

Battle

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Damage

Assessment

&

Repair

Smart Book

Doctrinal Guide to Battle Damage Assessment And Repair
(BDAR)

December 2015



Battle Damage Assessment & Repair Smart Book

Preface

Battle Damage Assessment and Repair (BDAR) is the process used to rapidly return disabled equipment to the operational commander by applying field-expedient repairs to damaged components.

BDAR may restore the minimum essential combat capabilities necessary to support a specific combat mission or to enable the equipment to self-recover. BDAR repairs may or may not return the vehicle to a fully mission-capable status. Operators/crew, maintenance teams (MTs), and recovery teams may accomplish these repairs.

Battle Damage Assessment (BDA) is the process used to quickly identify primary and secondary damage.

Battle Damage Repair (BDR) is accomplished by bypassing components or safety devices, cannibalizing or controlled exchange of parts from like or lower priority equipment, fabricating repair parts, jury-rigging, taking shortcuts to standard maintenance, and using substitute fluids, materials or components.

Mission, Enemy, Terrain and weather, Troops and support available-Time available and civil considerations METT-TC and METT- Time Space and Logistics (TSL) (USMC) conditions must always be considered prior to performing BDAR or recovery operations.

To ensure wartime proficiency realistic BDAR training must be conducted in peacetime during field training exercises. Refer to AR 750-1, Army Materiel Maintenance Policy, and ATP 4-33 Maintenance Operations and Procedures for additional guidance.



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WARNING

This manual contains nonstandard maintenance procedures. All normal maintenance and safety procedures should be observed when the tactical situation permits. Extra care shall be taken when maintenance is required in a hostile environment.

WARNING

High-risk battle damage repairs (involving possible danger to personnel or further damage to equipment) are only permitted in emergencies, normally in a battlefield environment, and only when authorized by the unit commander or his designated representative.

WARNING

Expedient BDR may be unreliable for extended periods of operation. Equipment must be operated at lower speeds, may require frequent stops and the repairs closely monitored. Sudden failures can result in loss of control and serious injuries.

WARNING

Expedient tire repairs are considered high risk repairs and should be applied only in emergency situations. The tires must be properly repaired or replaced by qualified field maintenance personnel at the earliest opportunity.

WARNING

BDR repairs on the battlefield may involve uploaded vehicles and live electrical circuits. Extreme caution must be used when performing expedient repairs to prevent injuries or death.



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WARNING

Repairing vehicles that have been contaminated by Depleted Uranium (DU) penetrators or have damaged DU armor may lead to heavy metal poisoning and/or radiation poisoning. Personal Protective Equipment (PPE) must be used.

WARNING

Some BDAR procedures may expose individuals to extremely hot surfaces. Care must be exercised when working around hot engines, cooling systems and other hot components.

WARNING

Sanding, grinding, or burning Chemical Agent Resistant Coating (CARC) paint produces Carcinogens which have been determined to cause. PPE must be used.

WARNING

Read all Material Safety Data Sheets (MSDS) accompanying the BDAR Kit prior to utilizing the products.

WARNING

PPE must be worn when handling some products in the BDAR kits (refer to MSDS sheets).

NOTE

Upon completion of all BDAR actions, record the location and type of repairs on a repair tag, and notify field maintenance personnel at the earliest opportunity.



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Section I - Battle Damage Assessment

BDA is the first and most important step of BDAR. It starts at the moment a malfunction or battle damage is detected. An accurate assessment determines the extent of damage including which systems or subsystems and components were damaged, the level of repair required, and the risk involved with making the repairs. The assessment will also include an estimate of personnel, time, and materials required to perform expedient repairs or determine if recovery assets are needed. If not handled correctly, resources will be wasted and opportunities to continue the mission will be missed. The objective of BDAR is to return a critical system to service without injury to personnel or causing further damage to the equipment.

A. Battle Damage Indicators

An important phase of BDA is recognizing Battle Damage Indicators (BDI). Operator/Crew awareness during the moment immediately after the equipment sustains battle damage or equipment failures is critical.

Identifying BDI is important because the systems affected, or the engine, may shut down immediately or shortly after the impact. BDI include:

Smoke - indicates that a particular area, damaged wiring harness, or leaking fluid containers could result in a fire if not quickly addressed.

Fire - indicates damage to previously mentioned areas of the vehicle and poses an additional threat of igniting leaking combustible fluids or damaged ammunition.

Loss of mobility - a sudden disruption of movement or change in direction indicating that wheels, tracks, axles, or power train components may be damaged.

Loss of systems - indicate a failure in steering, brakes, air pressure, cooling system, communications, weapons, turret and gun drives, or power train.

Unusual mechanical noises - indicate possible damage to the engine, transmission, gearboxes, axles, or driveline components. Continued operation may result in further damage to these assemblies due to loss of lubricants or wear caused by damaged parts.

Fault warning lights and alarms - indicate affected systems are not available and could place the crew or vehicle in danger, or the possibility of a component or system becoming unavailable if immediate action to repair



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the fault does not occur.

Leaking fluids - indicate that a cell, component, fuel line, hydraulic line, radiator, or brake line has been damaged. Fumes can be a health hazard if inhaled, and a buildup of fumes from combustible liquids in enclosed spaces can lead to fires or explosions.

Unusual odors - give specific indications of what type of material might be burning or leaking. Fuels, coolant, and hydraulic fluids emit particular odors that help identify which system is affected. Burning materials like rubber, paint, liquids, plastic insulation around wiring, and clothing also emit distinctive odors.

The ability to quickly recognize and identify various BDI will reduce diagnostic time and increase BDR accuracy.

B. Basic Rules of BDA (SAFETY)

First and foremost, think SAFETY! Consider METT-TC/METT-TSL (USMC) conditions before attempting to perform any BDA. Be certain that the area in and around the vehicle is free from hazards that could cause further injury to personnel or damage to the equipment.

Check for Chemical, Biological, Radiological and Nuclear (CBRN) contamination, if you suspect the battle area was contaminated by biological/chemical weapons or damaged munitions containing these hazards, adopt the appropriate level of protection, and decontaminate the vehicle and equipment as required. Request support from a chemical decontamination team if the contamination level exceeds your capabilities.

The same procedures apply to DU contamination. DU dust particles pose a serious health threat if inhaled, ingested, or absorbed through skin lesions. The use of a radiation meter is the only method for determining the presence and level of DU contamination.

When dealing with abandoned vehicles, carefully check for booby traps near, around, under, and inside the vehicle. Also, be aware of loaded weapons, live ammunition, damaged weapons, wiring, leaking combustible fluids, and Unexploded Ordnance (UXO). Do not disturb any ordnance that appears unstable or armed. If any of these conditions involve UXO, contact Explosive Ordnance Disposal (EOD) personnel immediately and do not continue with BDA until the area and equipment are rendered safe.



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Always conduct a thorough safety check of equipment and vehicles prior to performing any BDA. Failure to observe all safety procedures can lead to catastrophic consequences.

