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Recovery and Battlefield Damage Assessment and Repairs

U.S. Marine Corps

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DAMAGE ASSESSMENT AND REPAIR

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RECOVERY AND BATTLEFIELD DAMAGE ASSESSMENT AND REPAIR

OCTOBER 1995

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DEPARTMENT OF THE ARMY
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RECOVERY AND BATTLEFIELD DAMAGE ASSESSMENT AND REPAIR

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PREFACE

PURPOSE

This field manual provides doctrinal guidance on the use and employment of recovery and repair assets on the battlefield. Practical methods of recovering or repairing disabled or immobilized vehicles due to terrain, mechanical failures, or hostile actions are also addressed in this publication.

SCOPE

FM 9-43-2 is directed toward both the leader and the technician. Tactically, it provides a layout of how recovery and BDAR assets are employed on the battlefield. Technically, it provides principles of resistance and the mechanical applications to overcome them. Equipment, rigging techniques, and expedient repairs are summarized as a refresher for H8 ASI (recovery-trained) soldiers and as general guidance for others.

APPLICATION

The procedures and doctrine in this manual are designed for both wartime and operation other than war. Normally, BDAR should be used when and where standard maintenance practices are not practical due to METT-T. BDAR is not meant to replace standard maintenance practices, but rather to supplement them under certain conditions. Standard maintenance procedures provide the best and most effective means of returning disabled equipment to the operational commander, provided adequate time, parts, and tools are available.

High-risk battlefield damage repairs, (danger to personnel and equipment) are only authorized in

emergency situations, normally in a battlefield environment and only when directed by the owning unit commander or his designated representative. The goal is to return a combat system to battle in the least amount of time.

BDAR techniques are not limited to simple restoration of minimal functional combat capability. If full mission capability can be restored expediently with a limited expenditure of time and assets, this should be done. This decision is based on METT-T.

Some BDAR techniques, if applied, may result in shortened life or further damage to components. The commander must decide whether the risk of having one less vehicle outweighs the risk of applying a potentially destructive expedient repair. Each technique gives appropriate warnings and cautions and lists system limitations caused by this action.

When operating recovery assets around or on an aircraft, extreme caution and use of ground guides must be a factor.

Users of this manual are encouraged to submit suggestions, changes, or comments to improve this manual. Comments with justifications should be keyed to specific page, paragraph, and line of text; prepared on DA Form 2028 (Recommended Changes to Publications and Blank Forms); and forwarded to:

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The provisions of this publication are the subject of international agreement QSTAG 171, Procedures for Repair and Recovery of Military Technical Equipment.

Unless this publication states otherwise, masculine nouns and pronouns do not refer exclusively to men.

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CHAPTER 1

INTRODUCTION TO RECOVERY AND BATTLEFIELD DAMAGE ASSESSMENT AND REPAIR

Recovery and Battlefield Damage Assessment and Repair (BDAR) are separate and distinct subsets of maintenance. Both are the owning units' responsibility, both have a fundamental purpose of returning combat assets to the battlefield ASAP. The purpose of recovery is the rapid removal of a disabled vehicle from the battlefield while the purpose of BDAR is the rapid temporary repair of the vehicle in order to continue the mission or self-recover. Training for BDAR should include some training in recovery techniques. There are not any written policies for BDAR in the United States Marine Corps. Recovery vehicles, wheel and track, should carry at least one BDAR kit to aid in recovery operations.

RECOVERY

Recovery is retreiving, or freeing immobile, inoperative, or abandoned materiel from its current position and returning it to operation or to a maintenance site for repair. These actions typically involve towing, lifting, and winching. Towing is typically limited to moving vehicles to the nearest Unit Maitenance Collection Point. Recovery consists of: Self-recovery, like-recovery, and dedicated-recovery. Self-recovery actions use only the equipment's assets; like-recovery actions involve the assistance of a second, similar vehicle; and dedicated-recovery requires the assistance of a vehicle which is specifically designed and dedicated to recovery operations. Recovery also takes place during operations other than war (OOTW). Unless specifically mentioned, recovery Tactics, Techniques, and Procedures (TTP) and Doctrine, Organization, Training, Leader, Development, and Soldier (DOTLMS) considerations apply to both combat and OOTW.

SELF-VEHICLE

Self-recovery is initiated at the location a vehicle becomes mired or disabled. The operator/crew uses the basic issue items (BII) and additional authorized listing (AAL, OVE for USMC) items to perform self-vehicle recovery. Also the operator/crew can use the axe to cut branches to put under the tires/track to get better traction (if situation or country permits tree cutting).

When the equipment has a mechanical failure, the operator/crew will use the equipment's -10 manual to perform troubleshooting procedures with the tools available in the BII and AAL. When self-recovery fails, the operator/crew requests assistance from available like vehicles.

NOTE: By current doctrine, equipment self-recovery winches can only be used to recover the vehicle that it is mounted on. It cannot be

used to recover another mired vehicle. Dedicated recovery vehicles with trained operators will perform this function.

LIKE-VEHICLE

Like-vehicle recovery is used when self-vehicle recovery fails. The principal is to utilize another piece of equipment, of the same weight class or larger, to extract or tow the mired vehicle by use of tow bars, chains, tow cables, and Allied Kinetic Energy Recovery Rope (AKERR). The AKERR is used to extract a mired vehicle, it is not designed as a towing device. When self- and like-vehicle recovery is not practiced or available, then use dedicated recovery assets.

DEDICATED RECOVERY VEHICLE

Using a dedicated recovery vehicle is the second level of recovery. Dedicated recovery vehicles are used in situations where self/like-vehicle recovery is not possible due to the severity of the situation, safety considerations, or the inability to use like-vehicle assets employed in their primary function.

Recovery managers must ensure recovery vehicles are used only when required and returned quickly to a central location to support the unit. In addition to its recovery mission, this equipment is often used for heavy lifting required in maintenance operations. Recovery manager/supervisors must use all available resources carefully to provide sustained support.

BDAR

BDAR is the procedure used to rapidly return disabled equipment to the operational commander by expediently fixing, bypassing, or juryrigging components. BDAR restores the minimum essential

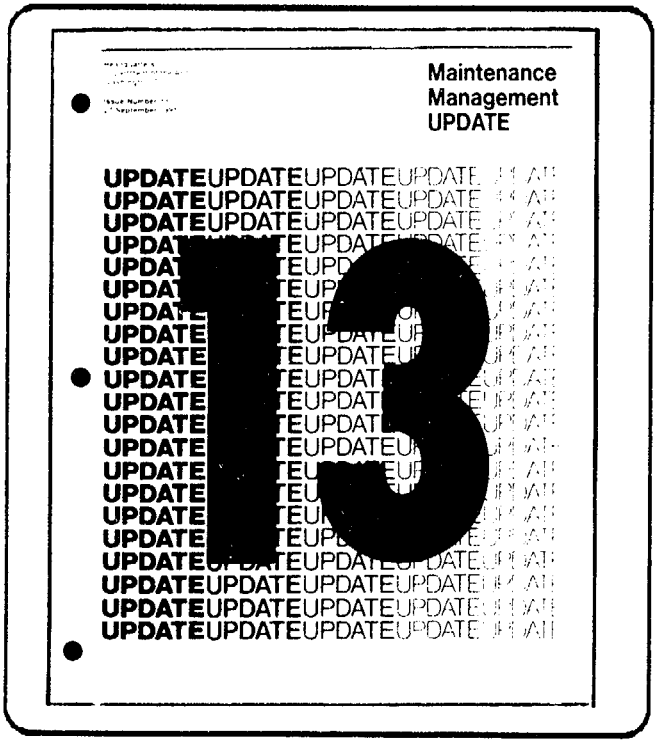


Figure 1-1. The Maintenance Management UPDATE, AR 750-1-DA Pamphlet 738-750

combat capabilities necessary to support a specific combat mission or to enable the equipment to self-recover. Depending on the repairs required and the amount of time available, repairs are temporary and may or may not restore the vehicle to fully mission capable (FMC) status. It is done by crew, maintenance teams (MT), maintenance support teams (MST), or recovery teams. BDAR will not fix all problems but has proven a 79 percent return to combat rate. BDAR fixes are not permanent repairs in accordance with AR 750-1. Replace these repairs with standard maintenance procedures as soon as possible and carry a circled X until replaced.

PEACETIME BDAR APPLICATION AND TRAINING

The Maintenance Management UPDATE, AR 750-1 (Figure 1-1), requires unit commanders to conduct non-distructive peacetime BDAR training. There are also critical soldier technical tasks that soldiers must master before performing BDAR or Recovery. Soldiers on BDAR or recovery teams must know how to read a map, handle booby traps, use the radio, and so forth. Each crewman should know how

to perform initial battle damage assessment (BDA) for his equipment and especially his crew position.

The Army maintenance standard is based on -10/-20 TMs and PMCS; there are specific occasions when peacetime BDAR can be applied. Units are encouraged to perform low-risk, nondestructive BDAR techniques during training events. A goal of Army training is to simulate combat conditions as closely as possible. It is at this time that commanders can direct the employment of BDAR for normal maintenance failures. Unit commanders should develop scenarios during training in which vehicle crews and unit/DS mechanics conduct BDAR and recovery operations. BDAR is found in individual and collective training tasks. Commanders should be aware of what MOSs require knowledge of BDAR. Company and battalion (ARTEP) tasks, especially in combat service support CSS units, require some knowledge of BDAR. Military Qualification Skills (MQS) for ordnance company grade officers also require awareness of the Army's BDAR policy and doctrine.

Peacetime BDAR training is necessary if we are to perform these vital tasks on the battlefield. Recent military operations have highlighted how U.S. forces can be projected almost overnight into situations where combat is expected and normal logistical arrangements are rudimentary.

Equipment operators and mechanics can probably master BDAR very quickly as they have already had some maintenance and mechanic training. Vehicle crew members should be taught BDAR techniques for their specific crew stations. Cross-training of organizational and DS is also necessary. Mechanics who can change a fan belt or fuel filter can easily learn how to do expedient fixes for these same items. Experience in live-fire tests at Aberdeen Proving Ground, Maryland and at Meppen, Germany, have demonstrated that soldiers can pick up the necessary skills to perform BDAR with a minimum of training. With the adoption of TACOM ground equipment BDAR kits and easy-to-use instructions, the task of training will be even easier for the commander. Another factor in performing BDAR training is the fact that techniques outlined in BDAR TMs are simple tasks with easy to comprehend illustrations.

Training BDAR does not require expensive or complicated training aids. Unit equipment, during field exercises, can have low-risk BDAR fixes applied to them until standard maintenance can be performed, if required. Soldiers can use BDAR TMs and kits to become proficient in their use and assessment procedures. If more sophisticated or difficult tasks are to be trained, then old radiators, gas tanks, hydraulic lines, and code H vehicles and equipment are often available through local DRMO. Supervisors at all levels should use the low-, medium-, and high-risk classifications when performing such training to minimize accidents and/or damage to equipment. The unit commander makes the desicion to use low-risk peacetime BDR during training.

To summarize, a unit training program should use the following outline to--

- Orient crew/operator/mechanic on BDAR doctrine and regulations.
- Train personnel in BDAR TM and kit use.
- Periodically review the following BDAR training films--
  - **709741 DA TVT 9-237**, Battlefield Damage Assessment and Repair - M1 Battle Damage Repair Kit.
  - **709740 DA TVT 9-236**, Battlefield Damage Assessment and Repair - The M2/3 Generic Battle Damage Repair Kit.
  - **709742 DA TVT 9-238**, Battlefield Damage Assessment and Repair, The M88 Battlefield Damage Repair Kit.

Train personnel in identifying BDAR fixes for any equipment breakdowns that can be used to restore full or partial operation. This includes--

- Installation of components from other vehicles that can be modified to fit or interchange with components in order to restore basic functional capability.

- Part fabrication, jury-rigging, and use of substitute fuels,fluids, and lubricants. Provide time in the unit training schedule to practice BDAR. During FTXs, low-risk BDAR should be allowed. Standard repair can be performed later. TACOM and ATCOM BDAR kits and training films can be used to familiarize personnel on kit utilization.

Use local materials from DRMO or other available equipment such as vehicle hulls used as range targets for hull repair. This will be especially helpful in familiarizing people with ground and aviation BDAR kits.

WAIVER OF PRECAUTIONS

In combat, BDAR/Recovery may be performed on vehicles and equipment which are fueled and/or armed. Other precautions may be waived at the discretion of the commander.

NBC ENVIRONMENT

BDAR/Recovery may be required in a chemically contaminated area or under adverse conditions with severe limitations involving personnel, facilities, equipment, and materials. Performance of repair/recovery tasks may be necessary while wearing protective gear. If the mission does not allow for a recovery team to recover the equipment, BDAR should be kept to a minimum, then recovered to a decontamination area. After decontamination, complete repairs. FM 3-5 (FM 11-10 for USMC)contains expedient decontamination procedures.

Full MOPP reduces the efficiency of recovery personnel. Protective clothing and equipment restricts the soldier's working ability. While wearing gloves, manual dexterity and touch sensation are reduced. Wearing the mask limits sight, speech, and hearing. in accordance with FM 3-4, recovery operations are considered to be a heavy work load. Heat buildup is a major factor in doing heavy work for long periods. The rate of work may be varied using short rest periods, rotation of heavy jobs, adequate water supply, and use of vehicle transportation.

When there is not a direct threat, the protection level for tasks requiring manual dexterity, visual

acuity, and voice communication may be reduced. General guidance on the levels of MOPP and associated protective clothing and equipment are covered in the unit SOP and FM 3-4.

CAUTION:

Recovery team personnel conducting BDAR or other recovery operations (under NBC conditions) must use caution to minimize any damage to their masks, hoods, or overgarments (for example, POL spills, and so forth). Recovery teams must be aware that vehicle filters or fluid reservoirs may also contain NBC contaminants, and caution should be exercised when checking or repairing those particular components.

Recovery teams must be trained in NBC defense procedures, monitoring, and detection techniques. The teams should have extra decontamination equipment, decontaminating agents, and protective clothing. Contaminated recovered equipment could spread an agent along the evacuation route. Contaminated recovered equipment flowing forward may spread an agent along the route and pose a hazard to uncontaminated units and equipment. Commanders should keep in mind that equipment used to recover contaminated equipment will also be contaminated. Contaminated equipment should not be evacuated to clean areas until fully decontaminated. The sooner the contamination is removed, the sooner you can reduce MOPP levels and begin restoring combat power.

A complete assessment needs to be made before entering a battle damaged vehicle, vessel, or aircraft before attempting to repair any damaged equipment. Some additional environmental concern of risk could be damaged ammunition that has depleted uranium (DU) as a component material. Depleted uranium emits low-level radiation, which is mostly an internal body hazard (open wounds, ingestion, inhalation). Depleted uranium, if it enters the body, can cause heavy metal poisoning. Inform medical personnel when any injured personnel are exposed to particles of depleted uranium or any known radiation hazard.

When working in an environment which is or may be contaminated with depleted uranium, soldiers should make every effort not to have skin come into contact with depleted uranium particles: they should keep sores and open wounds covered and use protective masks, M17/M40, to prevent inhaling or ingesting depleted uranium particles. When working in or around vehicles damaged by DU ammo or vehicles with DU armor damage, wear safety glasses and gloves, wash hands and face thoroughly before eating, drinking, and/or smoking! The area may contain unexploded ordnance, identifiable or unidentifiable enemy ordnance, or in aircraft, the emergency escape mechanisms with hatch opening and ejection explosives.

ENVIRONMENTAL PROTECTION

Fuel, oil, and other mechanical fluids spilled on the ground during BDAR operations can cause great great damage to the environment. As with many BDAR considerations, the level environmental protection will be mission dependant. Even in periods of heightened conflict, simple steps can help to perserve and protect our fragile environment. All practical efforts should be made to avoid environmental contamination. Spills over one gallon should be reported through the chain of command to the unit's logistical element, such as the Batallion's S-4.

TOOLS AND EQUIPMENT

The U.S. Army Materiel Command has designed special BDAR kits for ground equipment and Army aviation. These kits were designed for use at the breakdown site to allow the crew or maintenance personnel the capability to perform BDAR without access to special tools and equipment. Normally these kits are located with the MT or the DS MST. A smaller, lighter, and more inexpensive kit is being designed for the operator/crew for use onboard vehicles. BDAR is by no means limited to what can be performed with these kits, but for the first time, crew and maintenance personnel will have materiel and tools on hand specifically designed for BDAR. Vehicle BII, On Vehicle Equipment (OVE) for the USMC, organizational tools, and tools found with the DS contact teams are to be used when available.

HOST NATION SUPPORT MAY BE UTILIZED TO OFFSET PROBLEMS ENCOUNTERED BY UNITS DEPLOYED OVERSEAS

In an actual theater of operations, units will be expected to make extensive use of host nation military and commercial sources to perform BDAR and replenish kits. Each unit is expected and encouraged to modify its kits to suit its special operational needs and geographical environment. See Appendix A for additional information on BDAR kits.

HOST NATION SUPPORT (HNS)

Units deployed overseas find themselves at the end of a long line of communications. In addition, soldiers operate in harsh terrain and less than desirable climatic conditions. Units may expend their basic load of supplies very quickly and may face a long wait for replenishment. Deployment flow may not allow delivery of recovery assets until late in the deployment sequence. To offset these problems, HNS can be used to replenish contents of BDAR kits, and provide recovery assets, material, and equipment. Even in the most remote locations of the world, HNS will usually have industrial sources and automotive repair capabilities. material suitable for recovery. Procurement officers should be able to replenish BDAR kits and obtain other supplies and

tools required to perform BDAR and/or recovery operations. Higher headquarters publish command directives outlining HNS procurement procedures and sources of supply. BDAR kit contents are selected and designed to be replenishable from local sources. Commanders and maintenance personnel must be prepared to avail themselves of this valuable resource.

Host or hostile nation service stations, industrial facilities, and automotive service and supply centers are invaluable sources of supply. Use of local sources must be closely supervised by the responsible field procurement officer. Prompt payment of purchases and payment for rental space and facilities is crucial to maintaining friendly relations with the local population and retaining their support. If using abandoned HNS or hostile nation equipment that is suitable for BDAR and recovery operations, be sure to gain command approval prior to use. Procurement offices should be involved in the decison.

During operations in a host nation, such as OOTW missions, U.S. forces will comply with all applicable regulations including Status of Force Agreements, treaties, and international agreements. Important to BDAR are the HN laws governing spills such as fuel and oil. If no HN environmental laws exist, as was the case in Operation Restore Hope in Somalia, U.S. forces will follow the laws of the United States. See Appendix B for information on Combined and Multinational BDAR operations.

CHAPTER 2

PRINCIPLES OF RECOVERY

GENERAL

Recovery is performed to:

- Retrieve damaged equipment for repair and return to use.
- Retrieve abandoned equipment for further use.
- Prevent enemy capture of equipment.
- Ensure recovery assets are equipped with communications.
- Obtain enemy materiel and records for intelligence purposes or for use by US or allied forces.

Recovery assets are centrally managed. This provides direction, permits better management, and provides quicker responses to task organization, work load, and the tactical situation. In combat units, the recovery manager is designated at battalion level and is normally the BMO. Some combat arms battalions (that is, nondivisional, defense battalions, engineer battalions, and so forth) have company-sized units that operate without a BMO or BMT. In these type units, the senior maintenance supervisor, motor officer/sergeant, manage recovery assets.

The type and quantity of supported equipment, as well as tactical situation, may require the tailoring of recovery assets. Only the minimum number of recovery assets should be deployed for each mission.

The BMO or other designated individual coordinates recovery operation with overall repair efforts to support the commander's priorities and tactical situation most effectively. The following general principals apply to recovery management:

- Commanders must set recovery priorities.
- Using units are responsible for recovery of their equipment. Limited backup support is available from the next level of maintenance.
- Coordinate recovery operations with the maintenance effort.
- Recovery vehicles of the correct load class must be used to ensure safety.
- Recovery vehicles should not return equipment farther than the UMCP. This keeps recovery assets forward.
- Recovery teams must use NBC contamination avoidance principles to avoid contamination or to minimize targeting.
- Recovery teams should take all practical steps to avoid spills and other environmental contamination.

FUNDAMENTAL METHODS OF RECOVERY

INTRODUCTION

Three questions should come to mind when a soldier faces a recovery task: "What must be done?", "What equipment must be used?", and "What techniques must be used?" This chapter will answer these questions beginning with a summary of the four methods of recovery. It will give details about recovery tackle and how to use and maintain it.

WINCHING, LIFTING, TOWING, EXPEDIENTS

The four methods of recovery are:

- **Winching** - using winches on special purpose or cargo vehicles.
- **Lifting** - using lifting capabilities of special purpose vehicles.
- **Towing** - using the towing capabilities of similar or special purpose vehicles.
- **Expedients** - used when other methods are not adaptable to the situation, or when appropriate like-vehicles or dedicated recovery vehicles are not available.

RECOVERY SAFETY

Recovery can be inherently dangerous unless safety is continually observed and practiced. Each of the recovery functions (winching, lifting, and towing) must only be performed with safety as the primary concern. Always follow safety warnings in this manual and in the operator's manual for both the recovery vehicle and the recovered vehicle or equipment. Following are some key factors and actions that can help prevent unnecessary damage to equipment and more importantly, injury to personnel.

Know recovery equipment capabilities and limitations! Winches have tremendous power and if not properly secured to the disabled vehicle, they can rip off tow lugs, bumpers, and other attachments that often become missiles injuring personnel and/or damaging equipment. Always follow the safe rigging guidelines in this manual. Keep all but the minimum required personnel away from the recovery area. Each recovery crew member must know where other crew members are located at all times.

Ground chocks and spades have their limitations. If overloaded, the recovery vehicle can slide out of control.

Winch cables can break and backlash into personnel.

Exercise extreme caution when towing.

