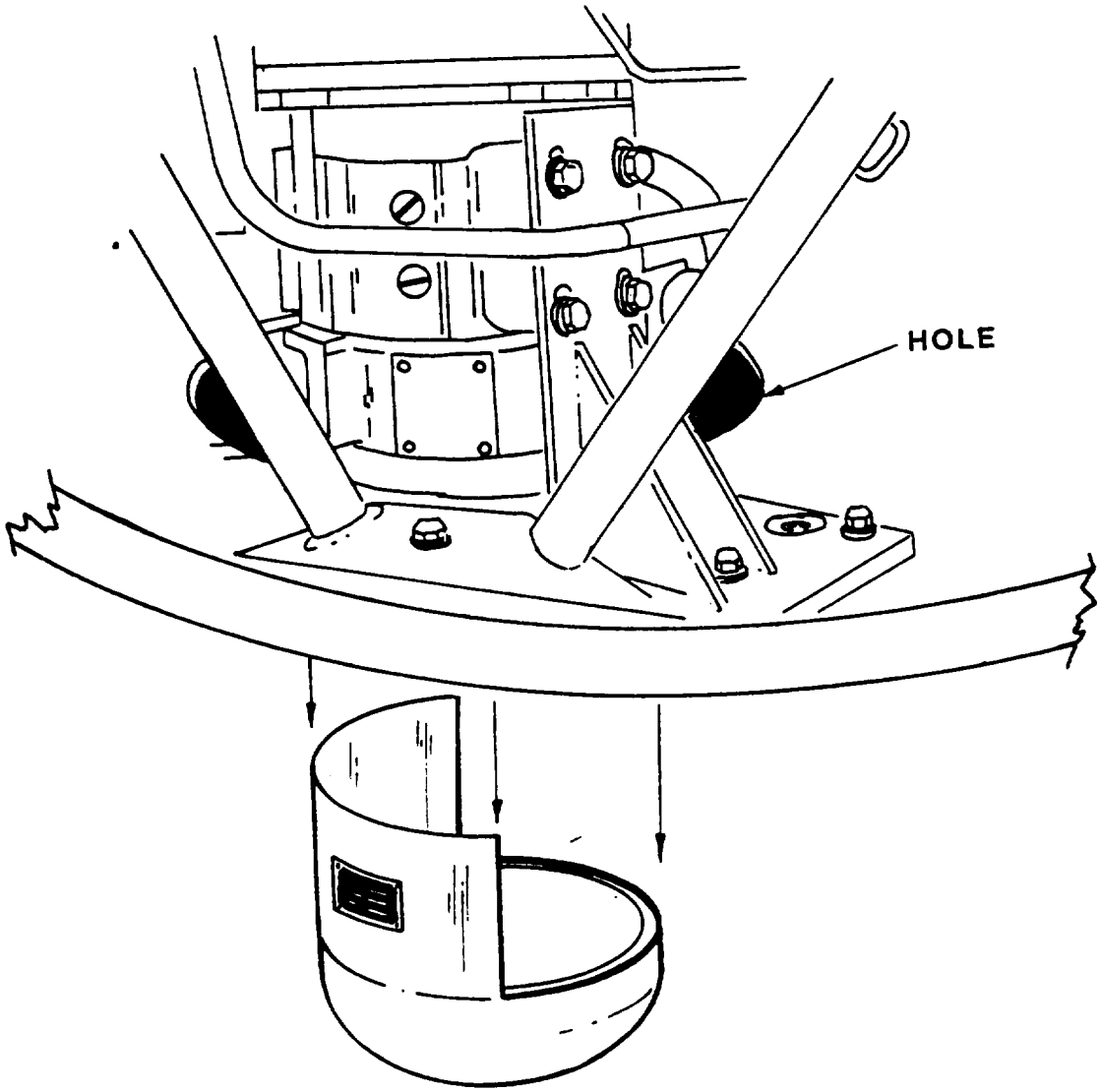


Figure 1. Turret Power Pack Replacement.

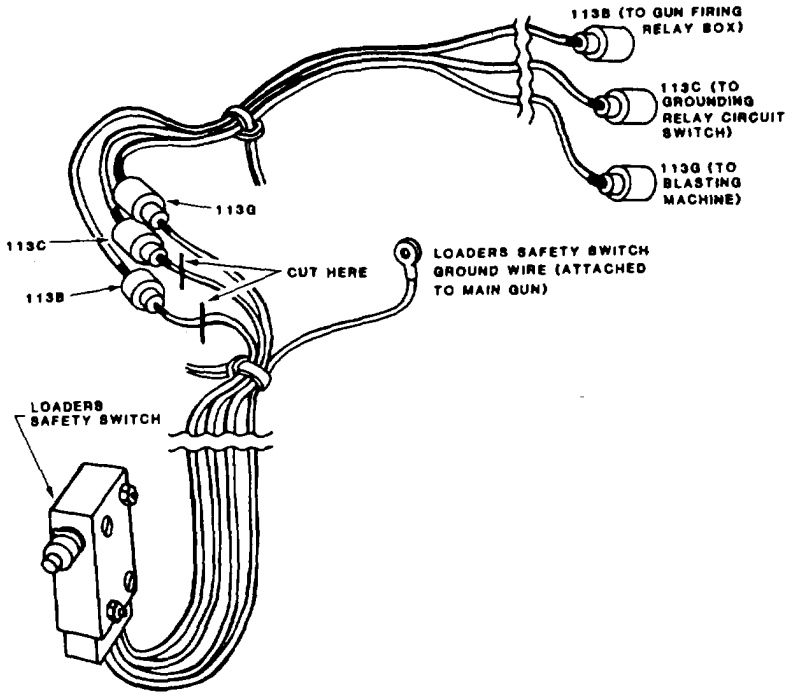
10-14. LOADER'S SAFETY SWITCH FAILURE

General Information:
Gun will not fire by any switch or the blasting machine. The loader's safety switch can be by passed using this procedure.

Limitations:
- No safety device.

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

Materials/Tools:
- Wire cutters
- Wire stripper or knife



Procedural Steps:

WARNING

The loader's safety system is disabled. The wires have to held together during each firing. Take care that they do not touch each other, or contact metal objects at all other times.

1. Identify and cut circuits 113B and 113C between safety switch and harness connectors as shown. Make sure the lengths of the two wires are different, so the ends of the dangling wires will not accidently touch each other.

NOTE
Be careful not to cut circuit 113G, which is the ground wire for the blasting machine. If circuit 113G is cut, the blasting machine is disconnected from the firing circuit.

2. Strip 1/2 inch of the insulation from the harness side of circuits 113B and 113C. To activate the firing circuit, manually touch the ends of these two wires together.

Procedural Steps (Cont'd)

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

10-15. M85 GUN INOPERATIVE; POWER LOSS

General Information
M85 machine gun will not fire due to loss of electrical power. A simple procedure will restore the firing circuit.

Limitations:
- None

Personnel/Time Required:
- 1 soldier
- 15 minutes

Material/Tools:
- Wire
- Wire strippers, or knife

Other Options:
- Fire weapon manually.

Procedural Steps:

WARNING

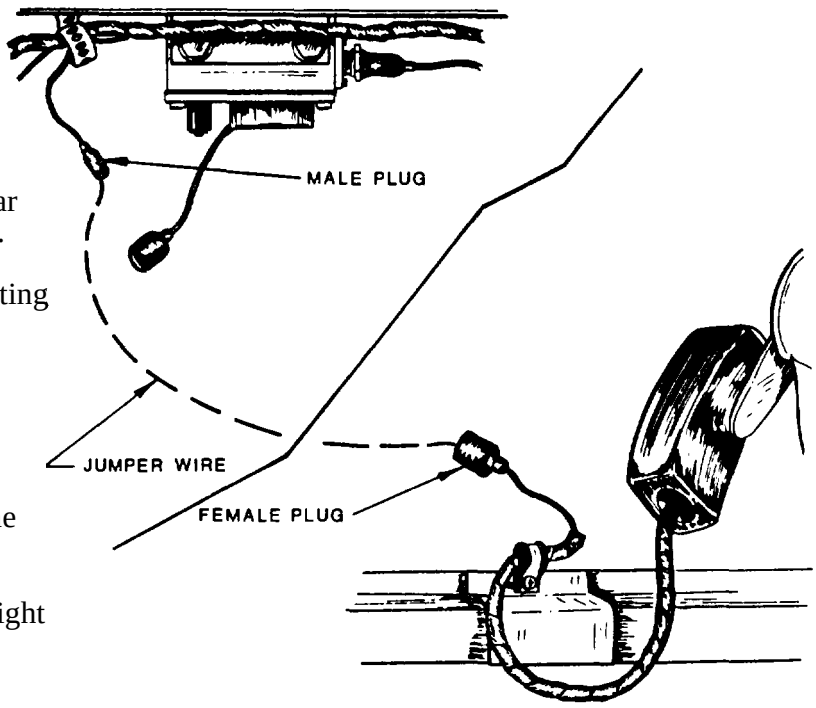
Ensure M85 machine gun is clear of ammo before attempting fix. Failure to do so could result in inadvertent firing of gun, resulting in injury or death to personnel.

1. Cut and strip wire going to the M85 trigger control.

2. Cut and strip wire from the hot side of the nearest working dome light.

3. Connect a wire from the dome light to M85 trigger control.

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



10-16. SLIPRING DEFECTIVE

General Information:
The slipring is the connecting link for transferring electrical power from the hull to the turret. This procedure gives an expedient to transmit the electrical power past a defective slipring.

Limitation:
Traversing is limited.

Personnel/Time:
- 2 soldiers
- 4 hours

Material/Tools:
- Tape
- Soldering iron
- Multimeter or expedient continuity tester.
- Twine or cord
- Solder, rosin-core

Other Options:
- Replace defective slipring

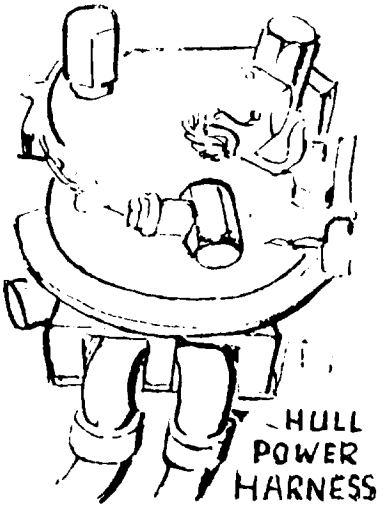
Assessment Steps:

1. Turn MASTER switch off.

2. Manually traverse the turret to gain access to the battery compartment.

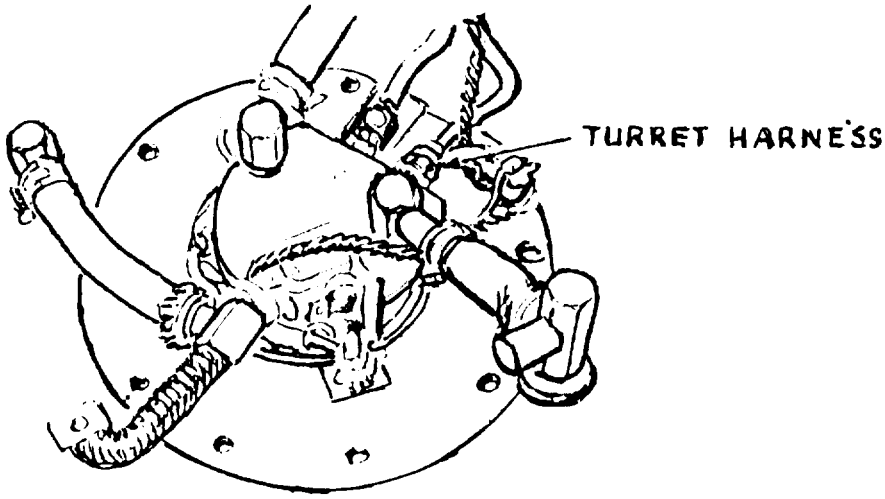
3. Remove slipring cover.

4. Disconnect hull power harness from the slipring.



Assessment Steps (Cont'd)

5. Turn MASTER switch to ON.
6. Check for 24 vDC at hull power harness connector.
7. Turn MASTER switch to OFF.
8. Disconnect turret power harness.



Assessment Steps (Cont'd)

9. Connect hull power harness to slipring.

10. Turn MASTER switch to ON.

11. Check for power at slipring turret connector.

    a. If power is present, go to topic" TURRET NO HYDRAULIC POWER", refer to para 6-10.

    b. If no power is present, go to step 12.

12. Bypass slipring by using battery ground cable.

13. Turn MASTER switch to OFF.

Procedural Steps

1. Remove one battery ground cable and remove terminal lugs from each end.

2. Disconnect hull power harness from slipring.

3. If terminals required to fit hull and turret power harness connectors are available, solder to each end of the battery ground cable if terminals are not available, strip approximately one inch of insulation from each end and tin with solder.

4. Connect battery cable to hull and turret power harness connectors.

5. Reinforce connections using cord, twine, or tape.

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

10-17. TURRET POWER PACK INTERCHANGEABILITY

General Information:
Power pack damaged beyond repair. Power packs from the M109, Ml 10, Ml and M48 series vehicles are interchangeable. Reservoirs and motors may vary in size and capability, but they will function.

Limitations:
- None

Personnel/Time Required:
- 1 soldier
- 1 hour

Materials/Tool:
- Power pack
- Hydraulic fluid

Procedural Steps:

1. Disconnect electrical connections.

2. Disconnect all hydraulic lines and plug them.

3. Unbolt and remove power pack.

4. Clean the mounting surfaces carefully.

5. Install new or used power pack.

6. Reconnect electrical connections.

7. Reconnect all hydraulic lines.

8. Replace any lost hydraulic fluid.

9. Perform operational check and inspect for fluid leaks.

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

10-18. MANUAL PUMP FLUID LOSS

General Information:
Hydraulic system damaged, manual pump will not operate without fluid.

Limitations:
- Frequent checks for leaks
- Degraded turret operations

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

Materials/Tools:
- Two large cans
- Hydraulic fluid, or oil

Other Options:
- See TM 9-2350-276-BD, Hydraulics.

Procedural Steps:

1. Disconnect hydraulic lines at powerpack going to manual pump.

2. Cut tops out of cans, or punch large holes into tops of cans.

3. Bend lines carefully so that they will hang into cans.

4. Fill input can with fluid, it will act as a reservoir, so the pump will operate.

5. When manual pump is operated the second can will catch fluid so it can be returned to input can.

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

10-19 MAIN ACCUMULATOR DAMAGED

a The hydraulic system used for gun operation can be operated in a degraded mode if the hydraulic lines are plugged or isolated on the system side of the accumulator. Operation will be eratic without the buffer action provided by the accumulator pressure.

b. The accumulator may also be replaced with an accumulator from an Ml tank or other M48/M60 series tank. The brake system accumulator from the Ml tank may also be used but the capacity is lower.

CHAPTER 11

COMMUNICATION SYSTEMS

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

11-1. Scope.

This chapter contains the fault assessment and expedient repair procedures needed to locate and fix battlefield damage to the vehicle's communications system.

11-2. General.

The procedures in this chapter are used to repair battlefield damage to the AN/VIC-1 intercommunications set, the radio systems, the KY-57 (KY-38) speech security system and all associated wiring and cables.

11-3. Functional Details.

a. The AN/VIC-l intercom set consists of the AM-1780 amplifier, four C-2298 or C-10456 control boxes, one C-2742 remote switching control box, four CVC helmets and all associated wiring and cables. The AN/VIC-1 allows voice intercom to take place 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 non-secure frequency modulation (FM) voice radio capabilities through the AN/VIC-1 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 with 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 amplifier and a R-442 auxiliary receiver.

c. The two current 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, 335-14 distribution box, KY-57 speech security device, MT-4626 mount and all associated wiring and cables.

(2) The Nestor speech security system consists of a 3-2731 distribution box, 3-3024 interconnection box, KY-38 speech security device, MT-3823 mount, AM-4979 amplifier and all associated wiring and cables.

SECTION II. General Operating Procedures

11-4. 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-l 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 11-1.

(2) Turn POWER switch on the radio (connected to 3501) 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 11-1.

(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.

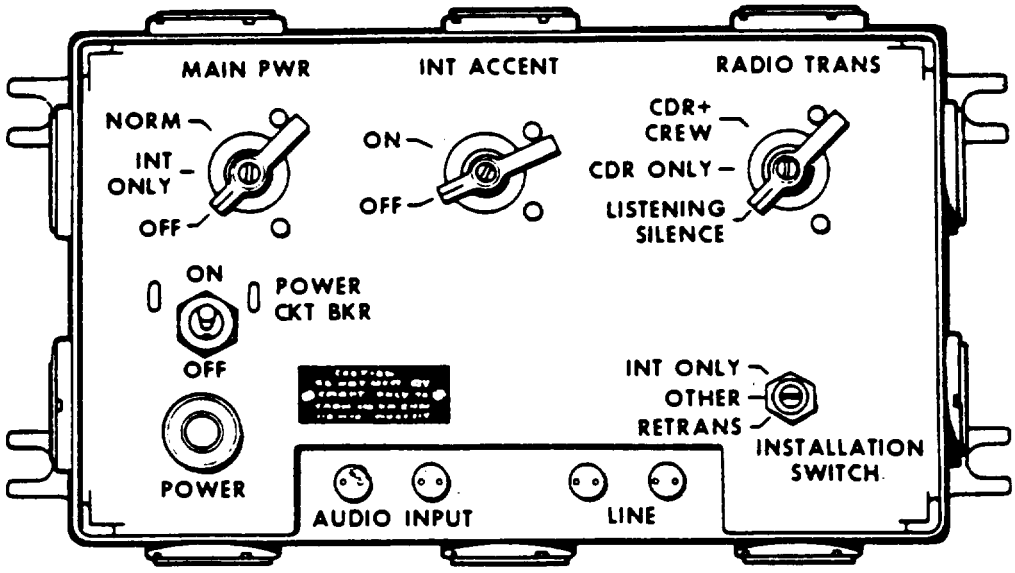


Figure 11-1. AM-1780 Amplifier

c. Normal Radio and Intercom Operation with Crew (Members Control Box. See figure 11-2.

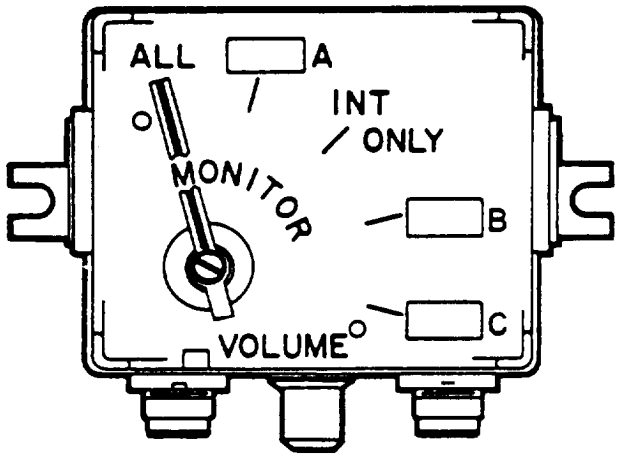


Figure 11-2. Crew Members Control Box

(1) Place the MONITOR switch in the desired position.

(a) ALL - Receives all radio and intercom transmission. Transmit 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

11-5. Fault Assessment Procedures.

a. Be sure to read Chapter 2 before starting 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. Procedures below 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 this manual.

b. Intercommunications Set Assessment.

Inspection reveals → Damage:

-AM 1780 Inoperative . . . . . go to para 11-6

No Damage Found

C-2298 or C-10456 . . . . . go to para 11-7
Inoperative

c. Radio System Assessmer

Inspection reveals → Damage:

-Radio Inoperative . . . . . go to para 11-8
(No Power)

-Radio does not receive . . . . . go to para 11-9

No Damage Found

-Radio does not transmit . . . . . go to para 11-10

-Radio Inop. in “New Squelch” pos go to para 11-11

-Aux Receiver Inoperative . . . . . go to para 11-12

d. Speech Security System Assessment.

