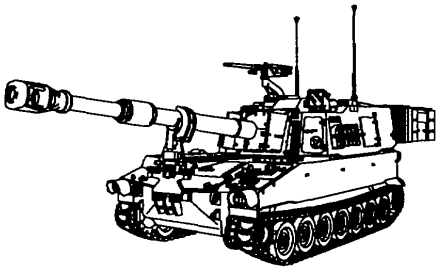
TECHNICAL MANUAL

OPERATOR'S, UNIT,
AND DIRECT
SUPPORT MAINTENANCE



BATTLEFIELD DAMAGE ASSESSMENT AND REPAIR

FOR

HOWITER, MEDIUM,
SELF-PROPELLED:
155MM, M109A6
(NSN 2350-01-305-0028)
(EIC:3FC)

HEADQUARTERS, DEPARTMENT OF THE ARMY
25 MARCH 1994

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HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington D.C., 25 March 1994

Technical Manual
TM 9-2350-358-BD

OPERATOR, UNIT, AND DIRECT SUPPORT MAINTENANCE

BATTLEFIELD DAMAGE ASSESSMENT AND REPAIR

FOR

HOWITZER, MEDIUM, SELF-PROPELLED:

155MM M109A6 (NSN 2350-01-305-0028)

REPORTING OF ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this manual. If you find any mistake or if you know of a way to improve the procedures, please let us know Mall your letter, DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2, located in the back of this manual, directly to Commander, US Army Armament, Munitions, and Chemical Command, ATTN AMSMC-MAS, Rock Island, IL 61299-6000 A reply will be furnished to you.

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HOW TO USE THIS MANUAL

Use this TM for expedient repairs or fixes on the M109A6 howitzer in battlefield environment. The repairs or fixes in this manual are not permanent nor are they normal maintenance procedures. When conditions allow, make normal repairs.

WARNINGS

Review warning pages prior to performing any procedure. Warnings in text are abbreviated ORGANIZATION.

ORGANIZATION

This manual contains general fault assessment tables in Chapter 2. These tables are organized by major howitzer system and direct you to detailed assessment procedures in other chapters. The detailed assessment procedures isolate the problem and lead to an expedient repair procedure, if one exists.

WHERE TO START

You must first determine which system, such as, engine, fuel, or cooling, has been damaged before beginning an expedient repair procedure in this manual. After you have identified the system, go to the table of contents, which will identify the chapter for the damaged system. Proceed to the appropriate fault assessment table to determine the fault, which in turn will direct you to the procedure to repair it, if it exists. If you do not know what your problem is, use the assessment procedures described in Chapter 2.

HOW TO USE AN EXPEDIENT REPAIR PROCEDURE

You will find all the information you need to perform the procedure on the first page.

All of the information blocks are described in the following paragraphs.

GENERAL INFORMATION. You will find a brief description of what can happen when a given component is damaged and/or a general idea of what the expedient repair will accomplish.

APPLICABILITY. The data under this heading identifies whether or not the procedure is applicable to a specific model or component if the procedure is applicable to all models or components, this heading will not be listed.

LIMITATIONS. Operational limitations caused by the repair action that could cause further damage/degradation to the howitzer are listed here.

PERSONNEL/TIME REQUIRED. The estimated number of soldiers needed and estimated time required to complete the repair are listed here.

MATERIALS/TOOLS. If materials and/or tools, other than those commonly available to the crew, Maintenance Team (MT), and Maintenance Support Team (MST) are needed, they are listed in this manual. If the listed items are not available, you are requested to improvise. Virtually anything that will do the job is acceptable.

OTHER OPTION(S). This lists other options you can use depending on availability of personnel, material, tools, and/or time. This does not include standard maintenance procedures or recovery. This list is not all inclusive, therefore other means of repair may be available, but not included in this manual. Anything that you can do to effect a repair is acceptable.

HOW TO USE THIS MANUAL - CONTINUED

APPENDIXES

At the back of this manual, you will find Appendixes A thru E. Following is a list of these appendixes and a brief description.

APPENDIX A - REFERENCES Lists publications referenced in this manual.

APPENDIX B - SPECIAL OR FABRICATED TOOLS. Lists peculiar tools, fabricated tools, and test equipment.

APPENDIX C - EXPENDABLE/DURABLE SUPPLIES AND MATERIALS LIST. Lists supplies and materials available for BDAR fixes.