Towed track vehicles and some wheel vehicles will not have any braking effect. The recovery vehicle must provide braking for the towed vehicle as well as itself. Remember, some track vehicles may also require a holdback vehicle during towing operations. Check the operator's manual.

Wrecker lift-towing operations also require extreme caution! The towed vehicle performs abnormally because the vehicle weight is not distributed on all wheels and the wrecker steering control is degraded because of reduced weight on the front wheels.

Other recovery lifting actions also require extreme caution to prevent injury to personnel and/or damage to equipment. Suspended loads can drop or slide. If the crane has a remote control, use it to keep away from the action. The remote control can also assist in observing equipment movement of the recovery actions and location of other crew members. Never exceed the limitations of the crane or its outriggers.

REMEMBER,
DURING RECOVERY OPERATIONS
SAFETY FIRST !

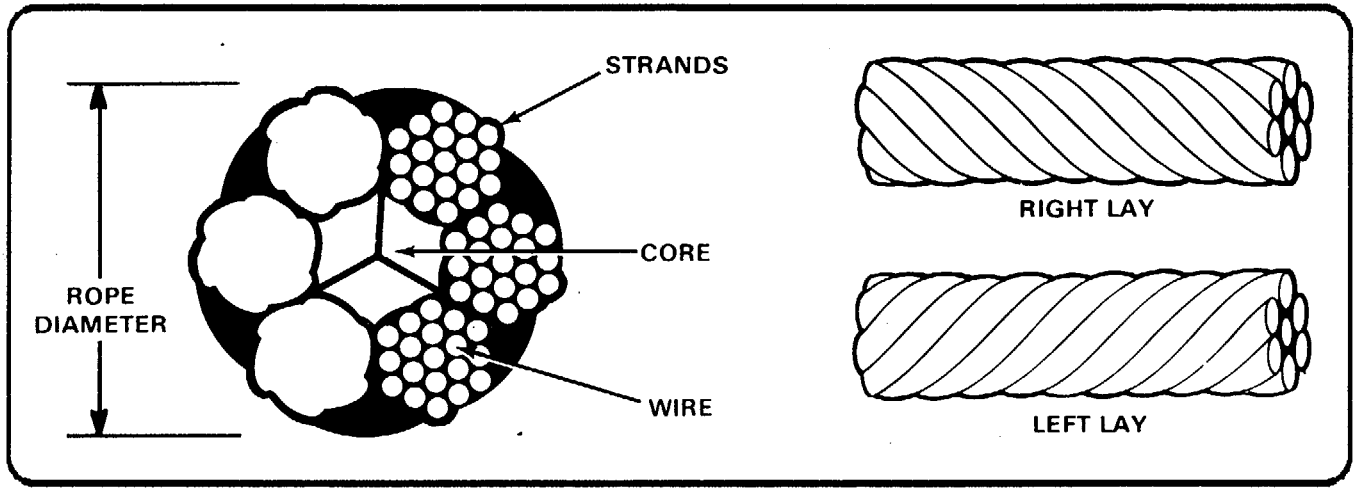


Figure 2-1. Wire Rope

RECOVERY EQUIPMENT

Wire Rope

A wire rope is made of many wires twisted together to make a strand. The strands are then twisted together around a core making a rope. Wire rope is designated by the number of strands per rope and the number of wires per strand.

Example: 6 x 19 rope is 6 strands per rope, 19 wires per strand.

Cores. Wire rope cores are of three types: fiber, strand, and independent. Each type gives support to the strands laid around it. Fiber cores will add flexibility and elasticity to a wire rope. Metallic strand cores will withstand high operating pressures,

resist heat, and give minimum stretch and additional strength. However, independent wire rope cores are often used for winches because they add the most strength.

Lay. The lay of wire rope is the combined direction of the lay of the wire in the strand and the direction of lay in the strands on the rope. Wire rope is made with either right or left lay, depending on the direction of the helix of the strands in the rope. In a right-lay rope, the strands are laid around the core from left to right, as in a right-hand screw thread. The strands of a left-lay rope are laid around the core from right to left, as in a left-hand screw thread. In most cases, it makes little difference whether a right- or left-lay rope is used. However, right-lay ropes are recognized as standard for most types of service.

Care and Use. Wire rope should be handled correctly at all times for best service and to prevent injury to personnel. When using wire rope, observe the following precautions.

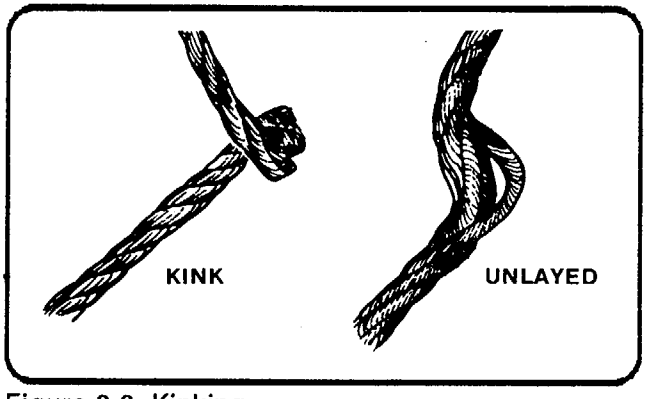


Figure 2-2. Kinking

New rope. When installing new wire rope,work the rope several times under a load so that it can adjust itself to working conditions, i.e. build memory.

Kinks. Avoid all kinks. Kinks make the rope unservicable. A kink cannot be straightened by pulling the rope taut since this merely unlays the rope.

Miscellaneous. Avoid pulling rope around small trees or flat surfaces since this causes strands to spread. Avoid using wire rope on sheaves that are too

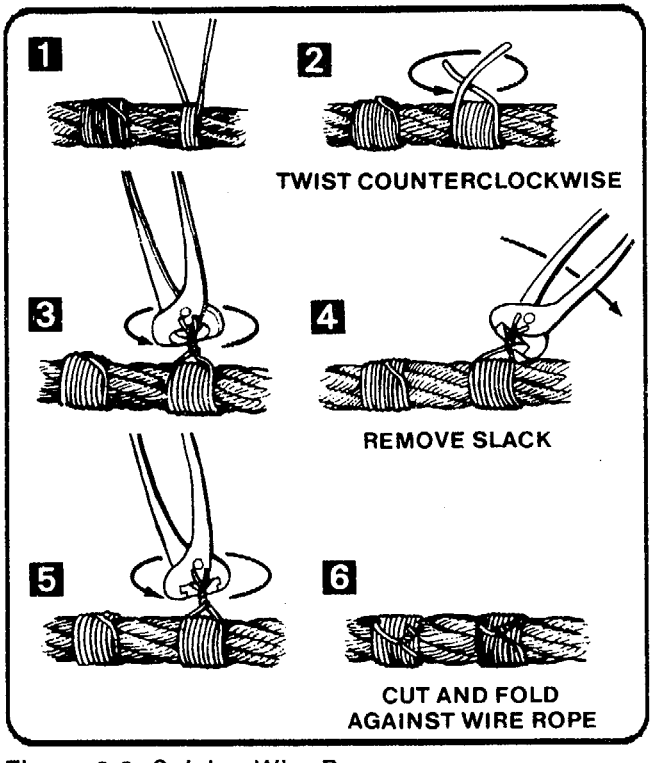


Figure 2-3. Seizing Wire Rope

small since this breaks wire in the strands and weakens the rope.

Wire rope lubrication. Be sure to lubricate wire rope which is in service. Lubrication protects the rope against corrosion, reduces friction within the rope, expels moisture, and preserves the rope. Wire rope is lubricated when manufactured, but requires periodic lubrication. Check the appropriate vehicle technical manual for type and interval of lubrication.

Seizing wire rope. Always bind the ends of wire rope to prevent strands and wire from untwisting. Before cutting wire rope, it is necessary to bind it. The seizing method is recommended when special fittings are not available. to the rope by hand. Keep the coils tight and the rope under tension. Twist the ends of the seizing wire counterclockwise, and tighten the twist enough to remove slack. The number of wraps for each end of the wire rope should be three times the diameter of the rope in inches. They should be made the same length as the diameter of the rope, and spaced a distance equal to twice the diameter of the rope.

WARNING:

When seizing wire rope, it is important to be safety conscious. Cables or wire ropes can become damaged through use. Personnel should always wear heavy gloves with leather palms when handling wire rope or cable to minimize potential injury. Gloves will prevent hands from being injured or cut because of broken wires.

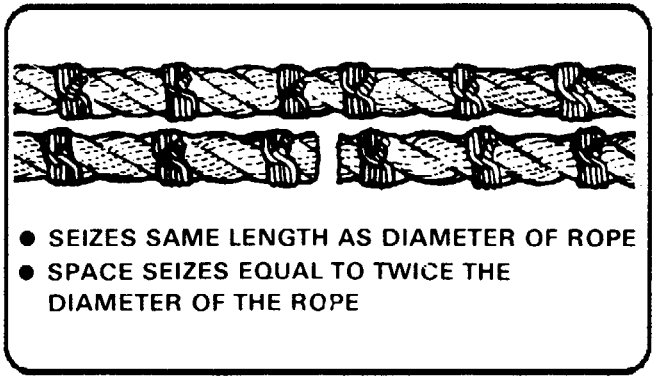


Figure 2-4. Cutting Wire Rope

Cutting: After seizing, wire rope may be cut by any of the following means:

- A special wire rope cutter and sledge hammer.
- A long tapered chisel and sledge hammer. (The chisel must be wider than the rope being cut.)
- A bolt cutter (small rope only).
- A hacksaw.
- An oxyacetylene cutting torch if rope is not to be spliced. This is a dangerous procedure. Exercise extreme caution.

Wire Rope Attachment

Fittings or end attachments for wire rope vary with use. The standard fittings for field use are thimbles and clips. Splicing is not practical in the field.

Thimbles. Thimbles are used in the loop formed when the rope is attached to the eye of hooks or

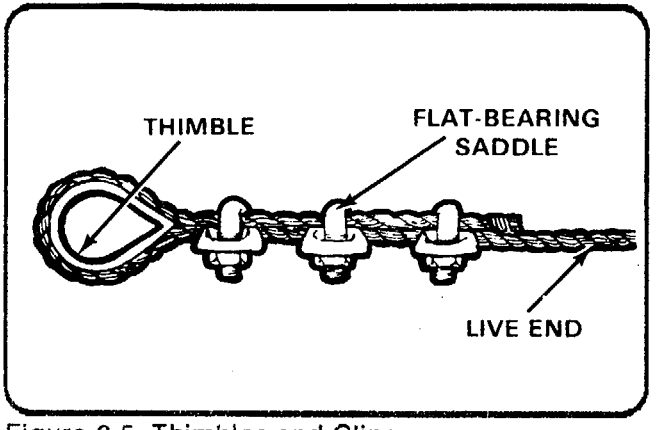


Figure 2-5. Thimbles and Clips

rings. Thimbles keep wire in the strand from shearing and breaking when stress is applied.

Clips. When attaching clips, place all the U-bolts on the short or dead end of the rope. This protects the live or stress-bearing end of the rope from possible crushing and abuse. The flat-bearing saddle or base and extended prongs of the body are designed to protect the rope and should always be placed against the live end. If clips are incorrectly installed, they will cause shearing, extensive wear, and breakage.

To determine the number of clips, torque, and spacing, refer to Table 2-2 of TM 5-725.

Fiber Rope

Fiber rope is generally referred to as cordage and consists of vegetable or synthetic fibers twisted together. Vegetable ropes are usually made of sisal or hemp fibers. Today most ropes are made of nylon fibers. These ropes are preferred because their tensile strength is nearly three times that of natural fibers. Nylon ropes are waterproof, return to normal size after being stretched, and resist abrasion, rot, decay, and fungus growth.

The strength and useful life of rope will be shortened considerably by lack of maintenance. It should be stored in a cool, dry place. Avoid dragging the rope through sand, grit, or bending it across sharp surfaces.

Inspect by untwisting strands slightly to open the rope for examination. Mildewed ropes will have a

THE SAFE WORKING CAPACITY OF A ROPE CAN BE OBTAINED BY SQUARING THE DIAMETER OF THE ROPE IN INCHES

musty odor, and inner fibers of the strand will have a dark appearance. Unserviceable ropes should be cut in small pieces to prevent their use for hoisting.

See Table 1-1, TM 5-725, for a detailed listing of the properties of manila and sisal rope. As a general rule, the safe working capacity (SWC) of a rope can be obtained by squaring the diameter of the rope in inches ($SWC = d^2$). This formula gives SWC in tons, allowing a safety factor of approximately four.

Example: SWC of a 1/2-inch rope is .5 X.5 = .25 tons.

BLOCKS

Blocks consist of a shell or frame with one or more grooved wheels called sheaves. Two basic constructions (snatch and conventional) are used in the military.

Snatch Block

A snatch block is used when it will not be a permanent part of a tackle system (ropes, blocks, and pulleys used to raise and lower loads and/or apply tension) and can be used as required based on the

situation. It is constructed so that the shell can be opened to admit a cable without reeving. Winch cables have attachment-like hooks or sockets on their free ends and can be reeved through a block.

Conventional Block

A conventional block is generally used where it will remain as part of a rigging system. On recovery equipment, it is used with fiber rope. To form a

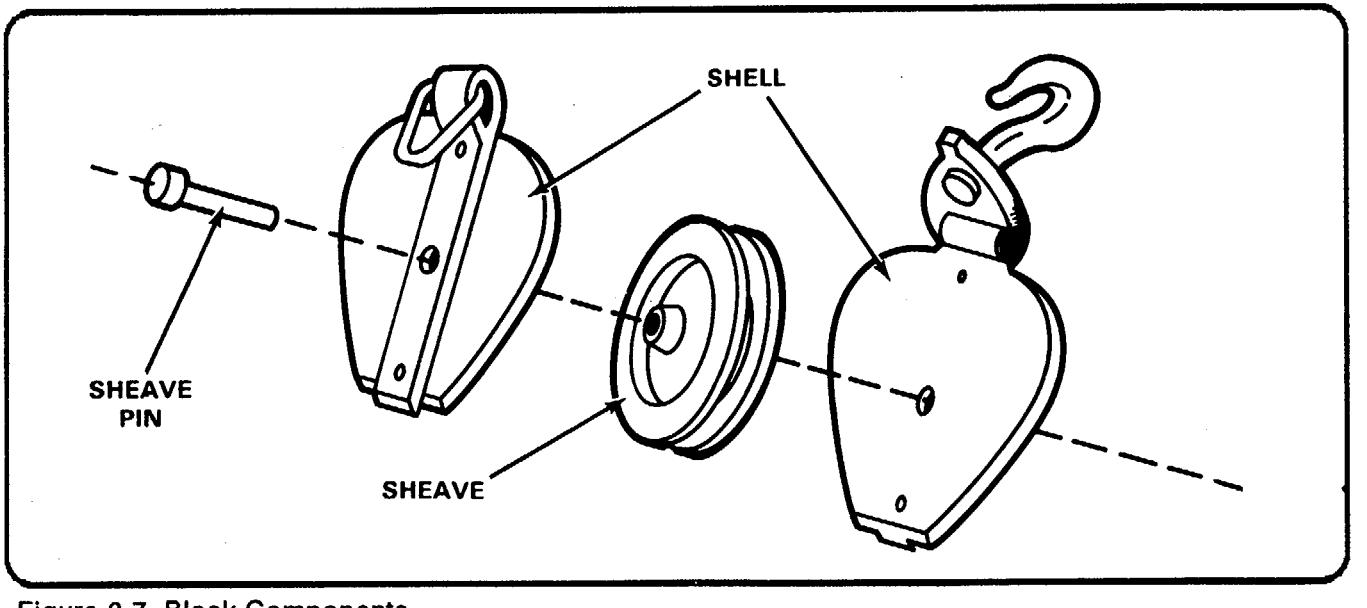


Figure 2-7. Block Components

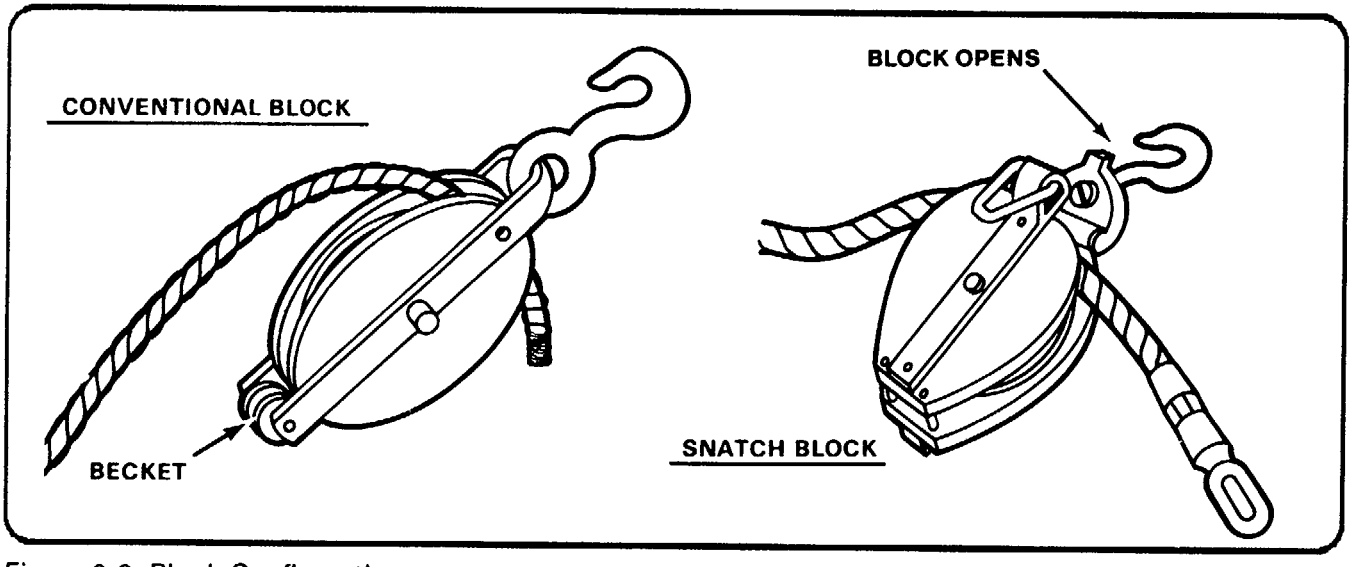


Figure 2-8. Block Configurations

tackle with conventional blocks, lay out the blocks, and thread or reeve the rope through the blocks.

Blocks have the following applications:

- A fixed block is a block attached to a stationary anchor. The sheave of a fixed block permits the rope to change direction.
- A running block is a block that is attached to and moves the load.

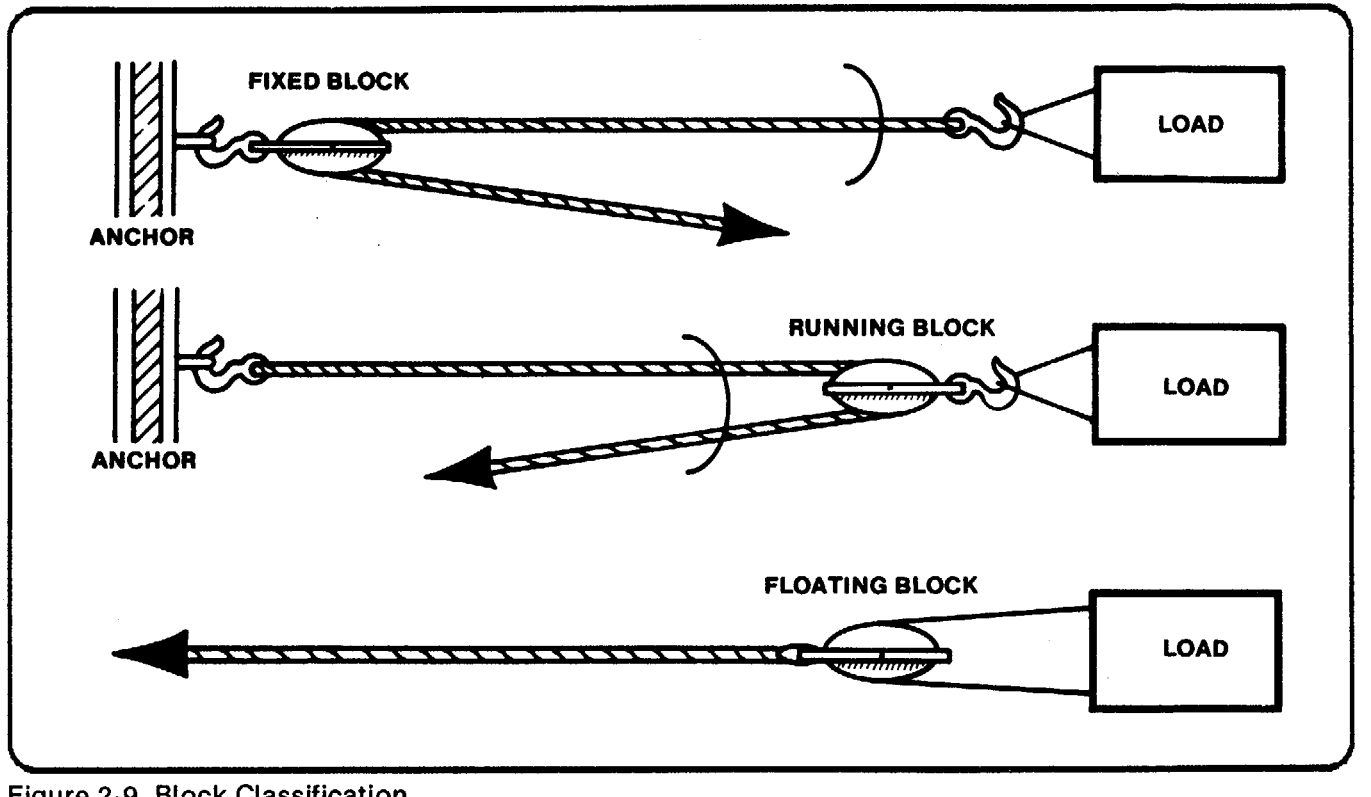


Figure 2-9. Block Classification

A FLOATING BLOCK ALLOWS PULL TO BE DISTRIBUTED EQUALLY TO BOTH TOW HOOKS OF A DISABLED VEHICLE

- A floating block is a block used with a tow cable allowing the cable when pulled to align with the power source. The pull can be distributed equally to both tow hooks of the disabled vehicle.