Inspection reveals → Damage:

-System Inoperative (No Power) . . . go to para 11-13

No Damage Found

-System Inoperative . . . . . go to para 11-14

11-6. 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 Mini-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. (Refer to para. 11-4.)

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 11-34.

(3) Repair the defective cable in accordance with the repair procedures in para. 11-30 or TM9-2350-276-BD.

b. If a defective cable is not found, then follow the troubleshooting procedures in TM 11-5820-401-12.

11-7. OBSERVABLE SYMPTOM: THE INTERCOM WORKS ON SOME CONTROL BOXES BUT NOT ALL

Detailed Assessment Steps:

1. Repeat steps 4 thru 6 in para. 11-6.

2. Replace CVC helmet and connecting cable with a known operational CVC helmet and connecting cable.

Detailed Assessment Steps (Cont'd)

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.

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 control box.

b. If the problem still exists, replace or repair the CX-4723 cable between the control box and the AM- 1780.

5. If the cable and/or the control box cannot be repaired or replaced, install the field expedient intercom described in para. 11-22.

11-8. 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. 11-6 and/or 11-8.

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.

Detailed Assessment Steps (Cont'd)

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. If 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 11-34.

(3) Repair the cable in accordance with the procedures in para. 11-30 or the electrical chapter of TM 9-2350-276-BD.

b. If a defective cable is not found, follow the troubleshooting procedures in TM 11-5820-401-12.

11-9. OBSERVABLE SYMPTOM: THE RADIO DOES NOT RECEIVE THE STATION

Detailed Assessment Steps:

1. Check that all switch settings are as described in para. 11-4.

a. If the problem still exists, refer to para. 11-7 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.

Detailed Assessment Steps (Cont'd)

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 MK-7777 or MK-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:

(1) Replace the defective cable in accordance with standard repair procedures.

(2) Replace the defective cable with an acceptable replacement cable listed in para 11-34, then go to step 7.

(3) Repair the cable in accordance with the procedures in para. 11-29.

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.

11-10. 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.

Detailed Assessment Steps (Cont'd)

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.

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. Ensure 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. Ensure 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 11-34.

(3) Repair the cable in accordance with the procedures in para. 11-29.

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.

11-11. 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 OFF.

2. Verify that the distant station is too far away for squelch operation by attempting 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. 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 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 11-5820-401-12.

11-12. OBSERVABLE SYMPTOM: THE AUXILIARY 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 clamps.

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.

Detailed Assessment Steps (Cont'd)

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 11-34.

(3) Repair the cable in accordance with the procedures in para. 11-30 or TM 9-2350-276-BD.

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.

11-13. OBSERVABLE SYSMPTOM: THE KY-57 (KY-38) SPEECH SECURITY SYSTEM DOES NOT HAVE POWER

Detailed Assessment Steps:

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.

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.

Detailed Assessment Steps (Cont'd)

4. Check cables for damaged or torn insulation.

NOTE

Do not attempt to repair any cables. Repair might breach security.

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 11-34.

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.

11-14. 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 11-5.

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. (See applicable Communication Electronic Operating Instruction (CEOI)).

3. Attempt to communicate with a different distant station to make sure the proper code settings are being used.

Detailed Assessment Steps (Cont'd)

a. If communication is restored, attempt to notify the original distant staiton 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 11-5810-256-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 11-5810-256-OP-4.

SECTION IV. Expedient Repair Procedures

11-15. GENERAL: This section contains expedient repair procedures to restore radio and/or intercommunications needed to complete the mission.

11-16. 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/transmitters.

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 11-5 or the electrical chapter.

11-17. 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:
l Slight reduction in reception and transmission range.

Personnel//Time Required:
l 1 soldier
l 15 minutes

Materials/Tools:
l Stick, dry, 4 to 6-inch length
l Wire, copper or cable, stripped telephone, WD-l/TT, l-foot length

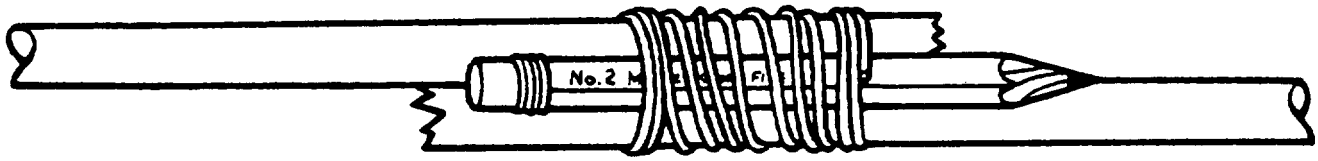
Other Options:
l Field expedient antenna (Refer to para. 11-18 or 11-19.)
l Field expedient ground plane antenna (Refer to para. 11-21.)

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.

11-18. 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:
- 1 soldier
- 15 minutes

Material Tools:
- Pole, wooden or stick, 10-foot length
- Tape, electrical, string or rope
- Wire, copper or cable, telephone, WD-l/TT, 10-foot length

Other Options
l Field expedient replacement antenna (refer to para. 11-19).
l Field expedient ground plane antenna (refer to para. 11-21).

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.

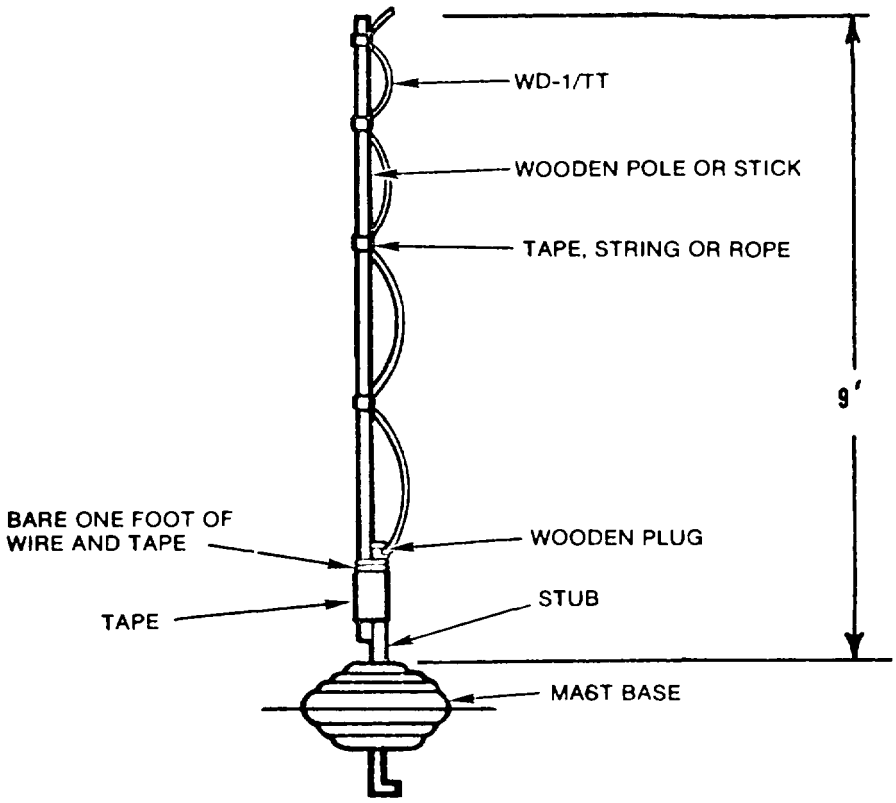
NOTE

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 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'd)



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

11-19. 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:
- 1 soldier
- 5 minutes

Material/Tools:
- Cable, telephone, WD-l/TT 8-foot length.
- Tape, electrical.

Other Options:
- Repair broken metallic whip antenna (Refer to para. 11-17.)
- Field expedient metallic whip antenna. (Refer to para. 11-18.)
- Field expedient ground plane antenna. (Refer to para. 11-21.)

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.

11-20. 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.

Personnal/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. 11-21.)

Procedral Steps:

1. Measure off and mark but do not cut five feet of coaxial cable.

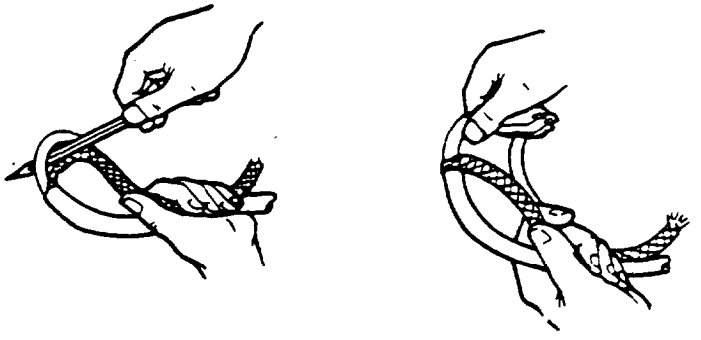
2. In one foot steps, strip the outer insulation from the cable to expose the braided shield wire. Use care so that the shield wire is not cut.

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.

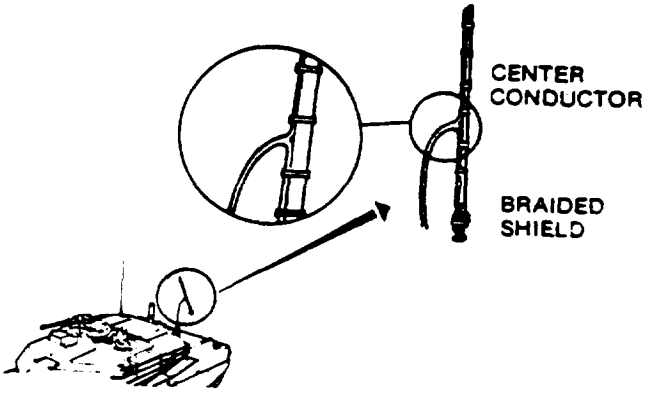
4. Work the pencil or nail between the shield wire and center conductor to form a hole. While keeping the loop formed, place a finger in the hole and slowly pull the center conductor out of the shield.

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 (Cont'd)



REMOVING BRAIDED SHIELD ON COAX CABLE



FIBERGLAS WHIP (TAPED)

6. Fasten @e 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 follow

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.

11-21. ONE-QUARTER WAVE ANTENNA FIELD EXPEDIENT GROUND PLANE

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:
- 1 soldier
- 30 minutes

Materials/Tools:
- Cable, l-roll, telephone, WD-1/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. 11-17.)
- Field expedient metallic whip antenna. (Refer to para. 11-18.)
- Field expedient replacement of fiberglass antenna. (Refer to para. 11-20.)
- For reception only, field expedient auxiliary antenna. (Refer to para. 11-19.)

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)

Length (meters) = 71.37 divided by frequency (MEGAHERTZ)

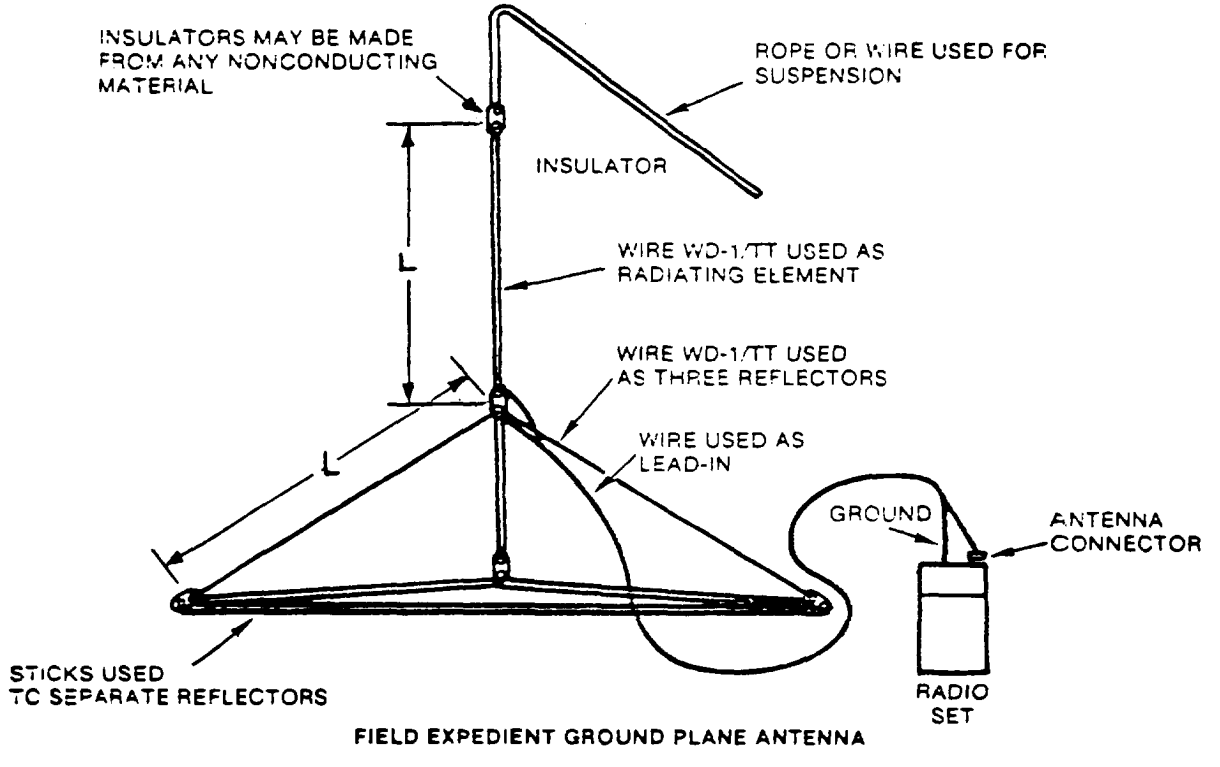
Example- A radiating element for a frequency of 50 MHZ:

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'd)

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, approximately the same length as the radiating element, 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'd)

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.

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

11-22. 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.

Personnel/Time Requred:
- 1 soldier
- 10 minutes

Materials Tools:
- One TA-312/PT or TA-l/PT field telephone for each station where requirement for intercom exists.
- Cable, telephone, WD-1/TT, 10 to l5-foot length.

Other Option(s):
- Replace with Soviet R-124 intercom. (Refer to paragraph 11-28).

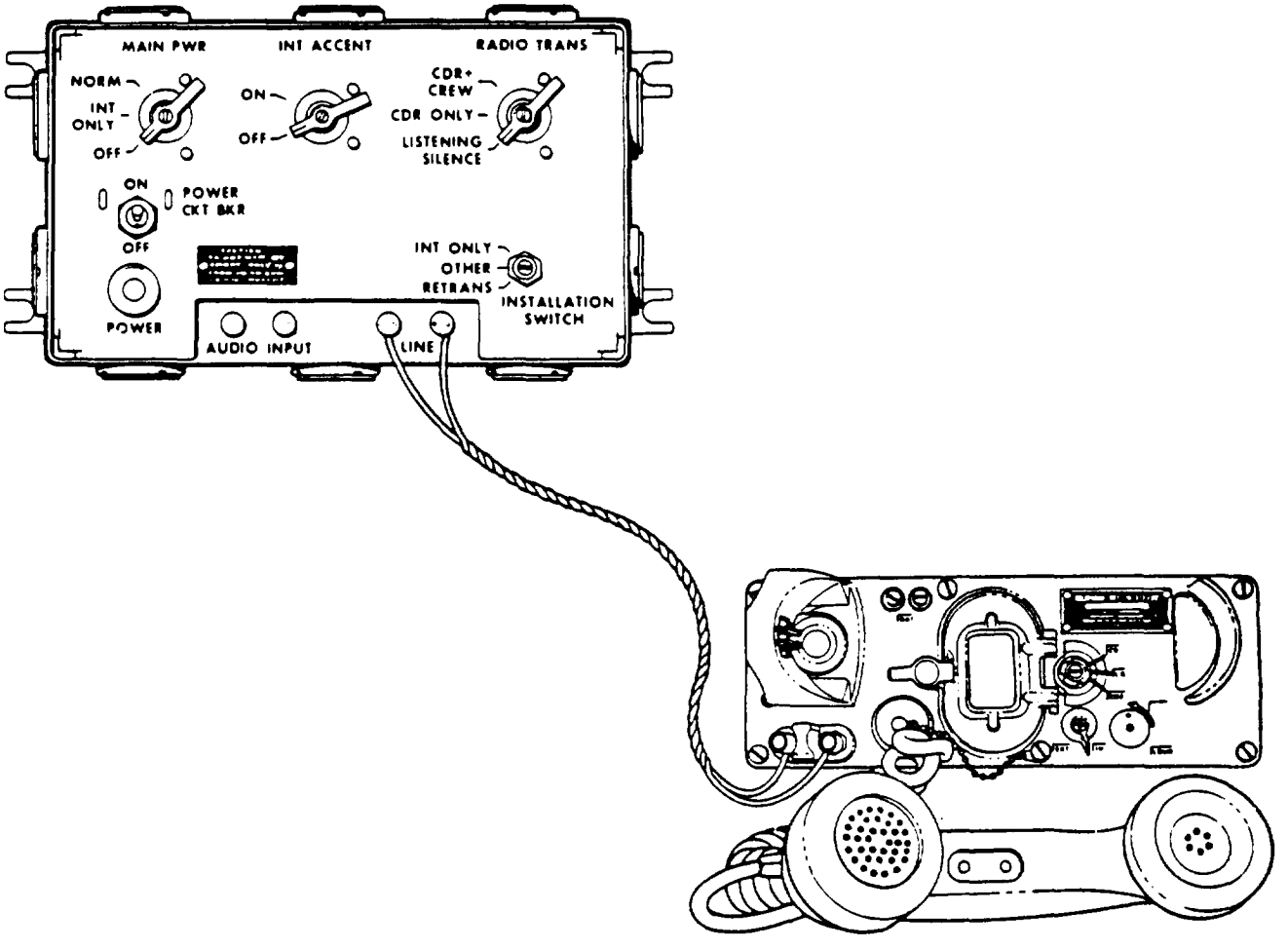
CAUTION

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-1 field telephones at the station(s) where the bad control boxes are located and run field telephone wire back to the AM-1780. The WD-l/TT should be hooked upon the “line” jacks of the AM-1780.

2. If the AM-1780 is not operational, replace the entire intercom system with TA-312 or TA-1 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.

11-23. FIELD EXPEDIENT RADIO SYSTEMS

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-1/TT,
- Field Telephone TA-312/PT, or TA-1/PT
- Flag set

Procedural Steps:

1. Substitute radio with:

   a. AN/VRC-12 series on foreign equipment. (Refer to para. 11-25.)

   b. Soviet equipment. (Refer to para. 11-26.)

   c. Foreign Allied equipment. (Refer to para. 11-27.)

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

11-24. 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.

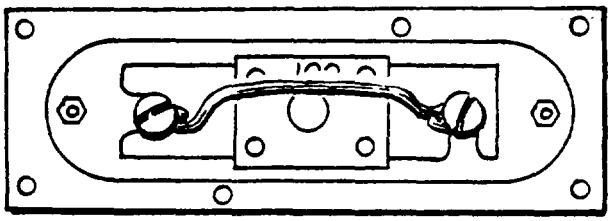
3. Carefully remove damaged mount from vehicle.

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 J-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.

11-25. FOREIGN EQUIPMENT INTERCHANGEABILITY (AN/VRC-12 SERIES)

General Information:
This procedure contains interchangeability information to be used if standard radio components are not available.

Limitation:
- None.

Personal/Time Required:
- 1 soldier
- 15 minutes

Materials/Tools:
- Component, radio, AN/VRC-12 series from foreign vehicle.

Other Options:
- Field expedient radio systems. (Refer to para. 11-23.)
- Replace radio with:
    1. Soviet equipment. (Refer to para. 11-26.)
    2. Foreign allied equipment. (Refer to para. 11-27.)

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	d. Netherlands
b. Israel	e. Spain
c. South Korea	f. Sweden

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

11-26. FOREIGN EQUIPMENT INTERCHANGEABILITY (SOVIET RADIO R-123M)

General Information:
This procedures 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-l/TT, 5-foot llength, (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, lo-foot length
- Gun, soldering
- Solder, rosin-core

Other Options:
- Substitute radio with:
  1. Foreign allied equipment (Refer to para. 11-27).
  2. Foreign AN/VRC-12 series equipment. (Refer to para. 11-25.)