APPENDIX D - SUBSTITUTE MATERIALS/PARTS. Lists repair parts which can be taken from other systems and used on the M109A6 howitzer, other countries with U S. combat vehicle, and substitutes for POL (petroleum, oils, and lubricants) used for the M109A6 howitzer.

APPENDIX E - BDAR FIXES AUTHORIZED FOR TRAINING. Lists BDAR fixes that have been approved for training. Training procedures are shown boxed in the index at the front of each chapter.

LIST OF ABBREVIATIONS/ACRONYMS

AFCS	Automated Fire Control System
ASTM	American Society of Testing and Measurements
AWG	American Wire Gage
BD	Battlefield Damage
BDA	Battlefield Damage Assessment
BDAR	Battlefield Damage Assessment and Repair
BDR	Battlefield Damage Repair
CAGE	Commercial and Government Entity
CC	Combat Capable
CEC	Combat Emergency Capable
CLP	Cleaner, Lubricant Preservative
CTA	Common Table of Allowances
CVC	Communications Vehicular Crewman
DA	Department of the Army
DD	Department of Defense
DOD	Department of Defense
EIR	Equipment Improvement Recommendation

LIST OF ABBREVIATIONS/ACRONYMS - CONTINUED

FM	Field Manual
FMC	Fully Mission Capable
GAA	Grease, Automotive and Artillery
GGP	Grease, General Purpose
GMD	Grease, Molybdenum Disulfide
GO	Lubricating Oil, Gear
JP	Jet Petroleum
LED	Light Emitting Diode
LO	Lubrication Order
LOMD	Lubricating Oil, Molybdenum Disulfide
LRU	Line Replaceable Unit
MCS	Microclimate Conditioning System
METT-T	Mission, Enemy, Terrain, Troops and Time
MFCC	Minimum Functional Combat Capability
MPH	Miles Per Hour
MST	Maintenance Support Team
MT	Maintenance Team
NATO	North Atlantic Treaty Organization
NIIN	National Item Identification Number
NBC	Nuclear, Biological, or Chemical
NSN	National Stock Number
OEA	Lubricating Oil, Internal Combustion Engine, Arctic
OE/HDD	Hydraulic Fluid Petroleum Base, Aircraft Missle and Ordnance
OHT	Hydraulic Fluid, Petroleum Base Preservative, Hydraulic Equipment
OMCP	Organizational Maintenance Command Post
ORS	O-ring Seal
O-156	Lubricating Oil, Aircraft Turbine Engine
PLS	Lubricating Oil, General Purpose, Preservative
PMCS	Preventive Maintenance Checks and Services

LIST OF ABBREVIATIONS/ACRONYMS - CONTINUED

POL	Petroleum, Oil, and Lubricant
QDR	Quality Deficiency Report
RBC	Rifle Bore Cleaner
RF	Radio Frequency
RFI	Radio Frequency Interference
RPO	Radiological Protection Officer
SF	Standard Form
SRC	Self-Recovery Capable
TAMMS	The Army Maintenance Management System
TM	Technical Manual
TMDE	Test, Measurement, and Diagnostic Equipment
U/I	Unit Of Issue
Vdc	Voltage Direct Current

CHAPTER 1

GENERAL INFORMATION

BDAR FIXES SHALL BE USED ONLY IN COMBAT OR FOR TRAINING AT THE DISCRETION OF THE COMMANDER. (AUTHORIZED TRAINING FIXES ARE LISTED IN APPENDIX E.) IN EITHER CASE, DAMAGES SHALL BE REPAIRED BY STANDARD MAINTENANCE PROCEDURES AS SOON AS PRACTICABLE.

SECTION I. INTRODUCTION

1-1. PURPOSE

a. This Technical Manual (TM) is for use by operators, unit, and direct support maintenance personnel. It provides procedures and guidelines for battlefield repairs on the M109A6 howitzer under the forward support maintenance concept during combat.

b. The purpose of Battlefield Damage Assessment and Repair (BDAR) is to rapidly return disabled combat equipment to the operational commander by expediently repairing, bypassing, or jury-rigging components to restore the minimum essential systems required for the support of a combat mission or to enable the howitzer to self-recover. These repairs are temporary, and may not restore full performance capability, and must be replaced with standard repairs at the first opportunity. For further Information on doctrine and guidance, see FM 20-30.