CHAINS

A chain is made of series of links fastened through each other. Each link is made of metal stock bent into

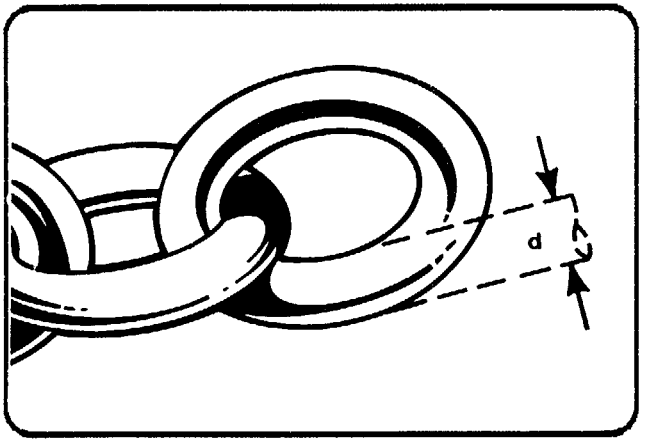


Figure 2-10. Measuring Chain Diameter

an oval shape and welded together. The chain is a major component of many recovery devices such as winch cable assemblies and safety chain assemblies.

The strength of a chain is measured using the formula, SWC = $8d^2$, where SWC = the safe working capacity in tons; d = the diameter of the chain stock in inches.

Example: SWC of a chain with a diameter of 1/2-inch is 8 x .5 x .5 = 2 tons.

Chains stretch and wear under excessive loading. Bent links and damaged welds indicate that a chain has been overloaded. Unlike cable, which fails a wire at a time chain fails all at once giving no warning of impending failure. Keep chains clean and lubricated. Inspect before using for bent links, corrosion, or worn spots. Remove worn or damaged chains from service. Do not paint chains; this restricts chain movement. Store in dry, well-ventilated places to prevent rusting.

HOOKS

Hooks are used as attachments on chains, wire rope, fiber rope, and blocks. The hook affords a means of hauling or raising loads without connecting directly to an object with rope or chain. Hooks may straighten and drop the load when overloaded. If they show cracks or excessive wear, discard them. The inside of a hook is usually an arc of a circle. If it has spread or straightened, discard it. The diameter is measured at the point where the hook starts to take the shape of an arc. Hooks should not be used to apply force or lift loads by bearing directly against the point of the hook. When hooks are used, the opening of the hook faces up so if the hook spreads open, the force will go down.

FIFTH WHEEL TOWING DEVICE (FWTD)

The FWTD, when mounted on a fifth-wheel-type tractor, will enable the tractor to function as a lift/tow vehicle. The FWTD will not replace wreckers, but will provide needed road towing capabilities. The FWTD will be used primarily in all geographical

areas where medium/heavy administrative and tactical wheel vehicles operate.

ALLIED KINETIC ENERGY RECOVERY ROPE

The AKERR is a multistrand, woven, nylon rope used for like-vehicle recovery. The rope is connected between the mired vehicle and the towing vehicle. The towing vehicle accelerates, stretching the rope, which creates potential energy. When the rope is fully stretched, it transfers the energy to the mired vehicle giving it a strong, sudden pull.

RESISTANCE

Resistance is defined as opposition to movement. In recovery operations, resistance is caused most often by terrain factors such as mud, sand, water, or the recovery tackle itself. This section will focus on vehicles disabled by terrain conditions.

There are two factors that can be applied to help reduce resistance. This section shows what they are and how to use them in recovery operations. Reduction factors discussed in this section do not apply to wheel vehicles.

Once load resistance is determined, effort must be applied to effect recovery. The third section discusses fundamentals of mechanical advantage.

TYPES OF RESISTANCE

Five types of resistance may occur in recovering vehicles disabled by terrain conditions. They are:

Grade Resistance

Grade resistance occurs when a vehicle moves up a slope. Grade resistance (including nosed-in vehicles) is estimated as equal to the weight of the vehicle plus cargo.

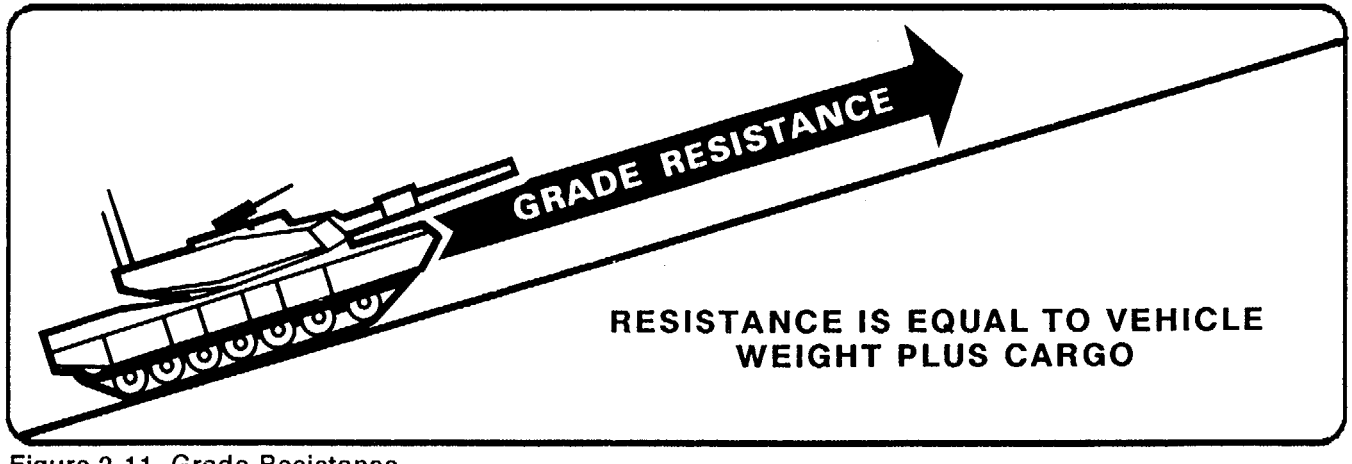


Figure 2-11. Grade Resistance

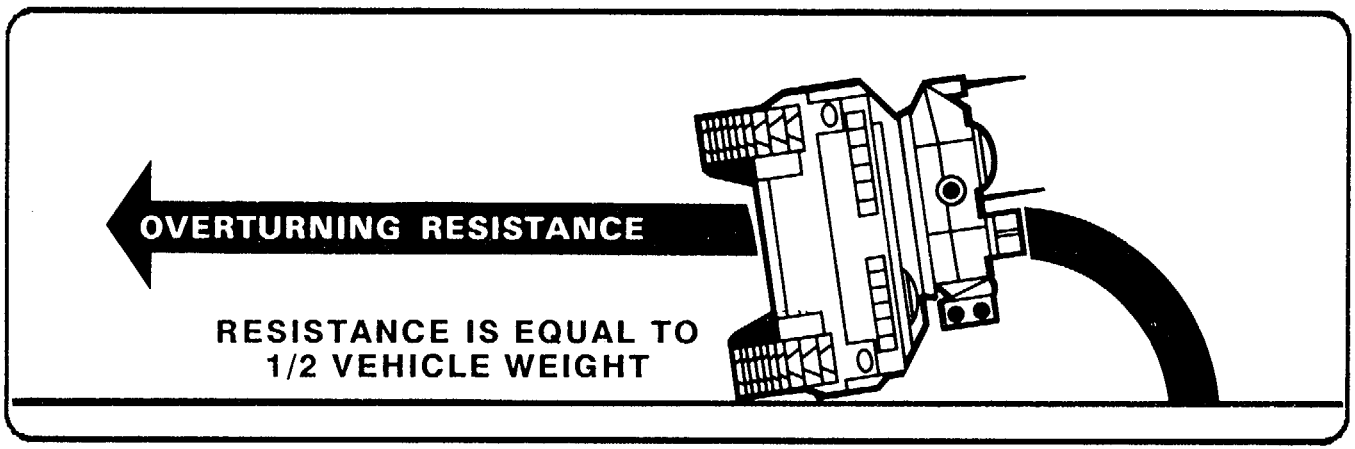


Figure 2-12. Overturning Resistance

Overturning Resistance

Overturning resistance is that weight of the vehicle that acts against the force exerted to bring it back on its wheels or tracks. This force is approximately half the vehicle's weight.

Mire Resistance

Mire resistance is created when mud, snow, or sand becomes impacted around the wheels, tracks, axle, gear housing, or hull. Mire resistance is described as wheel, fender, or turret/cab depth.

Wheel depth mires occur when wheel vehicles are mired up to the hub but not over the center. Track vehicles are mired up to the road wheels but not over the top. Estimate wheel-depth resistance as equal to the weight of the vehicle plus cargo.

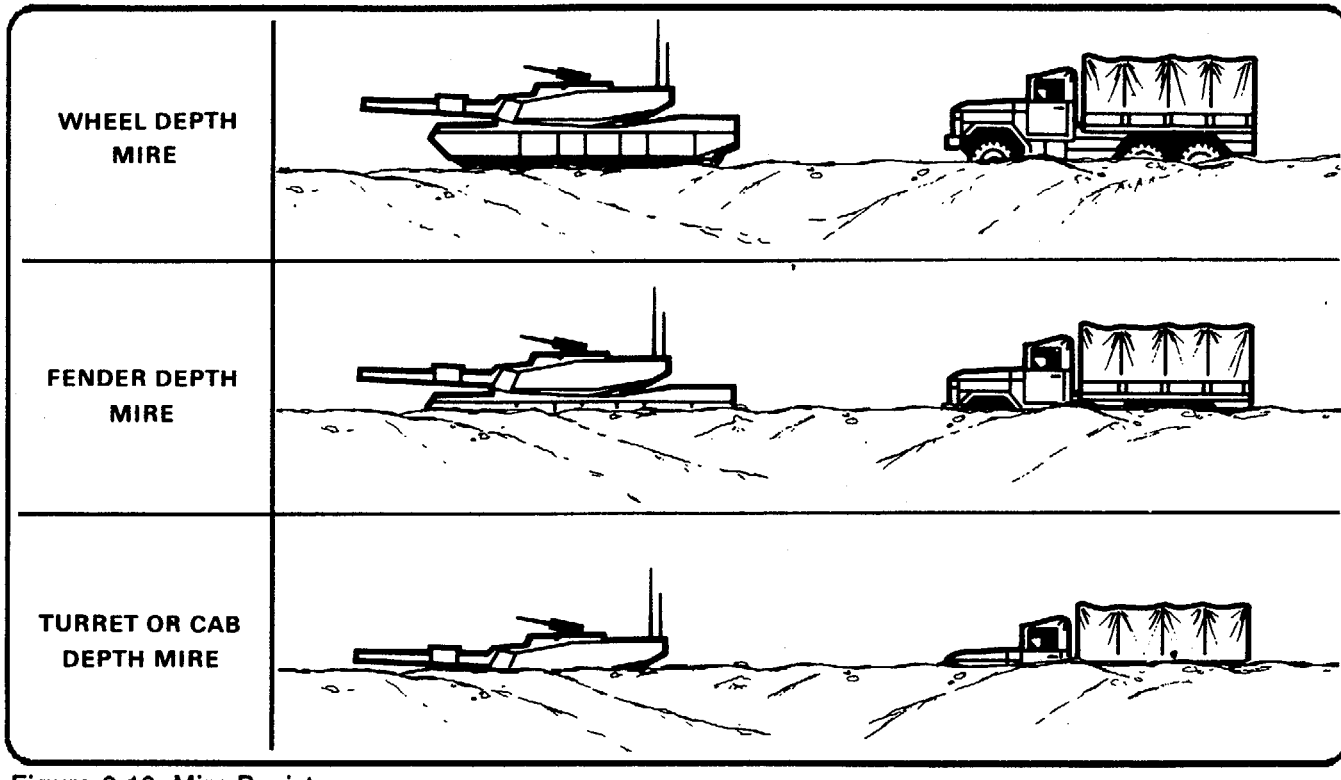


Figure 2-13. Mire Resistance

Fender depth mires occur when wheel vehicles are mired over the top of the hub, but not over the fender, and track vehicles are mired over the top of the road wheels, but not over the fender. Estimate fender depth mire resistance as twice the total weight of the vehicle plus cargo.

Turret or cab depth mires occur when vehicles are mired over the top of the fender. Estimate turret/cab depth mire resistance as three times the total vehicle weight plus cargo.

Water Resistance

Water resistance occurs when submerged vehicles are pulled from water to land. Estimate the amount of resistance met the same way as for land recovery. In some instances, the resistance to overcome is less

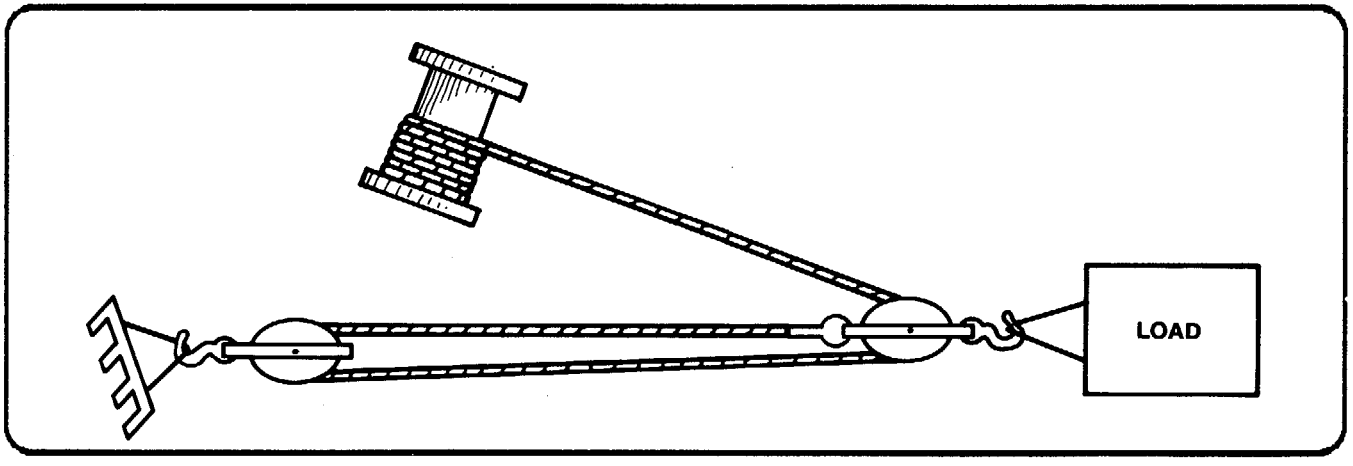


Figure 2-14. Tackle Resistance

than the rolling resistance of the same vehicle on land. See Marine Recovery, Chapter 4, for more information.

Tackle Resistance

Tackle resistance is that part of total resistance that is added to the recovery by friction in tackle. Tackle resistance is estimated as an additional 10 percent (.10) of the load resistance for each sheave used in rigging.

Example: In Figure 2-14, say the load is 40 tons, and two sheaves are used.

LOAD	**= 80,000 lb**
TACKLE RESISTANCE	**= 16,000 lb***
TOTAL RESISTANCE	**= 96,000 lb**

***2 x .10 x 40 tons**

RESISTANCE REDUCING FACTORS

Situation and mechanical resistance affect the load resistance of mired vehicles. However, since wheel vehicle resistances vary because of traction loss, reduction factors will only be applied to track vehicles.

Direction of Travel and Recovery

When a mired vehicle is recovered in the opposite direction of its travel, the tracks pass through ruts the vehicle made going into the mire. This reduces estimated resistance approximately 10 percent and is the preferred method of recovery.

Example: A tank weighing 106,000 pounds is mired at wheel depth and can be recovered in the opposite direction of travel. Estimate resistance as 106,000 pounds and subtract 10 percent for recovery in the opposite direction of travel. The load resistance equals 95,400 pounds

ESTIMATED RESISTANCE	106,000 lb
REDUCING FACTOR	x .10
	10,600 lb
	106,000 lb
	-10,600 lb
ESTIMATED LOAD RESISTANCE	95,400 lb

Power Applied to Tracks

When power is applied to the tracks of a mired vehicle, the movement of the tracks helps to break the suction of mud against the belly of the vehicle. This reduces estimated resistance by approximately 40 percent. Before computing the 40 percent reduction, make sure that the mire is not deep enough to prevent the operation of the vehicle's engine. For example, check the air intake and exhaust.

Example: A tank weighing 106,000 pounds is mired at fender depth. It cannot be recovered in the opposite direction of its original travel, but can apply power to its tracks. Estimated resistance (twice the weight of the vehicle) is 212,000 pounds, less 40 percent. The load resistance equals 127,200 pounds.

VEHICLE WEIGHT	106,000 lb
MIRED FACTOR (FENDER DEPTH)	x 2
RESISTANCE	212,000 lb
REDUCTION FACTOR (40% FOR POWER TO TRACK)	x .40
ESITIMATED REDUCTION	84,800 lb
	212,000 lb
	-84,800
ESTIMATED LOAD RESISTANCE	127,200 lb

Example: A tank weighing 106,000 pounds is mired at fender depth. It can be recovered in the opposite direction of its original travel and can apply power to its tracks. Estimated resistance (twice the weight of the vehicle) is 212,000 pounds, less 50 percent (10

percent for opposite direction, plus 40 percent for applying power to its tracks). The load resistance equals 106,000 pounds.

VEHICLE WEIGHT	106,000 lb	
MIRED FACTOR	x 2	
RESISTANCE	212,000 lb	
*REDUCTION FACTOR	x .50	
ESTIMATED REDUCTION	106,000 lb	LOAD
	212,000 lb	
	-106,000 lb	
ESTIMATED LOAD RESISTANCE	106,000 lb	

*40% POWER TO TRACK PLUS 10% RECOVERING OPPOSITE DIRECTION TO TRAVEL

NOTE 1: Reduction factors do not apply to wheel vehicles due to lack of traction. However, power applied to wheels may reduce resistance.

NOTE 2: Reduction factors are only a guide and apply more to wheel depth versus either fender or turret depth mire situations.

SOURCES OF EFFORT

Similar vehicles are the quickest and most available sources of recovery effort. On dry, level hardstand in first gear and reverse, the average vehicle exerts a force equal to its own weight. Terrain conditions affect the towing capability of a vehicle. These conditions may require two or more vehicles to exert the same force that one vehicle could under ideal conditions. When the situation does not permit recovery by a similar vehicle, use a winch. The most common situation occurs when the approach to the disabled vehicle does not provide good traction. A winch is a more positive source of effort since its capacity does not depend on terrain conditions.

A winch exerts its greatest force when it pulls by the first layer or the layer next to the bare winch drum. As each successive layer of cable is wound onto the winch drum, the diameter increases and the

TABLE 2-1
WINCH VARIABLE CAPACITIES

Winch Type	Cable Layer	Cable on Drum (ft)	Capacity (tons)
5 Ton	1	0 - 39	5.000
	2	40 - 85	4.225
	3	86 - 138	3.670
	4	139 - 199	3.230
	5	200 - 266	2.890
10 Ton	1	0 - 41	10.000
	2	42 - 91	8.450
	3	92 - 148	7.250
	4	149 - 213	6.400
	5	214 - 287	5.700
22.5 Ton	1	0 - 42	22.500
	2	43 - 93	18.850
	3	94 - 153	16.250
	4	154 - 220	14.250
	5	221 - 296	12.650
	6	297 - 380	11.400
30 Ton	1	0 - 55	30.000
	2	56 - 128	26.000
	3	129 - 208	23.000
	4	209 - 300	20.000
45 Ton	1	0 - 41	45.000
	2	42 - 91	38.000
	3	92 - 149	32.500
	4	150 - 200	28.500

NOTE: THE 70 TON IRV HAS A CONSTANT CAPACITY OF 70 TONS ANYWHERE ON CABLE.

winch capacity decreases. An exception is the constant pull winch found on the M88A2 where the force of pull remains constant regardless of the cable layer.

MECHANICAL ADVANTAGE (MA)

Overcoming Resistance

Applying effort to overcome resistance has always been a challenge to mankind. Modern machinery is

evidence of this. Energy released by burning small amounts of fuel in a modern engine provides the effort to move trucks weighing thousands of pounds. The truck engine, with various mechanical devices, can move the vehicle from a standstill through a wide range of speeds.

Mechanical Advantage

Mechanical advantage is a small amount of force applied over a long distance to move a heavy load a short distance. Mechanical advantage is needed whenever the load resistance is greater than the capacity of the available effort.

To determine the amount of mechanical advantage (MA) necessary in a recovery operation, divide the load resistance (LR) by the available effort (AE) and round any fraction to the next whole number. Rounding is required because only whole numbers can be rigged.

$$\frac{\text{LR} = 106{,}000 \text{ lb (LOAD)}}{\text{AE} = 90{,}000 \text{ lb (WINCH)}} = 1.1777$$

Round the fraction off to the next whole number.

REQUIRED MECHANICAL ADVANTAGE = 2:1

Leverage Principle

The use of levers is the most basic means to overcome resistance. A wrench handle, a can opener, and the gears of a truck overcome resistance by applying the principles of leverage. The simplest form of a lever is a rigid bar free to turn on a fixed pivot called a fulcrum. When effort is exerted on one end of the bar, the bar rotates around the fulcrum. Mechanical advantage is increased by extending the distance between the point where effort is applied and the fulcrum.