Procedural Steps:

NOTE

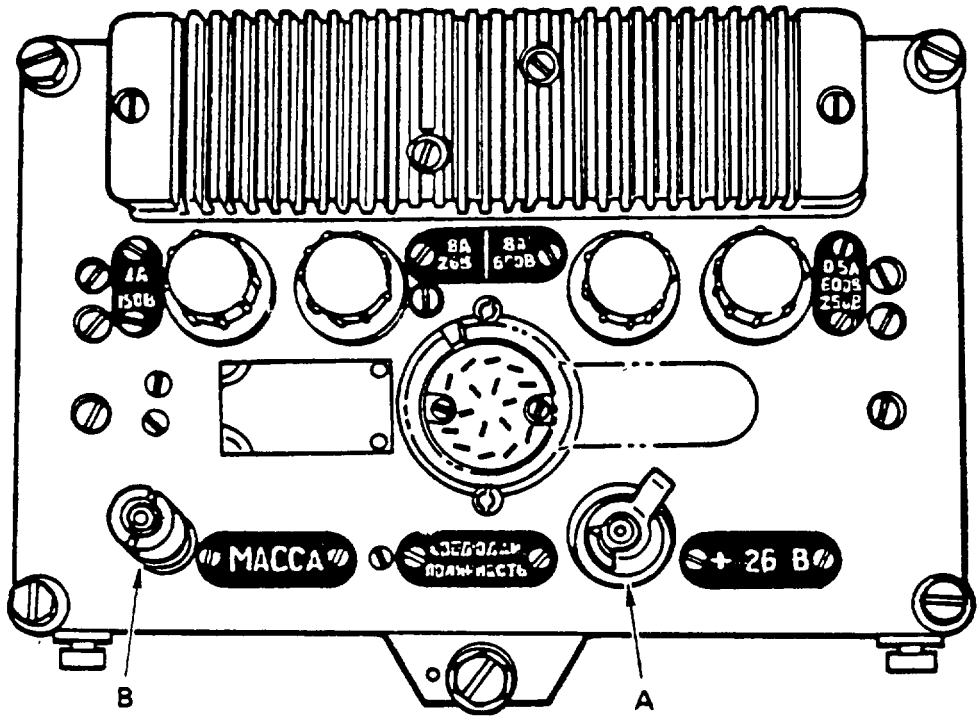
The AN/VIC-1 intercom should not have the R-123M wired through it. For proper operation of the intercom while the R-123M is being used, set the INSTALLATION SWITCH on the AM-1780 to INT ONLY position.

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 J-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 l/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.)

Procedural Steps (Cont'd)

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.)



4. Install the R-123M onto the MT-1029, and tie down with rope or web sling.

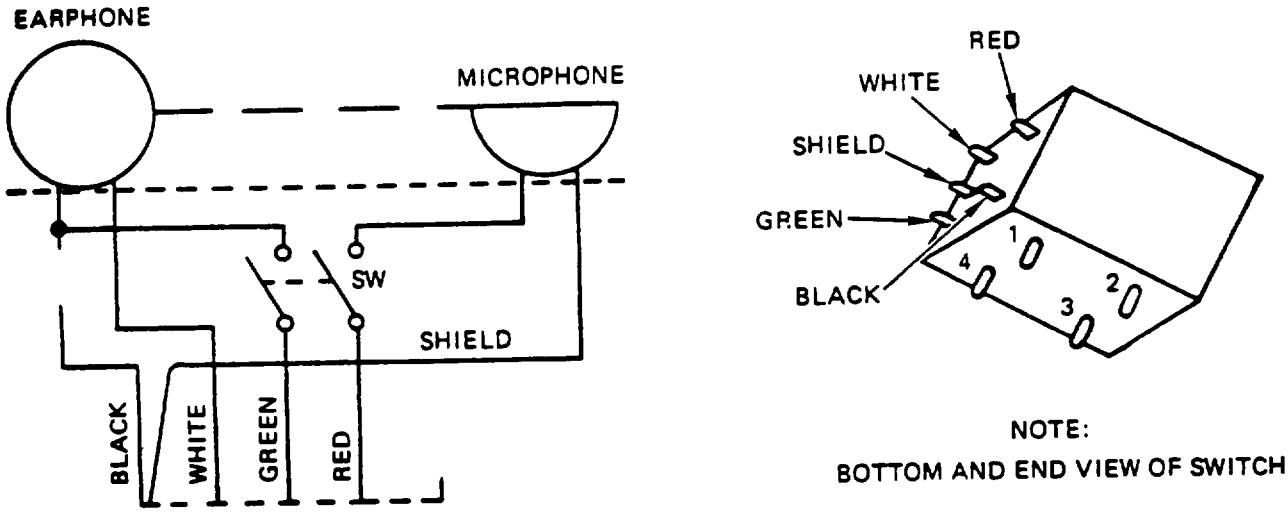
5. Remove the outer cover on the female end of the UC-273 connector to make it a male connector and insert it into the antenna connection point located on the right side of the R-123M immediately below the AHTEHHA sign. Attach the RF cable.

NOTE

o Frequency must be set manually on the MX6707. If possible use the auxiliary antenna.

o 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'd)

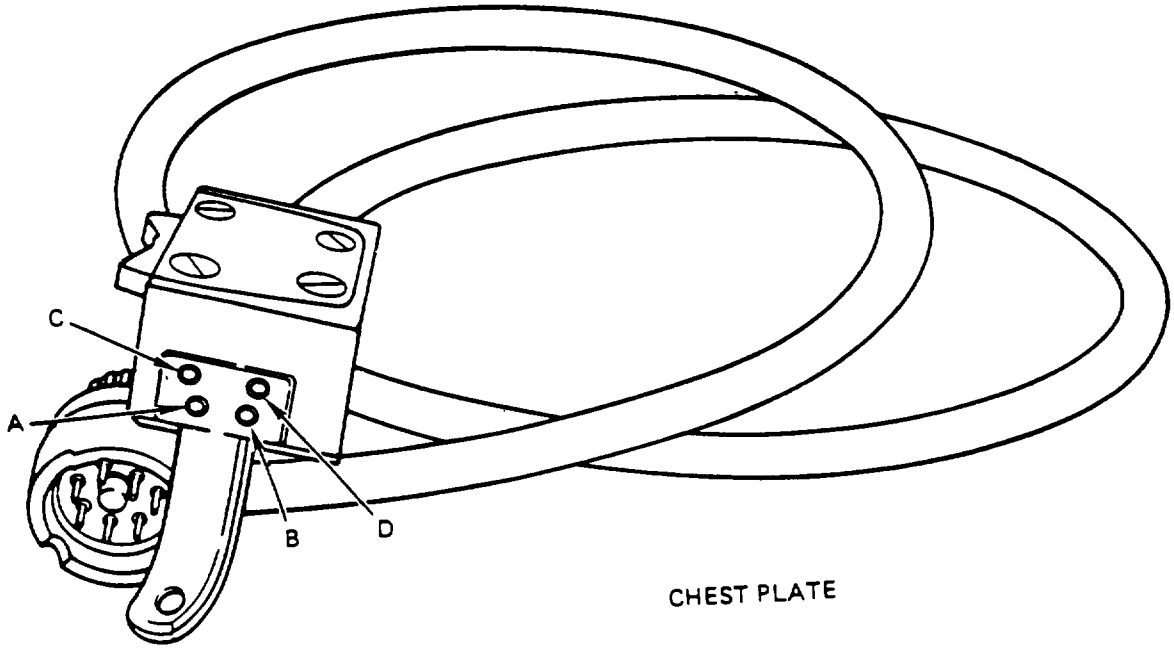


6. H-189 Handset:

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.)

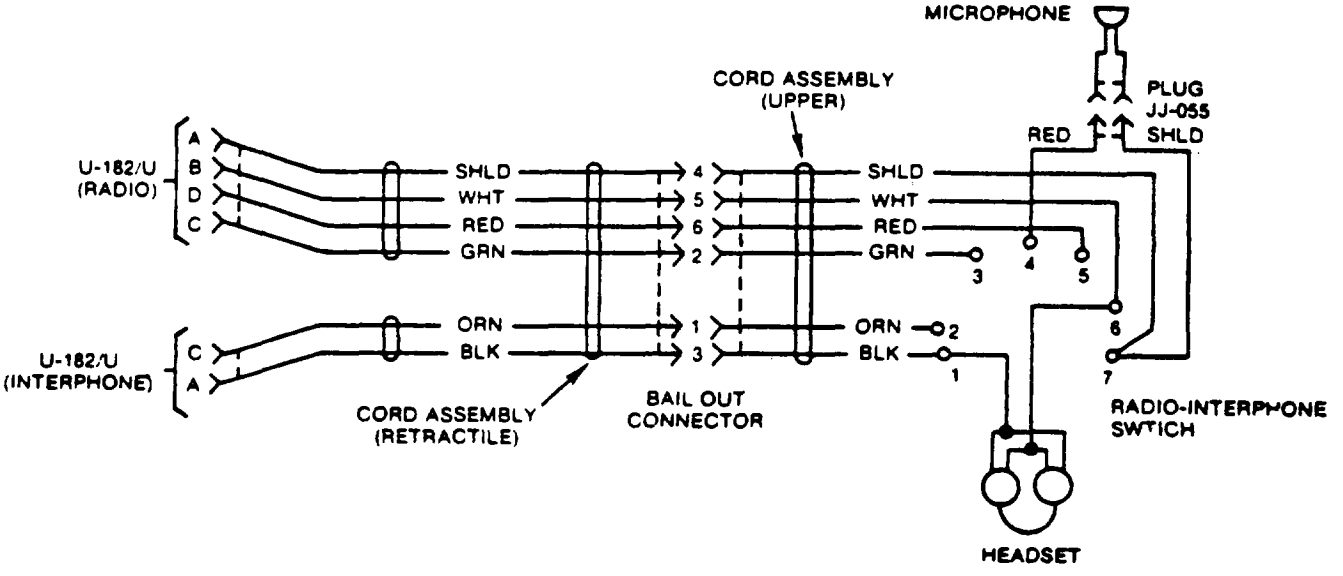
c. Hook the green wire connection to one of the outside jacks and the red wire to the other outside jack (points C and D).



Procedural Steps (Cont'd)

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 (l), shield (7), and red (4) wires.

c. Hook the white wire to one of the inside jacks on the Soviet chestplate and the black wire to the other inside jack (Points A and B on chestplate 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 chestplate 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.

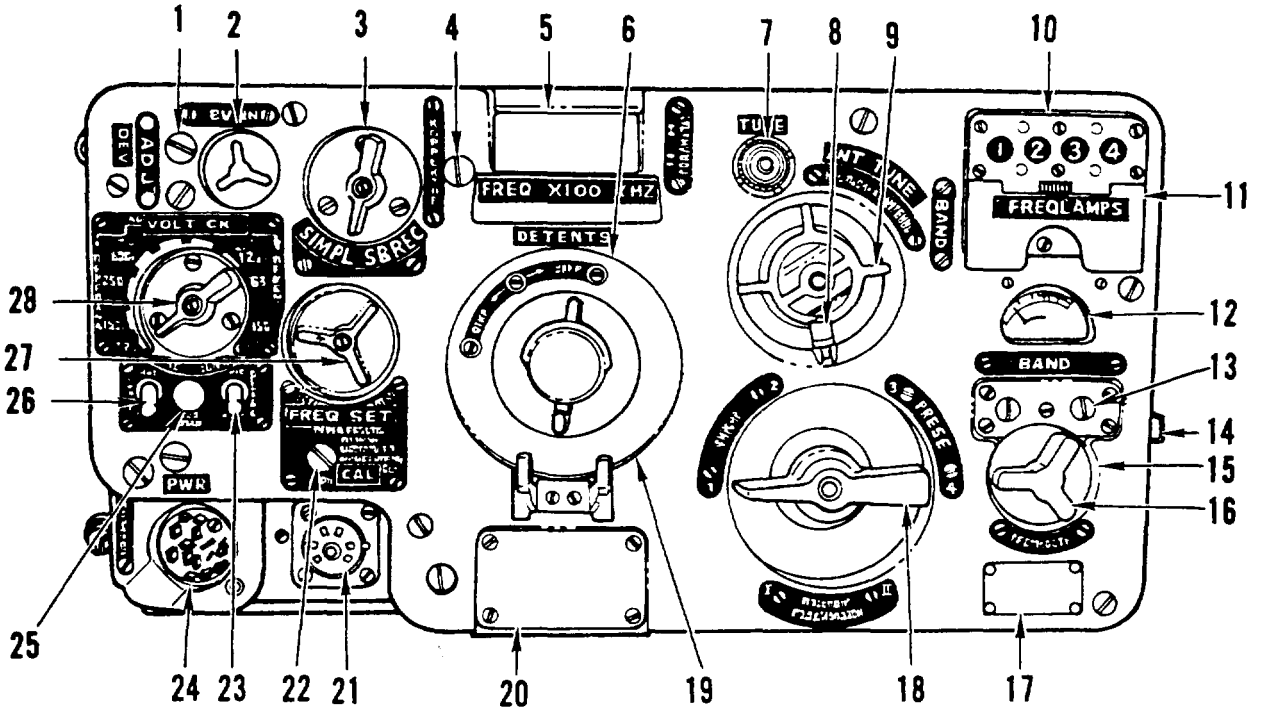
a. Make sure the POWER SWITCH (23) and the DIAL LIGHT SWITCH (26) are in the off (down) position.

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)

d. Turn the SQUELCH CONTROL KNOB (2) counterclockwise (off).
e. Turn the VOLUME CONTROL KNOB (16) all the way clockwise.
Turn the VOLTAGE CHECK/OPERATE SWITCH (28) to the receiver circuits portion of the scale; 1,2B (approximately the one o'clock position).
& Turn the power source on. The input voltage to the R-123M power supply should be 24 + 1 vDC for best operation.



1. DEVIATION ADJUSTMENT UNDER PLUG)
2. SQUELCH CONTROL KNOB
3. MODE SELECTOR SWITCH
4. INDEX LINE ADJUSTMENT (UNDER PLUG)
5. FREQUENCY DIAL VIEWING WINDOW
6. PRESET LOCKING SCREWS (UNDER COVER (19))
7. RF INDICATOR LAMP
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. DATA PLATE
18. PRESET CHANNEL/CONTINUOUS TUNE SELECTOR SWITCH
19. PRESET LOCKING SCREW ACCESS COVER
20. OPERATING FREQUENCY CARD
21. INTERCOM CONNECTOR
22. CALIBRATION ADJUSTMENT (UNDER PLUG)
23. POWER SWITCH
24. POWER INPUT CONNECTOR
25. TONE CALL BUTTON
26. DIAL LIGHT SWITCH
27. FREQUENCY TUNING KNOB VOLTAGE CHECK/OPERATE SWITCH

Procedural Steps (Cont'd)

h. Turn the POWER SWITCH (23) and the DIAL LIGHT SWITCH (26) to the on (up) position. At this time the FREQENCY 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.

Check the power supply in the receive mode by noting the reading on the INDICATOR METER (12) and turning the VOLTAGE CHECK/OPERATE SWITCH (28) clockwise 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 three 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.

1. 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.

. 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.

Procedural Steps (Cont'd)

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 H: 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.

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.

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).

Procedural Steps (Cont'd)

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 11 (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.

w. Turn the FREQUENCY TUNING CONTROL 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 CONTROL 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.

. 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 chooose 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.

Procedural Steps (Cont'd)

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.

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 H frequencies.

ad. Turn 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 e.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 tank using standard maintenance procedures.

11-27. FOREIGN EQUIPMENT INTERCHANGEABILITY (ALLIED RADIOS)

General Information:
This procedure contains general installation instructions for and Allied nation 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 U.S. AN/VRC-12 frequency range.

Personnel/Time Required:
- One 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. 11-25.)
- Replace with Soviet radio R-123M. (Refer to para. 11-26.)

Procedural Steps:
1. Refer to table 11-1 for comparison purposes in determining limitations.

Table 11-1. Allied Radios

Basic FM Radio & Country	Frequency Range (MHz)	Power Output Min (Watts)	Power Output Max	Bandwidth (KHz)	Range (km) Min	Range (km) 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

Procedural Steps (Cont'd)

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 US 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 J-22 on the U.S. radio mount and 3-501 on the AM-1780. This cable must be hooked up to the same connections to which the foreign vehicle intercom master control box was connected.

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 input connection on the front face of the foreign radio.

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

11-28. REPLACE AN/VIC INTERCOM WITH SOVIET R-124 INTERCOM

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 chestplate), or standard CVC helmet
- Intercom, Soviet, R-124
- Plate, chest, Soviet (one for each control box)
- Tape, electrical.
- Wire, 4-conductor, 18-gauge, 5-foot length or cable, telephone, WD-l/TT, 5-foot length (two required)
- Gun, soldering
- Solder, rosin-core

Other Option:
- Field expedient intercom (refer to para. 11-22).

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. 11-26.

NOTE

Power is obtained in the same manner as listed in step 1 of para. 11-26.

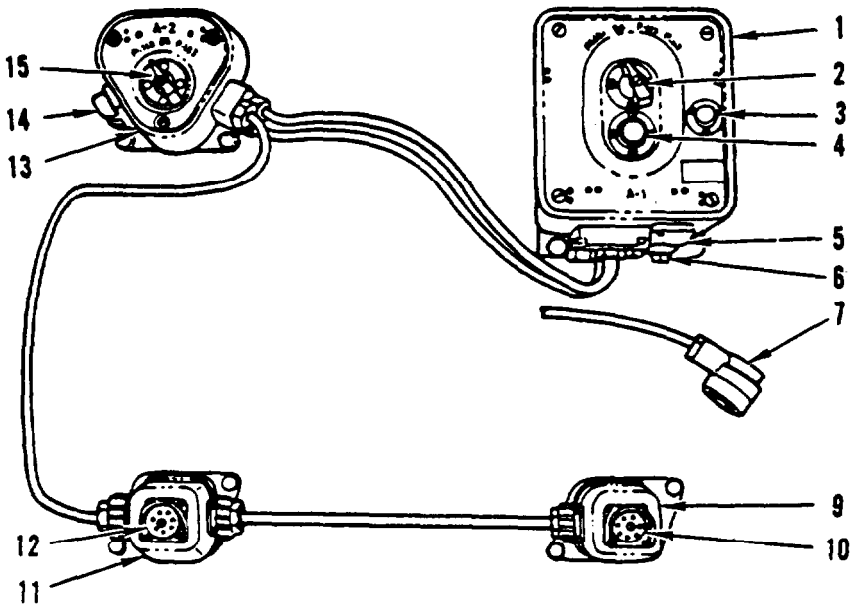
3. Attach the red and white wires from the power cable to the black terminal on the bottom of the A-1 box of the R-124. Attach the black and green wires from the power cable to the ground strap on the A-l box. See position 6 in the following illustration.

procedural Steps (Cont'd)

4. Operating procedures for the R-124.

NOTE

Operating Procedures are keyed to the intercom.



1. A-1 MAIN JUNCTION BOX
2. FUNCTION SWITCH
3. FUSE
4. VOLUME CONTROL
5. CVC RECEPTACLE
6. VOLTAGE CONNECTION POINT
7. R-112 CONNECTION CABLE
8. R-123 CONNECTION CABLE I NOT SHOWN)
9. A-4 TERMINATING BOX
10. CVC RECEPTACLE
11. A-3 INTERCONNECTING BOX
12. CVC RECEPTACLE
13. A-2 CONTROL BOX
14. CVC RECEPTACLE
15. FUNCTION SWITCH

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.

11-29. 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.

Limitation:
- None.

Personnel/Time Required:
- 1 soldier
- 20 minutes

Materials/Tools:
- See illustrations in this procedure for materials required.