C. Assess Primary Battle Damage

The initial damage assessment consists of visually inspecting the extent of primary damage to the exterior and interior components of the vehicle. The following questions must be answered during the primary damage assessment:

1. Have communications and area security been established?
2. Is the damage repairable on site by expedient means enabling the equipment to self-recover?
3. Does the extent of damage prevent the vehicle from being recovered with similar class or like vehicle?
4. Are dedicated recovery assets required?

D. Recovery Definitions

Self-Recovery - Indicates that the equipment is capable of clearing the battlefield under its own power with or without BDAR actions, but may not be Fully Mission Capable (FMC). It may also be used to recover other inoperable or damaged equipment not able to self-recover.

Like-Vehicle Recovery - If the vehicle cannot self-recover, determine if it can be moved to a safer location using a same type or heavier class vehicle. Depending on the weight classification, dedicated recovery assets may be required to move it to the nearest Maintenance Collection Point (MCP).

Dedicated Recovery - Is accomplished with specialized recovery equipment and trained recovery personnel (H8). Dedicated recovery assets should only be used on the battlefield when absolutely necessary.

E. Assess Secondary Damage

Assess secondary damage by tracing the path of the penetrator or behind armor debris. This is necessary to determine the extent of damage and operation limitations of systems and subsystems.



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F. Perform Systems Self-Test (BIT/BITE)

On equipment with built-in diagnostic capabilities perform a complete diagnostic check (if possible) to identify which systems are operational or off line. These procedures should be attempted only by trained operators and qualified personnel. Improper procedures can lead to injuries or further damage to the equipment.

G. Verify Operational Readiness of Systems and Subsystems

At the completion of the self-test, perform a functional test of operational systems. A system may be operational but not fully functional.

Examples:

1. Test indicates that the turret/gun drive is functioning, but the turret will not traverse 360° due to internal or external damage or an obstruction.
2. Communication system is operational, but the frequency range is limited.
3. Steering system works but the vehicle cannot make sharp turns.

H. Determine Mission Status of Equipment

Determining the mission status of equipment is very important for the tactical commander. Combat vehicles must be able to shoot, move, and communicate. Battle damage can disable or degrade one or more systems thus limiting the vehicle's mission capability. There are three BDAR classification levels which describe the mission readiness of equipment.

Fully mission capable - Indicates the equipment is functioning as designed and has no faults listed in the -10 manual in the "**equipment is not ready/available if**" column of the operator's Preventive Maintenance Checks and Services (PMCS).

Combat Capable - Means that the vehicle can operate in a combat environment with some limitations but meets the minimal function capability listed in the BDAR Technical Manuals (brakes, steering, forward and reverse capability).



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Combat Emergency Capable - indicates the vehicle meets the criteria for a specific mission, but not all systems (shoot, move, communicate) are fully functional. Additional damage may occur if the equipment is operated and the commander must decide if these limitations are acceptable for that specific emergency situation.

I. Perform BDR Risk Assessment

After identifying which systems or subsystems are not operational, determine the risk level for each repair. Repairs are classified in one of three risk level categories:

High Risk Repairs - This type of BDR can result in injury to personnel or cause further damage to the equipment. Example: Using a fuse or circuit breaker of higher amperage rating can cause circuit overloads and fires.

Medium Risk Repairs - This type of BDR may result in further damage to equipment but should not cause injury to personnel. Example: An engine with low coolant level may overheat causing the engine to eventually lock-up but should not impact the crew compartment.

Low Risk Repairs - This type of BDR may result in minor equipment failures but poses little or no threat to equipment or personnel. Example: Using a fuse or circuit breaker of lower amperage rating may cause equipment systems to frequently shut down when circuit is overloaded.

J. Prioritize Sequence of BDR

The battlefield is a chaotic environment with many unexpected circumstances. During the BDA process, it is important to perform an **“Equipment Triage”** Triage is a process used to determine which systems are mission essential and require immediate repairs.

After performing triage, repair only what is needed, spending time on non-essential repairs is a waste of resources. Specific repair procedures may not be listed in technical or field manuals, and repair parts, tools, and skilled personnel may not be available. Flexibility and ingenuity are crucial to successful performance of BDAR.



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The main objective of BDAR is to perform those actions required to get a system back into operation quickly, without injury to personnel, or without causing further damage to the equipment. Always follow unit SOP and consider METT-TC/TSL conditions.

K. Document All BDR Actions

Document the repairs on DA Form 5988E/DA Form 2404, and a repair tag. Place the repair tag on or near the repair for easy identification and notify field maintenance personnel at the earliest opportunity.

If unable to place the repair tag on or near repair area, place it on an item such as a convenient bracket in the driver's compartment or logbook to inform field maintenance personnel of the BDR location.



Section II - Fluid Line BDR Kit



CAUTION

The procedures for using compression fittings on steel or plastic Department of Transportation (DOT) air lines are basically the same. When repairing plastic DOT lines however, an insert must be placed at each end of the line inserted into the compression fitting. Failure to use the inserts will cause the line to fail under pressure.



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NOTE

Two wrenches are needed for tightening compression fittings. One is used to hold the fitting while the other to tighten the nut. The line must remain fully seated while tightening to prevent leaks or failure. Over tightening can also cause the fitting to crack.

NOTE

There should be no leaks with these types of repair however; hasty repairs and higher pressures may cause leaks to develop. The amount of acceptable leakage depends on the system and the acceptable risk level. Minimize system operation until reliable repairs can be performed. Refer to operator's manual for system pressures. As a guide, typical system pressures are listed in table below.

**Typical System
Pressures**

Low pressure range	1 to 145 psi	1 to 10 bars
Medium pressure range	145 to 1450 psi	10 to 100 bars
High pressure range	1450 to 5800 psi	100 to 400 bars

A. BDR Crushed or Severed Metal or Plastic Fluid Line



1. If crushed, cut the damage line completely through and cut out the crushed section. Make sure the cut is clean, straight, and remove any burrs.
2. Select the appropriate size union fitting; remove the nuts and sleeves.
3. Insert the clean cut side of the line into one side of the fitting making sure it's fully seated (approx. 1/4").
4. Place the other end of the line next to the fitting and mark the line so that it will overlap approximately 1/4" and seat against the internal lip of the fitting.
5. Set the fitting aside and cut the other end of the line on the mark as straight as possible and remove burrs.



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6. Slide a nut and sleeve onto one end of the line (observing direction) and insert the line into one end of the union fitting.
7. Slide the sleeve into the union fitting and fully tighten the nut while making sure the line remains fully seated in the fitting.
8. Slide a nut and sleeve (observing direction) on the other end of the severed line.
9. Insert the line into the union fitting (slight bending may be required) and slide the sleeve and nut toward the union fitting and tighten as described in step 7.