Lever Classification

Levers are divided into two classes. The location of the fulcrum with relation to effort and resistance determines the class of lever.

- **First-class lever:** The fulcrum is located between the effort and the resistance. A crowbar is a good example of a first-class lever.

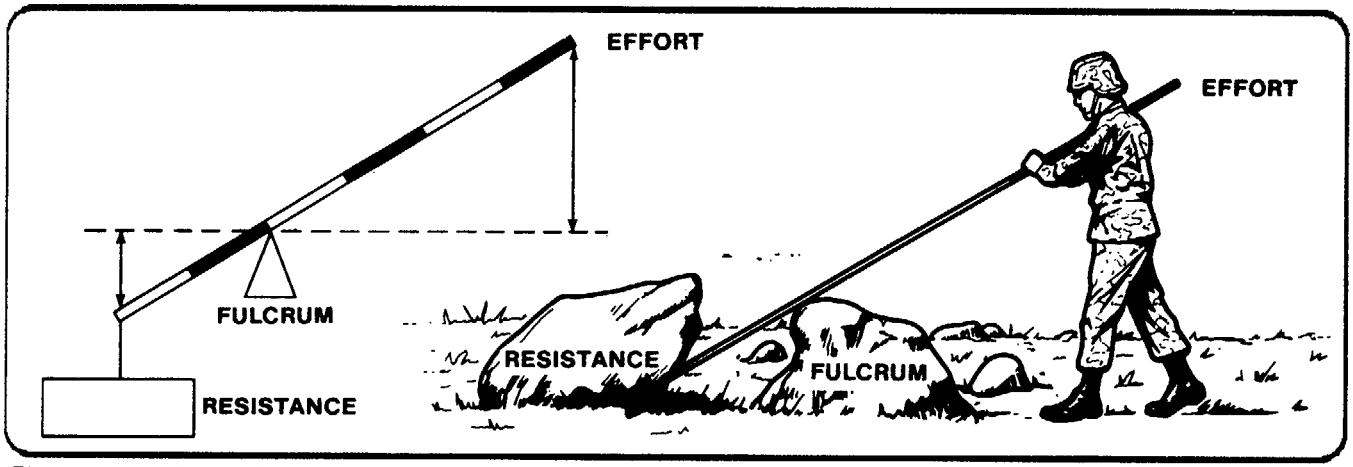


Figure 2-15. First Class Lever

- **Second-class lever:** The point of resistance is between the fulcrum and the effort. A wheelbarrow is a good example of a second-class lever.

Tackle

Tackle is a combination of ropes or cables and blocks used to gain a mechanical advantage or to change direction of pull. Tackle is classified as

- **Simple tackle:** Simple tackle is one rope or cable with one or more blocks.

- **Compound tackle:** Compound tackle is a series of two or more simple tackles. The output of one simple tackle is used as the effort for the other. Since a winch has only one cable, simple tackle will almost always be used during recovery operations.

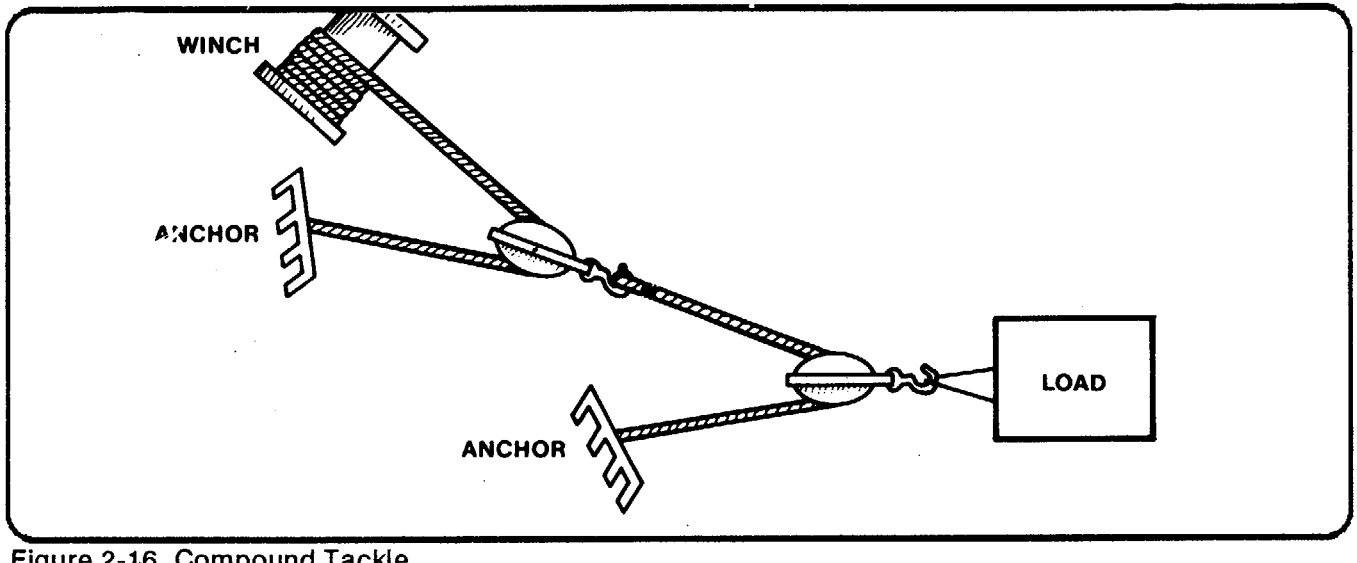


Figure 2-16. Compound Tackle

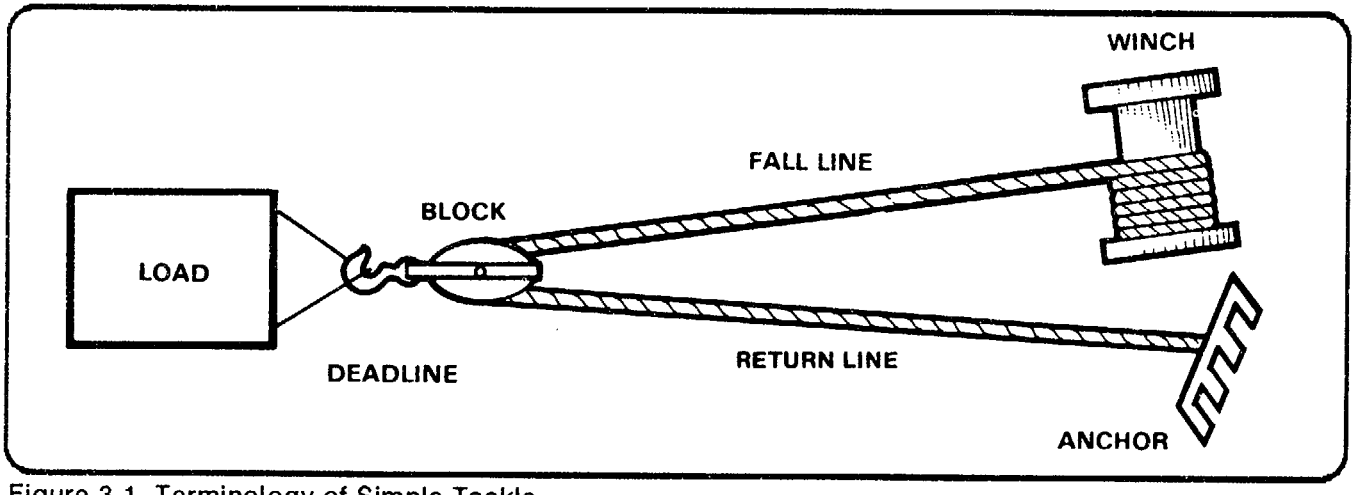


Figure 3-1. Terminology of Simple Tackle

RIGGING FUNDAMENTALS

FALL LINE

This is the winch line that runs from the source of effort to the first block in the tackle. There is only one fall line in a simple tackle system. The amount of force that must be exerted on the fall line relative to the available effort must be considered in every problem. To determine the fall line force, divide the total resistance by the mechanical advantage of the

tackle. The fall line force must be less than the capacity of the effort to accomplish the recovery. See Example in second section.

RETURN LINES

These are the winch lines between the blocks or the winch line from the sheave of a block to the point where the end of the line is attached. This force is always the same as the fall-line force.

DEAD LINES

These are lines used to attach blocks or other equipment to the load or to an anchor. To determine the dead line force, multiply the fall-line force by the number of winch lines supported by the dead line.

FLEET ANGLE

The achievement of even winding of the winch cable on the drum is important for wire rope life and winch operations. This is accomplished best by working with the proper fleet angle.

Illustration 3-2 shows the wire rope running from a fixed sheave, over a floating sheave, and then onto the surface of a smooth drum. The fleet angle is defined as the included angle between two lines; one line is drawn through the middle of the fixed sheave and the drum, and perpendicular to the axis of the drum. A second line is drawn from the flange of the drum to the base of the groove in the sheave. There are left and right fleet angles, measured to the left and right of the center line of the sheave.

Fleet angle should be restricted when wire rope passes over a fixed sheave and onto a drum. For the most efficient method and best service, the angle should not exceed 1 1/2 degrees.

MECHANICAL ADVANTAGE OF TACKLE

Mechanical advantage is needed whenever the load resistance is greater than the available effort. The amount of mechanical advantage needed is estimated by dividing the load resistance by the available effort. The mechanical advantage of any single tackle rigging is equal to the number of winch lines supporting the load or the number of winch lines that become shorter as power is applied to the winch.

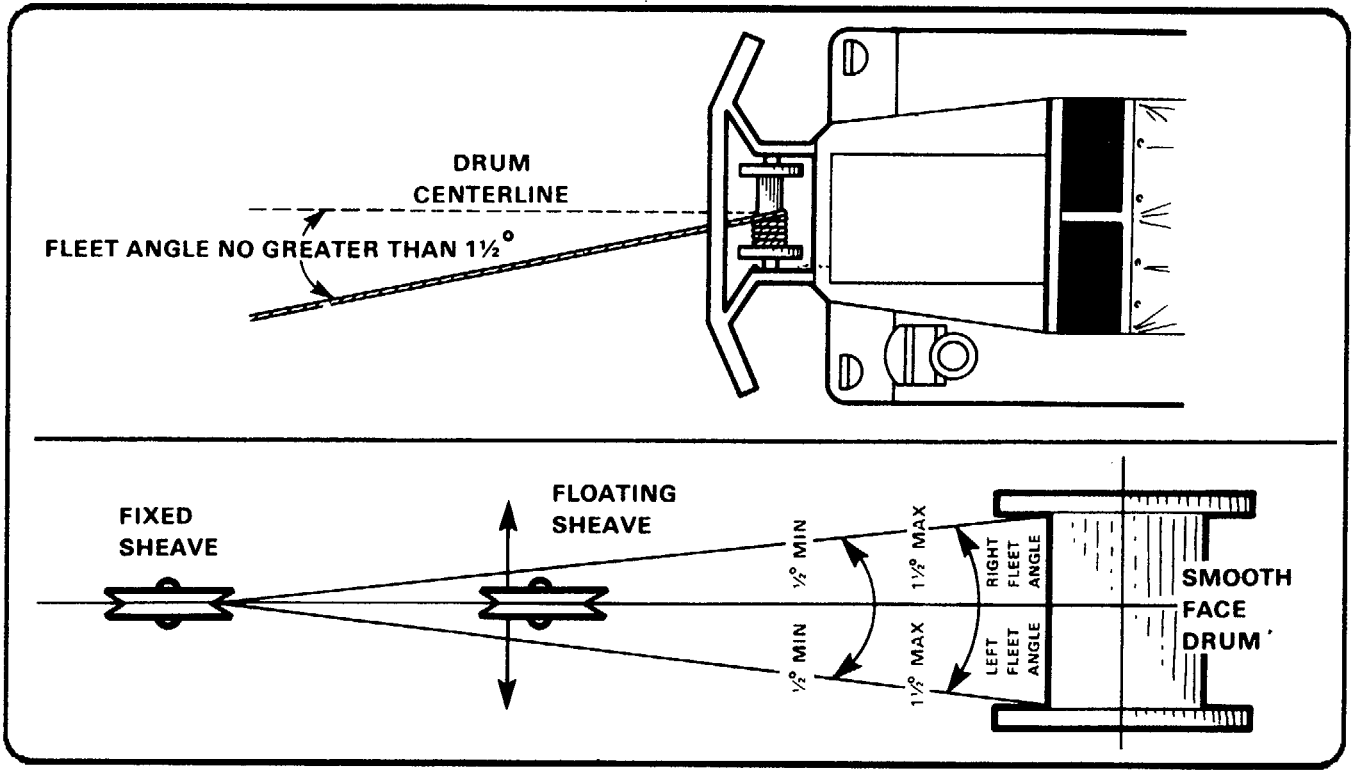


Figure 3-2. Fleet Angle

The lines can be attached directly or indirectly through a block.

TACKLE RESISTANCE

Friction created by a sheave rotating in its pin, the rope flexing around the sheave, or the rope scuffing in the groove of the sheave causes a loss in energy as

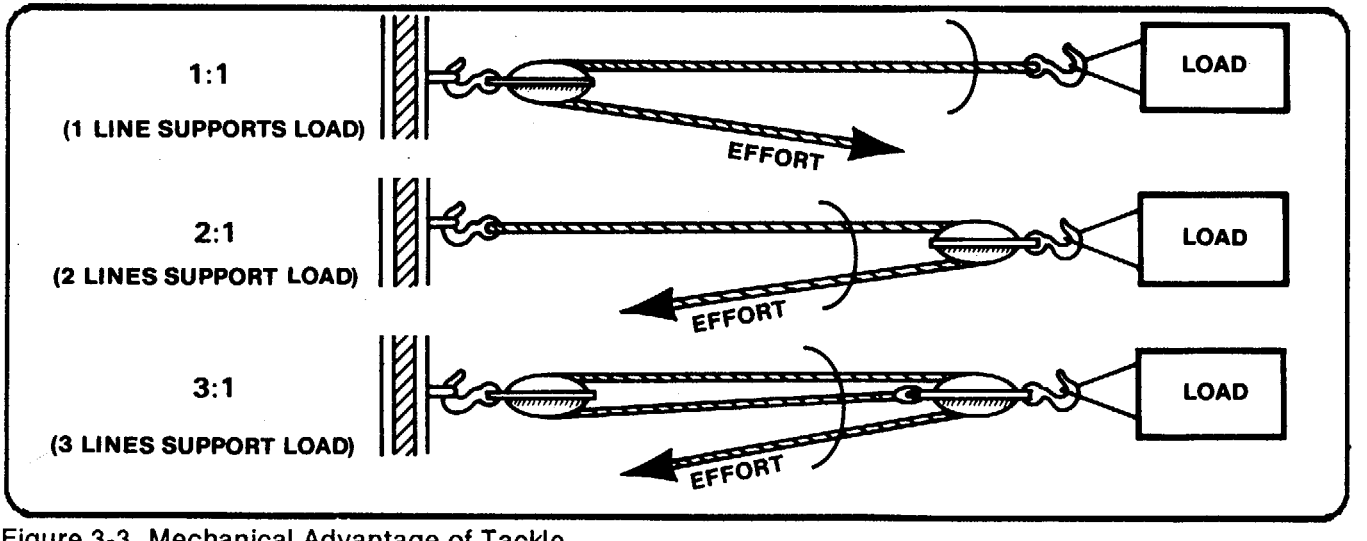


Figure 3-3. Mechanical Advantage of Tackle

FRICTION IN TACKLE CAUSES A LOSS IN ENERGY THAT MUST BE OVERCOME BEFORE THE LOAD RESISTANCE CAN BE MOVED

the rope passes around the sheave. This loss is resistance and must be overcome before the resistance of the load can be overcome. Each sheave in the rigging will create resistance. To determine tackle resistance, multiply 10 percent of the load resistance by the number of sheaves (not blocks) in the rigging.

Example: A load resistance of 20,000 pounds and a tackle with two sheaves (2 x 10 percent) are being used; therefore, 20 percent of 20,000 pounds equals 4,000 pounds tackle resistance.

TOTAL RESISTANCE

Since tackle resistance must be overcome before the load resistance can be moved, the load and tackle resistance are added. This resistance is total resistance (the total amount of resistance that the available effort must overcome).

Using the previous example of tackle resistance, the load resistance of 20,000 pounds, plus the tackle resistance of 4,000 pounds, equals a total resistance of 24,000 pounds.

DETERMINING LINE FORCES

The following example shows how to compute various line forces.

Example: A disabled vehicle had a load resistance of 14 tons (28,000 lb). The available effort (AE) is a winch with a maximum capacity of 5 tons (10,000 lb). What mechanical advantage (MA) must be rigged to recover this vehicle? What are the line forces?

- **STEP 1- Determine Initial Estimate**

$$\frac{\text{LOAD RESISTANCE}}{\text{AVAILABLE EFFORT}} = \text{REQUIRED MECHANICAL ADVANTAGE}$$

$$\frac{28{,}000\ (LR)}{10{,}000\ (AE)} = 2.8$$

REQUIRED MECHANICAL ADVANTAGE (MA) = 3

- **STEP 2- Verify Solution/Add Tackle Resistance**

An MA of 3 requires 2 sheaves; therefore, 2 x (10 percent per sheave) or 20 percent must be added to the load resistance.

$$28{,}000 + .20 \times 28{,}000 = 33{,}600$$

$$\frac{33{,}600\ (LR)}{10{,}000\ (AE)} = 3.36$$

REQUIRED MA = 4

This is not equal to the answer in step 1; therefore, you must reverify your answer.

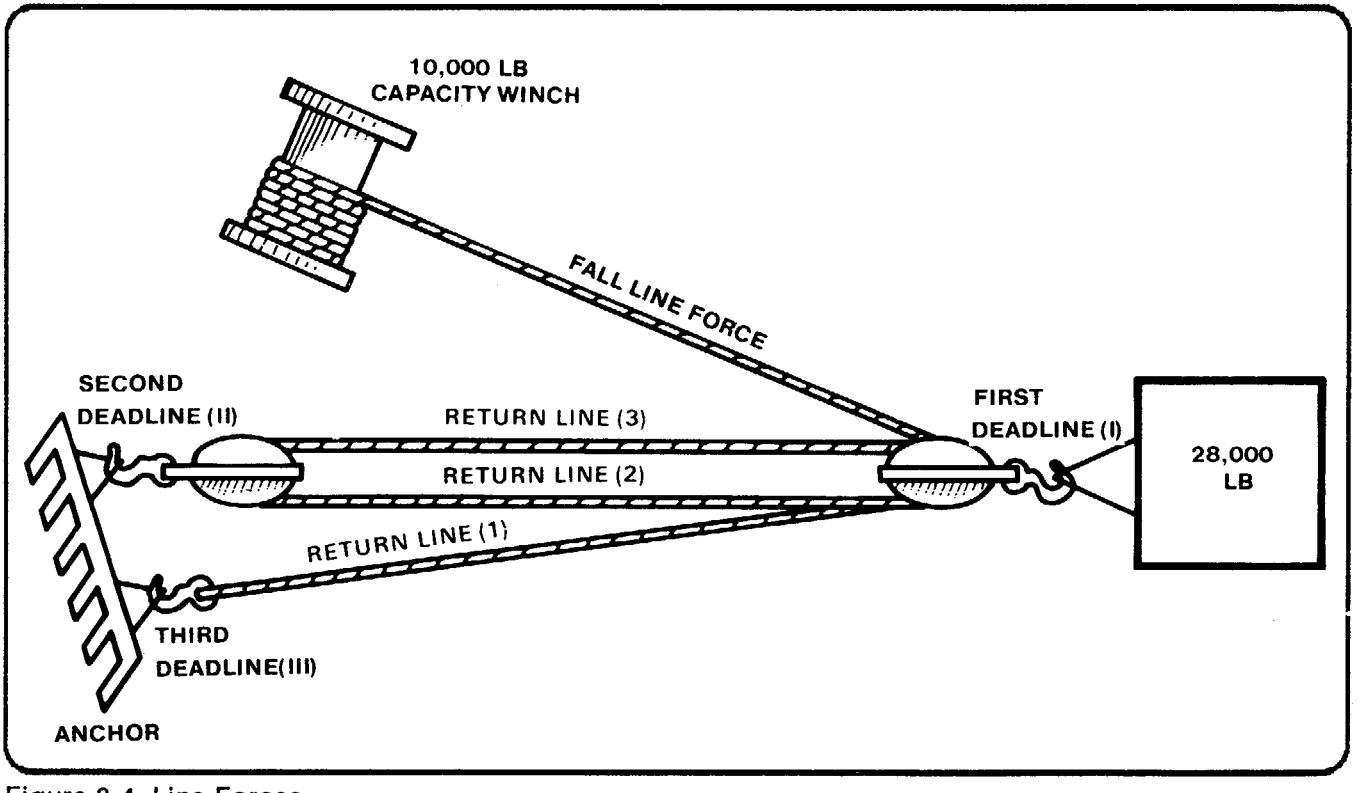


Figure 3-4. Line Forces

- **STEP 3- Reverify Solution**

A MA of 4 requires 3 sheaves. Therefore, 3 x (10 percent per sheave) or 30 percent must be added to the load resistance.

$$28{,}000 + .30 \times 28{,}000 = 36{,}400$$

$$\frac{36{,}400\ (LR)}{10{,}000\ (AE)} = 3.64$$

REQUIRED MA = 4

This is equal to the answer in step 2; therefore, you have reached a solution. Now determine all line forces.

- **STEP 4- Determine Line Forces**

a. Total resistance to overcome = load + tackle resistance. From the previous step, the total resistance is equal to 36,400 lb and the MA needed is 4.