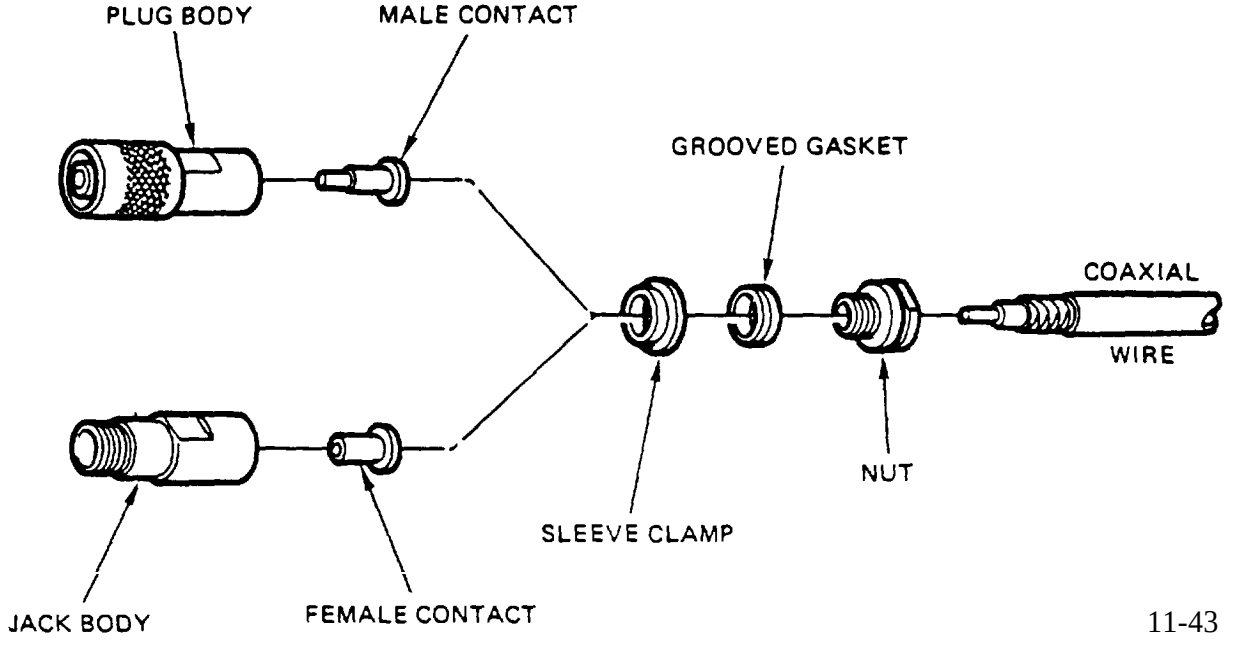
Other Option:
- See shielded cable repair procedures in electrical chapter.

Procedural STEPS:

NOTE

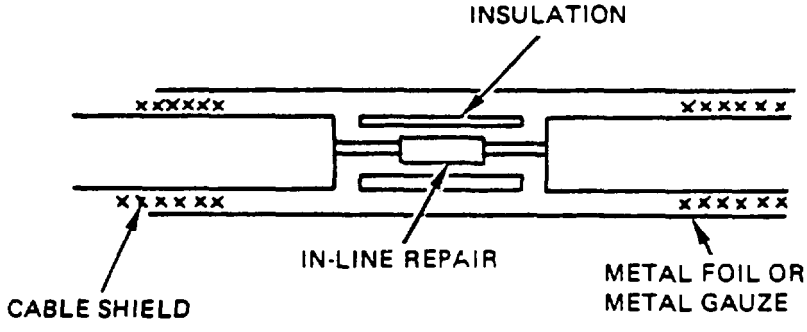
Do not attempt to repair broken or damaged coaxial cables unless absolutely necessary. Replace the entire cable whenever possible.

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'd)

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. Ensure 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 tank using standard maintenance procedures.

11-30. 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:
- 1 soldier
- 5-10 minutes per individual wire

Materials/Tools:
- Knife
- Tape
- Soldering iron
- Solder, rosin-core

Other Options:
- See other methods for splicing wires and cables in the electrical chapter in this TM and TM 9-2350-276-BD.

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.

11-31. 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 system chapter of this TM and TM 9-2350-276-BD.

- 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 3-801 and 3-804 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.

11-32. ISOLLATION OF NON-ESSENTIAL SYSTEMS (GENERAL)

General Information:
This procedure lists general guidelines for the isolation of non-essential systems.

Limitation:
* Varies depending on which system is isolated.

Personnel/Time Required:
- 1 soldier
- 5-30 minutes

Materials/Tools:
- Crimp-on 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.

Other Options (Cont'd)

● 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 AM-1780 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 tank using standard maintenance procedures.

11-33. 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 Suppressors.

Limitations:
● Possible loss of all communications.

Personnel/Time Requied:
● 1 soldier
● 5-10 minutes

Procedural Steps:

CAUTION

Without the transient voltage suppressor in the circuit, voltage spikes will be routed through the communications equipment and damage could occur. By-pass the suppressor only as a last resort.

Option 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.

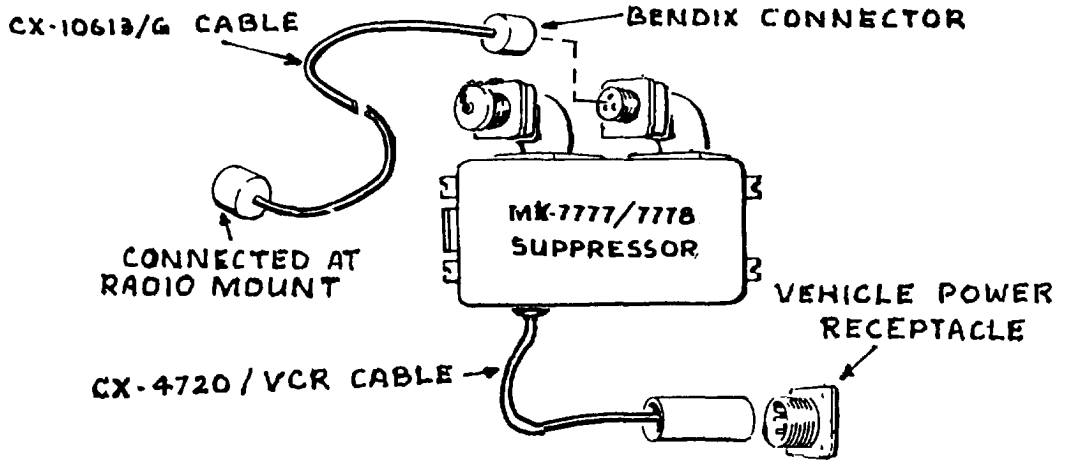
c. The MK-2096 is now removed from the circuit.

Option 2. Removal of MX-7777/MX-7778 transient voltage suppressor:

a. Locate the MX-7777/MX-7778 in the vicinity of the driver’s compartment.

Procedural Steps (Cont'd)

b. Remove the CX 10613/G cable which runs between the vehicle power receptacle and the rear of the voltage suppressor.



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 tank using standard maintenance procedures.

11-34. 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 y 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 11-35. This listing considers only US equipment. For information on foreign equipment interchangeability, refer to paragraph 11-25 through 11-28. 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.

INTERCHANGEABILITY LISTING

	Nomenclature	Description	Compatible Component	Compatible Vehicle	Notes
1.	ANTENNAS				
	AS-1729	N/A	AS-1729	All with radio	2
	AS-1729	N/A	Auxiliary Antenna	All with Aux. Receiver	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	N/A	Auxiliary Antenna	All with Aux. Receiver	2
	MS-116A	Bottom Element	MS-116A	All with Aux. Receiver	2
	MS-117A	Middle Element	MS-117A	All with Aux Receiver	2
	MS-118A	Top Element	MS-118A	All with Aux. Receiver	2
	MX-6707	Matching unit	AT-912	Some with radio	3
	AT-912	Matching unit	MX-6707	Most with radio	3
	AB-15	Mast Base	AB-558	Most with Aux Receiver	2
	AB-558	Mast Base	AB-15	Most with Aux. Receiver	2
2.	INTERCOM				
	AM-1780	Amplifier	AM-1780	All w/AN/VIC-1	2
	C-2296	Outside	C-2296	M60, M551 AVLB, MAB	2
	C-2297	Drivers Control Box	C-2297	M60, M551 AVLB, MAB	2

INTERCHANGEABILITY LISTING (Continued)

Nomenclature	Description	Compatible Component	Compatible Vehicle	Notes
C-2298	Member Control Box	C-10456	M1, M2, M3	2
C-2298	Member Control Box	C-2298	All w/AN/VIC/l	2
C-2742	Frequency Selector Box	C-2742	All w/RT-246	2
C-10456	Control Box	C-10456	M1, M2, M3	2
C-10456	Control Box	C-2298	All w/AN/VIC-l	1,7
3. CABLES				
CG-1773	4'0"	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
CX-4720	8'0"	CX-4720	M110	2,5
CX-4720	10'0”	CX-4720	AVLB	2,5
CX-4721	26”	CX-4721	M551, M113, M151	2,5
CX-4721	3'0"	CX-4721	M1, M561	2,5

INTERCHANGEABILITY LISTING (Continued)

Nomenclature	Description	Compatible Comoponent	Compatible Vehicle	Notes
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, M551 MAB	2,5
CX-4723	3'0"	CX-4723	M551, M561 M2, M3, MAB	2,5
CX-4723	4'0"	CX-4723	M901, M109	2,5
CX-4723	4'6"	CX-4723	M561	2,5
CX-4723	5'0"	CX-4723	Ml, M2, M3, M88 M113, M901, M561, M551, M577, AVLB	2,5
CX-4723	6'0"	CX-4723	AVLB	2,5
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

INTERCHANGEABILITY LISTING (Continued)

Nomenclature	Description	Compatible Component	Compatible Vehicle	Notes
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	Ml	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	Ml, M551	2,5
CX-7058	9'0"	CX-7058	M551	2,5
CX-7059	9'0"	CX-7059	M60	2,5
CX-7059	10'0"	CX-7059	M151	2,5
CX-7059	22'0"	CX-7059	Ml	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

INTERCHANGEABILITY LISTING (Continued)

	Nomenclature	Description	Compatible Component	Compatible Vehicle	Notes
	CX-7060	4'0"	CX-7060	Ml, 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	All w/AN/VIC-l	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"	CG-1773	AVLB, M2, M3	2,5
4.	CVC HELMETS				
	CVC	MK-1039	DH-132	Most with AN/VIC-l	2,6
	DH-132	MK-1697	CVC	Older Vehicles w/AN/VIC-l	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

INTERCHANGEABILITY LISTING (Continued)

Nomenclature	Description	Compatible Component	Compatible Vehicle	Notes
MT-4626	KY-57	MT-4626	All w/KY-57	2
AM-2060	RT-841	AM-2060	All w/RT-841	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	AH with Aux. Receiver	2,9
7. TRANSIENT VOLTAGE SUPPRESSORS				
MK-2096	Mini-Suppressor	MK-2096	M1, M2, M3	2
MK-7777, MK-7778	Suppressor	MK-2096 MK-7778 MK-7777	All w/AN/VIC-l	2
8. SPEECH SECURITY EQUIPMENT				
AM-4979	Amplifier	AM-4979	M113	2
J-2731	Distribution Box	J-2731	M113, M60 M577, M578, M88	2
3-3024	Interconnecting Box	3-3024	M88, Ml 13, M577, M578, M60	
KY-38	SSE	KY-38	All w/KY-38	2

INTERCHANGEABILITY LISTING (Continued)

Nomenclature	Description	Compatible Component	Compatible Vehicle	Notes
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
CX-11996	14'0" x 3'0"	CX-11996	M60, M113	2,5
CX-11996	10'0" x 5'0"	CX-11996	M577, 578 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 ASSOCIATED WITH INTERCHANGEABILITY LISTING

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.

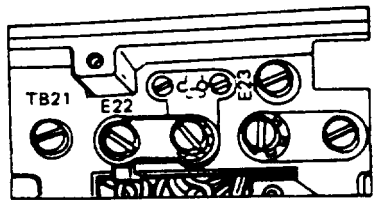
NOTE #4 - This precludes usage of RT-524 and should not be done unless RT-524 is inoperative.

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.

NOTE #6 - Ensure for comparability of connector. 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-WC- 1 intercom then the “Pivot terminal link” must be in position as shown below.



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 receptacle, 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 mount, 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.

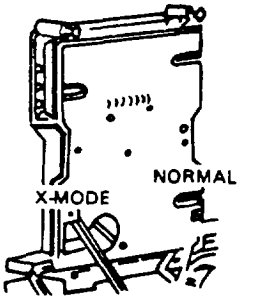
H Be sure leaf springs are equally curved.

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.



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.

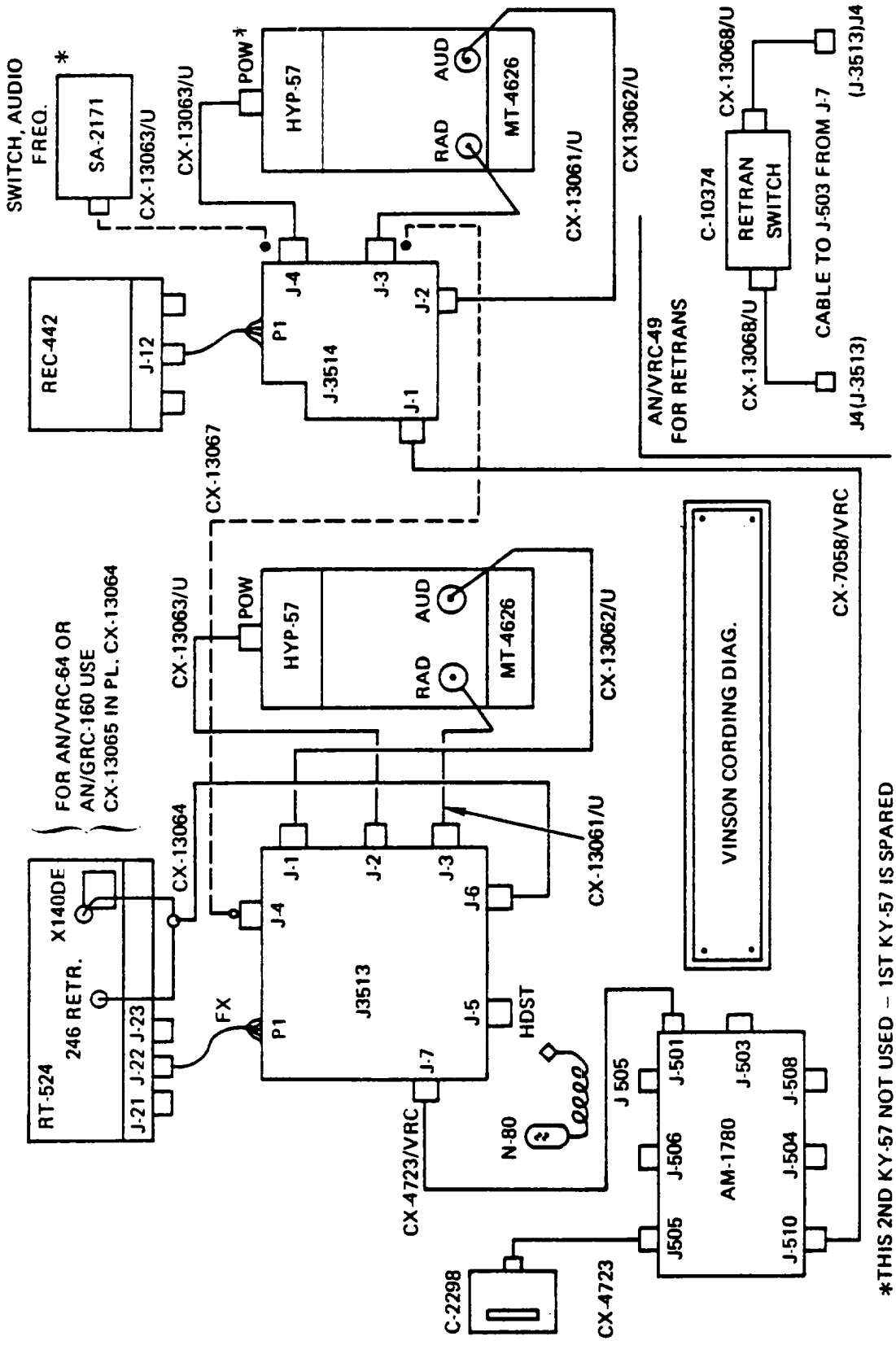
NOTE #10 - Loss of automatic channel selection if RT-246 is being used.

Section V. Common Vehicle Cording Diagrams

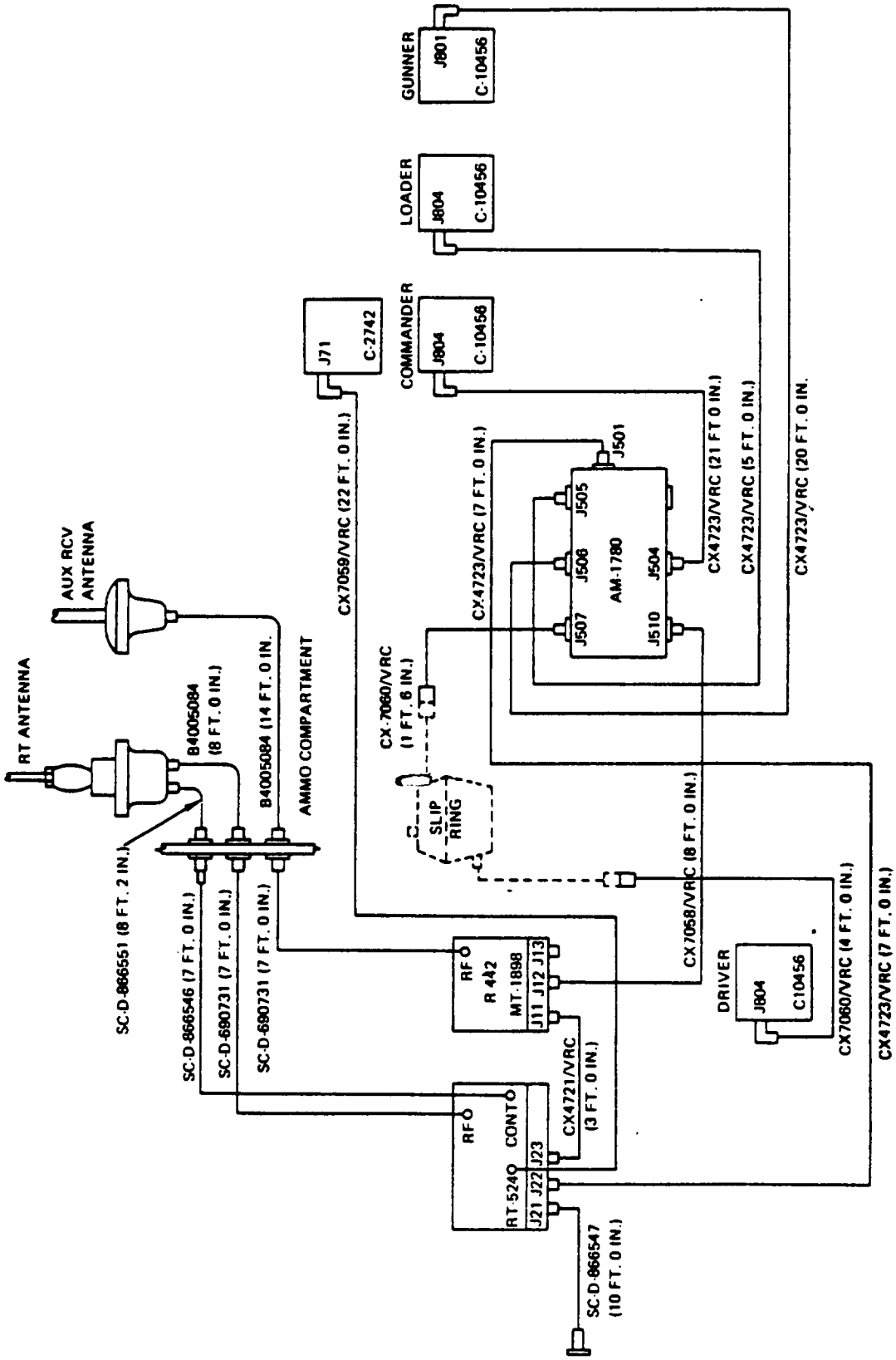
11-35. General.