10. Operate the repaired system and check for leaks. There should be no leaks if the BDR was performed properly. This can be a permanent repair.
11. Record the BDR action taken, location of repair, and notify field maintenance personnel at the earliest opportunity.

B. BDR Crushed or Severed Section of Metal or Plastic Fluid Line



1. Cut off the damaged section of the line leaving straight cuts on both ends and remove any burs.
2. Select the appropriate size fittings (2 ea.) from the BDAR kit.
3. Remove the nuts and sleeves from the fittings.
4. Slide a nut and sleeve (observing direction) over one end of the severed line and insert the line into a fitting making sure it is fully seated (approx. 1/4").



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5. Slide the sleeve into the fitting and fully tighten the nut while making sure the line remains fully seated.
6. Select appropriate size section of line from the BDAR kit and slide a sleeve and a nut (observing direction) onto one end.
7. Insert the end of the splice line into the fitting making sure the line is fully seated (approx. 1/4").
8. Slide the sleeve into the fitting and fully tighten the nut while making sure the splice line remains fully seated.
9. Slide a nut and sleeve (observing direction) over the other end of the severed line and place the end into a fitting.
10. Slide the sleeve and nut toward the fitting and fully tighten while ensuring the line is fully seated.
11. Place the free end of splice line next to the open fitting and mark it making sure it overlaps approximately 1/4" from the end of the fitting and cut the line on the mark as straight as possible and remove any burs.
12. Slide a nut and sleeve on the splice line (observing direction) so they face toward the open end of the fitting.
13. Insert the end of the splice line into the fitting (slight bending may be required).
14. Slide the sleeve and nut toward the fitting and fully tighten while ensuring the line is fully seated.



15. Operate system and check for leaks. There should be no leaks with this type of repair. This can be a permanent repair.
16. Record the BDR action taken, location of repair, and notify field maintenance personnel at earliest opportunity.

C. BDR Punctured or Severed Rubber Fluid Line





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1. If punctured, cut the line completely and remove any obstructions.
2. Select the appropriate size hose mender and hose clamps.
3. Insert the hose mender up to the center ring into one end of the hose (a little lubrication and pliers may be required).
4. Slide a hose clamp over the hose and tighten to secure the hose to the hose mender.
5. Slide a hose clamp over the other end of the hose and slide the hose over the hose mender (a little lubrication and pliers may be required).
6. Secure and tighten hose clamp as in step four (4).



NOTE

For higher pressures, ensure hose mender is fully inserted and use two high quality hose clamps on each side for increased reliability. Operate equipment only as needed until reliable or permanent repairs can be performed. Not recommended for high pressure applications.

7. Tape over the repair with duct tape or self-fusing tape (two layers) overlapping approximately six inches on each side of the repair to restrain the hose should the repair fail during use.
8. Operate the system and check for leaks.
9. Record the BDR action taken, location of repair, and notify maintenance personnel at the earliest opportunity.



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D. BDR Crushed or Severed Section of Rubber Fluid Line



1. Cut off the crushed or damaged section of line and remove any obstructions.
2. Select the appropriate size hose menders (2 ea.), hose clamps (4 ea.), and a section of same inside diameter hose from the BDAR kit.
3. Insert a hose mender into one side of the severed hose.
4. Insert the hose mender into the splice section of hose from the BDAR Kit.
5. Slide two hose clamps onto the hose and tighten the hose clamps to secure the severed line and splice section on the hose mender.
6. Insert a hose mender on the other end of the severed line.
7. Line up the splice section of hose with the hose mender and cut off excess hose if needed.
8. Slide two hose clamps onto hose and insert hose mender into splice section hose.
9. Tighten both hose clamps to secure the hoses to the hose mender.



10. Tape over the repair with duct tape or self-fusing tape (two layers) overlapping approximately six inches on each side of the repair to restrain the hose should the repair fail during use.
11. Operate system and check for leaks.
12. Record the BDR action taken, location of repair, and notify maintenance personnel at the earliest opportunity.



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E. BDR Steel or Plastic Fluid Line with a Rubber Hose Section

1. Cut the damaged ends of the steel or plastic line. The ends don't have to be perfectly square but remove any burs to facilitate sliding the hose over the steel or plastic line.



2. Select appropriate size rubber hose section from the BDAR Kit.
3. If desired cut a section of the hose but make sure it overlaps both ends of the severed hard line by a couple of inches for proper clamping.

CAUTION

For higher pressures always use two hose clamps on each side of the repair to prevent the lines from separating under pressure. Operate equipment only as needed until more reliable or permanent repairs can be performed. The amount of acceptable leakage depends on the system and the acceptable risk level.

4. If the hose fits snugly over the hard line, place a bead of RTV silicon around the circumference of the line at least one half inch from the end of the line.
5. If the hose fits loosely over the hard line, use a compression fitting sleeve, or build a bead (ring) using tape or metal polymer for a snug fit.
6. Slide the hose section over the hard line while twisting the hose to ensure proper sealing of the RTV (if a tape bead was used apply RTV to both sides of the bead and place a clamp on each side of the bead).
7. Slide two hose clamps over the hose at the point where the RTV bead was placed and tighten the clamps.



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8. Repeat steps 4 thru 7 for the other end of the line.



9. Tape over the repair with strong duct tape (two layers) overlapping each end by six inches (if possible) to secure the repair.
10. Allow the RTV to cure for at least fifteen minutes before pressurizing the system.
10. Check the system for leaks. This temporary repair should be reliable if the system is operated only as needed.
11. Record the BDR action taken, location of repair, and notify maintenance personnel at earliest opportunity.

F. BDR Rubber Hose spliced with section of metal or plastic line

NOTE

The steps and procedures for this repair are identical to BDR procedures in Section II E. The only difference is a rubber hose is spliced with a section of hard line. Record the BDR action taken, location of repair, and notify maintenance personnel at earliest opportunity.





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SECTION III - Electrical BDR Kit

WARNING

In a combat environment it may not always be possible or practical to completely turn off all electrical power or to disconnect the vehicle batteries. Use extreme caution when making electrical repairs. Carefully isolate and tape damaged wires to prevent shorts and repair only the critical circuits needed to restore move, shoot and communicate capabilities. Failure to comply can result in serious injuries.

NOTE

Electrical wiring in most cases is either color coded or individual wires are numbered. On single color multi-wire harness it may be necessary to cut the insulation further to expose the wire numbers.

A. BDR Severed Electrical Conductors.

1. Separate and identify each severed wire to be reconnected.
2. Move the suppression shield mesh (if equipped) out of the way. It may be necessary to cut it further in order to splice the wires.

CAUTION

The harness suppression shield is connected to ground. Make sure none of the shield strands touch or become connected to any of the conductor wires during repairs.

3. Cut off the damaged section and remove approximately one half inch (1/2") of insulation from both ends of the severed wire.