NOTE: There is one sheave in block A and two in block B.

b. Fall line force:

$$\frac{\text{TOTAL RESISTANCE (LR)}}{\text{MA}} = \text{FALL LINE FORCE}$$

$$\frac{36{,}400}{4} = 9{,}100 \text{ lb}$$

Double Check: The fall line force is less than the winch capacity.

c. Return line force:

Return line force = Fall line force

Lines No 1, 2, and 3 = 9,100 lbs

d. Dead line Force:

Dead line force = number of supported winch lines x line force

DEAD LINE I = 4 x 9,100 lb = 36,400 lb
DEAD LINE II = 2 x 9,100 lb = 18,200 lb
DEAD LINE III = 1 x 9,100 lb = 9,100 lb

NOTE: If field expedient slings are used as dead lines, refer to TM 5-725 to determine sling leg forces. Field expedient slings are considered to be slings constructed using materiel not part of the recovery vehicle's BII.

RIGGING TECHNIQUES

The rigging techniques used depend on terrain, the type of vehicle, and the distance between the recovery vehicle and disabled vehicle.

MANPOWER METHOD

The manpower method is used when the winch cable and other rigging equipment are lightweight and can be carried easily by the crew members to where they are needed.

BACKUP METHOD

The backup method is used when the recovery vehicle can be safely positioned within 25 feet of the disabled vehicle. Pull out enough main winch cable to attach to the disabled vehicle. Place the main winch snatch block in the loop of the cable and attach the block to the disabled vehicle. Back up the recovery vehicle allowing the main winch cable to be spooled from the winch drum until sufficient cable is removed to obtain maximum winch capacity. The il-

lustration below shows the recovery vehicle in position to perform the winching operation.

LEAD METHOD

The lead method is used when terrain conditions do not permit close access to the disabled vehicle. Use the boom winch cable to pay out the main-winch rigging to the disabled vehicle. Since the hoist-winch cable weighs less than the main-winch cable, it can be carried to the disabled vehicle.

To rig for the lead method, assemble the main-winch tackle just in front of the recovery vehicle as in preparation for the backup method. Attach the hoist-winch cable to the main-winch snatch block;

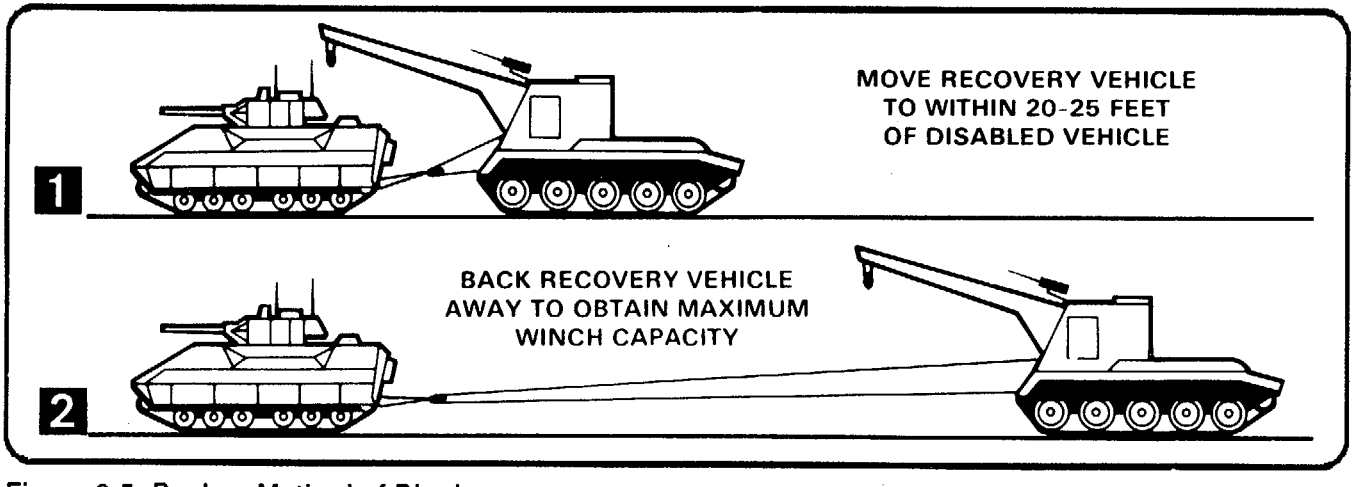


Figure 3-5. Backup Method of Rigging

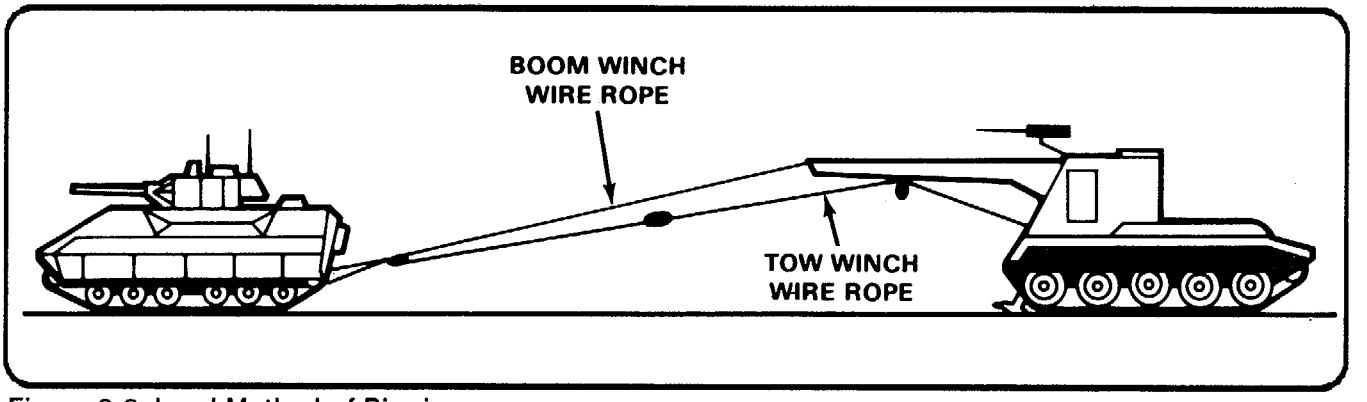


Figure 3-6. Lead Method of Rigging

then manually pull out the loop formed by the hoist-winch cable and place it into a snatch block that is attached to the disabled vehicle. By paying in the hoist-winch cable, the main-winch tackle will be pulled to the disabled vehicle.

METHODS OF ATTACHING TACKLE

In recovery operations, rig the tackle so no damage is done to the vehicle or equipment. For instance, on disabled wheel vehicles, attach the rigging (tackle) to the bumper lifting shackles on both sides

of the tow pintle. If the pulling force is attached only to one frame member, the truck frame could be pulled out of alignment.

CAUTION:

The pull on the tow pintle should not exceed what is specified in the operator's manual. Even though the bumper lifting shackles are designed to withstand force from a horizontal or vertical pull, a sling attachment must be used to apply the effort equally to both shackles. For vehicles not equipped with bumper lifting shackles, effort should be applied to the main structural members, not to the bumper or bumper brackets.

On wheel vehicles, whether the pull is made from the front or rear, apply the effort to both bumper lifting shackles or the tow pintle. The force exerted on each leg of the sling is slightly greater than half the resistance.

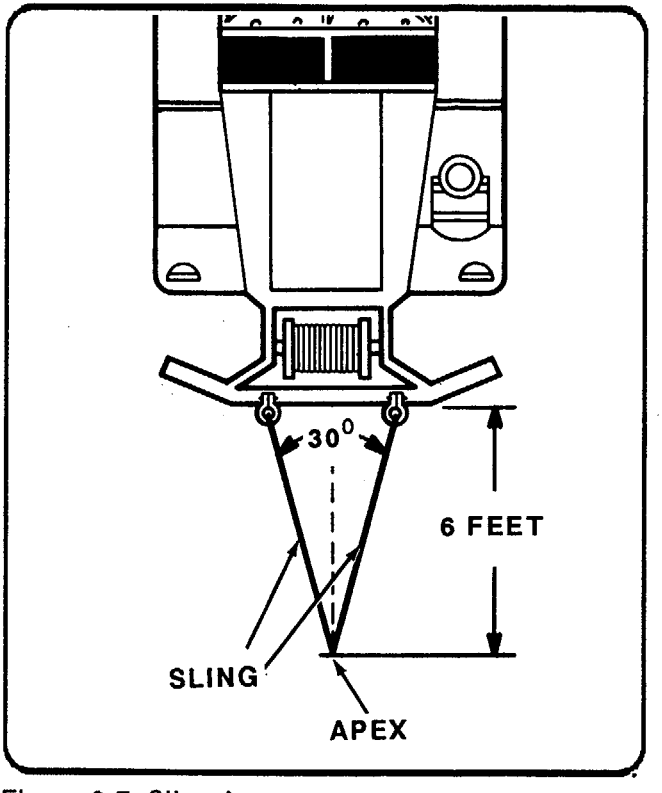


Figure 3-7. Sling Arrangement

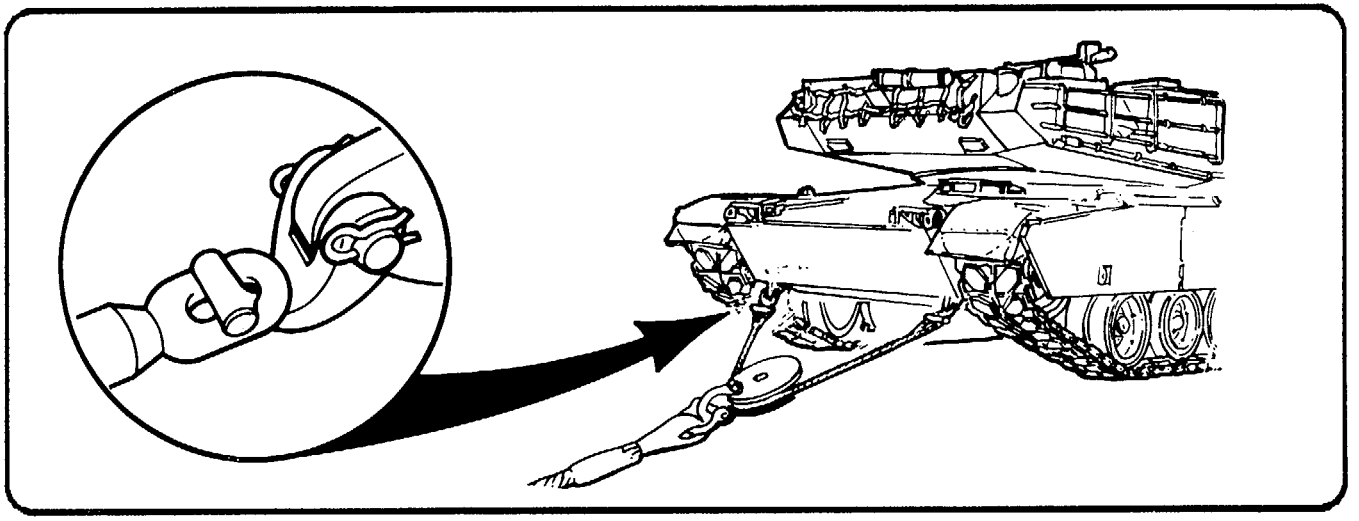


Figure 3-8. Floating Block Attachment

On track vehicles, always attach rigging to the tow hook or lugs. The lifting eyes are not designed to withstand the pulling force required for recovery. Use an attachment that will distribute the applied force to each side of the vehicle. If the vehicle requires towing after winching, time can be saved by using the same attachment.

When a disabled track vehicle does not require towing or mechanical advantage, use the main winch snatch block with one tow cable to form a floating block hookup. This hookup is easy to install and distributes the effort evenly to both tow hooks. To rig a floating block, attach the ends of the tow cable to the two tow hooks. Place the snatch block in the loop

formed by the tow cable. Attach the winch cable to the snatch block. Ensure cables and attachments can withstand forces.

When a disabled vehicle requires a 2:1 mechanical advantage rigging, and if towing over rough terrain after winching is required, use two tow cables to make the attachment. The attachment, illustrated above, is the quickest to rig.

When towing a vehicle over relatively level terrain or on highways, use the tow bar method of attachment. Attach the tow bar to the tow lugs of the disabled vehicle and attach the winch rigging to the lunette of the tow bar. After winching, disassemble the rigging and place the tow bar lunette in the recovery vehicle's tow pintle.

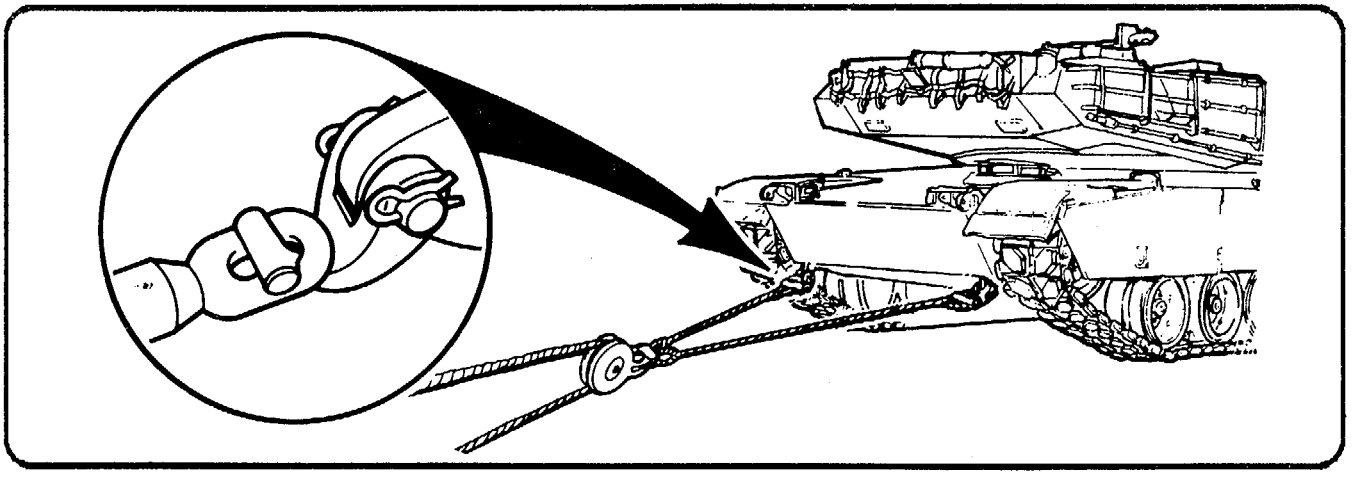


Figure 3-9. Tow Cable Attachment

If a 3:1 mechanical advantage is required, attach the running block to one of the tow lugs of the disabled vehicle, the change-of-direction block to the tow lug on the recovery vehicle, and the end of the winch cable to the other tow lug on the disabled vehicle.

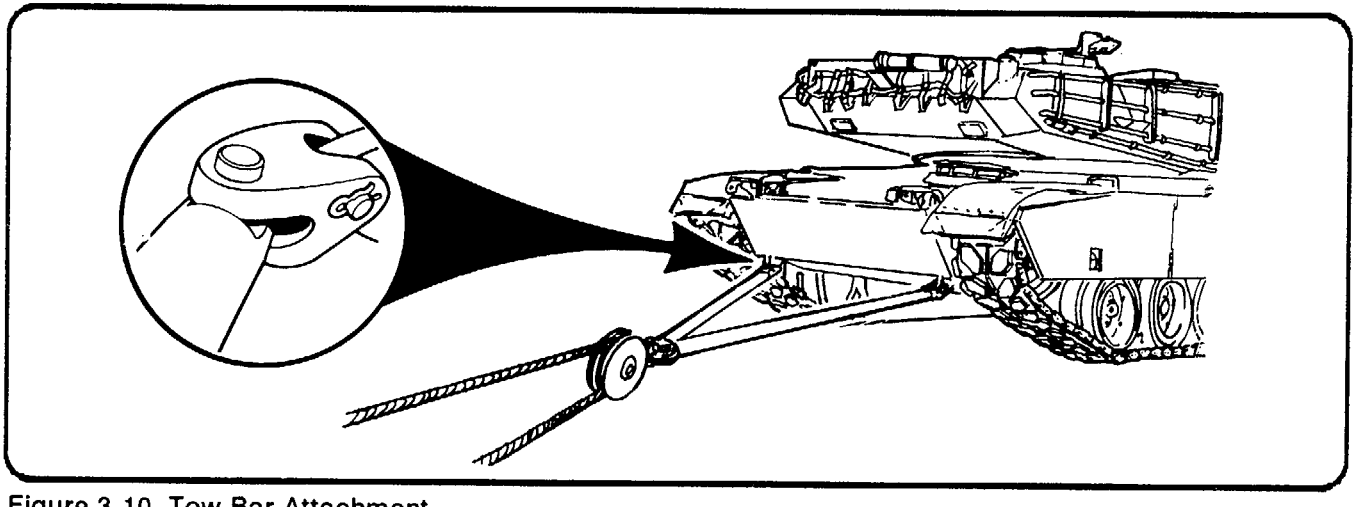


Figure 3-10. Tow Bar Attachment

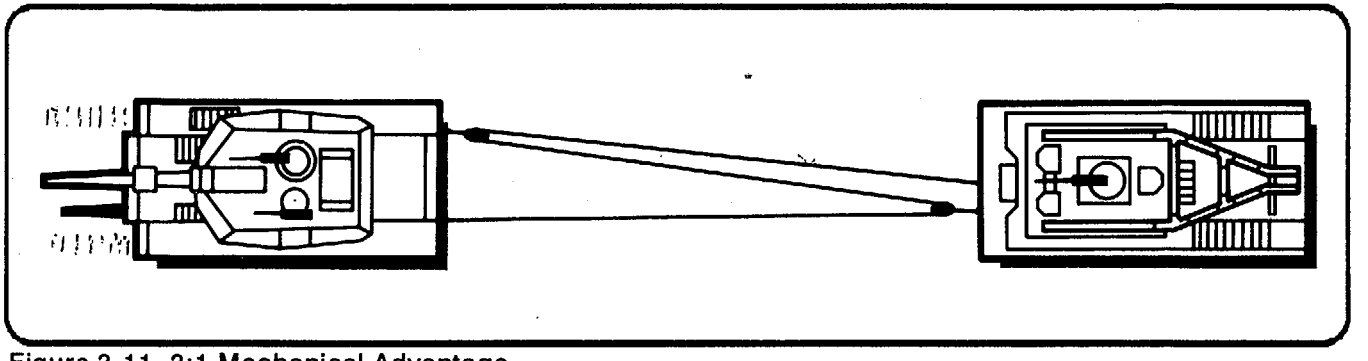


Figure 3-11. 3:1 Mechanical Advantage

ANCHORS

USE OF ANCHORS

Frequently, wheel and track vehicles must have some anchoring means when winching heavy loads with tackle. An anchor can assist in holding a recovery vehicle, improvising a change of direction pull, or supporting part of the load during a winching operation. Most existing recovery vehicles have ground chocks or spades.

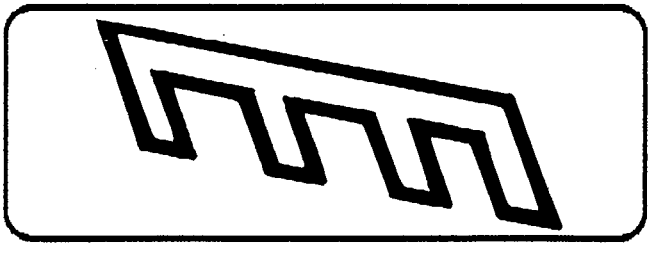


Figure 3-12. Anchor Symbol

TREES, TREE STUMPS, LARGE ROCKS, OR OTHER VEHICLES MAY BE USED AS ANCHORS IN RECOVERY OPERATIONS

NATURAL ANCHORS

An anchor that does not have to be constructed is a natural anchor. Examples are trees, tree stumps, and large rocks or other vehicles. Avoid dead or rotten trees or tree stumps, and examine rocks and trees carefully to make sure they are large enough and embedded firmly in the ground.

MECHANICAL ANCHORS

There are several types of mechanical anchors. The type constructed depends on holding ability requirements, type of soil, availability of material, and the situation.

Log Deadman

A log deadman is one of the best types of anchors for heavy loads. The deadman consists of a log buried in the ground with the dead line connected to its center. When constructing a deadman, place it where the direction of pull is as horizontal as possible. Take advantage of sharp banks or crests to increase the holding power with less digging. Dig a trench large enough for the deadman and as deep as necessary for good bearing. When digging, slant the trench in the

direction of the pull at an angle of about 15° from the vertical. To strengthen the anchor, drive stakes in front of the deadman at each end. Dig a narrow inclined trench for the dead line at the center of the deadman. Tie the dead line to the center of the deadman so that the main or standing part of the line leads from the bottom of the deadman. This prevents the deadman from rotating out of the trench. If the dead line has a tendency to cut into the ground, place a small log under the line at the outlet of the trench. The strength of the deadman depends on the strength of the log and the holding power of the earth.