1-2. SCOPE

a. This TM describes BDAR procedures applicable specifically to M109A6 howitzers. For further information on expedient repairs of a general nature applicable to systems or subsystems common to more than one combat vehicle, see TM 9-2350-276-BD.

b. Many repair techniques helpful in preparing a howitzer 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. For further information on recovery-associated expedient repairs, see FM 20-22.

c. All possible types of combat damage and failure modes cannot be predicted, nor are all effective field repairs known. This TM provides guidelines for assessing and repairing battlefield failures of the M109A6 howitzer and is not intended to be a complete catalog of all possible emergency repairs. The repairs described here serve as a guideline and are intended to stimulate the experienced mechanic to devise methods, as needed, to rapidly repair equipment in a combat crisis.

d. Use this TM in conjunction with the M109A6 howitzer system TM's (TM 9-2350-314 series) and Lubrication Order (LO 9-2350314-12). A complete listing of TMs is contained in Appendix A.

1-3. APPLICATIONS

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 in a battlefield environment. Standard maintenance procedures will provide the most effective means to return 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 or in training, and only at the direction of the commander.

1-3. APPLICATIONS - CONTINUED

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 M109A6 howitzers. The commander must decide whether the risk of having one less howitzer available for combat outweighs the risk of applying the potentially destructive repair technique. Each technique gives appropriate warnings and cautions, and lists system limitations caused by this action.

1-4. DEFINITIONS

a. Battlefield Damage (BD) 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. Battlefield Damage Assessment (BDA) 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, 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 at once.
(2) Isolate the damaged areas and components.
(3) Determine which components must be fixed.
(4) Prescribe fixes.
(5) Determine if parts of 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.

c. Battlefield Damage Repair (BDR) 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 M109A6 howitzer.
(3) Repair using M109A6 howitzer parts that serve a non-critical function elsewhere on the same howitzer for the purpose of restoring a critical function.
(4) Bypassing of non-critical components in order to restore basic functional capability.
(5) Expeditious cannibalization procedures.
(6) Fabrication of parts from kits or readily available materials.
(7) Jury-rigging.
(8) Use of substitute fuels, fluids, or lubricants.

1-4. DEFINITIONS - CONTINUED

d. Maintenance Teams (MT) consist of unit level mechanics, who may be trained in BDAR procedures MTs 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 crew will assist the MT in restoring the vehicle to mission capability.

e. Maintenance Support Teams (MST) consist of direct support mechanics and technical specialists, who are trained in assessing battle damage in addition to their specialty. MSTs are called by the MT when vehicle damage exceeds MT assessment capability or unit repair capability.

f. 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. Fully Mission Capable (FMC) means that the howitzer can perform all its combat missions without endangering the life of the crew. To be FMC the howitzer must be able to move, shoot, and communicate with no faults listed in the "Equipment is not ready/available if" column of the operator's Preventive Maintenance Checks and Services (PMCS).

h. Combat Capable (CC) means that the howitzer meets the Minimum Functional Combat Capability (MFCC) requirements (para 1-8).

i. Combat Emergency Capable (CEC) means that the howitzer 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 howitzer if it is used. The commander must decide if these limitations are acceptable for that specific emergency situation.

j. Self-Recovery Capable (SRC) means that the howitzer meets the needs for recovery under self-power. It could include hazardous equipment conditions such as partial brakes or limited steering.

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

l. Scavenge means to salvage components from other vehicles that are damaged and/or unserviceable.

1-5. QUALITY DEFICIENCY REPORT/EQUIPMENT IMPROVEMENT RECOMMENDATIONS (QDR/EIR)

If your howitzer needs improvement, let us know Send us an Equipment Improvement Recommendation (EIR). You, the user, are the only one who can tell us what you don't like about your equipment. Let us know why you do not like the design. Put it on an SF 368 (Quality Deficiency Report). Mall it to us at Commander, U S. Army Armament, Munitions and Chemical Command, ATTN AMSMC-QAD, Rock Island, IL 61299-6000. We will send you a reply.

SECTION II. STANDARDS AND PRACTICES

1-6. BDAR CHARACTERISTICS

BDAR 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. WAIVER OF PRECAUTIONS

Under combat conditions, BDAR may be performed on M109A6 howitzers which are fueled or armed. Other similar precautions may be waived at the discretion of the commander.