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4. If the wires are long enough and the harness can be moved, it may be possible to twist the wires together and then tape each individual wire.
5. If the wires are too short to twist together try using a butt connector.
6. Insert the wires into the butt connectors and crimp both ends of the wire in the butt connector. Tape each repaired wire individually.
7. If the damaged wires are extremely short a wire splice will be necessary.
8. To insert a wire splice by twisting the wires together, cut a section of wire from the spool in the BDAR Kit and strip the insulation approximately three fourths ($3/4$ ") on both the wire splice and the severed wires.
9. Twist the ends of the wires together and tape each individual splice.
10. If butt connectors are used remove approximately one half inch ($1/2$ ") of insulation and crimp the wires in the butt connectors.
11. Tape each individual splice making sure there are no bare wires showing and no suppression shields strands were twisted, crimped or taped to any of the conductors.
12. Slide the suppression shield over the repair and make sure it overlaps itself to restore the suppression shield function.
13. If the shield is too short a piece from other non-critical damaged wires can be cut and used. Otherwise use a piece of wire from the BDAR Kit and strip a large section of insulation from the wire.
14. Twist the bare wire over the suppression shield making contact on both ends and tape it tightly together.
15. Tape the entire repair tightly making sure to overlap a couple of inches on each end of the splice with electrical or self-fusing tape.
16. Record the BDR action taken, location of repair, and notify maintenance personnel at earliest opportunity.



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B. BDR Severed High Current Conductors.

WARNING

High voltage/current conductors carry high amperage which can cause electric shock, severe burns or death. These are primary conductors for the starting system, charging systems and to supply power for auxiliary equipment and electronic power supplies. Remove all jewelry and metal items to prevent shorts. Failure to observe all safety precautions can result in serious injuries or death.



1. Depending on the types of repairs carefully cut and remove approximately one half inch ($\frac{1}{2}$ ") to three fourths inch ($\frac{3}{4}$ ") of insulation. Make sure the bare wire does not touch other wires or the vehicle body.
2. If replacing a damaged battery terminal with a universal battery terminal from the BDAR kit, loosen the terminal clamp and slide the bare wire under the clamp and tighten the screws.
3. If the wire is thinner (higher gage number) and remains loose after tightening, flip the clamp over with the dimple facing down and tighten the bolts. The wire must be tight to prevent overheating and arching when current is flowing.
4. If replacing a terminal lug, select the appropriate size lug, slide the wire into the lug and crimp it tightly with pliers or a hammer until it is tight on the wire.
5. If splicing a severed wire, select the appropriate size butt connector, slide both ends of the severed wire into the butt connector and crimp it in the same manner described in step "4".



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6. Insulate the repairs with electrical or self-fusing tape making sure to overlap the repair at least two inches on both sides when possible.



7. Record the BDR action taken, location of repair, and notify maintenance personnel at earliest opportunity.

C. Expedient BDR of High Current Conductors



1. Repairs vary depending on the methods chosen. For typical repairs, carefully cut and remove approximately three fourths inch ($\frac{3}{4}$ ") to one inch (1") of insulation. Make sure the bare wire does not touch other wires or the vehicle body.
2. If the wires are long enough, carefully slide a hose clamp over one end of the wire then place both ends of the wire together and tighten the clamp over the wires. If two clamps are needed remove enough insulation to accommodate both clamps.
3. Seal the repaired area with two layers of electrical tape or one layer of self-fusing tape making sure to overlap a couple of inches on both sides of the repair for a tight seal.
4. If the high current wire is not long enough, fabricate a splice using a section of the same gage from a damaged wire when available.



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5. If a section of the same gage wire is not available, fabricate a splice using several sections (20 to 30) of 16 gage wire from the BDAR kit.
6. Cut sections of wire twice the length of the splice and remove three to four (3" to 4") inches of insulation from both ends of wires.
7. Remove approximately the same amount of insulation from both ends of the severed high current wire.



8. Bundle the spliced wires and tightly twist the bare wires together at both ends.
9. Twist one bare end of the splice tightly around one bare end of the high current wire.



10. Secure the splice tightly with electrical tape or hose clamps.
11. Repeat the procedure for the other end of the high current wire.



12. Use two layers of electrical tape or self-fusing tape making sure to overlap a couple of inches on both sides of the splice for a tight seal.
13. Record the BDR action taken, location of repair, and notify maintenance personnel at earliest opportunity.



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D. BDR Severed Coax Cable

WARNING

Prior to attempting any repairs to communications equipment make sure power is turned off. Failure to comply can result in severe burns, electrocution or death.

1. Remove approximately one inch of the outer insulation cover on both ends of the severed coax cable taking care not to damage the suppression shield.
2. Peel back (do not cut off) the metal suppression shield at both ends of the severed coax cable.



3. Carefully remove approximately one half to three fourths inch (1/2" to 3/4") of the thick inner insulation without damaging the core wire.

NOTE

The core can be twisted tightly together. Butt connectors can also be used to join severed coax cables especially those with a single solid core wire.

4. If a butt connector is used remove enough inner core insulation, slide the butt connector over one end of the wire before overlapping the wires.



5. Select a butt connector large enough to allow the wires to overlap inside and slide both ends of the splice into the butt connector.





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6. Crimp the butt connector tightly to ensure good contact in the splice.
7. If a butt connector is not used (multi strand core) spread the individual wires on both ends to intertwine the strands. Twist the strands tightly together.
8. Use electrical tape or self-fusing tape and apply it tightly over the core wires. Apply enough tape to the thickness of the inner insulator making sure that suppression shield strands are not in contact with the core wires.
9. Apply self-fusing tape over the entire inner insulation making sure the splice joints are completely sealed.
10. Slide the suppression shield over the repaired area making sure one side overlaps the other.



11. Apply self-fusing tape tightly over the entire repair area making sure to overlap one to two inches on each side of the repair.
12. Record the BDR action taken, location of repair, and notify maintenance personnel at earliest opportunity.

Section IV - Polymer BDR Kit

NOTE

For effective and reliable repairs with epoxies and polymers, surface preparation is critical. Surfaces must be free of all contaminants and scuffed up as much as possible for proper adhesion.

A. BDR With Metal Epoxy Stick

1. Assess the damage and determine the most reliable method of repair.



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NOTE

In an emergency, the metal epoxy can be applied to damaged components contaminated with POL products as a temporary means of minimizing fluid loss. For reliable repairs the surface area must be clean and free of contaminants.

2. Clean and degrease the surface around the damaged area thoroughly. Make sure it is completely dry before applying the epoxy.
3. Roughen the area with a wire brush or sand paper and re-clean the area to remove any debris that may have accumulated.



4. Determine the amount of the metal epoxy needed to make the repair.



5. Remove the epoxy from the tube, peel back the plastic cover (do not mix it with the epoxy) and cut the desired amount of epoxy.
6. Move the plastic cover over the exposed epoxy end and fold it over to seal it; then place it back in the plastic tube to prevent premature hardening of the remaining epoxy.





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7. Knead the epoxy until a uniform gray appearance is achieved.