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.

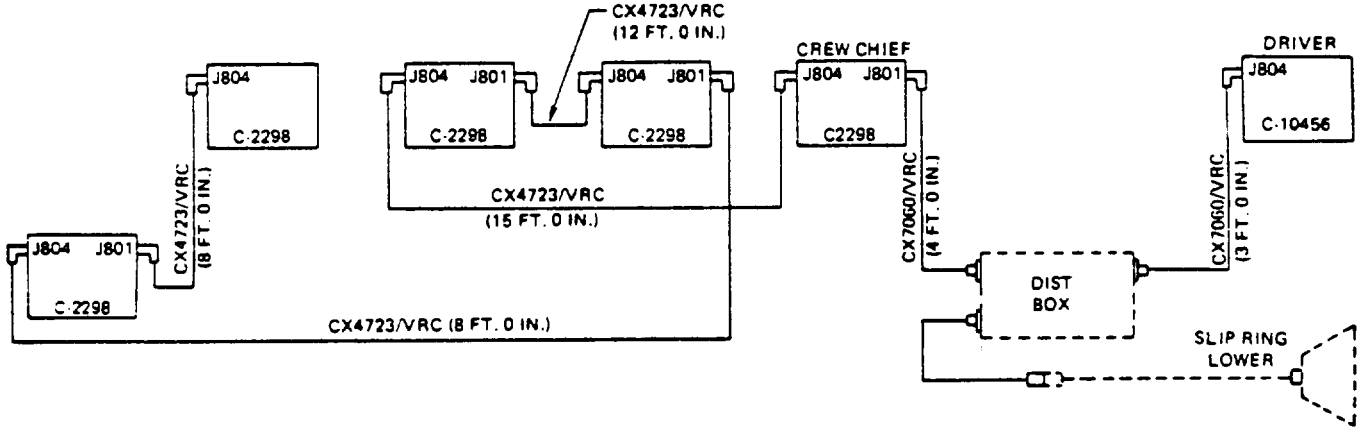
Cording Diagram For (Cont'd):



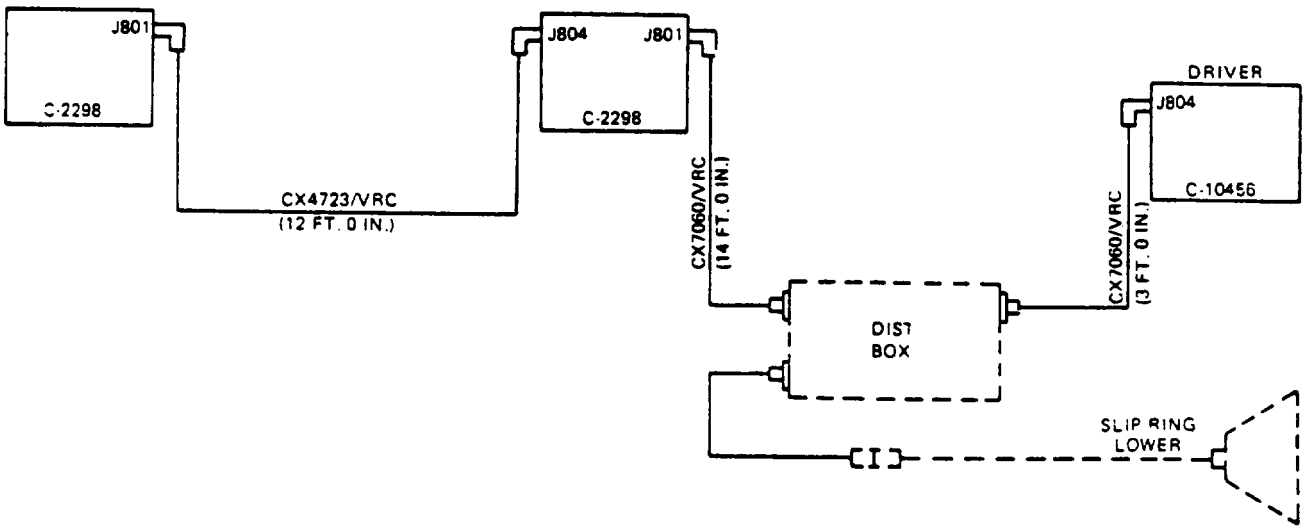
KY-57 General Configuration



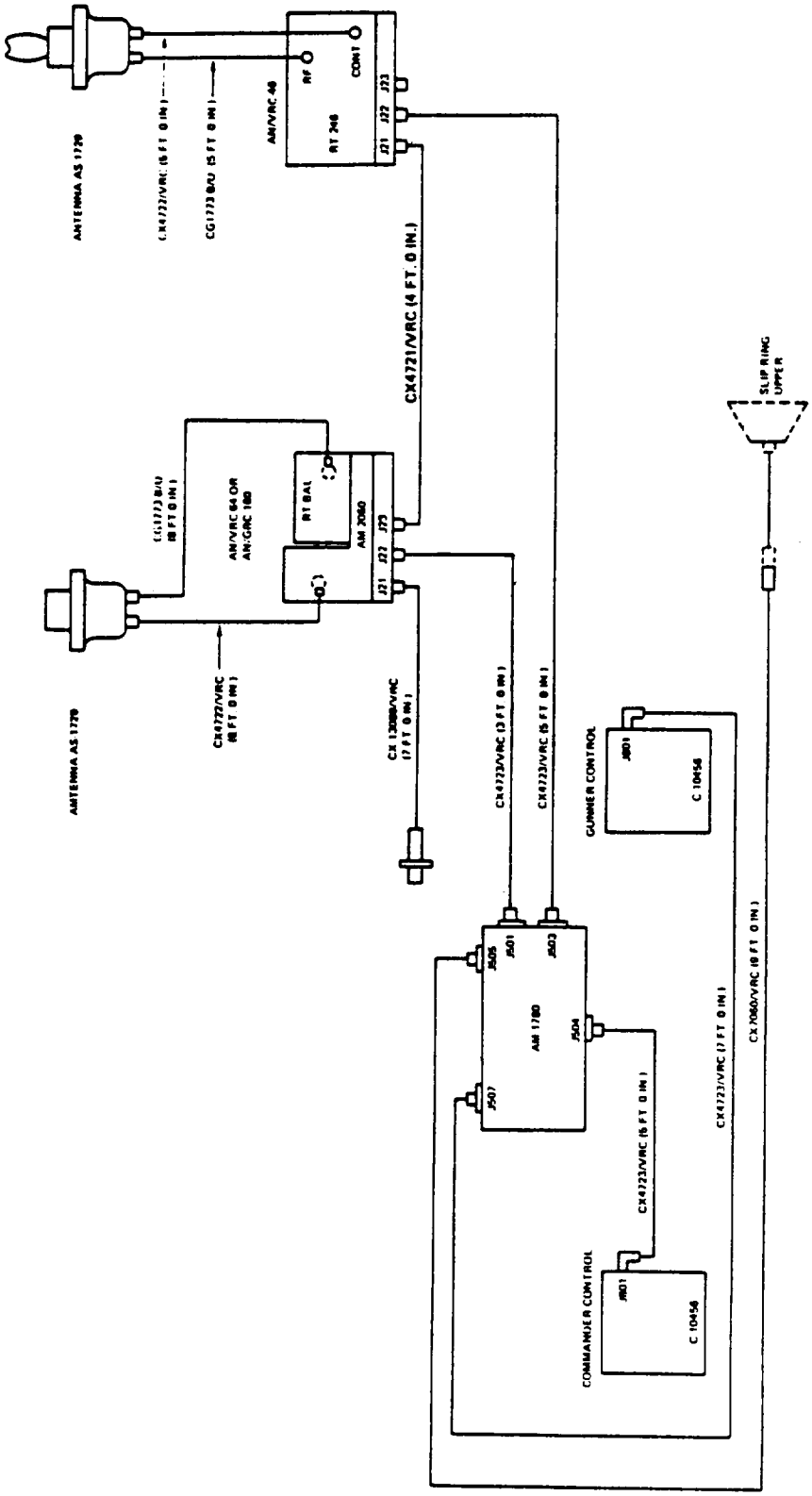
AN/VIC-l and AN/VRC-12 in M1 Tank



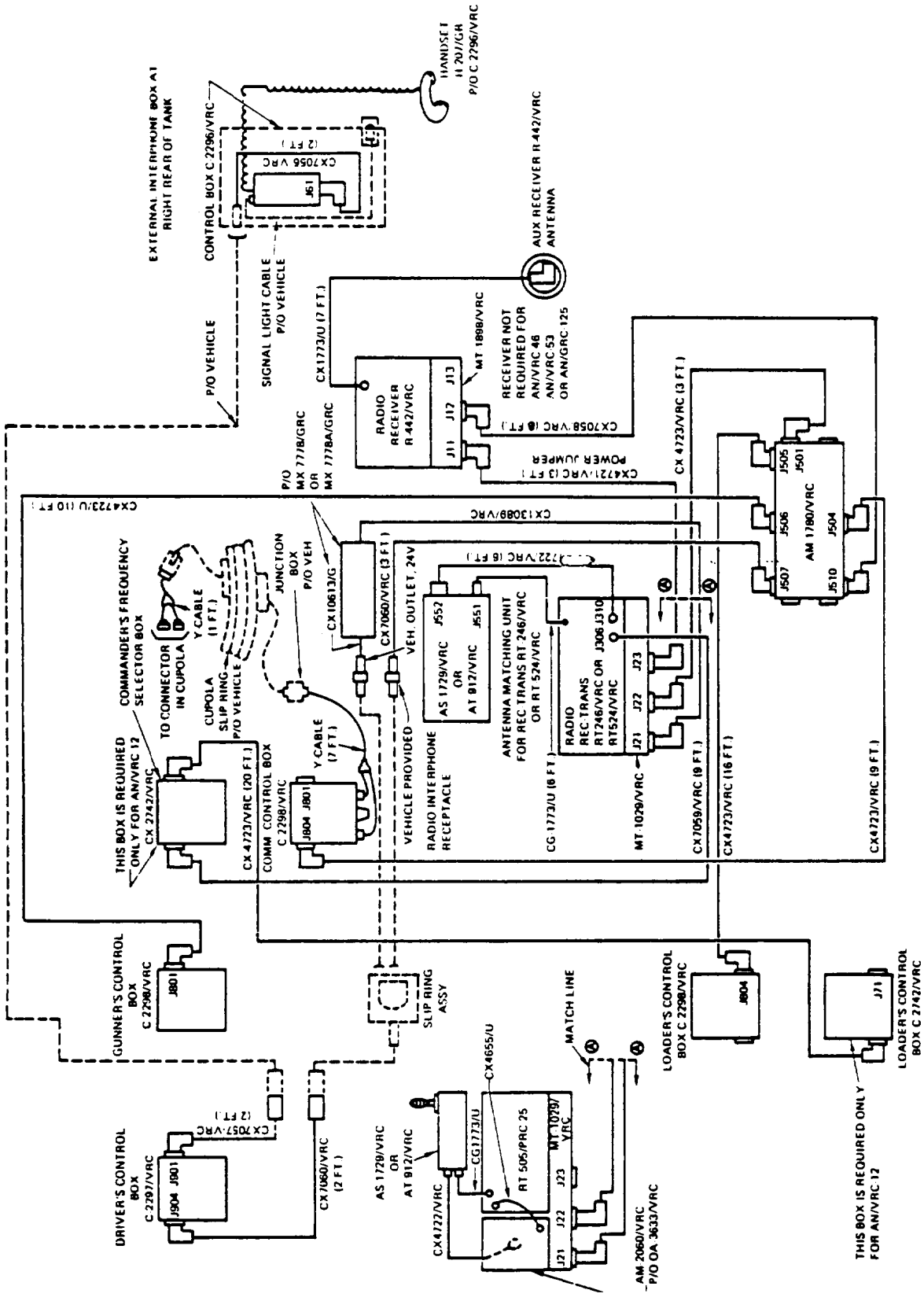
AN/VRC-46, AN/VRC-64, or Two AN/GRC-160% with AN/VIC-l in M2 (chassis)



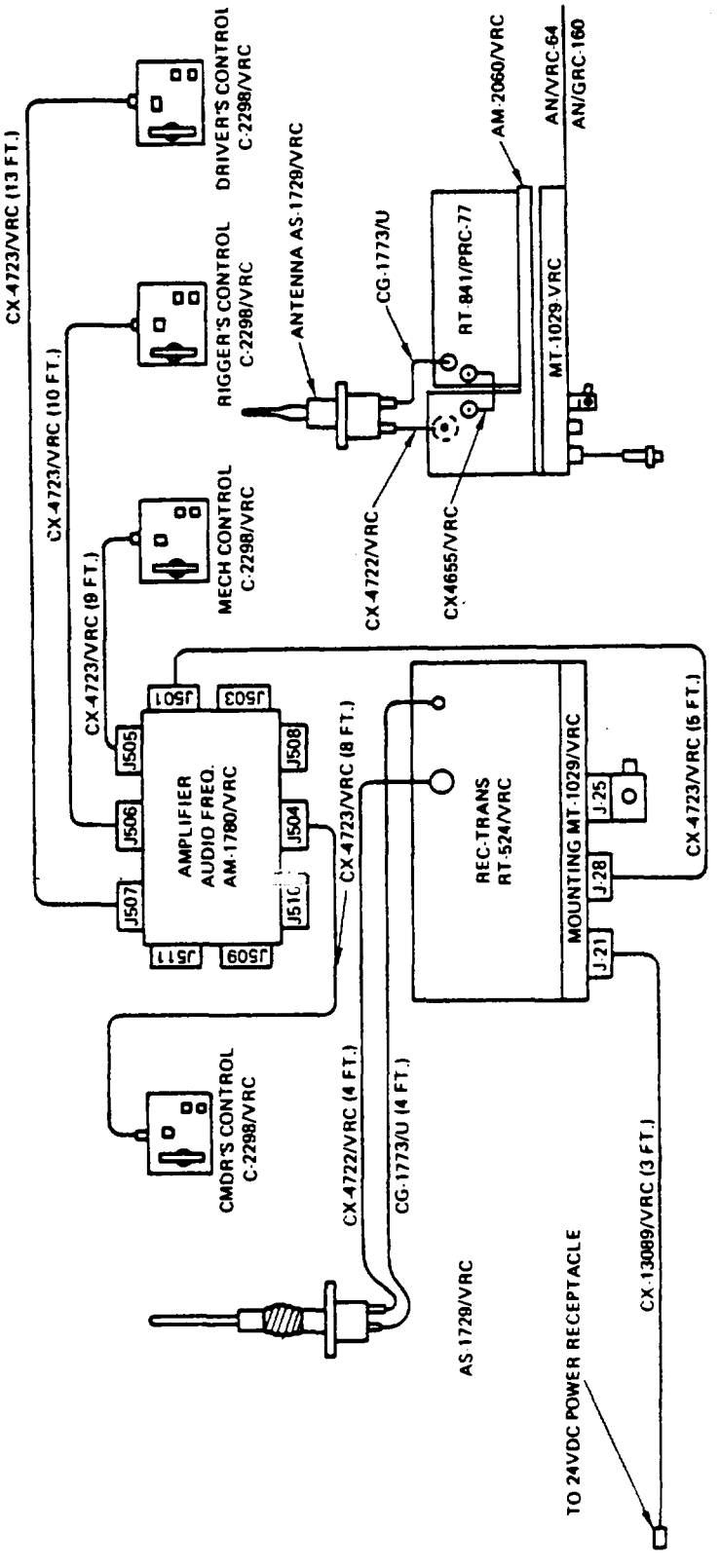
AN/VRC-46, AN/VRC-64, or Two AN/GRC-160% with AN/VIC-l in M3 (chassis)



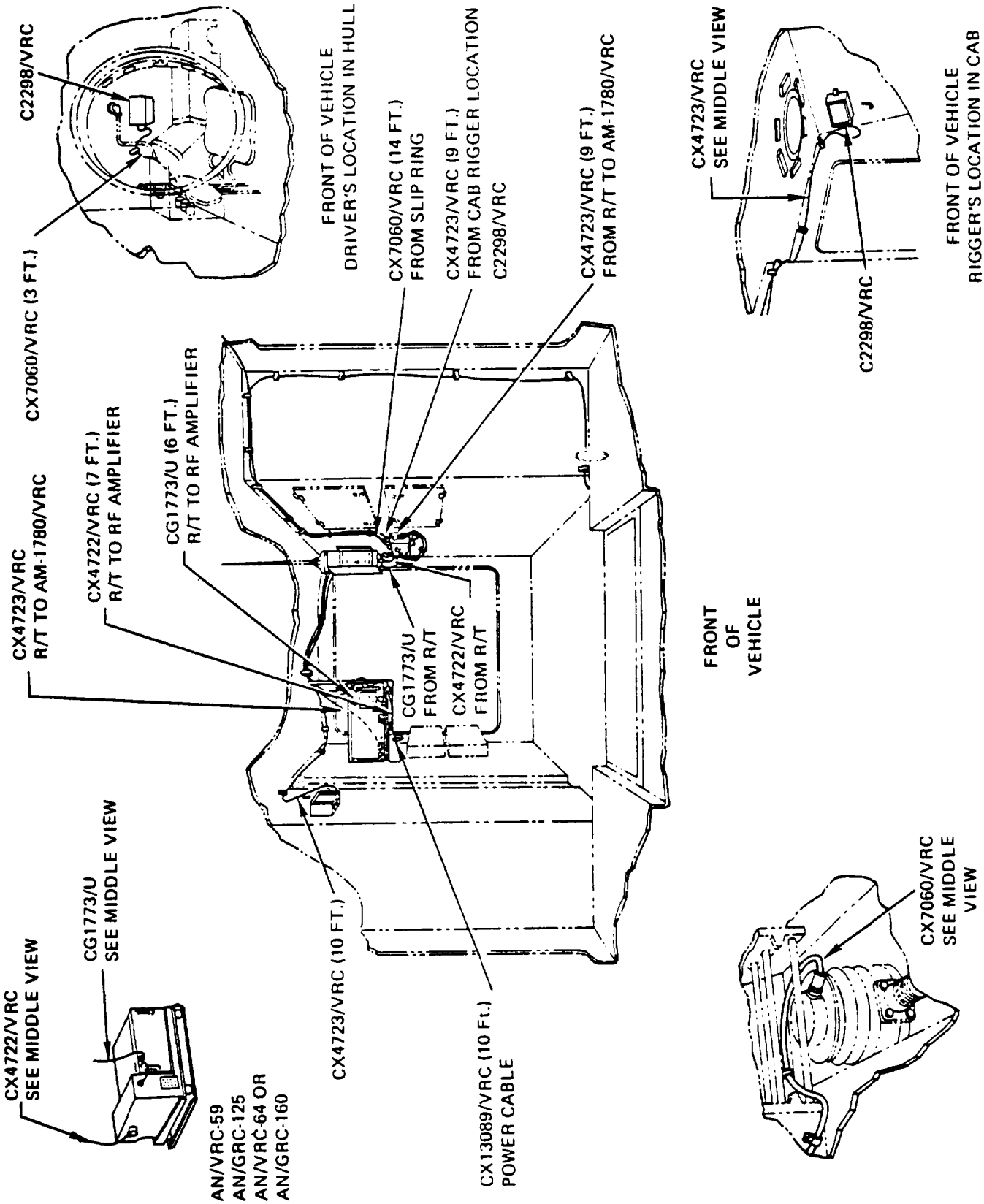
AN/VRC-46, AN/VRC-64, or Two AN/GRC-160's with AN/VIC-l in M2 and M3 (Turret)