Picket Holdfasts

A picket holdfast is constructed by using two or more sound wooden pickets at least 3 inches in diameter and 5 feet long. Drive the pickets about 3 feet into the ground, 3 to 6 feet apart, and in line with

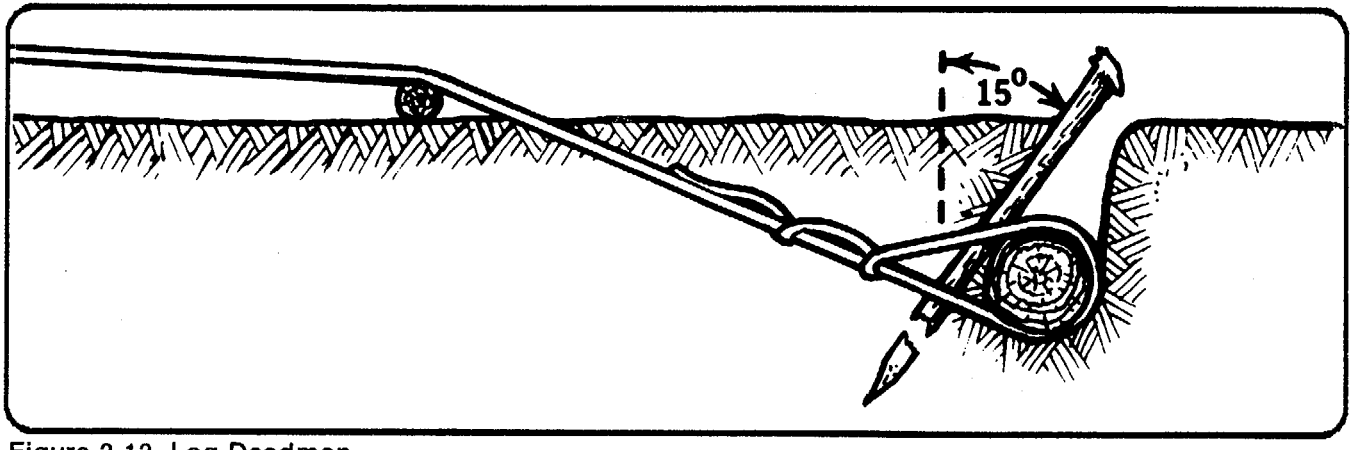


Figure 3-13. Log Deadman

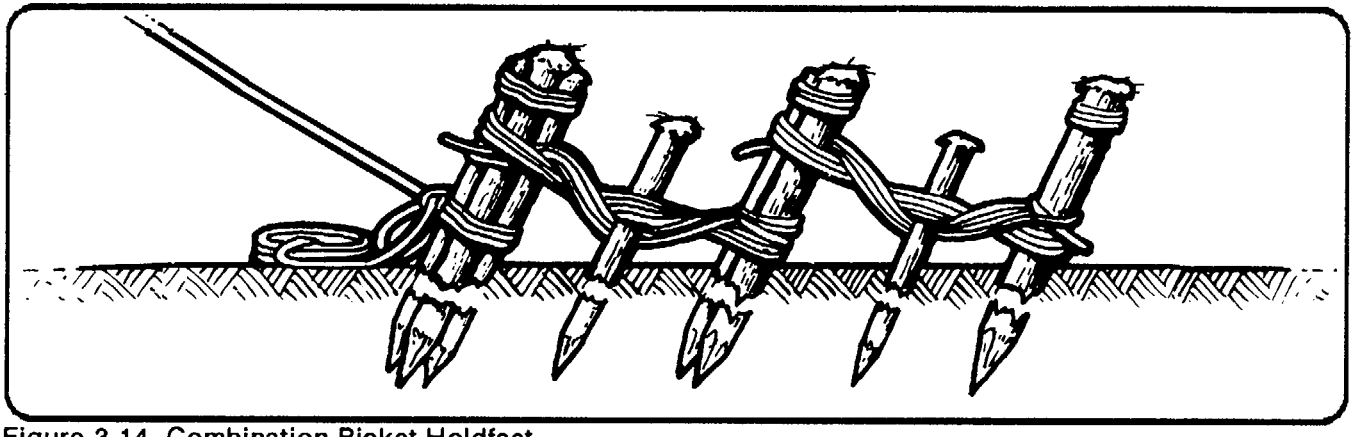


Figure 3-14. Combination Picket Holdfast

the dead line. Tie the pickets together with fiber rope by first tying one end of the rope to the top of the front picket with a clove hitch. Then make four to six wraps of the rope, starting from the top of the front picket to the bottom of the rear pickets, and tie the other end of the rope to the bottom of the rear picket with a clove hitch. Finally, pass a stake between the rope wraps midway between the pickets. Tighten the rope by twisting it with the stake, and then drive

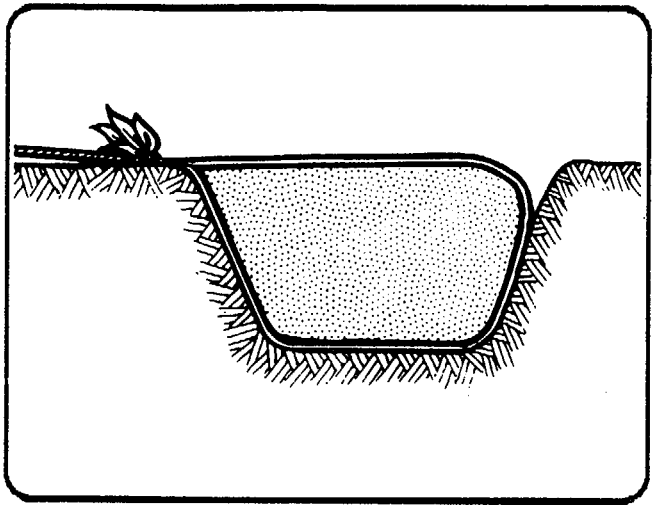


Figure 3-15. Sand Parachute

stake into the ground. Repeat this operation for each successive pair of pickets.

The strength of the holdfast depends on the first or front picket. To reinforce it, drive two or more pickets into the ground close to the front picket. Tie them together before tying to the rear picket.

Sand Parachute

A sand parachute is used as an anchor in a sandy area with no trees. Dig a large deep hole and line it with a tarpaulin. Fill the tarpaulin with the sand removed from the hole, lash the four corners together, and attach the rigging. The sand parachute has limited holding ability and should not be used when a major effort is required.

Scotch Anchor

A Scotch anchor is used to anchor a truck during winching operations when natural anchors are not available. Select a log at least 6 inches in diameter and 2 feet wider than the vehicle. Dig a shallow trench about 3 or 4 inches deep parallel to the front axle, just ahead of the front wheels. Then, lay a tow chain across the center of the trench, place the log in the trench, and move the vehicle forward until both front tires are against the log. Finally, attach both chain ends to the bumper lifting shackles, and remove all slack from the chain.

As pressure is applied to the winch, the front wheels are pulled onto the log, making the chain taut

and anchoring the vehicle. If more than one tow chain is available, a similar method may be used. Lay two tow chains across the trench next to the inside of each front wheel. Place the log in the trench, and move the vehicle forward until both front wheels are against the log. Then, wrap the chains through the bumper lifting shackles, remove slack from the chains, and fasten them together.

Vehicle

A vehicle can be used as an anchor to assist in the recovery of a mired vehicle equipped with a winch. The winch cable is payed out to the anchoring vehicle and the mired vehicle winches itself out. The anchoring vehicle should not attempt to pull; it is only an anchor.

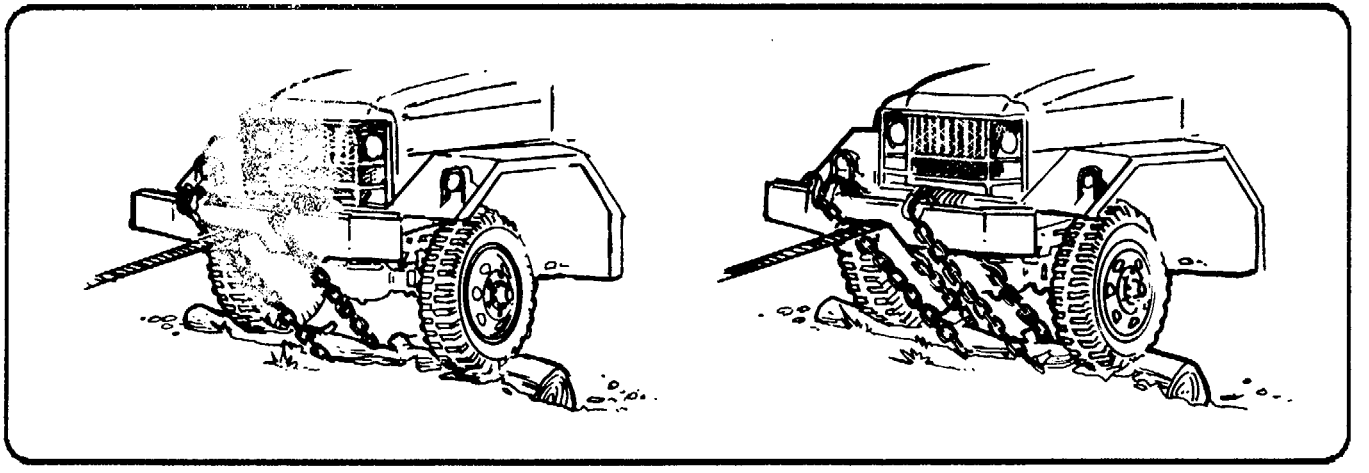


Figure 3-16. Scotch Anchors

CHAPTER 4

RECOVERY OPERATIONS

Recovery is a big job. Prior to any recovery, calculate resistance, inspect your tackle, and keep a rigging reference handy. A haphazard approach to recovery can lead to death, dismemberment, and damaged equipment. THINK SAFETY.

SAFETY PRECAUTIONS

INTRODUCTION

A successful recovery operation is accomplished quickly and safely. Be careful when erecting and using equipment. This prevents damage to the vehicles and equipment and injury to personnel.

ACCELERATION IMPACT

Do not apply loads suddenly (shockload). This puts excessive strain on the equipment and it may fail. Failure occurs when a weight is allowed to fall for a distance and is suddenly stopped. A similar strong force happens when power is engaged suddenly.

BACKLASH

Take extra care to avoid accidents. Make every effort to stand clear of wire rope under tension. When wire rope is drawn taut and then released suddenly by a break, its recoil (or backlash) will cut a person in two. A winch line under load stretches like a rubber band and stores up a lot of energy. In fact, a steel winch cable weighing 50 to 500 pounds has a better spring than rubber. A broken winch cable snapping back could be compared with a rifle bullet, except the bullet makes a fairly clean hole and the winch cable makes a messy wound. Treat a wire rope under tension with the same respect you would a loaded gun.

CROSSED CABLES

Make sure the rigging lines are not crossing each other before the winching operation is continued. Crossed rigging lines can rub against each other causing damage to the cable or an increased amount of tackle resistance. Crossed cables are only recommended for towing a disabled vehicle.

FUEL OR OIL SPILLAGE

If fuel or oil has spilled from the disabled vehicle, there must be **NO SMOKING** and **NO OPEN FLAMES**. Make sure the exhaust flash from other vehicles is not directed at the vehicle with spilled fuel or oil. Clean up spilled fuel or oil thoroughly before attempting to start the recovery vehicle's engine. When winching or lifting a disabled fuel carrier, thoroughly ground the vehicle to keep static electricity from igniting the fuel. The POL carrier should have the necessary grounding equipment.

Fuel, oil and other mechanical fluids commonly spilled on the ground during BDAR operations can cause great damage to the environment. As with many BDAR considerations, the level of environmental protection will be mission dependant. Even in periods of heightened conflict, simple steps can help to conserve and protect our fragile environment. All practical efforts should be made to avoid environmental contamination. Spills over one gallon should be reported through the chain of command to the unit's logistical element, such as the battalion S4.

GROUND GUIDES

For safe control of a recovery operation, there should be two ground guides to prevent confusion. One ground guide in the front, and one in the rear, one ground gives the signals. The ground guides should stand apart from other personnel at the recovery site and be in a position where operators can easily observe the signals. The operators must know the meaning of the signals to be used and act only on those signals (See Appendix C).

CAUTION:

A winch line makes a deadly slingshot. If the dead line of a snatch block breaks, a 200-pound snatch block can travel as far as 300 yards in the air. All personnel observing should stand at least one cable length away from and opposite the angle of pull when the cable is under stress.

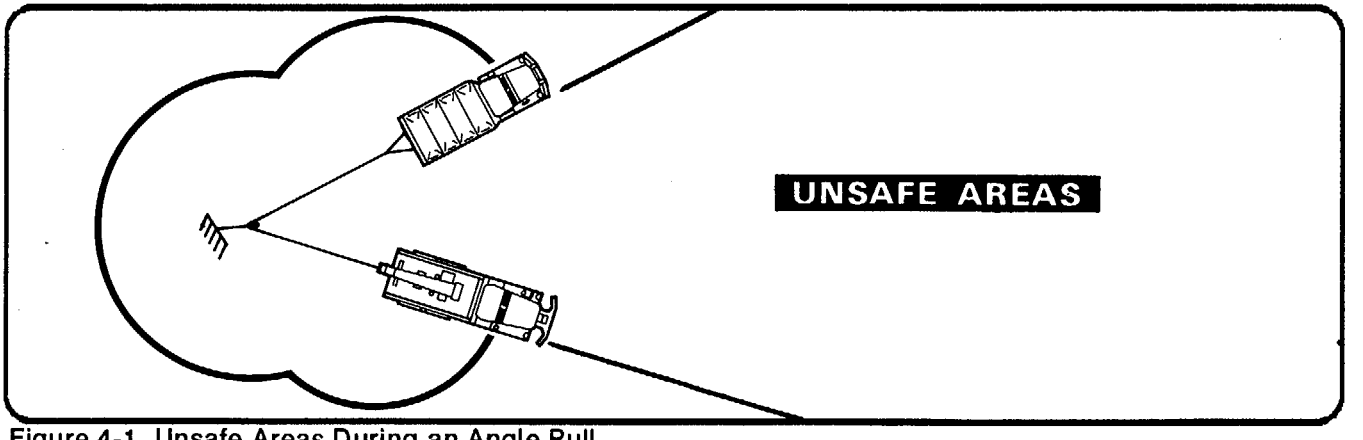


Figure 4-1. Unsafe Areas During an Angle Pull

HANDLING CABLES

Cables and wire ropes may become damaged through use. The wires that make up the strands of the rope may break. Personnel handling wire ropes should wear heavy, leather-palmed gloves to prevent hand injuries or cuts from broken wires. Never allow a moving cable to slide through the hands even when gloves are worn since broken wires can cut through the gloves. Never step over a cable under tension.

HOOK POSITIONS

For rigging, position the hook with the open part (throat) upward. If the hook should straighten out from overload, the rigging would be forced downward. If the hook were positioned with the open part (throat) down, the rigging would travel upward unrestricted and cause serious injury to personnel or damage to vehicles.

HOLDBACK VEHICLES

Towing track vehicles may require the use of a holdback vehicle. When using tow bars, if the recovery vehicle is lighter than the disabled vehicle, a holdback vehicle or braking method (that is, a driver with operable brakes in the towed vehicle) is required. A holdback vehicle or braking method is mandatory when using tow cables.

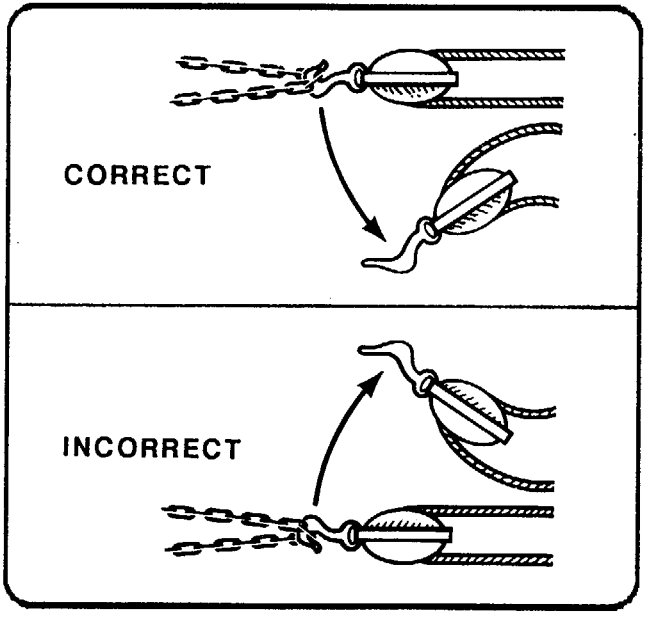


Figure 4-2. Hook Positions

CAUTION:
Take care to avoid injury to crew members and equipment caused by heat generated from combat vehicle exhaust systems. See TB 43-0001-39-1 for guidance on construction of an exhaust grate heat deflector.

INSPECT RIGGING

Inspect equipment thoroughly before the recovery operation starts. Direct the recovery vehicle operator to apply power to the winch to remove the slack from the rigging; then stop the operation so that the rigging can be inspected without endangering personnel.

OPERATOR/DRIVER SAFETY

Operators and other personnel, in both the recovery and disabled vehicles, should keep their hatches closed during a recovery operation and use their periscopes to view hand signals.

POSITIONING GUN TUBES

During tank recovery, position the main gun tube so that it will not be damaged. If the gun tube of a disabled tank is involved in a collision (this might occur on a nosed or overturned tank), support maintenance personnel should always check the gun before firing.

RIGGING BETWEEN VEHICLES

While rigging is being erected between vehicles, turn off the engines and apply the brakes. This prevents possible injury to the recovery personnel or damage to the vehicles. When riggings are erected using a recovery vehicle that must have its engine running to operate the equipment, position the spade or chocks (wheel vehicle) and apply the brakes to prevent movement. The driver will remain in position.

SAFETY KEYS AND SHACKLE PINS

Safety devices/keys should be in place on all tow hooks, shackles, or other items of equipment. Even though the safety device/key supports no great load, its absence can allow a pin to move and place an excessive force on only a part of a connection. Some shackles use a threaded-type pin. If the pin is not completely threaded into the shackle part, the shackle or pin can be bent or broken when force is applied.

When using pins with safety keys, such as the type in tow bars, all pins in a vertical plane should have their heads pointing up. Then, even if the safety key should break or fall out, the pins will remain in position if the load shifts.

SPEED

Take care when towing vehicles so that you maintain control of both the towing and towed vehicles. Consider terrain, weather, and road conditions. Never exceed tow speeds listed in operator's manuals.

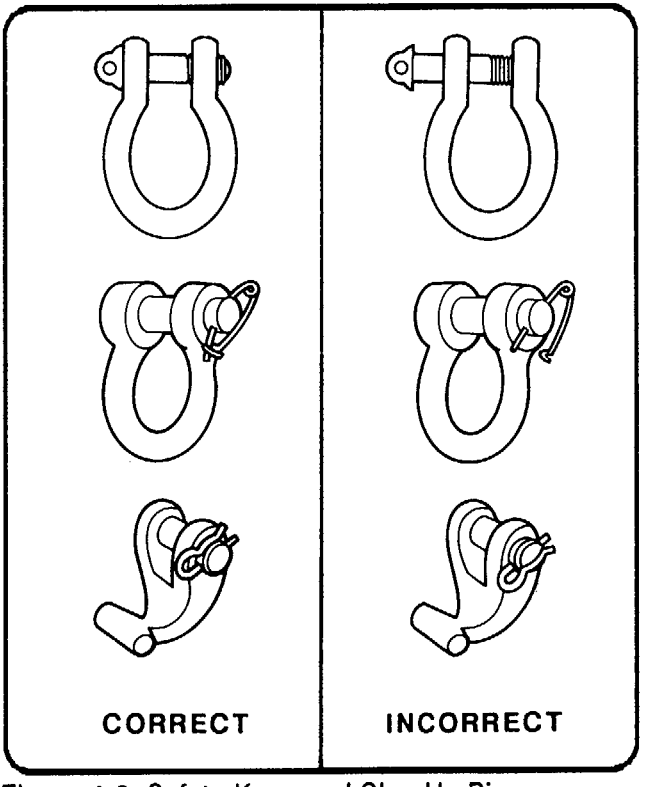


Figure 4-3. Safety Keys and Shackle Pins

RECOVERY PROCEDURES

In any recovery operation, use the following eight-step method.

- **STEP 1. RECONNOITER AREA**

Check the terrain for an approach to the load; then determine the method of rigging and the availability of natural anchors. As with a tactical mission, a recovery crew must know the problem before making decisions.

Make a complete ground survey of the area; then select the best route of approach to the disabled vehicle to prevent possible disablement of the recovery vehicle.

When selecting the evacuation route, ensure the military route classification number will support the combination vehicle classification (recovery plus towed vehicles). Refer to FM 5-36 for further information.

- **STEP 2. ESTIMATE THE SITUATION**

Estimate the resistance created by the load and determine the capacity of the available effort. For most recovery operations involving winching, the available effort would be the maximum capacity of the winch. In some recovery operations, the maximum distance between the winch and the disabled vehicle could be restricted, making the available effort as little as half the winch capacity.

- **STEP 3. CALCULATE RATIO**

Compute an estimated mechanical advantage for the rigging by dividing the resistance of the load (step 2) by the available effort (the capacity of the winch).

- **STEP 4. OBTAIN RESISTANCE**

Compute the tackle resistance and total resistance. Determine the resistance of the tackle. The

percent of the load resistance as determined in step 2 is multiplied by the number of sheaves in the rigging. The determined resistance of the tackle added to the load resistance equals the total resistance.

Total effort available is winch capacity multiplied by the mechanical advantage (as computed in step 3). If effort available is more than total resistance, proceed to step 5. If it is less, go to step 3 and add mechanical advantage.

- **STEP 5. VERIFY SOLUTION**

Compute line forces to compare with the winch and dead line capacities. Divide the total resistance (step 4) by the mechanical advantage (step 3). The result is the force of the fall line. The fall line force must be less than the capacity of effort. Therefore, this step of the recovery procedure is the key step to solving the problem.

When verifying the solution, if the computed fall line force is greater than the effort, the mechanical advantage must be increased. Note that no physical work has occurred up to this point. As a result, no time is lost moving equipment or having to reerect rigging equipment. Compute the dead line force, determine the required strength of equipment capacity, and choose the correct equipment to use as dead lines.

- **Step 6. ERECT RIGGING**

Orient the crew, instruct them to assemble the tackle, and then move to a safe location. Advise the crew members of the plan, direct them to erect the tackle, and assign specific tasks. Crew members who have finished their tasks should assist those who are having difficulty. The crew members can save time by having a thorough knowledge of the tackle to be erected and by helping each other. Observe all safety precautions!