NOTE

Working time for this product is approximately 3-5 minutes at ambient temperatures between 65° and 80° F.

8. Shape the epoxy into a cone so the tip barely fits in the hole. Place it over the hole and mushroom the end over the repair area to prevent it from falling into the hole. Allow thirty minutes before refilling the assembly.



9. Record the BDR action taken, location of repair, and notify maintenance personnel at earliest opportunity.

B. BDR With 1:1 Ratio Metal Polymer

NOTE

If the entire contents of the polymer packets are not needed for a particular repair, the corners of the packets can be cut and the desired amount squeezed out. Use equal amounts of Base and Solidifier for (1:1) or two parts solidifier for 2:1 etc... to ensure proper curing and reliability. Packets can be resealed by bending the corners and taping them closed. Once open, polymer shelf life will be significantly reduced. Read instructions, some polymers are not suited for component temperatures exceeding 120° F.

1. Assess the damage and determine the most reliable method of repair. Large perforations may require a patch plate while smaller perforations may require only reinforcement tape.



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NOTE

All polymers require good surface preparation for proper adhesion and reliability. Contaminated surfaces will cause the polymer to not adhere properly resulting in an unreliable repair. Use only cleaning agents or solvents that leave no surface residue. Do not mix the polymer until all surface preparations are complete.

WARNING

DU and CARC paint contain particles that can be harmful if ingested or come in contact with open wounds. Protect exposed skin and wear appropriate PPE when scraping or sanding surfaces known to have these properties.

2. Brush or wipe away loose debris and paint and clean the damaged area thoroughly with a suitable cleaner/degreaser.
3. Roughen the surface with a wire brush, sandpaper, or any means available to ensure proper adhesion.



4. Clean and degrease the surface again to remove any contaminants and allow to completely dry.
5. If the damage is large, use a patch plate from the BDAR kit or fabricate one from thin scrap metal and prepare both patch plate surfaces.



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6. Bend the patch plate to match the contour of the damaged area.
7. If the damage is small but large enough for the polymer to fall through use a piece of re-enforcement tape one to two inches larger than the hole.



NOTE

This type of polymer may be available in two separate packets (base and solidifier) or Siamese packets with a removable center strip. Prior to mixing both components knead each individual packet to ensure all properties have not separated especially in cold weather. Do not use the polymer if the equipment surface and the ambient temperatures are below 45° F or above 120° F.

8. If the polymer is in separate packages, push the polymer away from one edge and cut off the end of the base and solidifier packets just behind the seal.



NOTE

The curing process begins as soon as the base and solidifier come in contact. Do not allow them to touch unless you are ready to apply the polymer.

9. Using the straight edge of the mixing utensil or other suitable tool, squeeze out the entire contents of the packets onto a clean working surface.



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10. Mix the base and solidifier thoroughly to achieve a uniform color free of any streaks.
11. The polymer in the Siamese packets can be mixed in the packets after removing the center strip or on a clean working surface as in step “9”.
12. To remove the strip, face it away from you, unfold the packets and with one in each hand snap it away from each other. The center dividing strip will pop off.
13. Quickly mix the base and solidifier together to achieve a uniform color free of any streaks.



NOTE

Be prepared to apply the polymer mixture quickly to the damaged area. The working times for the product are as follows:

1:1 Metal Polymer Working Times

Temperature	41° F (5° C)	59° F (15° C)	77° F (25° C)
Use all material within	5 min	4 min	3 min

14. Apply the polymer mixture to the damaged area extending approximately 2-3 inches around the area.
15. If the product was mixed in the packets, cut off one corner and squeeze the polymer out and around the damaged area.



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16. If needed, apply the reinforcement tape by dabbing it into the first layer of polymer until it oozes through the tape to remove trapped air and provide a good bond.
17. If a patch plate is used, shape the contour to match the surface, apply polymer around the outside perimeter of the patch plate and press it onto the damaged area to remove any air pockets. Make sure all the edges are buried in the polymer for a good seal.



18. Apply the final coat of polymer over the reinforcement tape or patch plate making sure the entire repair is thoroughly covered and all edges are completely sealed.



19. If one packet was not enough to cover and seal the repair, an additional layer of polymer can be applied when the first layer has completely hardened. The process can be accelerated by heating the repaired area with warm air from a heat gun or other similar sources.



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20. Always consult the unit SOP and local ordinances prior to disposing of packets and utensils used for repairs. Once the product hardens it can usually be disposed of in normal refuse containers.
21. Record the BDR action taken, location of repair, and notify maintenance personnel at earliest opportunity.

C. BDR With 2:1 or 3:1 Ratio Metal Polymer

NOTE

These polymers are the best choice for engine blocks and coolant system with higher operating temperatures and pressures. The metal polymers have a thick pasty consistency preventing mixing in the packets. If the entire contents will be used, the polymer is premeasured with 2:1 or 3:1 mixing ratio. If smaller amounts are desired, cut off a small section of a corner on the base and solidifier packets, then squeeze two or three (depending on polymer) equal parts of base and one equal part of solidifier. To seal, bend back the cut corners and seal them with tape. Once opened the shelf life will be reduced and like other polymers curing begins when both base and solidifier make contact.

1. External Engine Block Crack or Puncture (Engine Operational)

- a. Locate the damaged area and assess the extent of damage.
- b. Thoroughly clean, degrease and prepare the damaged area.

NOTE

Larger punctures may require use of a patch plate. When repairing cracks, drilling a small hole at the end of the crack will prevent it from spreading and grinding a groove along the crack will significantly increase reliability.

- c. On a clean surface squeeze the contents of the base and solidifier packets (or desired equal amounts 3:1 base to solidifier) near each other without touching.
- d. After verifying that the surface is ready, mix the polymer thoroughly until a uniform color is achieved free of any streaks. Keep in mind that



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working time at 77° F is less than ten minutes. Refer to the table below for approximate working times.

2:1 & 3:1 Metal Polymer Working Times

Temperature	41° F (5° C)	59° F (15° C)	77° F (25° C)
Use all material within	20 min	15 min	10 min

- e. Apply the polymer to the damaged area squeezing it into the cracked surface to ensure maximum sealing. Allow at least one hour curing time at ambient temperatures between 60° F and 80° F, and at least thirty minutes at temperatures above 80° F. If the engine or the component is still warm the curing process will be accelerated.
- f. Replenish lost fluids (if needed) and monitor the repair and instruments for overheating or fluid pressure loss during operation.
- g. Record the BDR action taken, location of repair, and notify maintenance personnel at earliest opportunity.

2. Punctured Coolant Radiator (Engine Operational)

WARNING

Hot engine coolant can cause severe burns. Make sure the cooling system has depressurized and cooled significantly before attempting any repairs. Failure to comply will result in serious injury.

NOTE

Due to the location of most coolant radiators it may be difficult to access and identify the source of the leak. The radiator may require removal for proper patching.