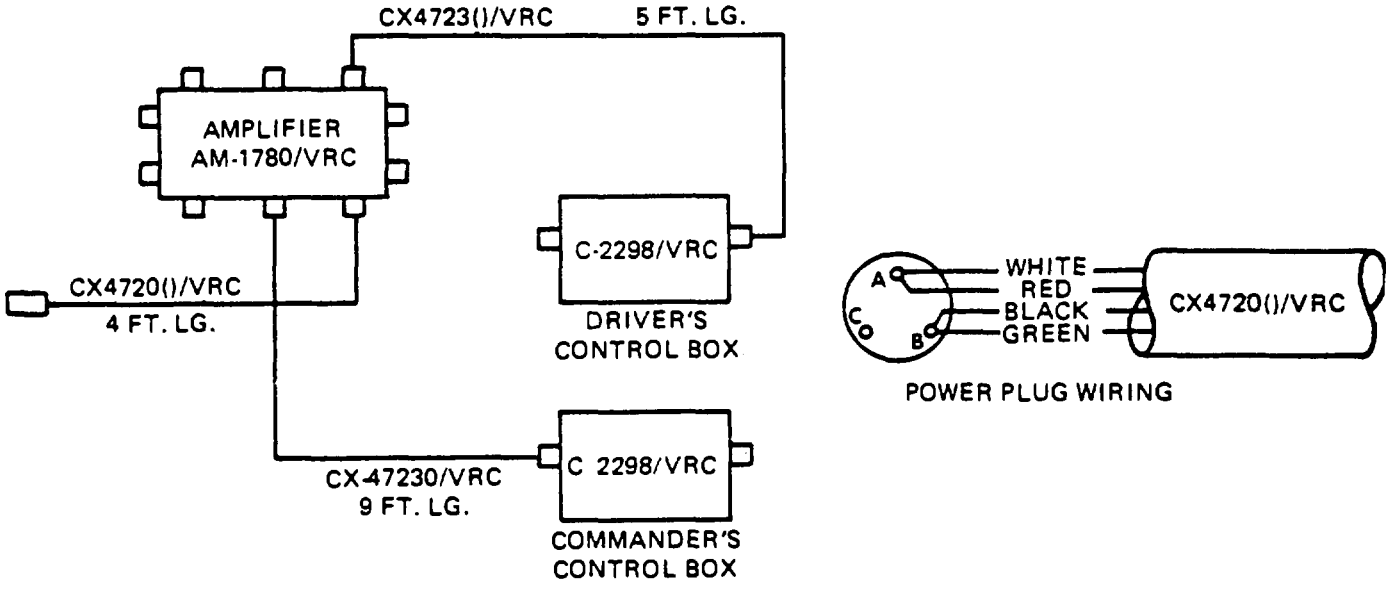
AN/VIC-1 and AN/VRC-12 in M60A1 Tank



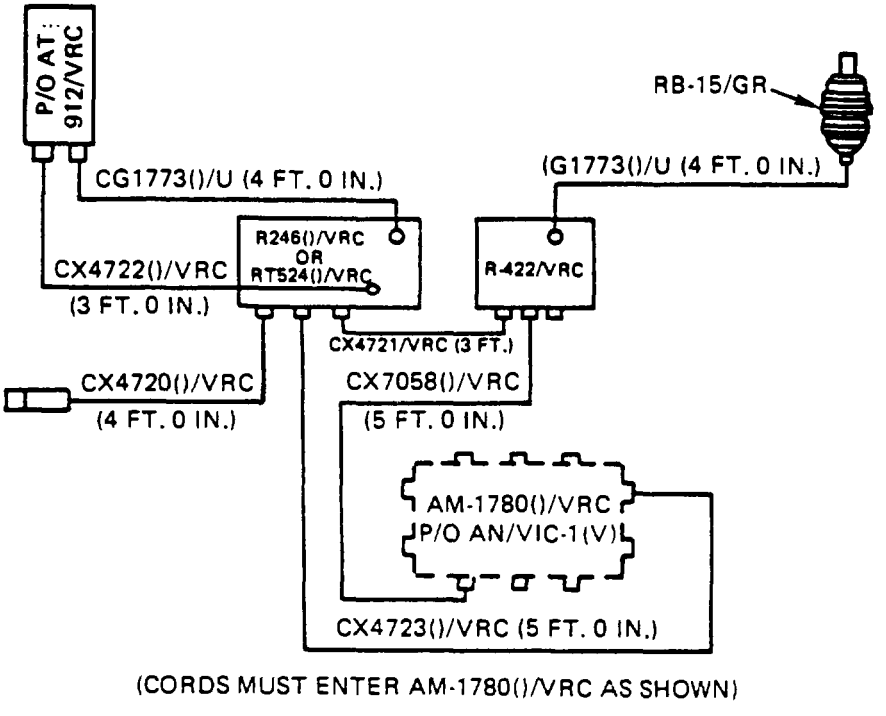
AN/VRC-46, AN/VRC-64, or AN/GRC-160 with AN/VIC-1 in M88A1



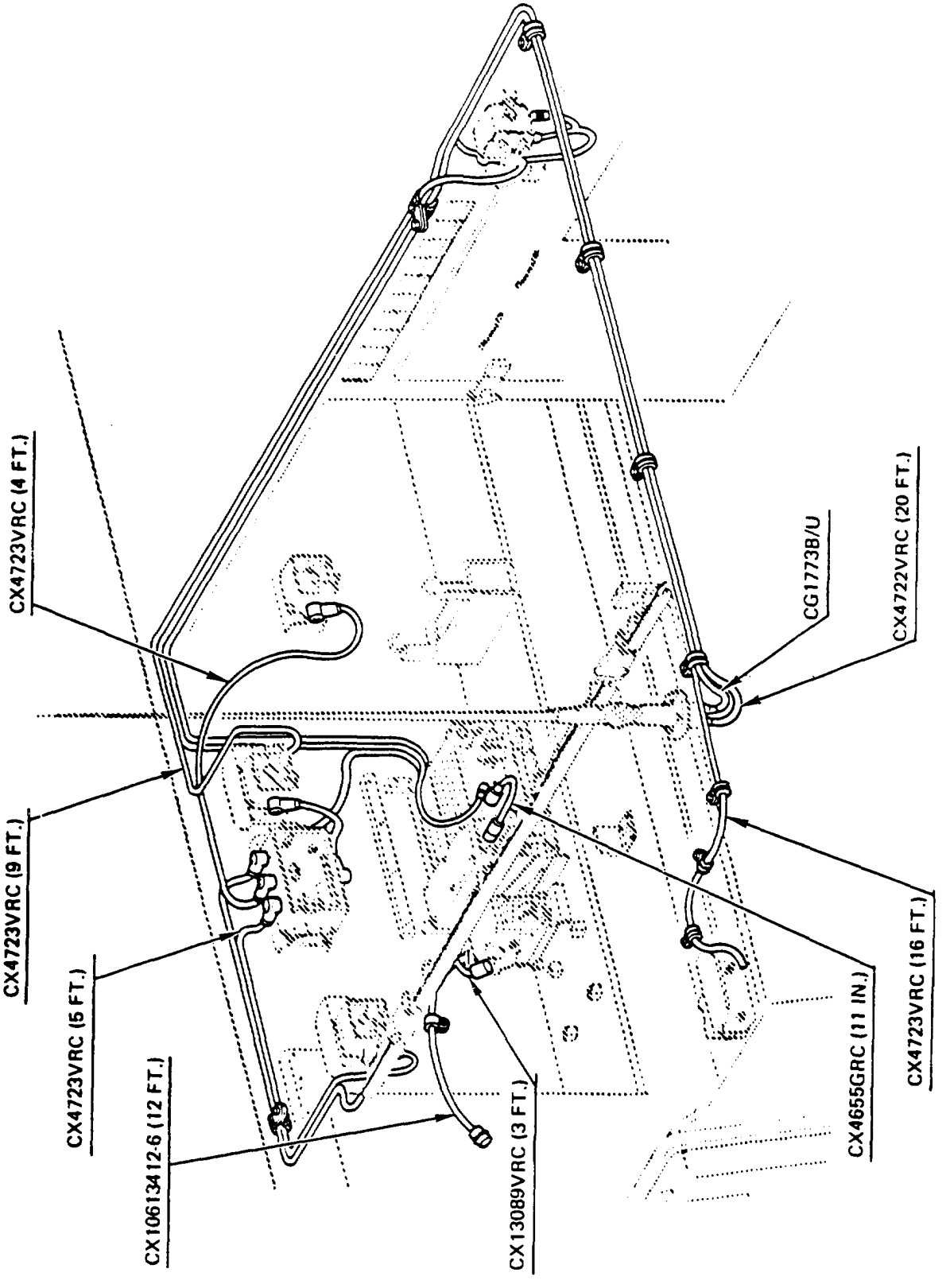
AN/VRC-46, AN/VRC-53, AN/GRC-125, AN/VRC-64, or AN/GRC-160 and AN/VIC-1 in M578



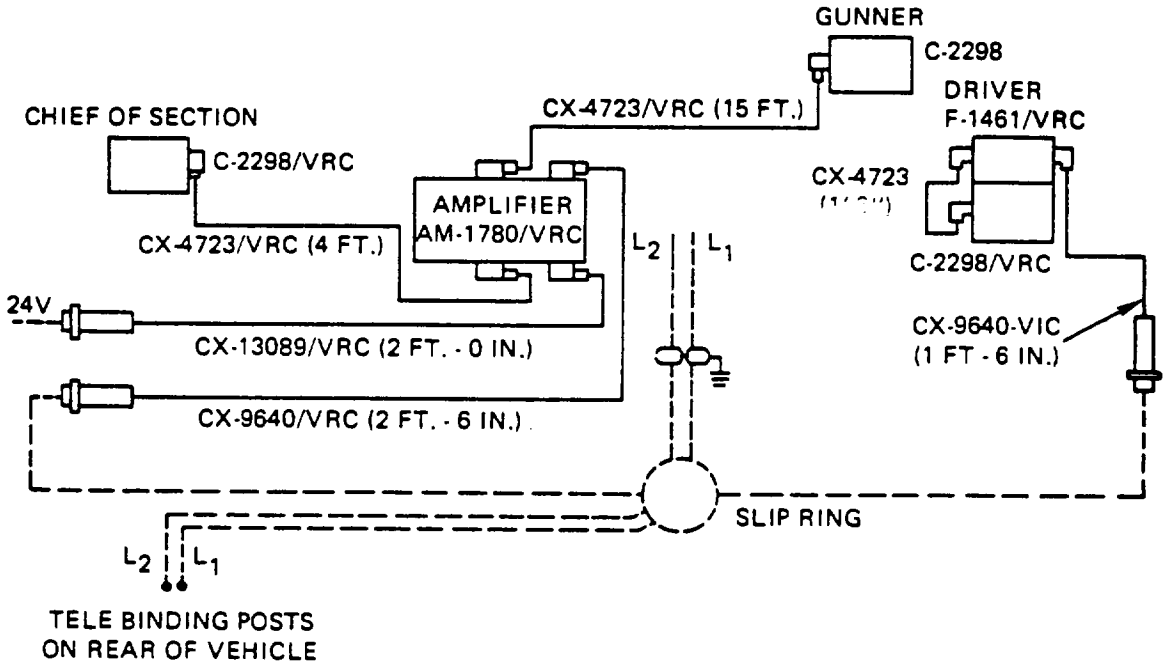
AN/VIC-l in M113 and M577



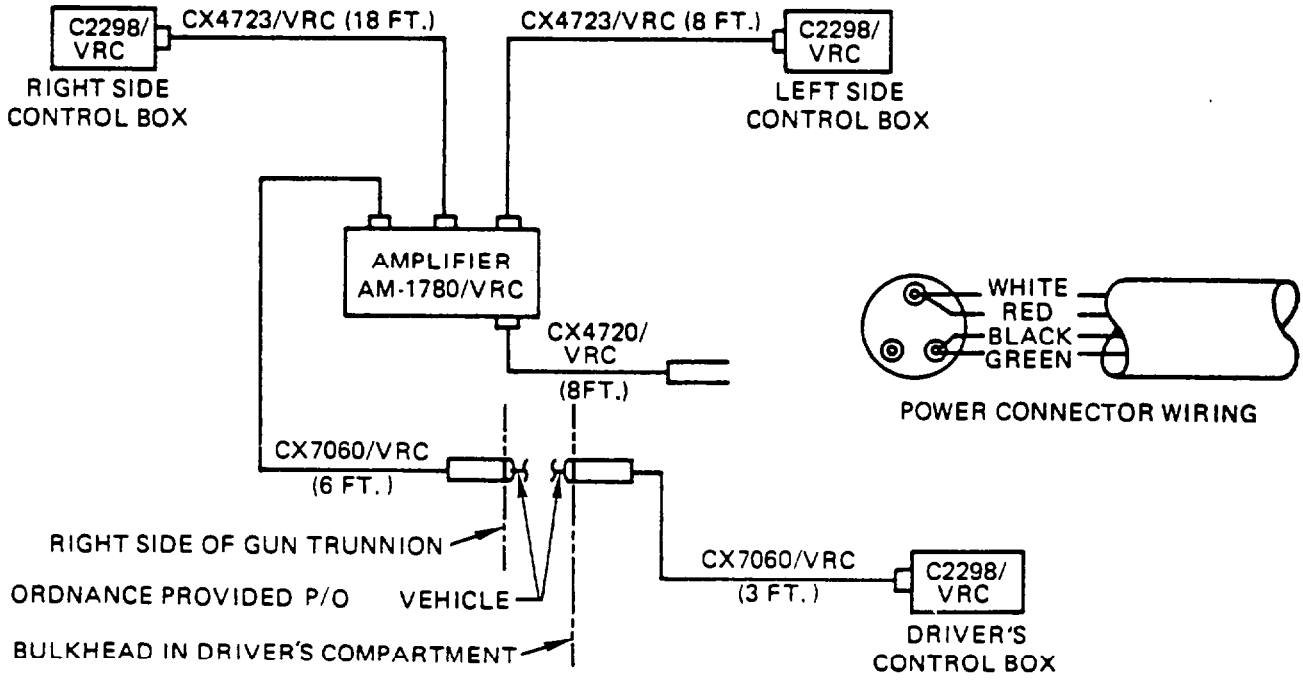
AN/VRC-12 in Ml13 Family



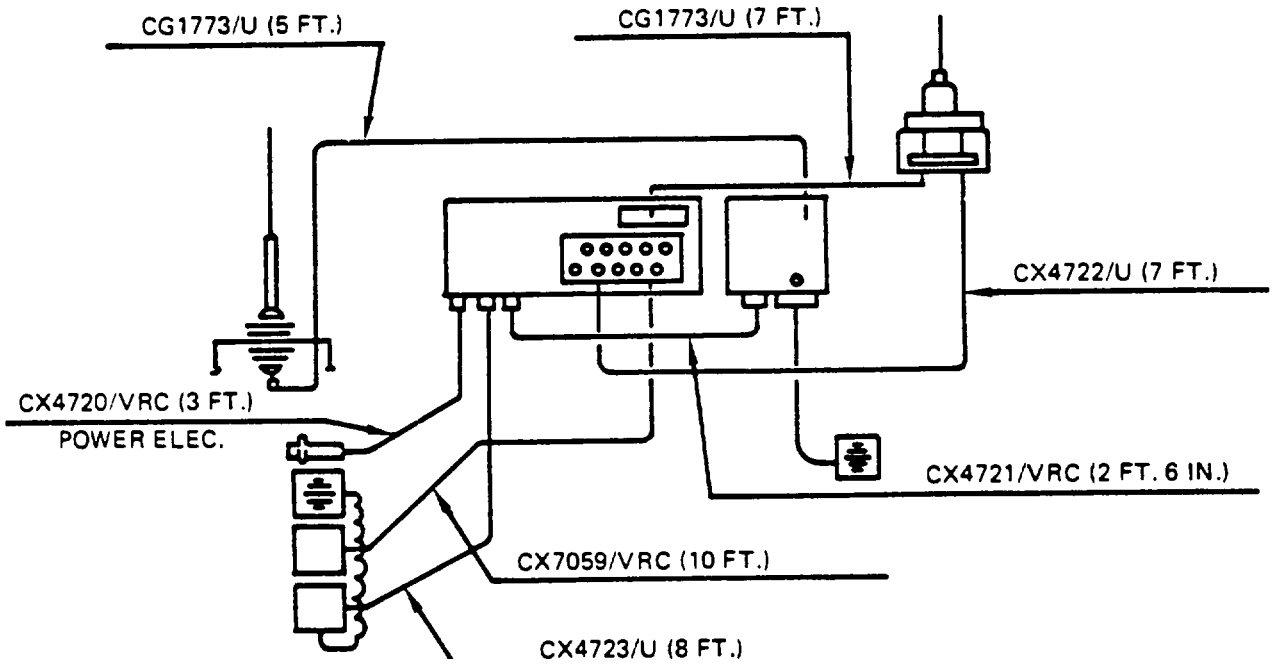
AN/GRC-160 and AN/VIC-1 in Improved TOW Vehicle M901