- **STEP 7. RECHECK RIGGING**

Make sure that tackle is rigged for proper and safe operation. Direct the operator to remove most of the slack from the lines and to inspect for correct assembly. If any corrections must be made, direct the crew members to make them. Explain the details of

the operations to the operators of the recovery vehicle and the other vehicles involved. Direct operators to be prepared to watch for and act on signals. Then move to a safe location where signals can be observed by all vehicle operators.

- **STEP 8. YOU ARE READY**

Signal the operators to apply winch power and recover the load. Be alert and make sure that nothing obstructs the operations of the equipment, and that all personnel on the ground remain at a safe location.

NOTE: This eight-step procedure should be followed during all recovery operations. To assist in memorizing these steps and their sequence, they are arranged so that the first letter of each step will spell out the word "Recovery." This plan is of value to recovery crews, for application and supervision, and also to commanders for determining the efficiency of their recovery crews and their need for training.

RECONNOITER AREA
ESTIMATE SITUATION
CALCULATE RATIO
OBTAIN RESISTANCE
VERIFY SOLUTION
ERECT RIGGING
RECHECK RIGGING
YOU ARE READY

Figure 4-4. Eight-Step Recovery Procedure

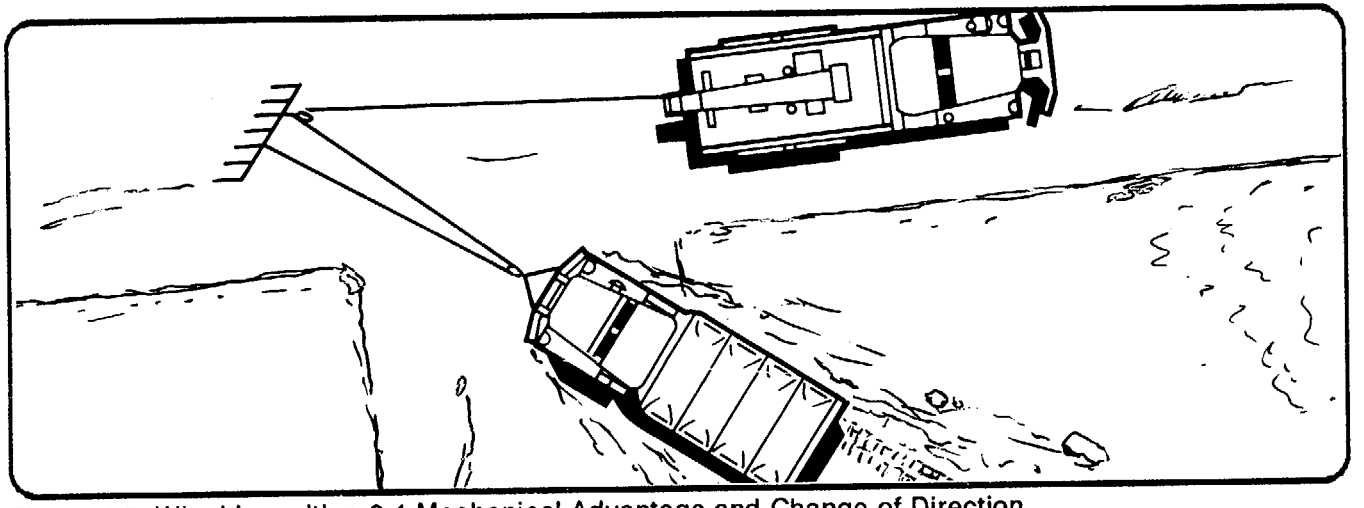


Figure 4-5. Winching with a 2:1 Mechanical Advantage and Change of Direction

RECOVERY METHODS USING WHEEL RECOVERY VEHICLES

TYPES AND USAGE

Recovery using wrecker trucks is performed by trained recovery personnel (see Appendix D). Use these special purpose vehicles for recovery when the methods used by the operator, crew, or platoon do not fit the situation or when their efforts have had no success. The methods of recovery performed with special purpose vehicles are winching, lifting, and towing.

NOTE: This section summarizes winch, lift, and tow procedures. For more in-depth information, refer to the technical manuals which relate to the operation of the equipment and its specific capabilities.

WINCHING

Factors that must be considered, during the recovery of a mired truck using a wrecker truck, are the resistance of the load, the approach to the load, and the distance between the wrecker and mired vehicle.

Mired trucks may have a resistance greater than the winch capacity of the wrecker. Also, the wrecker may not be able to align itself with the truck due to terrain. If so, use a 2:1 mechanical advantage and change of direction block.

The direct pull is the simplest winching operation and can be used when the resistance is less than the winch capacity.

WHEEL TOWING

Recovered vehicles must often be towed to a repair shop. The method of towing depends on the terrain and the mechanical condition of the disabled vehicle. A wrecker truck is capable of towing vehicles in the following ways:

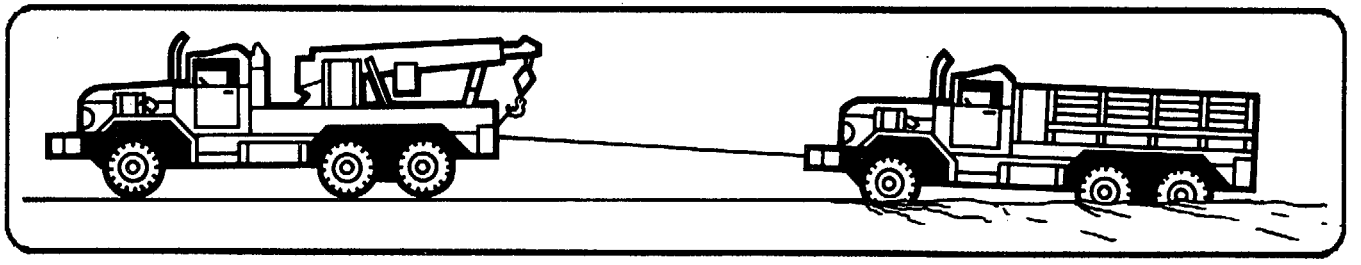


Figure 4-6. Direct Pull Winching Operation

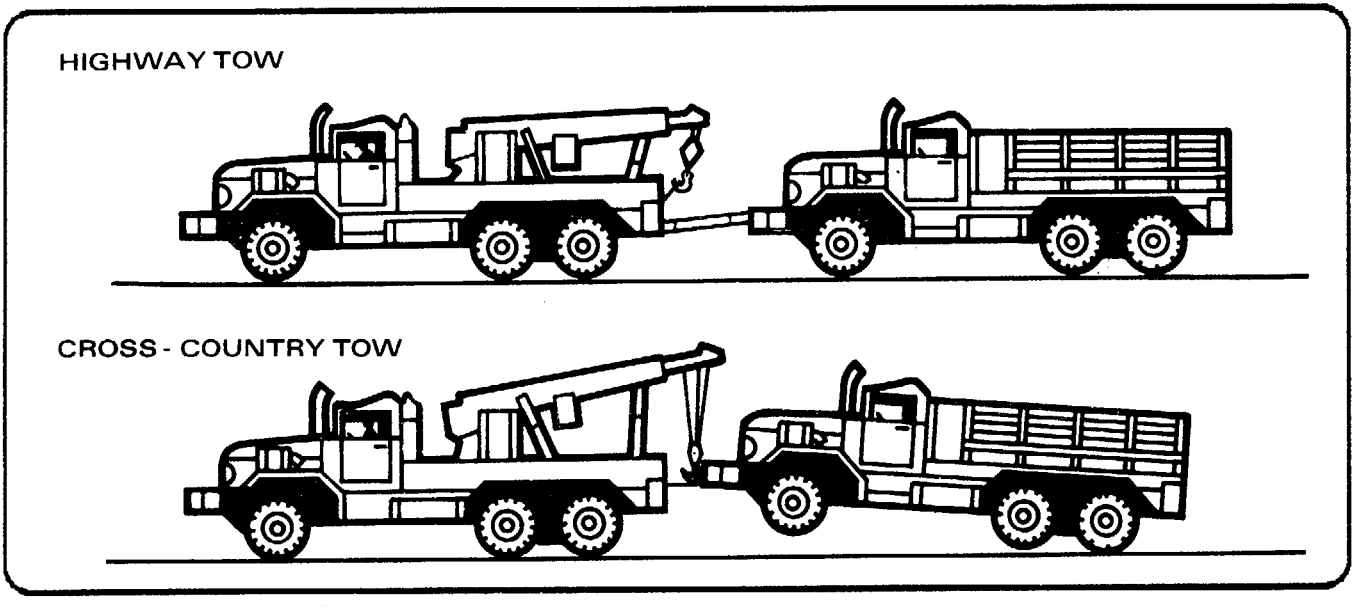


Figure 4-7. Wheeled Towing

Highway Tow

To use a highway tow, attach the tow bar to the disabled vehicle's lifting eyes and the wrecker truck tow pintle. All wheels of the towed vehicle are on the ground. A driver is not required in the towed vehicle.

CAUTION:

Safety chains must be used in addition to the tow bar. Properly used, safety chains will retain a towed vehicle should the tow bar fail or become disconnected. Cross the chains under and around the tow bar. Fasten to the shackles of the towing vehicle around a structural member or the underside of the vehicle to be towed. Leave sufficient slack for turns, but not enough to come in contact with road surface.

Cross-Country Tow

Over rough terrain, a cross-country tow controls the towed vehicle better. To rig for the cross-country tow, attach a chain-lifting sling or the hoisting bar between the truck's front lifting shackles. Attach a tow chain from the wrecker tow pintle to the disabled truck's lifting shackles. Place the hoist block hook in the lifting sling approximately 12 to 18 inches off the ground.

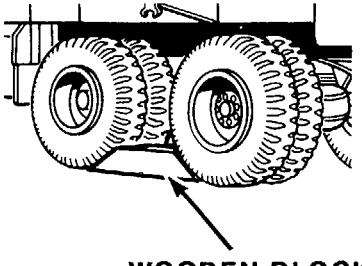
Extend the boom as little as possible to remove the slack from the tow chain to keep the towed vehicle from ramming into the rear of the wrecker truck. Support the boom with the shipper braces to prevent impact loads on the crane mechanism.

WARNING:

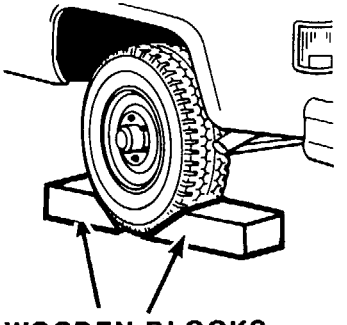
Extreme caution should be exercised to avoid damage to the towed vehicle. If at all possible, use the lift towing procedure before using cross-country tow or highway-tow procedures.

Lift Tow

If the front end of the vehicle is damaged, use lift-tow procedure even though the disabled vehicle is being towed on the highway. Attach axle clamps to the front axle of the disabled vehicle and attach the tow bar to the axle clamps. Be careful not to damage brake lines. Procedures are the same as cross-country towing except that a tow bar is used in place of the chain.



WOODEN BLOCK



WOODEN BLOCKS

HOOKING UP TO VEHICLE

1. BEFORE HOOKING UP TOW BAR OR DISCONNECTING DRIVE OR PARKING BRAKE, CHOCK VEHICLE WITH BLOCKS SO THAT IT CANNOT MOVE.

2. PLACE A BLOCK OF WOOD OR OTHER SUITABLE OBJECT BETWEEN REAR TIRES OR IN FRONT AND BACK OF ONE TIRE. MAKE SURE OBJECT EXTENDS FULL WIDTH OF TIRE.

UNHOOKING FROM VEHICLE

1. BEFORE UNHOOKING TOW BAR OR HOOKING UP DRIVE OR PARKING BRAKE, CHOCK VEHICLE WITH BLOCKS SO THAT IT CANNOT MOVE.

2. PLACE A BLOCK OF WOOD OR OTHER SUITABLE OBJECT BETWEEN REAR TIRES OR IN FRONT AND BACK OF ONE TIRE. MAKE SURE OBJECT EXTENDS FULL WIDTH OF TIRE.

CAUTION: FAILURE TO REMOVE THE BLOCK COULD RESULT IN DAMAGE.

Figure 4-8. Chocking/Blocking Wheeled Vehicles.

NOTE 1: A key towing principle is to keep as much weight as possible on the front wheels of the towing vehicle. Do this by keeping the towed vehicle as close as possible to the towing vehicle without causing damage to either vehicle. Raising the boom slightly (one or three holes), not extending the boom or only extending it as little as possible, and keeping the tow bar as short as possible, will all help keep weight on the front axle of the towing vehicle.

NOTE 2: Use extreme care when towing disabled vehicles. Check the disabled vehicle's technical manual for vehicle preparation, precautions that must be taken, and vehicle speed.

RECOVERY METHODS USING TRACK RECOVERY VEHICLES

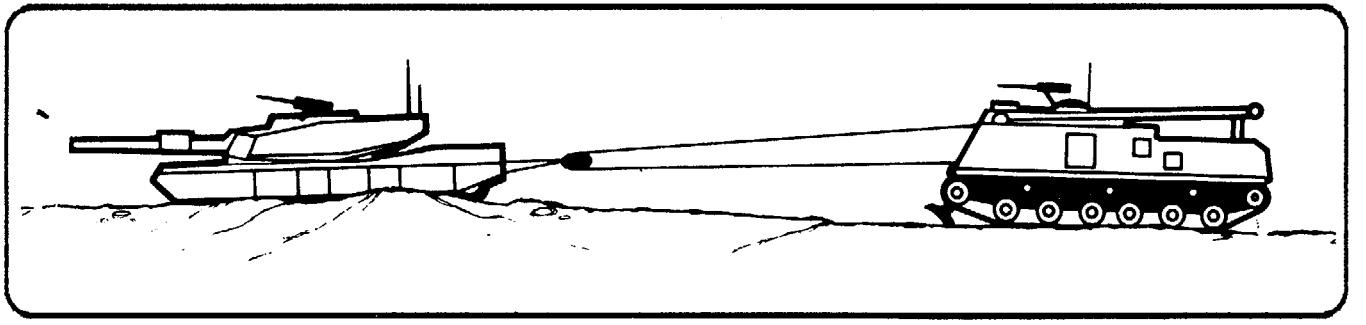


Figure 4-9. 2:1 Mechanical Advantage

WINCHING

Recovery with one recovery vehicle is used for recovering most mired track vehicles. To prepare for winching, position the recovery vehicle as nearly in line as possible with the mired vehicle. It must be at a distance to obtain maximum winching capacity. A greater mechanical advantage may be required.

There are several advantages in using a M88A1 when recovering mired track vehicles.

The M88A1 has a constant pull 70-ton main winch which will affect most recoveries on a single line. This allows the recovery crew to position the M88A1 as close as practical to the mired vehicle, allowing

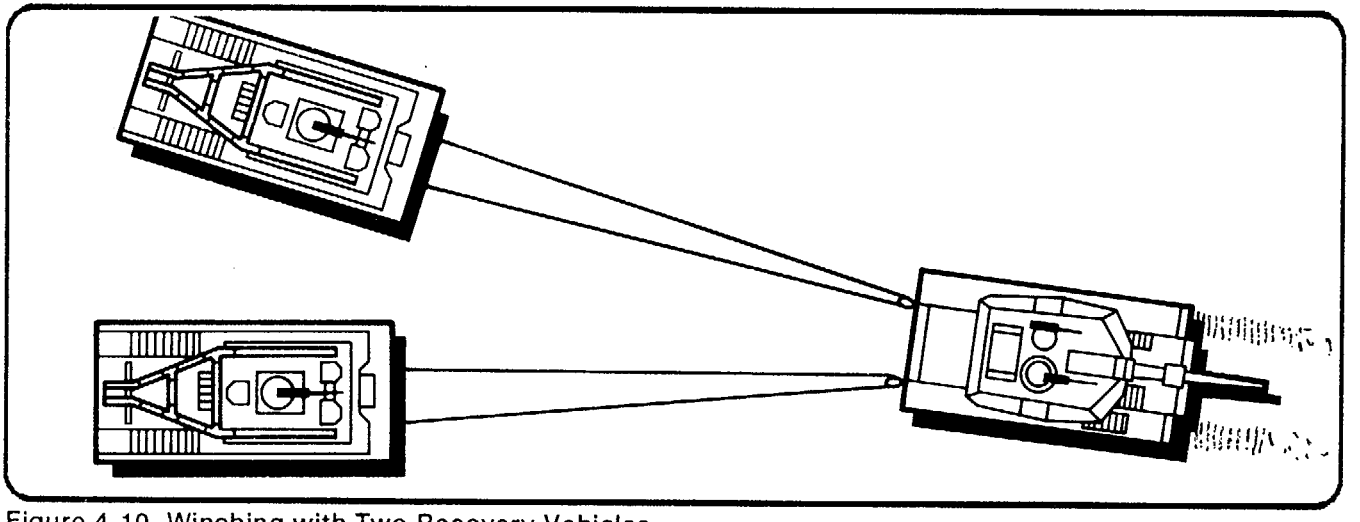


Figure 4-10. Winching with Two Recovery Vehicles

distance for the mired vehicle to get on solid ground. Testing has shown that the flat smooth hull of the Abrams-series tanks provide less resistance than is expected. This should allow most of the mired tanks to be recovered using a single line pull from the M88A1.

Recovery with two recovery vehicles is used only when the load resistance of a mired track vehicle is so great that the calculated fall line force is more than the winch capacity of one recovery vehicle with a 3:1 mechanical advantage.

To take full advantage of their winch capacities, the recovery vehicles are positioned side by side. The same length of winch cable can then be used. Rig each recovery vehicle for 2:1 mechanical advantage. Attach the snatch block of each rigging to a tow lug on the mired vehicle. To synchronize winch speeds, both recovery vehicle operators should use the hand throttle to set engine speed at the desired RPM and compensate with the winch control lever to maintain taut cables.

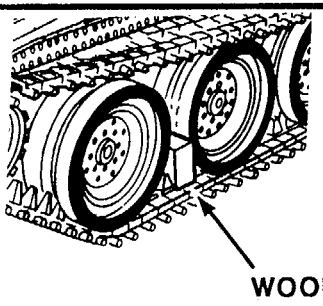
TRACK TOWING

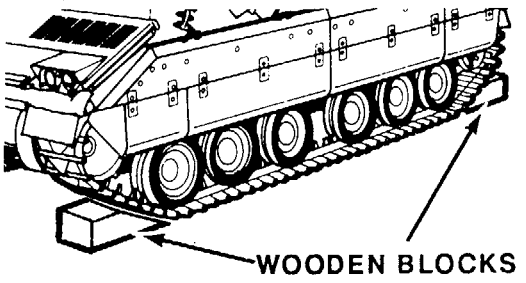
Although towing can be done with similar vehicles, it is often necessary for the recovery vehicle to tow a disabled vehicle to some point where repairs can be made or evacuation effected. The method of tow depends primarily on the type of terrain.

CAUTION:
Take care to prevent further damage to the vehicle when towing. Do not engage the towed vehicle's transmission during towing operations. Check the disabled vehicle's -10 manual or vehicle preparation, any further precautions, and the towing speed.

Highway Tow

Attach the recovery vehicle's tow bar to the tow lugs of the disabled vehicle. Place the lunette of the tow bar in the recovery vehicle's tow pintle. This could be done using a small block and tackle attaching one part to the tow bar and the other to a place on the recovery vehicle higher than the tow pintle. This should allow a single soldier to raise the tow bar





HOOKING UP TO CARRIER

1. BEFORE HOOKING UP TOW BAR OR DISCONNECTING DRIVE BETWEEN DIFERENTIAL AND FINAL DRIVES, CHOCK VEHICLE WITH BLOCKS SO THAT IT CANNOT MOVE.

2. PLACE A BLOCK OF WOOD OR OTHER SUITABLE OBJECT BETWEEN TRACK GUIDES AND TWO SETS OF ROAD WHEELS OR ONE IN FRONT AND ONE IN THE REAR OF THE TRACK. MAKE SURE OBJECT EXTENDS FULL WIDTH OF BOTH ROAD WHEELS.

UNHOOKING FROM CARRIER

1. BEFORE UNHOOKING TOW BAR OR HOOKING UP DRIVE BETWEEN DIFERENTIAL AND FINAL DRIVE, CHOCK VEHICLE WITH BLOCKS SO THAT IT CANNOT MOVE.

2. PLACE A BLOCK OF WOOD OR OTHER SUITABLE OBJECT BETWEEN TRACK GUIDES AND TWO SETS OF ROAD WHEELS OR ONE IN FRONT AND ONE IN THE REAR OF THE TRACK. MAKE SURE OBJECT EXTENDS FULL WIDTH OF BOTH ROAD WHEELS.

CAUTION: FAILURE TO REMOVE THE BLOCK COULD RESULT IN SEVERE TRACK DAMAGE.

Figure 4-11. Chocking/Blocking Tracked Vehicles.

to the pintle without getting between the two vehicles. Secure the pintle in the closed position. A driver is not required in the towed vehicle.

If the recovery vehicle is lighter than the disabled vehicle, a holdback vehicle or a driver to operate the brakes in the towed vehicle is required so that the towed vehicle will not overrun the recovery vehicle.