- a. Identify the location and extent of damage. Pin holes and very small punctures may be temporarily repaired with radiator stop leak.



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- b. If radiator stop leak will be used, make sure there is some coolant in the cooling system and start by pouring one or two containers of stop leak into the radiator and filling it completely with water (only in warm temperatures).
- c. Start the engine (leave radiator cap loose) and observe for leaks. If necessary add more stop leak one container at a time until the leak stops or there is minimal leakage.

NOTE

The stop leak in the BDAR Kit works best when engine is running and coolant is circulating. When the engine is stopped the sealing particles tend to settle to the bottom of the radiator and the coolant may drain.

- d. If the damage is too great for stop leak to be effective, the damaged cooling tubes may have to be pinched closed or the damaged radiator tank patched.
- e. Using a set of needle nose pliers, carefully remove approximately one inch of cooling fins on each side of the damaged tube.



- f. This Procedure may cause pin holes on adjacent tubes which must also be sealed.
- g. Pinch the severed coolant tube shut at both ends, and fold the pinched ends over approximately 1/2”.



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NOTE

On large multicore radiators, if the tubes in the center rows are also damaged, it will be necessary to remove a larger section of the front rows to access the hidden tubes. This can be accomplished by a step method (stair case) from front to back. This allows for all damaged tubes to be crimped then sealed with polymer if desired.

- h. After pinching the damaged tubes closed stop leak can be used to seal small pin holes or for a more reliable repair polymer can be used.
- i. Completely clean and degrease the area to be sealed with the polymer and follow the same mixing procedures given for external engine block repairs.
- j. Cover the entire damaged area with polymer mixture to seal the pinched tubes and any possible pin holes on adjacent coolant tubes.



- k. Allow at least one hour curing time at ambient temperatures between 60° F and 80° F, and at least thirty minutes at temperatures above 80° F. If the radiator is still warm the curing process will be accelerated.
- l. Operate the system and monitor for leaks and overheating.
- m. Record the BDR action taken, location of repair, and notify maintenance personnel at earliest opportunity.

D. BDR With 1:1 Ratio Rubber Polymer

NOTE

Rubber Polymer is not well suited for medium and high pressure applications. When used, reinforcement tape or other means of overlapping the damage must be employed and sealed with the rubber polymer. Do not use the rubber polymer in high humidity or damp conditions, the polymer



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may not adhere properly. Rubber conditioner must also be used to enhance the bonding surface of the material being repaired.

1. Locate the damage and determine the best and most reliable repair method.



2. If the inside diameter of the hose is small enough a hose mender and clamps may be the best choice.
3. Clean and roughen approximately 2-3 inches around the damage area with a wire brush or sand paper to enhance the bonding surface.



4. Apply a light coat of conditioning agent to the prepared surface around the damaged area. The conditioning agent must be dry to the touch (approximately 15 min.) before applying the rubber polymer.



5. Based on the amount of damage and operating pressure determine if reinforcement is required for a reliable repair.
6. If reinforcement tape is used make sure it is larger than the damaged area and long enough to wrap around the hose.





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7. Knead the polymer in each packet especially in colder environments. Move the polymer away from one edge and cut off one end of both the base and solidifier packets behind the seal.



NOTE

Make sure all surface preparations are completed before mixing or allowing both parts of the polymer to touch. The working time for this polymer is extremely short and must be used within the time limits shown in the table. Hotter temperatures accelerate the curing process.

1:1 Rubber Polymer Working Times

Temperature	41° F (5° C)	59° F (15° C)	77° F (25° C)
Use all material within	6 min	4 min	2 min

8. Using a straight edge of the mixing tool or other suitable device, squeeze out the contents of the base and solidifier onto a clean mixing surface.





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9. Mix the two components thoroughly to achieve a uniform color free from any streaks.



10. Apply a thin layer of polymer to the prepared surface with applicator. Press down firmly when applying the mixture to remove entrapped air and to ensure maximum contact with the surface.



11. Immediately contour the mixture to the correct profile around the surface of the hose.
12. Apply the reinforcing tape (when needed) into the uncured mixture forcing it into the polymer until it oozes through.
13. Apply a second coat of polymer to completely cover and overlap the repair.



14. Allow a couple of hours curing time (at 77° F) before pressurizing the system.
15. Record the BDR action taken, location of repair, and notify maintenance personnel at earliest opportunity.



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Section V - Tire BDR Kit



NOTE

Many tactical wheels are equipped with run-flat rings allowing continued operation of the vehicle. However, travelling long distances and rough terrain can cause the deflated tires to overheat and shred. If the damage is minimal and the situation permits the tire can be quickly plugged and re-inflated. This will provide a better ride control and stability. Plugs can be cut in half to minimize waste.

CAUTION

Tire plugs are intended as a temporary repair for Central Tire Inflation System (CTIS) (if equipped) to maintain tire inflation or to manually re-inflate tires. These repairs may or may not be reliable and operators should be aware that the repaired tire could deflate unexpectedly. Speed should be considerably reduced when operating on run-flats or plugged tires.

A. Plug Punctured Tire Tread

1. Locate the damage and determine if it can be repaired with tire plugs.





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NOTE

If the tire is still inflated or partially inflated prepare the tire plug before removing the object and perform the following steps quickly to preserve air if a means to inflate the tire is not immediately available.

2. Remove debris or embedded objects with pliers.



3. Lightly coat the probe (only if necessary) with lubricant. The lubricant can cause the plug to slide back out under pressure especially in larger and higher pressure tires.



4. Immediately after the object is removed, insert the probe to preserve air. The probe may require some force and a twisting action to insert it fully. The probe separates the steel belts and also helps determine the direction of the puncture to insert the plug. Not all punctures are straight in.





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NOTE

8. Remove the probe from the puncture and quickly insert the plugs to minimize air loss making sure to follow the same path (direction) as the puncture.

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10. Hold the insertion tool release mechanism against the tire and slowly remove the insertion tool (avoid excessive twisting which can break the tool). The release mechanism will ensure the plug remains in the tire and free the insertion tool from the plug.
11. Trim off any excess plug to approximately $\frac{1}{8}$ to $\frac{1}{4}$ inch above the tire tread.



12. Check the repair and re-inflate the tire. Use water to verify that the repair was successful. Minimal leakage is acceptable and CTIS (if equipped) should maintain pressure. Check the tire periodically and re-inflate as needed if the system is not equipped with CTIS.



13. Record the BDR action taken, location of repair, and notify maintenance personnel at earliest opportunity.



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B. Plug Punctured Tire Sidewall

NOTE

Small single or multiple side wall punctures can often be temporarily repaired with tire plugs. Plugging procedures are the same as the tread plugs. Some punctures may require multiple plugs inserted tightly to stop or reduce air loss. The tire sidewall is the thinner part of the tire between the thread and the bead portion of the tire. Operating speed should be considerably reduced when operating on run flat or plugged tires.



