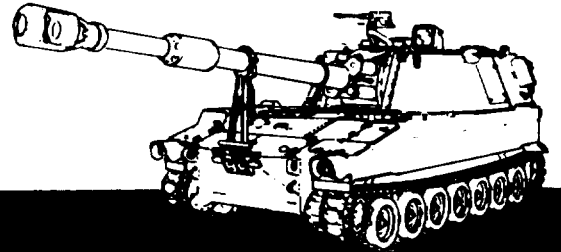


TECHNICAL MANUAL

OPERATORS, ORGANIZATIONAL
DIRECT SUPPORT AND
GENERAL SUPPORT MAINTENANCE



BATTLEFIELD DAMAGE ASSESSMENT AND REPAIR

M109/M110/M578
VEHICLES
HOWITZER, MEDIUM,
SELF-PROPELLED
FULL-TRACKED

M109A2 Howitzer
NSN 2350-01-031-4586 (EIC: 3EZ)
M109A3 Howitzer
NSN 2350-01-031-8851 (EIC: 3E2)
M109A4 Howitzer
NSN 2350-01-277-5770 (EIC: 3E8)
M109A5 Howitzer
NSN 2350-01-281-1719 (EIC: 3E7)
M110A2 Howitzer
NSN 2350-01-041-4590 (EIC: 2E3)
M578 Recovery Vehicle
NSN 2350-00-439-6242 (EIC: 3LA)

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HEADQUARTERS, DEPARTMENT OF THE ARMY

31 JANUARY 1984

**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.**

OPERATOR'S, ORGANIZATIONAL
DIRECT SUPPORT AND GENERAL SUPPORT
MAINTENANCE

GENERAL BATTLEFIELD DAMAGE
ASSESSMENT AND REPAIR
for
M 109 AND MI 10 SERIES
SELF-PROPELLED HOWITZER
AND M578 RECOVERY VEHICLE

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, U.S. Army Armament, Munitions and Chemical Command, ATTN; AMSMC-MAS, Rock Island, IL 61299-6000. A reply will be furnished directly to you.

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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 maintenance personnel. It provides procedures and guidelines for battlefield repairs on the M 109 Self-Propelled Howitzer/M 110 series Self-Propelled Howitzer/M578 Recovery Vehicle, Full-Tracked, 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 fining, 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 M 109 vehicles/M110 series vehicles/M578 Recovery Vehicles. Expedient repairs of a general nature applicable to systems or subsystems common to more than one combat vehicle are covered in TM 9-2350-276-BD. ■

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

c. All possible types of combat damage and failure modes can not be predicted nor are all effective field expedient repairs known. This TM provides guidelines for assessing and repairing battlefield failures of the M 109 vehicles/M110 series vehicles/M578 Recovery Vehicles and is not intended to be a complete catalog of all possible emergency repairs. The repairs described here will serve as guidelines and will stimulate the experienced operator or mechanic to devise expedients as needed to rapidly repair equipment in a combat crisis. ■

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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 M 109 vehicle/M 110 series vehicle/M 578 Recovery Vehicle. The commander must decide whether the risk of having one less vehicle available for combat outweighs the risk of applying the potentially destructive expedient repair technique. Each technique gives appropriate warnings and cautions, and lists systems limitations caused by this action.

1-4. Definitions.

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

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

- (1) Short cuts in parts removal or installation.
- (2) Installation of components from other vehicles that can be modified to fit or interchange with components on the vehicle.
- (3) Repair using M109/M110/M578 parts that serve a non-critical function elsewhere on the same vehicle for the purpose of restoring a critical function.
- (4) Bypassing of non-critical components in order to restore basic functional capability.
- (5) Expedient cannibalization procedures.

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- (6) Fabrication of parts from kits or readily available materials.
- (7) Jury-rigging.
- (8) Use of substitute fuels, fluids or lubricants.

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

- (1) Determine if the repair can be deferred, or if it must be done.
- (2) Isolate the damaged areas and components.
- (3) Determine which components must be fixed.
- (4) Prescribed 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. **Maintenance Support Team** (MST) consists of direct support/general support mechanics and technical specialists, who are trained in assessing battle damage in addition to their specialty. The MST is called by the MT when vehicle damage exceeds MT assessment capability or organizational repair capability.

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

- (1) The unit's mission and the commander's requirements.
- (2) The maintenance capability of the unit, including the available skills, tools, repair parts, and materials.
- (3) How to detect contamination and effect decontamination of equipment.
- (4) The unit's maintenance workload.
- (5) The maintenance capability of all accessible rally and maintenance collection points,

g. The term **fully mission capable** (FMC) means that the vehicle can perform all its combat missions without endangering the life of the crew. To be FMC the vehicle must be complete and fully operable with no faults listed in ■ the "Not Fully Mission Capable If:" column of the operator's Preventive Maintenance Checks and Services (PMCS).