1-8. OPERATING CHARACTERISTICS

The Minimum Functional Combat Capability (MFCC) criteria for the M109A6 howitzer are as follows:

NOTE

These criteria may be waived for recovery or if the tactical situation demands otherwise (combat emergency capable).

a. Armament and Fire Control.

(1) Main gun must have recoil mechanism, equilibrator, and cannon assembly.

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

b. Mobility.

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

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

(5) Must be capable of normal braking/stopping from 10 mph and brakes must hold on a 30 percent slope.

(6) Vehicle steering system must be operational.

c. Communications. Must have intercom between chief-of-section and driver.

1-9. TRAINING

The Unit Commander must ensure that an adequate number of members of his organization, including supervisors, are trained In BDAR procedures applicable to his equipment. Each howitzer crewman should be trained to perform initial battle damage assessment for his crew position. The BDAR procedures which are contained within boxes on the BDAR procedure index at the beginning of each chapter are those authorized for training purposes. A summary listing of these training procedures is also presented in Appendix E, BDAR Fixes Authorized for Training.

1-10. ENVIRONMENT

BDAR may be required in a chemically toxic environment or under other adverse conditions with severe limitation in personnel, facilities, equipment, and materials. Performance of repair tasks may be necessary while wearing protective gear. For further information on decontamination procedures, see FM 3-5.

1-11. PERMANENT REPAIR

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

SECTION III. TASKS AND RESPONSIBILITIES

1-12. GENERAL

a. BDAR procedures are applicable at all levels, from crew through direct 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 or possible to restore the howitzer to the combat-ready condition required for continuation of the mission.

b. Battlefield damage repair items consist of essential tools, substitute parts, and expendable supplies and can be carried on board each howitzer to enable the crew to rapidly fix the simplest and most common types of damage/failure. (Refer to Appendix B (Special or Fabricated Tools), Appendix C (Expendable/ Durable Supplies and Materials List), and Appendix D (Substitute Materials/Parts)).

1-13. TAGGING/IDENTIFYING BDAR REPAIRS

a. All components of a vehicle, which are repaired using BDAR or other techniques, shall be reported on DA Form 2404, DD Form 1577, or similar conspicuous tag. 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 permanent standard repair.

b. Since it is impractical to attach tags to expediently repaired components located on the outside of the vehicle, the fix shall be reported on DA Form 2404, DD Form 1577, or similar tag.

c. A tag should also be placed conspicuously in the chief-of-section’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.

1-14. CHIEF-OF-SECTION AND CREW

a. The crew of the damaged howitzer will make the first assessment immediately after damage has occurred. Crew members will provide the chief-of-section 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 chief-of-section must make an initial out-of-action report to the executive officer including these essentials.

(1) Howitzer damaged (out-of-action or impaired)

(2) Location of Howitzer

(3) Firepower status

(4) Mobility status

(5) Manning status

(6) Current and anticipated enemy action

b. If communication capability is damaged, the chief-of-section 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 howitzer to a covered or concealed position to prevent additional combat damage. This is the first priority. If the howitzer is not capable of self movement, use any vehicle, including other howitzers, 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 to possibly return fire.

d. 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. The following safety checks 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 leaked or accumulated?

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

(5) Is the fixed fire extinguisher system operational and are portable fire extinguishers serviceable? Crew members should be stationed inside and outside the howitzer with portable fire extinguishers and be prepared to manually actuate the fixed fire extinguisher system.

f. A functional/operational test should be performed next on those systems which appear undamaged. Only those systems found to be damaged or inoperative shall be identified.

g. The chief-of-section shall report to the executive officer 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 the crew is possible, he shall report a total estimated repair time and what functions may be restored.

1-14. CHIEF-OF-SECTION AND CREW - CONTINUED

h. The executive officer 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 and available materials and tools.

1-15. MAINTENANCE TEAMS (MT)

a. The 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 concealment may be necessary. This is still considered on-site.

b. If the howitzer has been left unattended in the forward battle area, the immediate area of the howitzer should be checked for mines, and the howitzer should be checked for booby traps before starting the battle damage assessment. The MT should also make the safety checks listed in paragraph 1-14e.

c. The MT assessment will be more thorough than the crew's, using unit 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 unit test equipment, if required.

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

d. Using this information and following the steps in paragraph 1-15c, 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 howitzer.

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 howitzer is repairable, the MT shall provide for recovery of the howitzer to a designated collection point.