1. With the probe determine the direction of the puncture. Steel cords are located closer to the tire thread and bead and in some cases make it impossible to insert a plug.
2. Once the direction of the puncture is identified, insert the desired number of plugs in the same manner used for plugging tread punctures.



3. To seal small leaks around the plugs and provide additional re-enforcement, rubber polymer with re-enforcement tape can be used over the plugs.
4. Record the BDR action taken, location of repair, and notify maintenance personnel at earliest opportunity.



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C. Seal Tire Side Wall Plug With Rubber Polymer

1. Clean and roughen the surface around the plugs with wire brush or sand paper.



2. Apply a light coat of rubber conditioner to the damaged area. Allow drying to the touch (approximately 15 min).



3. Prepare and mix the polymer as demonstrated in Section IV D, Steps 4-9.

NOTE

Ensure the tire is deflated or there is no air escaping around the plugs. Leaking air will form bubbles and prevent the polymer from sticking properly. Keep in mind the short working time of the polymer.

4. Quickly apply a base layer of polymer extending 2"- 3" beyond and around the damaged area.





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5. Immediately apply the reinforcement tape making sure to squeeze out air bubbles and until polymer oozes through the tape. Work from the center toward the edges and ensure the entire surface is covered.



6. Starting from the center, quickly apply the remainder of the polymer over the entire repair completely covering the reinforcement tape. Spread polymer higher at the center and tapering toward the edges.

NOTE

If an additional layer of polymer is needed, wait until the repair has cured (approximately 1 hour at 77° F). A second layer can be applied without surface preparation or conditioner up to four (4) after the initial repair providing the area was not contaminated while curing.

7. Re-inflate the tire after the polymer repair completely cures (one to two hours depending on ambient temperature).



8. Record the BDR action taken, location of repair, and notify maintenance personnel at earliest opportunity.

D. Other Uses For Tire Plugs

1. Tire plugs can be flattened and used as gaskets or seals.
2. Plugs can also be used to expediently plug perforated hoses, lines, oil pans and other fluid containers without surface preparation.



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Section VI - Drive Belt BDR Kit

A. Emergency (V) Belt Replacement

NOTE

The adjustable emergency “V” belt in the BDAR kit is intended for V type pulleys. Since most automotive systems today employ continuous (serpentine) belts the “V” belt kit has limited applications. In emergency situations the “V” belt can be successfully used on serpentine pulleys to drive a water pump or another critical accessory by placing the belt up-side down. An adjustable serpentine solution is being researched.

1. Remove any remaining pieces of the damaged V belt and ensure pulleys are not damaged.



2. Pull the belt tight around sheaves and overlap the ends to estimate the number of links that must be removed.



3. Hold the belt inside out. Fold it back at the point where the links must be removed and hold with one hand. Twist the tab 90° until it's in line with the slot. Pull the slotted link over the tab.





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4. Twist the belt 90° until it is in line with the slot. Remove the tab from the two slotted links and remove the excess links.



5. To assemble the belt, reconnect the ends by holding the belt with the tabs pointing outward.
6. Place the end tab through the two slots of the two links on the opposite end of the belt. Rotate the tab 90° until it is perpendicular to the belt.



7. Fold the belt back and twist the tab 90°. Insert the twisted tab through the slot, and straighten the tab.



8. Turn the belt over so the tabs are on the inside. Determine the direction of rotation and align the belt's directional "arrow" so it will rotate in the same direction as the drive pulley.



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NOTE

In an emergency the belt can be assembled slightly smaller and forced over the last pulley. For best results, loosen the adjusting pulley and ensure the belt is tight. Under operation the belt will heat up and loosen and may require periodic adjustment. Reduced speeds will insure longer operating times.

9. Fit the belt around the pulleys and slide the adjustment pulley to apply adequate tension on the belt to prevent slippage.



10. Record the BDR action taken, location of repair, and notify maintenance personnel at earliest opportunity.

B. Expedient (V) Belt Repair

NOTE

Broken or damaged V belts can be expediently repaired or fabricated using materials from the BDAR Kit. Reduced speeds and operating time may be required and belts replaced frequently. Some broken V belts can be temporarily mended by drilling small holes near the broken ends and mending them together with steel lacing wire. The wider the belt is the more re-enforcement strands it will need.



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1. To mend a broken V belt, drill small holes on a solid portion of the belt near the broken ends (cut the ends off if shredded).
2. Cut small sections of steel wire and feed them through the holes on both ends.
3. The wire ends must end up on the back or wide part of the belt away from the pulley.
4. Secure the wire ends by twisting them several times and making sure the belt ends remain in alignment. Cut off excess wire ends and fold the twisted portion onto the belt in the opposite direction of rotation.
5. Use a section of duct tape and tightly cover the repaired area overlapping three to four inches.
6. Loosen the adjusting pulley (or component) and place the belt over the pulleys making sure the twisted wire ends lay opposite of the direction of travel.
7. Adjust the belt tension (do not over tighten) and tighten the adjusting pulley bolts.
8. Operate at reduced speeds and check belt frequently.
9. Record the BDR action taken, location of repair, and notify maintenance personnel at earliest opportunity.

C. Fabricate Expedient Drive Belts

1. Expedient V drive belts can be fabricated using thin rope, electrical wires and tape. Reliability is limited and equipment should be operated only as needed.
2. A solution for expedient serpentine drive belts has not been developed. Recommend spare belts for emergencies with installation instructions.
3. Always record the BDR action taken, location of repair, and notify maintenance personnel at earliest opportunity.



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Section VII - Hardware BDR Kits



In addition to the intended primary functions of these items, application is limited only by one's imagination. The hardware BDR Kits consists of the following:

Large Hole Plugs – Two (2) large and two (2) medium hole plugs.

Small Hole Plugs – Four (4) smaller sizes of expandable hole plugs.

Hose Clamps – Six (six) sizes of hose clamps for fluid line repairs and many other applications.

Patch Plates – Made from soft bendable metal, easy to cut, designed for patching large holes in fluid reservoirs and many other applications.

Inserts – Four (4) sizes of plastic DOT pneumatic line inserts. These are required when using compression fittings to prevent crushing the plastic line.

Sleeve – Six (6) sizes of compression fitting sleeves. These sleeves become unserviceable when used. The extra sleeves allow the compression unions in the kit to be re-used after the damaged line is replaced.

Self-Tapping Screws – Used for multiple applications

Anti-seize Tape – Used for sealing pipe threads

Duct Tape – Multiple applications and uses

Self – Fusing Tape – Multiple applications and uses, it will not stick to any surface, it only fuses to itself. For proper fusing stretch the tape as much as possible without breaking it to activate the self-fusing properties and overlap it. The tape can be easily removed by cutting it.