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

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

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

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

1-5. BDAR Recommendations and QDR/EIR.

a. Personnel originating new BDAR procedures should forward them directly to Commander, U.S. Army Armament, Munitions and Chemical Command, ATTN: AMSMC-MAS, Rock Island, IL 61299-6000. Personnel are encouraged to develop and report new BDAR ideas, techniques and procedures.

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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, U.S. Army Armament, Munitions and Chemical Command, ATTN: AMSMC-QAD, Rock Island, IL 61299-6000. A reply will be sent directly to you.

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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 vehicle crewman should be trained to perform initial battle damage assessment for his crew position.

1-8. Waiver of Precautions.

Under combat conditions, BDAR may be performed on M 109 vehicles vehicles/M 110 series vehicles/M578 Recovery Vehicles, which are fueled and/or armed. Other similar precautions may be waived at the discretion of the commander. See paragraph 1-13e.

1-9. Environment.

BDAR may be required in a chemically toxic environment or under other adverse conditions with severe limitations in personnel, facilities, equipment, and materials. Performance of repair tasks may be necessary while wearing protective gear. Expedient decontamination procedures are described in FM 3-5.

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

The Minimum Functional Combat Capabiltiy (MFCC) criteria for the M 109 vehicles/M 110 Series Vehicles/M578 Recovery Vehicles are as follows:

NOTE

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

a. Armament and Fire Control.

- (1) M 109 Vehicle: Turret must traverse 360 degrees and elevate with no oscillations either manually or by power.
- (2) M1 10 Series Vehicle: Turret must traverse either manually or by power 30 degrees right or left of center.
- (3) M109/M110: Main gun must have Recoil Mechanism, Turret, Equilibrators, and Cannon Assembly.
- (4) M109/M110: Must have an operational fire control mount and an indirect sighting device.

b. Mobility.

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

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

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

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

(c) May not be missing two adjacent roadwheel positions.

(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 vehicle to be incapable of traveling 10 miles per hour on a level, unimproved road.

c. Communications. No requirements. ■

1-11. Permanent Repair.

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

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

1-12. General.

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

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

1-13. Commander and Crew.

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

- (1) Vehicle damaged (out-of-action or impaired).
- (2) Location of vehicle.
- (3) Firepower status.
- (4) Mobility status.
- (5) Manning status.
- (6) Current and anticipated enemy action.

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

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

not possible, then the turret should at least be turned in the direction of engaging fires in order to limit damage and possibly return fire.

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

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

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

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

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

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

(5) Is the fire extinguishing system operational? If not, then one crew member should be stationed in the 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/operational test should be performed next on those systems which appear undamaged. For systems with a built-in self-test feature, this will be done. Only those systems found to be damaged or inoperative, shall be identified.

g. The vehicle commander shall report to the executive officers post 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 executive officers post 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 battery or battalion trains. The MT assessor performs his assessment and the

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

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

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

- (1) Reviewing the crew's out-of-action report, if available.
- (2) Interviewing commander and crew if available.
- (3) Visually inspecting damaged parts and systems.
- (4) Performing a self-test,
- (5) Making tests with organizational test equipment, if required.
- (6) Performing additional vehicle operational tests, as necessary.

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

- (1) Determine what must be repaired or replaced.
- (2) Determine sequence and priority of repair actions.
- (3) Estimate repair times for each repair task.
- (4) Total the repair task times and determine if the repairs can be performed in the time available.
- (5) Determine repair location and, if other than on-site, arrange for recovery of the vehicle to the repair site.

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

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

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

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

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

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

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

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

(1) Needed spares on-site.

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

(3) Other needed spares or repair parts.

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

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

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

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

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

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

1-16. Time Limits for Repairing Damage.

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

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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	<ol style="list-style-type: none"> 1. Operator/Crew 2. Battalion Maintenance Team (MT) 3. Maintenance Support Team (MST) from Forward Support Maintenance Company 	2 Hours
Battalion Trains (OMCP)	<ol style="list-style-type: none"> 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	<ol style="list-style-type: none"> 1. Forward Support Maintenance Co. 2. Maintenance Support Team (MST) from Maintenance Battalion 3. Maintenance Support Team (MST) from COSCOM 	24 Hours
Division Support Area	<ol style="list-style-type: none"> 1. Maintenance Battalion 2. Maintenance Support Team (MST) from COSCOM 	36 Hours
Corps Support	<ol style="list-style-type: none"> 1. COSCOM Maintenance Companies 	96 Hours