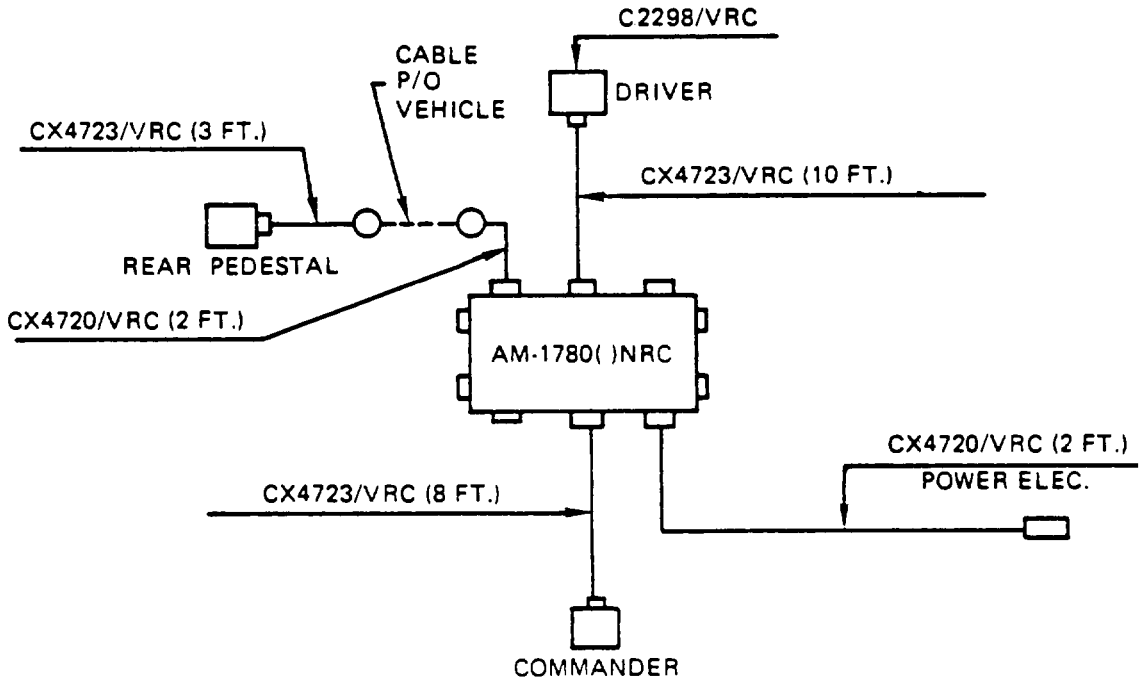
AN/VIC-l in M109A2 and M109A3



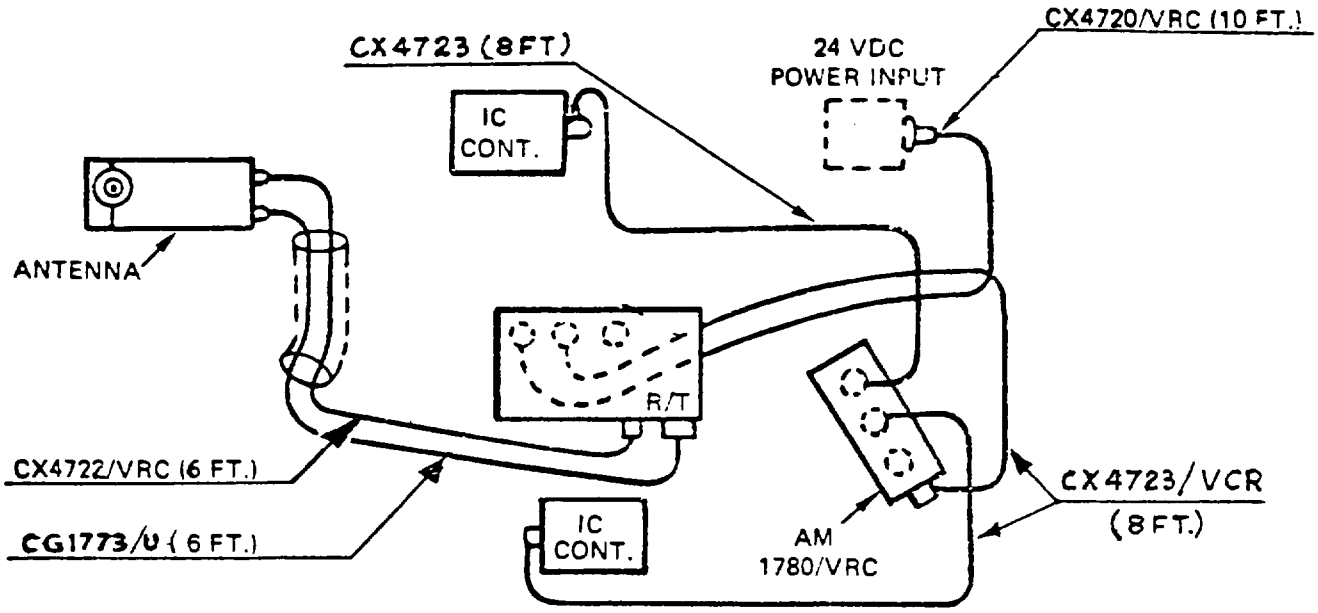
AN/VIC-l in M107 and M110



AN/VRC-12 in l/4-ton Truck, M151A1

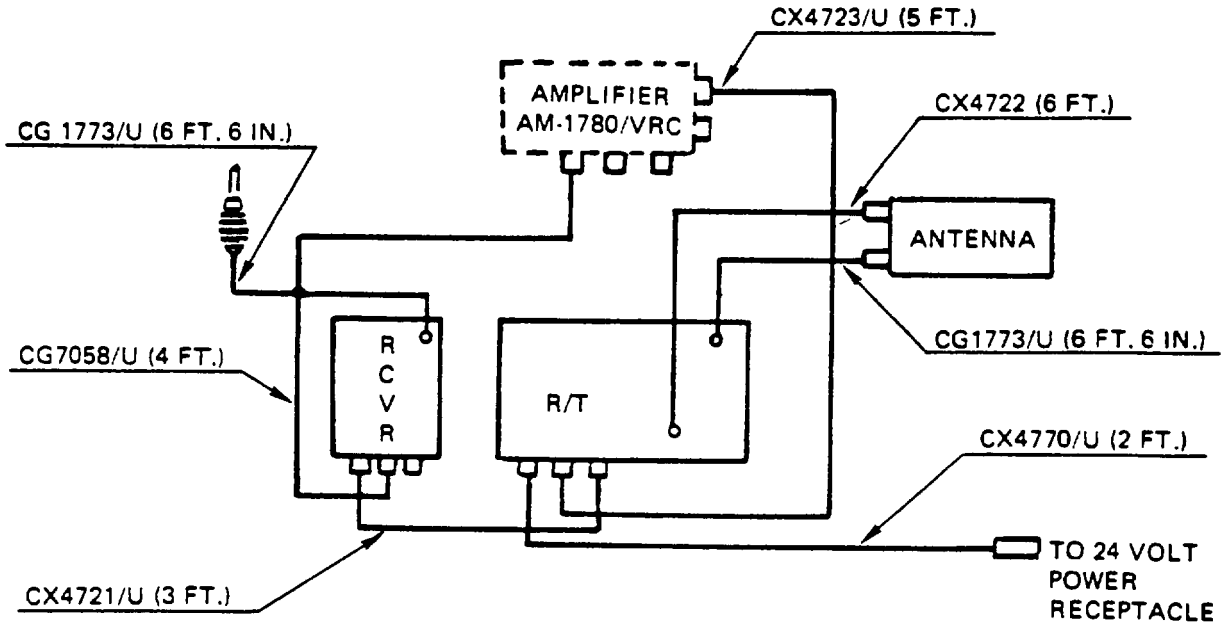


AN/VIC-1 in Mobile Floating Assault Bridge/Ferry

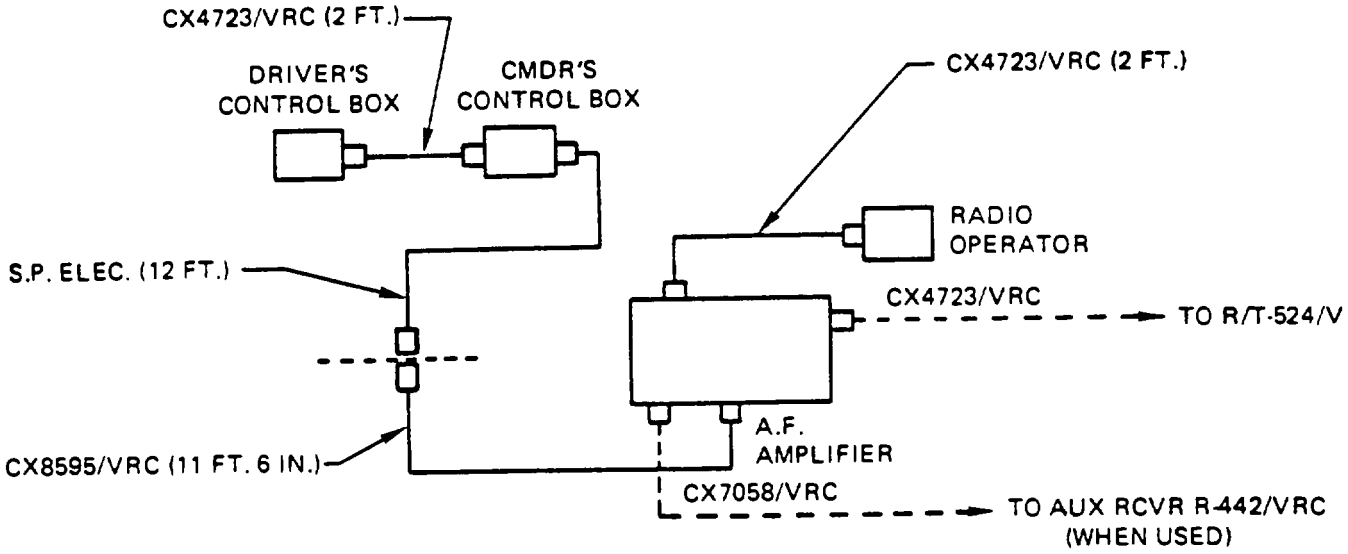


NOTE: THERE IS A 40 FT. AUDIO EXTENSION CABLE AND RF CABLE BETWEEN THE MX-6707 AND THE R/T.

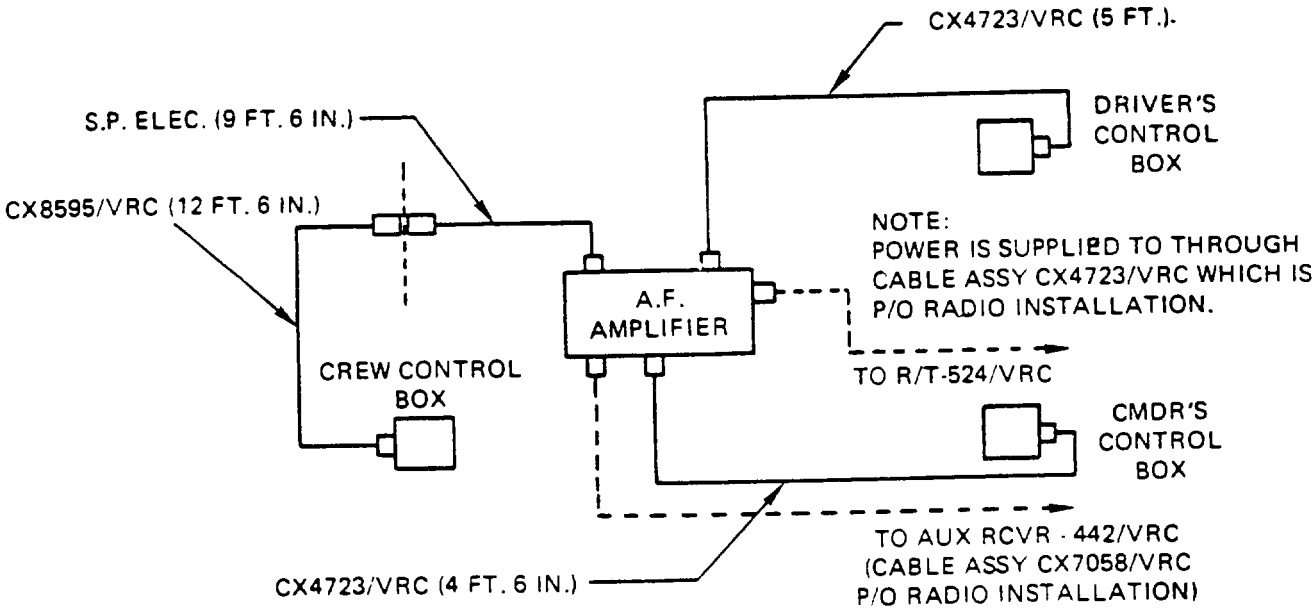
AN/VRC-12 and AN/VIC-l in AVLB (M60 Chassis)



AN/VRC-12 or AN/VRC-47 in M561



AN/VIC-l 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

BOAR 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, expendable supplies, and spares or repair parts from other systems which may be utilized for repairs on the M48/60 tank.

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	SOP. How M109	S.P. How M108	SOP. How M107	Lance
Japan			x				
New Zealand		x					
Pakistan	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	

TabIe A-3
Africa and Middle East

	Tank M60/M48 Family	M113 FOV	S.P. How M11O	S.P. How M109	SOP. How M108	S.P. How M107	Lance
Egypt	x	x					
Iran	x	x	x	x			
Ethopia		x		x			
Zaire		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					

SECTION III. Expendable Supplies

A-3 General.
This appendix lists items recommended for the support of the M 109 Howitzer 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 recommenced 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	o	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	o	5330-00-467-3615	Gasket, material, 1/32 in. (w.o.g. resistant)	sh

EXPENDABLE SUPPLIES AND MATERIALS - Continued

ITEM NUMBER	LEVEL	NSN	DESCRIPTION	u/I
16	o	4720-00-62 >-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	o	9650-00-26&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)	
27	MT	5320-00-510-7823	Rivet, pop, aluminum, AB4-2A 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	o	533-00-054-5273	Screen Wire Mesh 60 in. x 150 ft	roll

EXPENDABLE SUPPLIES AND MATERIALS - Continued

ITEM NUMBER	LEVEL	NSN	DESCRIPTION	U/I
31	o	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 AND MATERIALS - Continued

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

SECTION IV. Interchangeability Parts With Same NSN

A-4 General.

This section lists and cross-references by National Stock Number (NSN) and name weapon systems having these parts. Parts pertaining to the turret are listed in table A-4. Parts pertaining to the hull are listed in table A-5.

TABLE A-4

TURRET SPARES AND REPAIR PARTS

M48/60 PARTS		WEAPON SYSTEM									
NSN	Description	M2 M3 BFV	M39 A2 Series	M1 Tank	M88 Rec Veh	M109 S.P. How.	M110 S.P. How.	M113 Fov	M578 Rec Veh	M728 C.E.V.	M809 Series 5 Ton
1015-00-017-9244	Clamp, Retractor Breech			X							
6240-00-019-3102	Lamp, Incandescent			X							
1015-00-125-3927	Spring, Helical			X							
5315-00-135-9675	Pin, Shoulder Breech			X							
6145-00-144-0083	Wire, Electrical			X							
5330-00-171-6758	Retainer, Packing Accum.			X							
1015-00-191-9071	Plunger, Breech			X							
3110-00-198-0272	Bearing, Ball			X							
5360-00-201-1643	Spring, Helical Race			X							
2640-00-222-4525	Cap, Pneumatic Valve			X							
1015-00-235-4455	Bracket, Gun Mount			X							
5315-00-240-1008	Pin, Spring			X							
1015-00-329-1712	Collar, Breech Ring			X							
1025-00-443-4817	Piston, Hydraulic			X							
1025-00-512-1938	Cap, Accumulator			X							
5365-00-516-8043	Spacer Ring, Gun Mt.			X							
5305-00-518-8000	Setscrew, Gun			X							
5365-00-530-7968	Ring Retaining Trav. Mech.			X	X						
5340-00-543-3776	Plug, Expansion Breech			X							
3110-00-555-5233	Bearing, Ball			X							
2520-00-580-0126	Accum. Assy. Servo Mech. and Bkt. Assy.			X							
5365-00-597-4355	Ring, Retaining Elev. Acc.			X							
5315-00-616-4261	Pin, Spring			X							
5315-00-616-5526	Key, Woodruff (fan)			X							
5360-00-651-4075	Spring, Helical Torsion			X							
1015-00-678-3547	Retainer, Outer			X							
1015-00-678-4269	Plunger, Firing Breech			X							

TABLE A-4

TURRET SPARES AND REPAIR PARTS - Continued

M48/60 PARTS		WEAPON SYSTEM									
NSN	Description	M2 M3 BFV	M39 A2 Series	M1 Tank	M88 Rec Veh	M109 S.P. How.	M110 S.P. How.	M113 Fov	M578 Rec 5 Ton	M728 CEV	M809 Series
1015-00-678-4271	Conductor, Firing Breech			X							
1015-00-678-4274	Plunger, Closing Breech			X							
5315-00-678-4274	Pin, Straight Breech			X							
1015-00-678-4275	Retractor, Firing Pin			X							
1015-00-678-4276	Guide, Firing Pin			X							
1015-00-678-4278	Spring Adj. Plunger			X							
1015-00-678-4279	Plate, Firing Breech			X							
1015-00-678-4281	Clutch, Closing			X							
1015-00-678-4283	Spring, Closing Clutch			X							
5315-00-678-4286	Pin, Straight Breech			X							
5315-00-678-4287	Pin, Straight Breech			X							
5315-00-678-4290	Pin, Straight Breech			X							
1015-00-678-4291	Crank, Operating			X							
5305-00-678-4293	Set Screw, Cannon			X							
1015-00-678-4294	Shaft, Operating			X							
1015-00-678-4295	Adjuster, Closing			X							
1015-00-678-4298	Crank, Breech Block			X							
1015-00-678-4300	Stop, Breech Block			X							
1015-00-678-4305	Contact, Firing Breech			X							
3120-00-678-4306	Bushing, Sleeve Breech			X							
5365-00-678-4309	Spacer, Sleeve Breech			X							
5360-00-678-4310	Spring, Helical Breech			X							
5360-00-678-4318	Spring, Helical Breech			X							
5360-00-678-4319	Spring, Helical Breech			X							
5360-00-701-9574	Spring, Helical Gun Mt.			X							
5360-00-703-5517	Spring, Helical Gun Mt.			X							
5365-00-703-7928	Plug, Machinegun Mt.			X							
5365-00-720-8064	Ring, Retaining, CWS			X							
1015-00-723-7771	Plunger, Breech			X							
1015-00-723-7795	Plunger, Breech			X							

TABLE A-4

TURRET SPARES AND REPAIR PARTS - Continued

	M48/60 PARTS	WEAPON SYSTEM									
NSN	Description	M2 M3 BFV	M39 A2 Series	M1 Tank	M88 Rec Veh	M109 S.P. How.	M110 S.P. How.	M113 Fov	M578 Rec Veh	M728 CEV	M809 Series 5 Ton
5360-00-730-5828	Spring, Helical Breech			X							
1025-00-733-8195	Body, Air Valve			X							
1015-00-751-9144	Insert, Breech			X							
5365-00-754-1083	Ring, Retaining			X			X			X	
5365-00-796-9843	Bushing, Breech Mech.			X							
1015-00-769-9844	Plunger, Detent			X							
5365-00-776-7615	Ring, Retaining			X			X				
1015-00-791-6044	Retainer Assembly			X							
5360-00-798-5147	Spring, Helical Seat			X							
1015-00-799-2054	Lock Breech, Gun			X							
5360-00-799-3352	Spring, Helical Breech			X							
1025-00-801-6646	Fitting, Accumulator			X							
1025-00-801-6653	Fitting, Accumulator			X							
1015-00-802-7651	Key, Evacuator Lock			X							
5365-00-803-7305	Ring, Retaining, Gun Mt.			X							
5365-00-803-7313	Ring, Retaining, Trav. Mech.			X							
5365-00-803-7315	Ring, Retaining			X							
5365-00-804-2025	Ring, Retaining, CWS			X							
5365-00-803-7317	Ring, Retaining			X	X					X	
5315-00-805-6875	Pin, Straight			X							
5340-00-809-1490	Clamp, Loop			X							
5340-00-809-1492	Clamp, Loop			X							
5315-00-810-3701	Pin, Spring			X							
5315-00-810-3702	Pin, Straight			X							
5315-00-814-3530	Pin, Straight			X							
5315-00-814-3531	Pin, Straight			X							
1025-00-820-3198	Detent, Breech			X							
5365-00-842-7854	Ring, Retaining						X			X	
5315-00-844-3956	Pin, Spring			X							

TABLE A-4

TURRET SPARES AND REPAIR PARTS - Continued

	M48/60 PARTS	WEAPON SYSTEM									
NSN	Description	M2 M3 BFV	M39 A2 Series	M1 Tank	M88 Rev Veh	M109 S.P. How.	M110 S.P. How.	M113 Fov	M578 Rec Veh	M728 CEV	M809 Series 5 Ton
5315-00-844-3966	Pin, Spring			X							
5315-00-844-3958	Pin, Spring			X							
5360-00-857-9744	Spring, Helical CWS			X							
1015-00-887-1406	Driver, Firing Pin			X							
5315-00-895-9169	Pin, Straight, Gun Mount			X							
1015-00-968-6328	Plug, Index			X							
1015-00-968-6329	Cam, Breech Operating			X							
2520-00-972-2651	Kit, Parts Accumulator			X							
5315-01-048-6696	Pin, Straight			X							
1015-01-077-1524	Guide, Sleeve			X							
1015-01-079-2961	Spring Assembly, Breech			X							
1015-01-090-8044	Chamber Assembly, Evacuator			X							
1015-01-092-9085	Tube, Cannon			X							
5365-01-K00-2500	Ring, Retaining			X							