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Appendix: A BDAR Kit Component List



Kit, BDAR NSN 5180-01-575-1265			
Item	Qt	NSN/ Vendor PN/ CMDC PN	Contact Information
Tool Bag	1	MC06A10049	800-528-9504 www.chocktawdefense.com/
Comp. List	1	MC06A10014	“
Smart Book	1	B00079	410-278-3050 leeescoebdarfeedback@conus.army.mil
MSDS/ COTS Lit.	1	MC06A10081	800-528-9504 www.chocktawdefense.com/
Tags BDAR	6	DD Form 1577 MC06A10013	“
Gloves	6	AMMEX #IN44110000M MC06A10064	877-882-1500 www.affirmed.com/
Cable Ties	20	5975-00-985-6630 73125296 MC06A10069	800-6457270 www1.msdirect.com/
V-Belt Auto.	1	3030-00-224-8358 408030 MC06A10065	800-243-3374 800-528-9504 www.fennerdrives.com/
Respirator Mask	4	#305050 MC06A10067	877-882-1500 www.affirmed.com/
Metal Polymer Kit 1:1	3	MC06A10052	800-528-9504 www.chocktawdefense.com/
Repair Kit Comp. 3:1	2	MC06A10053	“
Rubber Polymer Kit 1:1	3	MC06A10054	“
Tray, Top	1	BC06V10070	“
Tape, Duct	1	POLIKEN 231/220 BC06V10016	800-806-7580 www.findtape.com/
Metal Epoxy	1	570-2-0000 R570-2-0000	800-527-9916 www.partsmaster.us/
RTV Silicone	2	V: 64478126 CMDC: B00020	800-645-7270 www1.msdirect.com/
Tape, Electrical	1	V: 54041488 CMDC: B00021	“
Leak Preventive	6	V: ASBP24/12 CMDC: B00022	800-434-9954 www.gowestermann.com/



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Wire, Non Electrical	1	V: 73360273 CMDC: BC06V1009	800-645-7270 www1.msdirect.com/
Wire (16) Electrical	1	V: XNS-TB-124	800-827-1144 www.jcwire.com/
Wire (22) Electrical	1	V: XNS-TB-125 CMDC: BC06V10011	"
Tray, Middle	1	CMDC: BC06V10071	800-528-9504 www.chocktawdefense.com/
Tape, Self Fusing	2	V: RT1000202001USZ CMDC: BC06V10008	877-847-2628 www.harborproducts.com/
Cleaner Degreaser	2	CMDC: MC06A10063	800-528-9504 www.chocktawdefense.com/
Hacksaw, Folding	1	V: 01921253 CMDC: BC06V10018	800-645-7270 www1.msdirect.com/
Hacksaw Blade	1	V: 1479278 CMDC: BC06V10015	"
Acid Brushes	2	V: 06551915 CMDC: B00023	"
Wire Stripper	1	V: 00321539 CMDC: BC06V10017	"
Tray, Bottom	1	CMDC: BC06V10072	800-528-9504 www.chocktawdefense.com/
Tape, Anti-seize	1	V: M1250 CMDC: BC06V10018	800-999-8828 www.dealpro.com/
lug, 2" Environ.	2	V: 592-0000466 CMDC: RBDAR64G2	800-824-1556 www.tchweb.com/
lug, 4" Environ.	2	V: 592-0000467 CMDC: RBDAR65G2	"
Clamp, Hose #6	6	V: 9861501 CMDC: B00025	800-645-7270 www1.msdirect.com/
Clamp, Hose #10	6	V: 9861543 CMDC: B00026	"
Clamp, Hose #16	6	V: 9861584 CMDC: B00027	"
Clamp, Hose #24	2	V: 9861626 CMDC: B00028	"
Clamp, Hose #40	2	V: 9861709 CMDC: B00029	"
Clamp, Hose #56	2	V: 9861782 CMDC: B00030	"
Electrical Kit	1	CMDC: MC06A10097	800-528-9504 www.chocktawdefense.com/
Fluid Line Kit	1	CMDC: MC06A10098	"
Hardware Kit	1	CMDC: MC06A10099	"
Tire Kit	1	5180-01-542-8146 V: SSKTPXB CMDC: BC06V10029	800-888-9021 www.safetyseal.com/



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Appendix: B References

Army Regulations

- AR 750-1, Army Material Maintenance Policy, 12 September 2013

Department of the Army Pamphlets

- DA Pam 700-48, Handling Procedures for Equipment Contaminated with Depleted Uranium or Radio Active Commodities, 21 September, 2002.
- DA Pam 750-8, The Army Maintenance Management System (TAMMS) User's Manual, 22 August 2005

Field Manuals

- ATP 4-31, Recovery and Battlefield Damage Assessment and Repair, 27 August, 2014

Technical Bulletins

- TB 9-1300-278, Guidelines for Safe Response to Handling, Storage, and Transportation Accidents Involving Army Tank Munitions or Armor which Contain Depleted Uranium, 23 February 2001

Technical Manuals

- TM 3-251-BD, BDAR for Chemical Defensive Materiel, 23 September 1987
- TM 5-3835-222-BD, BDAR for POL Equipment, 23 June 1989
- TM 9-1000-257-BD, BDAR for 105-MM Howitzer Series, 04 April 2003
- TM 9-1000-258-BD BDAR for 155-MM Howitzer Series, 06 January 1988
- TM 9-2320-356-BD BDAR for Tactical Wheeled Vehicles, December 1987
- TM 9-2350-200-BD-1, BDAR for Tank, Combat, Full-Track: 105-MM Gun, M1, 105-MM Gun, IPM1, and 120-MM Gun, M1A1, 11 September 1991
- TM 9-2350-252-BD, BDAR for Bradley Fighting Vehicle (BFV), M2, M3, M2A1, and M3A1, September 1990



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- TM 9-2350-274-BD, BDAR for M109/M110/M578 Vehicles, Howitzer, Medium, Self-Propelled, Full-Track, 31 January 1984
- TM 9-2350-275-BD, BDAR for M113 Family, Carrier, Personnel, Self-Propelled, Full-Track, 09 February 1984
- TM 9-2350-276-BD, BDAR for Combat Vehicles, 10 February 1984
- TM 9-2350-284-BD, BDAR for Bradley Fighting Vehicle, M2A2 and M3A2, January 1992

References (continued)

- TM 9-2350-358-BD, BDAR for Howitzer, Medium, Self-Propelled: 155MM, M109A6, 25 March 1994
- TM 9-6115-624-BD, BDAR for Generators, 28 September 1990
- TM 11-5800-215-BD, BDAR for Communications-Electronics Equipment, 01 December 1986
- TM 9-2355-311-BD 0 BD for Stryker FOV May 2007
- TM 9-2320-329-BD, for MRAP FOV Vehicles (Draft) May 2009

USMC Equivalent regulations

- Not available at this time



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For information and feedback regarding the U.S. Army
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TRADOC Project Office for Battlefield Recovery and
BDAR
360 Lanyard Road
Aberdeen Proving Ground, MD 21005

COM: 410-278-3050/4115
DSN: 298-3050/4115

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