TABLE A-5

HULL SPARES AND REPAIR PARTS

M48/60 PARTS		WEAPON SYSTEM									
NSN	Description	M2 M3 BFV	M39 A2 Series	M1 Tank	M88 Rec Veh	M109 S.P. How.	M110 S.P. How.	M113 Fov	M578 Rec Veh	M728 Cev	M809 Series 5 Ton
5315-00-014-1283	Pin, Straight, Headless			X	X					X	
2530-00-015-2774	Spacer, Hub Track			X	X					X	
4730-00-018-9566	Plug, Pipe	X		X	X	X	X		X	X	X
2920-00-034-4216	Shaft, Shouldered									X	
4730-00-050-4203	Fitting, Lubrication			X							
4730-00-050-4208	Fitting, Lubrication			X							
5340-00-057-3537	Clevis, Road End			X							
2530-00-063-5824	Roadwheel Assembly			X	X						
4730-00-080-9847	Adapter, Straight				X	X	X		X		
5340-00-088-1254	Clamp, Loop			X							X
5340-00-088-6655	Clamp, Loop			X							
2920-00-088-8613	Motor, Field Winding										X
4820-00-093-3756	Valve, Check	X							X		
3110-00-100-0337	Cup			X							
3110-00-100-0593	Cup			X							
3110-00-100-0684	Cone			X							
2920-00-100-3403	Kit, Part Electrical				X						
3110-00-100-3617	Cone,			X							
3110-00-100-4194	Roadwheel Hub Assembly Cone and Cup			X							
3110-00-100-5377	Bearing, Support Roller			X							
3110-00-100-6147	Bearing, Ball			X				X	X	X	
5940-00-143-4777	Terminal Lug			X							
3110-00-157-0531	Bearing, Roller			X			X		X		
3110-00-157-0535	Bearing, Needle			X			X		X		
5935-00-163-7116	Connector, Plug	X						X			

TABLE A-5

HULL SPARES AND REPAIR PARTS - Continued

M48/60 PARTS		WEAPON SYSTEM									
NSN	Description	M2 M3 BFV	M39 A2 Series	M1 Tank	M88 Rec Veh	M109 S.P. How.	M110 S.P. How.	M113 Fov	M578 Rec Veh	M728 CEV	M809 Series 5 Ton
5340-00-177-3957	Clevis Rod End						X			X	X
3110-00-180-7117	Bearing, Roller			X				X			
3110-00-183-6912	Bearing, Ball Annular			X						X	
5935-00-189-2538	Connector, Plug	X									
4730-00-221-1889	Manifold, Fuel			X							
3110-00-227-3249	Bearing, Roller Needle			X			X				
5945-00-232-5773	Relay, Eletromagnetic	X		X		X				X	
6105-00-234-1278	Motor, D.C.			X							
5930-00-234-1390	Switch, Thermostatic				X						
2540-00-237-3693	Latch, Pintle Hook				X						
6645-00-255-1370	Meter Time							X			
4810-00-269-8221	Valve, Fuel Regulator				X	X					
4730-00-287-3279	Plug, Pipe	X			X		X	X	X		
4730-00-289-5176	Plug, Pipe			X	X	X	X	X	X	X	
5925-00-295-5492	Circuit Breaker			X							
4820-00-301-7395	Valve			X							
4820-00-301-7375	Valve, Angle			X							
4730-00-329-9659	Tube, Reducer			X							
5940-00-399-6676	Terminal Assembly			X	X						
5935-00-407-5469	Connector, Plug	X									
4730-00-448-5223	Elbow, Tube-to-Boss			X							
4730-00-472-9938	Pipe, Elbow			X							
4810-00-487-2775	Valve, Solenoid			X	X					X	
5935-00-493-6424	Connector, Plug							X			
2540-00-508-0126	Accumulator				X						
5935-00-518-3576	Connector, Plug	X						X			X
5305-00-518-8000	Set Screw, Gun			X							

TABLE A-5

HULL SPARES AND REPAIR PARTS - Continued

M48/60 PARTS		WEAPON SYSTEM									
NSN	Description	M2 M3 BFV	M39 A2 Series	M1 Tank	M88 Rec Veh	M109 S.P. How.	M110 S.P. How.	M113 Fov	M578 Rec Veh	M728 CEV	M809 Series 5 Ton
4820-00-535-6483	Valve, Pneumatic				X						X
3110-00-554-2733	Bearing, Ball Annular			X							
4730-00-595-1884	Pipe, Plug			X		X		X			
5365-00-598-0942	Ring, Retaining				X						
5940-00-599-6581	Adapter, Batt. Term.			X							
2580-00-602-5743	Retainer, Oil Seal				X						
5315-00-616-5520	Key, Woodruff						X		X		X
2910-00-620-0399	Cap, Fuel Tank Retaining			X							
5305-00-678-4293	Set Screw, Cannon			X							
2590-00-679-0478	Kit, Drain Valve			X	X						
4730-00-720-0231	Tube, Reducer			X							
5935-00-728-6769	Connector, Plug	X	X					X			
5316-00-737-3455	Pin, Straight Headless			X			X	X	X		
5360-00-752-1425	Spring, Helical Comp.			X			X	X	X		
5935-00-759-8574	Connector, Receptacle	X						X			
5310-00-770-8035	Nut, Sleeve			X	X		X		X	X	
5935-00-785-7156	Connector, Receptacle	X						X	X	X	
5365-00-803-7303	Ring, Retaining							X	X	X	
5365-00-803-7305	Ring, Retaining				X			X			
5365-00-803-7317	Ring, Retaining			X						X	
2815-00-808-2421	Element, Filter			X							
4730-00-808-5089	Adapter, Straight Pipe			X							
2540-00-821-2277	Latch, Pintle Hood				X						
2920-00-822-2287	Plunger Assembly				X					X	
4820-00-835-9814	Valve, Check	X							X		
5365-00-838-8049	Ring, Retaining							X			
5925-00-840-5393	Circuit Breaker	X		X				X		X	
3110-00-841-1504	Bearing, Roller Cylinder					X		X			

TABLE A-5

HULL SPARES AND REPAIR PARTS - Continued

M48/60		WEAPON SYSTEM									
NSN	Description	M2 M3 BFV	M39 A2 Series	M1 Tank	M88 Rec Veh	M109 S.P. How.	M110 S.P. How.	M113 Fov	M578 Rec Veh	M728 CEV	M809 Series 5 Ton
5945-00-840-5393	Circuit Breaker			X						X	
3110-00-851-4276	Bearing, Roller Needle			X			X				
5935-00-852-9611	Connector, Receptacle			X							
3110-00-871-2832	Bearing, Roller Needle							X			
3110-00-882-3822	Bearing, Roller					X		X			
2920-00-888-8613	Motor, Field Winding									X	
4730-00-892-5348	Elbow, Pipe to Tube									X	
5330-00-900-8006	Seal, Rubber Special			X							
4730-00-908-3193	Clamp, Hose			X							
4730-00-908-6269	Clamp, Hose			X							
4730-00-908-8593	Adapter, Straight Head			X							
4730-00-935-1643	Coupling, Half Quick Dis.			X							
5940-00-981-1574	Relay, HNB K5, 9, 10, 18	X					X				X
5945-00-981-1574	Relay	X					X				
4730-01-030-4930	Plug, Pipe			X							
4730-01-030-4950	Plug, Pipe			X							
4810-01-035-6274	Valve, Regulating			X							
4730-01-047-3243	Coupling, Assy Quick Dis.			X							
4820-01-053-4866	Cock, Drain		X	X	X					X	X
5930-01-059-0117	Connector, Receptacle			X		X				X	
4820-01-070-7670	Valve, Safety Relief			X	X						
5945-01-096-0375	Relay 2A/01 K2	X									
2590-01-097-3342	Regulator, Voltage			X							
6110-01-097-3342	Voltage Regulator			X							
2590-01-102-6857	Ignition Control			X							
2920-01-109-4609	Cover, Access	X									
4820-01-135-4914	Valve, Globe			X							
2920-01-140-0116	Contact Assembly, Fuel				X						

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. General.

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).

SECTION II. Tools

TOOLS

ITEM NUMBER	LEVEL	NSN	DESCRIPTION
1	c	5110-00-277-4591	Blade, hand hancksaw: 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, hard 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: Irnd nose w/cutter, 6 in.

TOOLS - Continued

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 hall, 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	o	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
			Opening, In.
26	c	5120-00-237-0982	Socket, socket wrench, 3/8 sq dr, 12 pt opening, regular length
27	c	5120-00-189-7924	Socket, socket wrench, 7/16 sq dr, 12 pt opening, regular length
28	c	5120-00-237-0984	Socket, socket wrench, 1/2 sq dr, 12 pt opening, regular length
29	c	5120-00-189-7932	Socket, socket wrench, 9/16 sq dr, 12 pt opening, regular length
30	c	5120-00-189-7946	Socket, socket wrench, 5/8 sq dr, 12 pt opening, regular length

TOOLS - Continued

ITEM NUMBER	LEVEL	NSN	DESCRIPTION
			Opening, In. - Continued
31	c	5120-00-235-5870	Socket, socket wrench, 11/16 sq dr, 12 pt opening, regular length
32	c	5120-00-189-7985	Socket, socket wrench, 3/4 sq dr, 12 pt opening, regular length
33	c	5120-00-189-7933	Socket, socket wrench, 13/16 sq dr, 12 pt opening, regular length
34	c	5120-00-189-7934	Socket, socket wrench, 7/8 sq dr, 12 pt opening, regular length
35	c	5120-00-189-7935	Socket, socket wrench, 15/ 16 sq dr, 12 pt opening, regular length
36	c	5120-00-189-7927	Socket, socket wrench, 1 sq dr, 12 pt opening, regular length
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 in. lg, 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, sraight bar hex: PN 12284998
44	c	5120-00-240-5328	Wrench, adjustable: 8 in.

TOOLS - Continued

ITEM NUMBER	LEVEL	NSN	DESCRIPTION
			Opening, In. - Continued
45	c	5120-00-277-4244	Wrench, plier: straight jaw, 8-1/2 in.
46	c	5120-00-148-7917	Wrench Set, combination box with open end, 12 components, 5/16 in. - 1 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

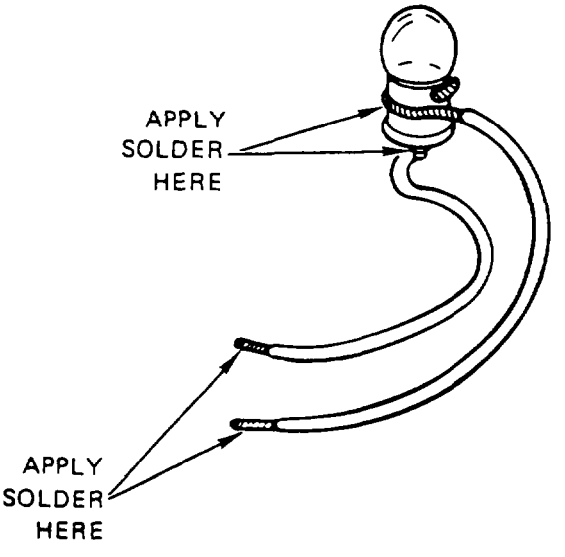
Sometimes, in the process of assessing the battlefield damage, it is necessary to make voltage and resistance measurements to determine where the fault is. Standard test equipment (voltmeter, ohmmeter, SWR meter, etc.) should be used whenever possible. If standard test equipment is not available, field 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.

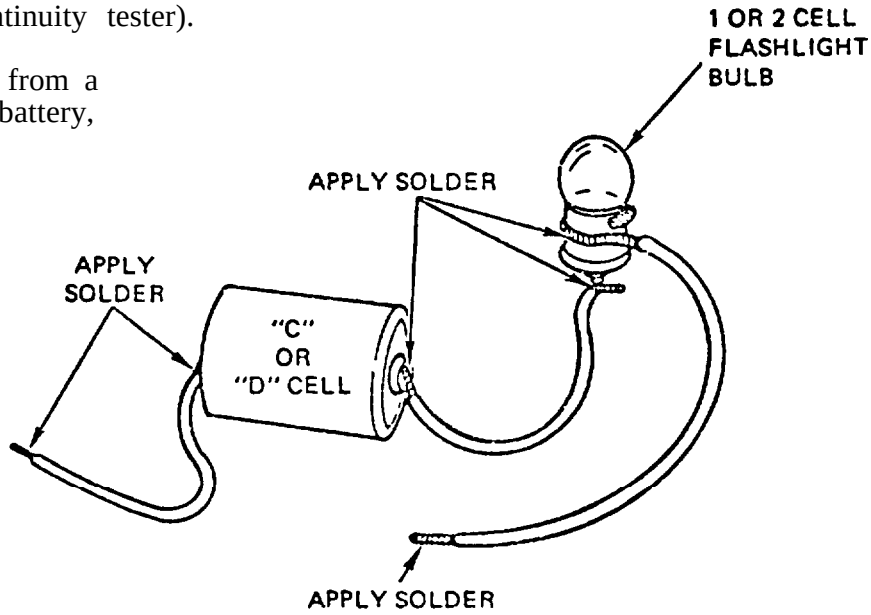
A voltmeter can be made from a light bulb and two pieces of wire. The pieces of wire can be connected to the case and center terminal of the bulb by means of solder, twisting, or simply holding the wire ends against the bulb (see illustration). The voltage rating of the bulb should be close to the value 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 to voltage source when ready to make measurement.



FIELD EXPEDIENT TEST EQUIPMENT (CONT):

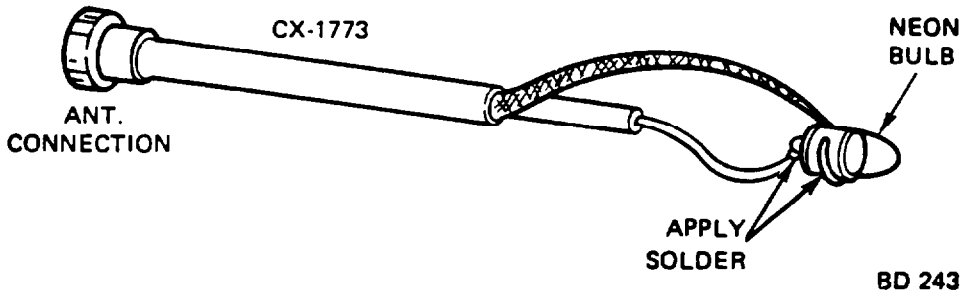
2. Making an Ohmmeter (continuity tester).

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/4-inch to l/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 (Cent}

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.

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 Step

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.

APPENDIX C

PETROLEUM, OIL AND LUBRICANT (POL) SUBSTITUTES FOR DIESEL ENGINES

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 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) B1ending in 55 Gallon Drums. Add the blending fuel directly into a drum and mix by rolling the drum.

(3) B1ending 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.

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) (l-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 (Avaiation Turbine Fuel)
3. ASTM-D-1655 (Aviation Turbine Fuel) (Jet B)
4. NATO-F-44 (Aviation Turbine Fuel)
5. MIL-T-83133 (Avaition Turbine Fuel) (JP-4)
6. NATO-F-34 (Aviation Turbine Fuel)
7. ASTM-D-1655 (Aviation Turbine) (Jet A-1)
8. ASTM-D-2880 (Turbine Fuel) (0-GT, 1-GT, 2-GT, 3-GT, 4-GT)
9. MIL-F-16884 (Marine Diesel) (DFM)
10. NATO-F-76 (Navy Distilate Fuel)
11. MIL-F-815 (Navy Distilate) (FO-1 & FO-2)
12. NATO-F-75 (Navy Distilate) (Low Pour Point)
13. ASTM-D-396 (Fuel Oil) (No. 1 & 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 (Emergent y) 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 through charcoal or cloth. Any significant quantity of water must be removed.
6.	Any Alternate Fuel	Used engine oil	

* *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)

Lubrication Point	Temp. Range	LO Authorized				Alternates			Incompatible or Ineffective Fluids	Notes
		LO Ref (Grd #)	Lube	US Specification	NATO Product	US Spec or Use Equiv NATO Prod	Soviet	Expedient		
Engine	Above 32°F +40°F to -10°F 0°F to -65°F	2	OE/HDO-30 OE/HDO-10 OEA	MIL-L-2109 MIL-L-2104 MIL-L-46167	O-238/739 O-238/739 O-183			Nearest grade of MIL-L-2104 or MIL-L-46167		
Transmission	Above 32°F +40°F to -10°F 0°F to -65°F	2	OE/HDO-30 OE/HDO-10 OEA	MIL-L-2104 MIL-L-2104 MIL-L-46167	O-238/739 O-238/739 O-183			Any Hydraulic Fluid Turbine Oils		
Final Drive Universal Joints	All	3	GAA	MIL-G-10924	G-403	MIL-L-2105		Vegetable or animal fat (Peanut Butter, Butter, Cooking Oil, etc.)		
Hydraulic Brake Master Cylinder	Above 32°F +40°F to -10°F 0°F to -65°F	3	HB HB HBA	VV-B-680 VV-B-680 MIL-H-13910						
Final Drive	Above 32°F +40°F to -10°F 0°F to -65°F	1	OE/HDO-50 OE/HDO-30 OEA	MIL-L-2104 MIL-L-2104 MIL-L-46167	O-238/739 O-238/739 O-183		M-8GI, M-10 GI, M-8V M-10V, M-8A, M-10A, AS-9, AS-10, AS-11	Any Hydraulic Fluid Turbine Oils		
Hydraulic Power Pack	All	4	OHT	MIL-H-6083D	C-635	MIL-H-5606 (NATO H-515) MIL-H-46170 (NATO H-549)		Commercial Heavy Transmission Fluid		
Backlash Assembly (with AOS only)	All	4	GAI	MIL-G-23827		MIL-G-10924				
Traversing Gear Box	Above 32°F +40°F to -10°F 0°F to -65°F	4	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		

Lubrication Point	Temp. Range	LO Authorized				Alternates			Incompatible or Ineffective Fluids	Notes
		LO Ref (Grd #)	Lube	US Specification	NATO Product	US Spec or Use Equiv NATO Prod	Soviet	Expedient		
Turret Support Bearings	All	4	GAA	MIL-G-10924	G-403	MIL-G-23827	See Above	MIL-L-2105 (See Above)		
Turret Traversing Ring and Pinion Gear	All	4	GAA	MIL-G-10924	G-403	MIL-G-23827	See Above	MIL-L-2105 (See Above)		
Backlash Assembly (with AOS only)	All	4	GAI	MIL-G-23827		MIL-G-10924				
Traversing Gear Box	Above 32°F +40°F to -10°F 0°F to -65°F	4	OE/HDO-10 OE/HDO-10 OEA	MIL-L-2104 MIL-L-2104 MIL-L-46167	0-238/739 0-238/739	Any Hydraulic Fluid	See Above	Cooking Oil Water		
Cupola Ring Gear	All	5	GAA	MIL-G-10924	G-403	MIL-G-23827	See Above	MIL-L-2105 (See Above)		
Cradle Trunion Bearings	All	5	GAA	MIL-G-10924	G-403	MIL-G-23827	See Above	MIL-L-2105 (See Above)		
Elevating Screw Jack	All	5	GAA	MIL-G-10924	G-403	MIL-G-23827	See Above	MIL-L-2105 (See Above)		
Azimuth Lock	All	5	GAA	MIL-G-10924	G-403	MIL-G-23827	See Above	MIL-L-2105 (See Above)		
Cannon Base	Above 32°F +40°F to -10°F 0°F to -65°F	5	PL-M PL-S PL-S	MIL-L-3150 VV-L-800 VV-L-800	0-198 0-190 0-190					
Replenisher	All	5	OHT	MIL-H-6083D		MIL-H-5606 (NATO H-515) MIL-H-46170 (NATO H-544)				
Loader Safety Switch	Above 32°F +40°F to -10°F 0°F to -65°F	5	PL-M PL-S PL-S	MIL-L-3150 VV-L-800 VV-L-800	0-198 0-190 0-190					
Breech Operating	Above 32°F 40°F to -10°F 0°F to -65°F	5	PL-M PL-S PL-S	MIL-L-3150 VV-L-800 VV-L-800	0-198 0-190 0-90					

APPENDIX D

Not Used

APPENDIX E

BDAR FIXES AUTHORIZED FOR TRAINING

BDAR TRAINING FIXES SHALL BE
USED ONLY AT THE DISCRETION OF THE COMMANDER.
DAMAGES SHALL BE REPAIRED BY STANDARD MAINTENANCE
PROCEDURES AS SOON AS PRACTICABLE.

APPENDIX E
BDAR FIXES AUTHORIZED FOR TRAINING (CONT'D)

APPENDIX E
BDAR FIXES AUTHORIZED FOR TRAINING

*U.S. GOVERNMENT PRINTING OFFICE: 1990 543-016/40003

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