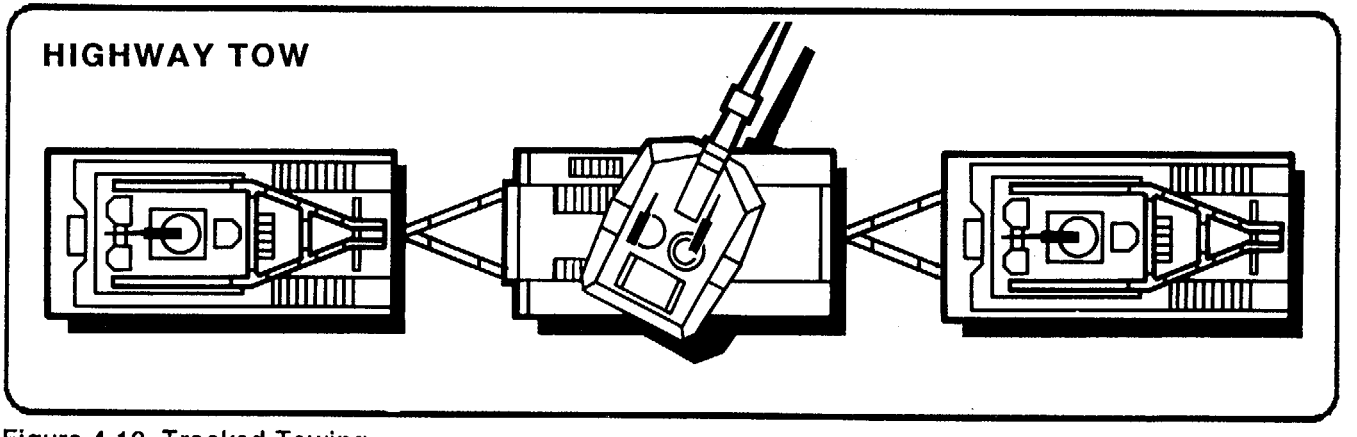


Figure 4-12. Tracked Towing

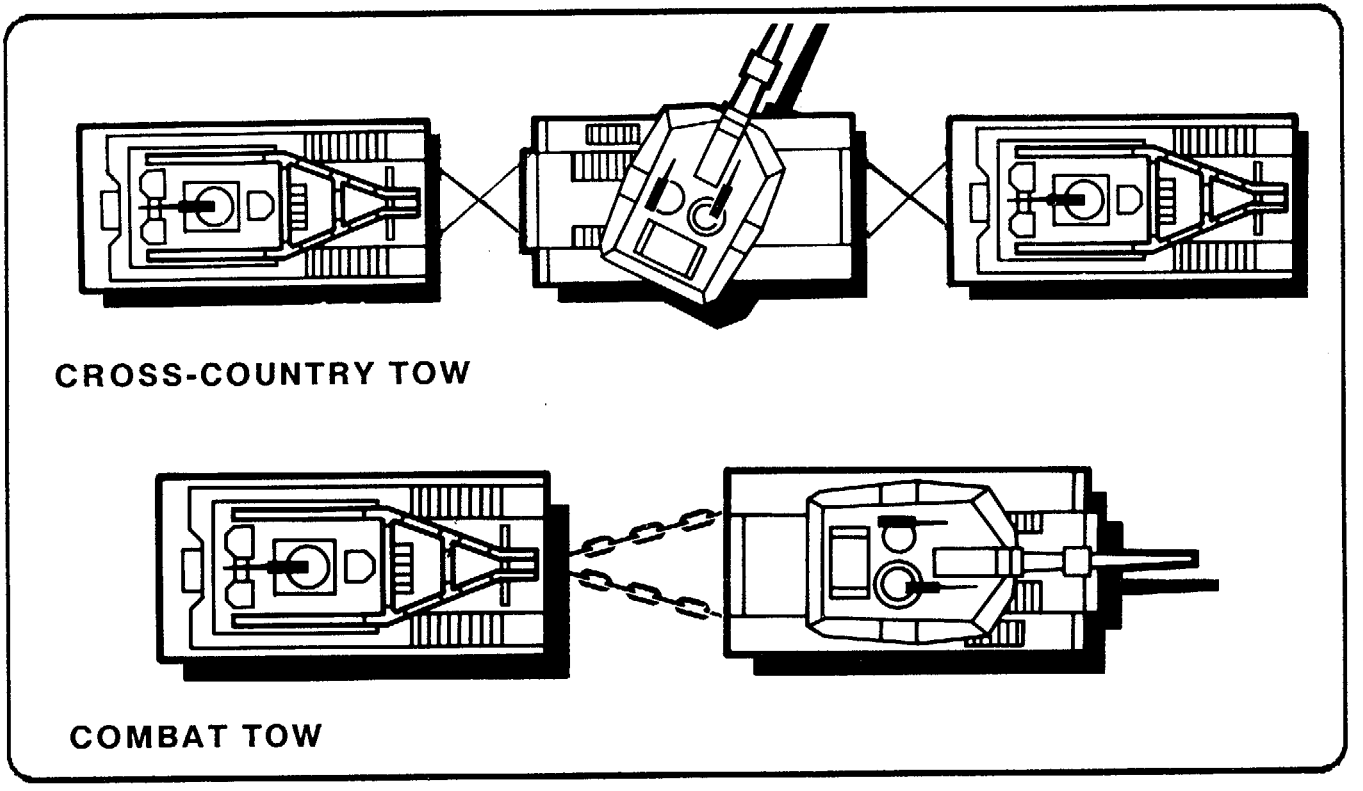


Figure 4-12 (Continued).Tracked Towing

Cross-Country Tow

Only in extreme cases, or as a backup, will crossed tow cables be used as a method of towing. Use crossed tow cables between the recovery vehicle and the disabled vehicle as when towing similar vehicles. A holdback vehicle or a driver to operate the brakes in the towed vehicle is required so that the towed vehicle will not overrun the recovery vehicle.

Combat Tow

Use combat tow to make a towing connection under small-arms fire to provide the least possible exposure of personnel. Attach the lifting V-chain to the recovery vehicle's tow pintle before moving it to the disabled vehicle. Move the recovery vehicle into the danger area. Back it up until contact is made with the front of the disabled vehicle. If possible, a crew member in the disabled vehicle can connect the V-chain legs to the front tow hooks of the disabled vehicle. The recovery vehicle then moves out, towing the disabled vehicle. Do not use combat tow for distances greater than one-quarter mile. Conditions permitting, change the towing procedure after that distance.

TOW BAR HANDLING

Before attempting to tow a disabled vehicle, make sure you are familiar with the location, features, and operation of all components of the tow bar. Some tow bars have operator's instruction decals mounted on them. Ensure the proper tow bar is used based on the equipment being towed. Tow bars can be used to tow any vehicle up to the gross weight of the tow bar's towing capacity.

Before attaching tow bar to a disabled vehicle, chock wheels and/or set emergency brake. After attaching tow bar to a disabled vehicle, remove chocks and release emergency brake before moving.

Refer to disabled vehicle's technical manual for proper towing procedures (for example automatic versus standard transmission, and so forth).Ensure the proper pin assemblies are in the clevis holes and always be sure the quick release pins are properly secured. They snap automatically.

TOWING OPERATIONS ON GRADES

Towing a disabled vehicle is never easy, but towing up or down a grade can be even more difficult and dangerous. While towing a disabled vehicle, do not attempt to negotiate a grade (either up or down) greater than 25 percent unless you have the express permission of your commander.

NOTE: Under no conditions will you ever negotiate a slope greater than 30 percent while towing a vehicle.

In order to know which grades to avoid, you have to know how to classify them. Grades are defined in terms of percent, or the amount of a grade's vertical height (rise) over its horizontal length (run). If a road gains 25 feet of height over 100 feet of length, it is classified as a 25 percent grade.

The best way to classify a grade is with a surveyor's level, which will be BII on the Improved Recovery Vehicle, M88A2. The operator stands at the top (or bottom) of the hill, and chooses a point as close to the bottom (or top) of the hill, as possible where he will be traveling. The operator then looks through the sight of the level at the point he has chosen and turns the level knob until he sees the level bubble centered between the witness marks. He then just reads the percent grade off the indicator.

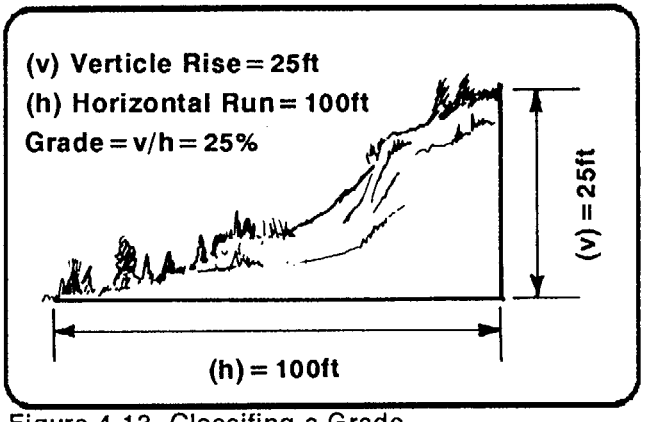


Figure 4-13. Classifing a Grade

An expedient method uses a small level, a 10-inch piece of flat wood and a ruler. Lay the piece of wood on the steepest part of the grade, with the length of wood running up and down hill. Put the level on the piece of wood and start to raise the downhill side of

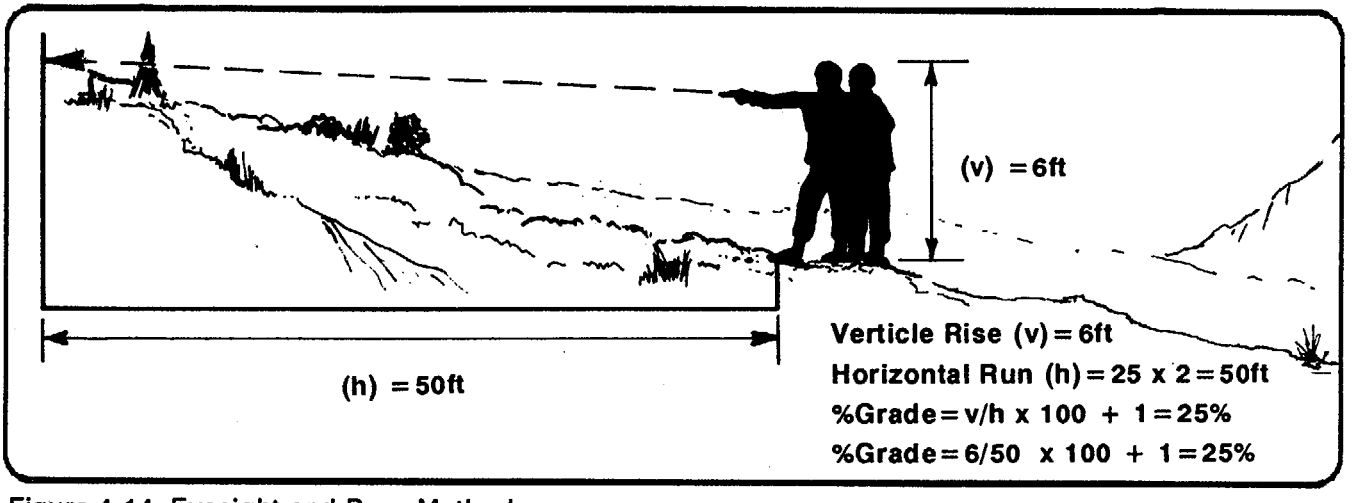


Figure 4-14. Eyesight and Pace Method

the wood up, until the bubble in the level is between the witness marks. Measure the distance between the road and the bottom of the wood. If it is 3 inches, you are on a 30-percent slope; 2.5 inches, and you are on a 25-percent slope, and so on.

One other way of determining grade is the eyesight and pace method. You need to know your height and the length of your stride. If a soldier is 6 feet tall and his step is 2 feet long, he stands at the bottom of the hill and picks a spot on the hill that is the same height as his head. He then walks to that spot counting his steps. Once he reaches the spot, he multiples his steps by his stride (2 feet) and then divides his height (6 feet) by that number multipled by 100 and adds 1.

Take the following items into consideration while doing your terrain analysis.

- Trails/grades with sharp curves mean additional control is needed during ascending and descending. There is no safety zone in case of a run-away load.

- Inclement weather (rain, snow, ice) will naturally affect the road conditions, making them more likely to cause loss of traction.

- Dry, dusty soil can cause a loss of traction as well as wet muddy soil. Do not let the soil conditions fool you.

If you have to shift into first gear to climb a grade, there is a good chance it is too steep to descend that way with a towed load. Check it before descending.

If you can find a way around the steep grades, good. If not, what are your options? First notify your commander. Tell him the percent grade of the road, weather visibility, and what the road conditions are (wet, dry, muddy, paved). The recovery vehicle driver's experience, and the type load he is towing will play an important role in the commanders decision. If you, the driver, do not feel confident in negotiating the grade, make that known to the commander. The best course of action may be to get the most experienced wrecker/recovery vehicle operator on the site to take the mission.

Other options may be:

- Try using a braking vehicle in back of the towed load.

- For tracked vehicles, hook up the final drives, start the engine (if possible; if not, brakes of disabled vehicle will not work) and try using the disabled tracks brakes in conjunction with the recovery vehicle. This will call for communication between vehicles, and very good coordination. Remember to disconnect the final drives again at the bottom of the hill.

- In some cases, winching the disabled vehicle downhill might be possible.

In summary, ensure you conduct a good route reconnaissance on your way to the disabled vehicle's site. Avoid all hills or roads with a grade of 25 percent or greater when at all possible while towing a load. If not, notify your commander, and take proper precautions.

RECOVERY WITH THE FIFTH WHEEL TOWING DEVICE

The FWTD converts a fifth wheel tractor into a vehicle for lift-towing. The tractor requires no modification to accept the device. It can lift-tow disabled vehicles from the front or rear.

CAUTION:

Never exceed gross vehicle weight or gross axle weight rating of the tractor the FWTD is mounted on. The tractor on which the device is installed should be the largest available for use and have a long wheel base. Handling characteristics of the towing vehicle will be adversely affected when less than 50 percent of front axle weight remains on front wheels. As in all lift- tow operations, CAUTION must be exercised.

Towing From Rear End of Disabled Vehicle

Lower the bar to its lowest position. Back the tractor to within a foot or two of the rear end of disabled vehicle. Raise the tow bar so it is about the same height as the lower edge of the disabled vehicle's frame. Back the tractor until it almost contacts the end of the frame on the disabled vehicle. Fasten one end of a lift chain to a strong frame member on one side of the disabled vehicle. Keeping slack out of the lift chain, fasten it to the grab hook of the tow bar. Fasten the other lift chain the same way.

Release the brakes on the disabled vehicle. Raise the tow bar fully. The rear wheels of the disabled vehicle should be 4 inches above the road surface. Install boom support pins to prevent downward travel

of the boom. Secure the free ends of lift chains. Attach safety chains. Secure the steering wheel so that the front wheels do not move from the straight ahead position.

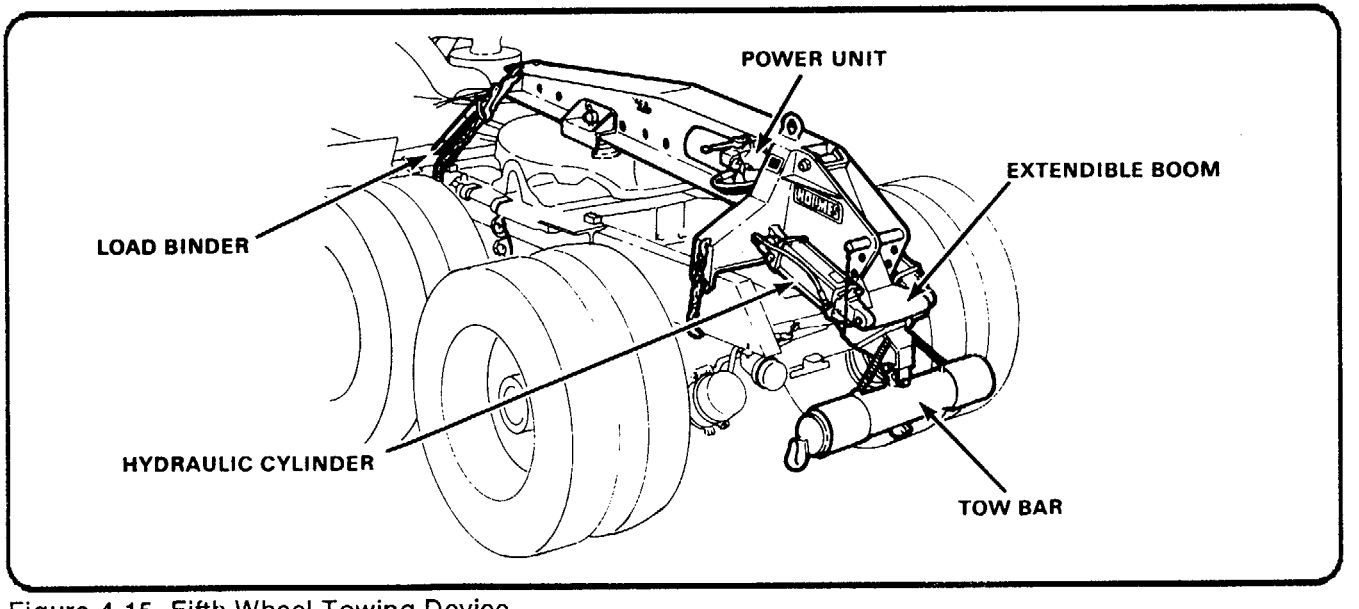


Figure 4-15. Fifth Wheel Towing Device

Towing From Front End of Disabled Vehicle

Front end connecting procedures are similar to rear end towing procedures. However, lift chains are wrapped around the front axles not the frame rails. When wrapping chains around axles, be careful not to damage brake or air lines. Also, towing vehicles with low front bumpers may require extending the boom to lower the tow bar sufficiently.

CAUTION:

SAFETY CHAINS MUST BE USED IN ADDITION TO LIFT CHAINS. Properly used, safety chains will retain a towed vehicle should the lift chains fail or come undone. Cross the chains under the tow bar and fasten their ends around a structural member on the underside of the vehicle being towed. Leave sufficient slack for turns but not enough to contact road surface.

RECOVERY WITH ALLIED KINETIC ENERGY RECOVERY ROPE

The AKERR kit consists of a multistrand, woven nylon rope, two large shackles, four small shackles, and a canvas bag. It is used to effect like-vehicle recovery. The concept of operation behind the AKERR is the stretch of the rope and its subsequent attempt to return to its normal length providing a sudden snatch effect. This effect provides additional recovery force. Maximum effectiveness is achieved when the recovering vehicle is of the same or greater weight class than the mired vehicle.

WARNING:

Use only shackles issued with AKERR kit. Other shackles may look the same but could fail during AKERR operations. Personnel could be injured or killed or equipment damaged if the wrong shackles are used.

Vehicles currently authorized to use AKERR are listed below:

TYPE VEHICLE	VEHICLE WEIGHT
M109A1/M109A6	55,000 lb
M992	57,500 lb
M578	54,000 lb
M551/M551A	36,000 lb

CAUTION:

Keep personnel 100 feet to the side of vehicle and close all vehicle hatches. If towing attachments fail, metal pieces can be catapulted at high velocity. The towing vehicle reverses as closely as possible to the bogged vehicle. The rope is connected and snaked to allow tangle-free deployment. For situations where it is not possible to get close to the bogged vehicle, extension cables may be used. Rigging for individual vehicles is illustrated in TM 9-4020-200-10. The AKERR must be connected directly to the recovery or towing vehicle. Engage gears in both recovering and mired vehicles to allow for travel in the same direction.

On a prearranged signal, the recovery vehicle will accelerate at maximum speed. At the same time, the mired vehicle (if possible) will accelerate to assist the recovery effort. Continue maximum acceleration until the recovery vehicle is stopped or the mired vehicle is recovered.

The towing vehicle is slowed or halted; its kinetic energy is converted into the potential energy of a stretched rope. The energy is transferred by the rope into the bogged vehicle. After a slight pause, the bogged vehicle rises free. If the vehicle is not freed by the first attempt, the process should be repeated. Once free, continued towing by AKERR is possible. After recovery is effected, remove the AKERR and wash it with low pressure water.

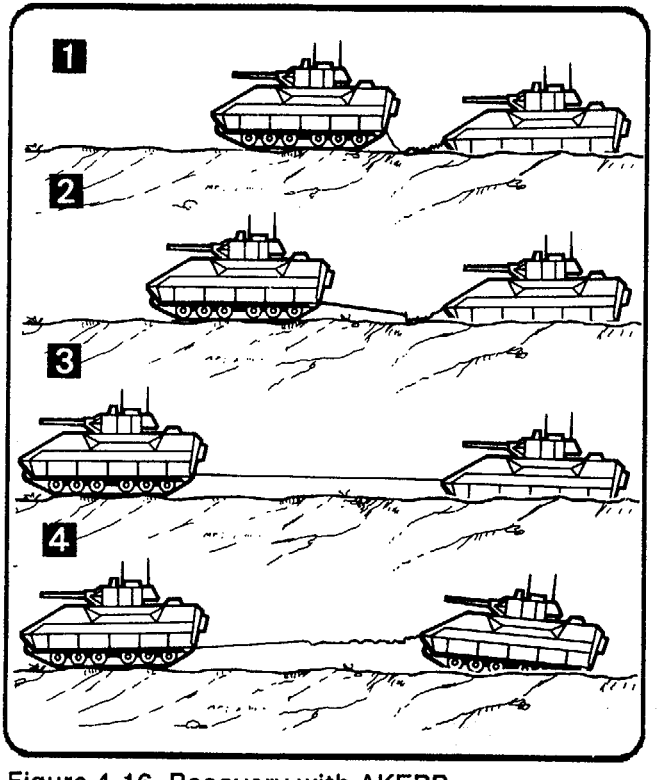


Figure 4-16. Recovery with AKERR

THE CONCEPT OF OPERATION BEHIND THE AKERR IS THE STRETCHING ACTION OF ROPE AND THE SUBSEQUENT ATTEMPT TO RETURN TO ITS NORMAL LENGTH

SPECIAL RECOVERY SITUATIONS

NOSED TRUCK

The recovery of a nosed truck using a wrecker may require only a towing operation. Some situations may require all three of the wrecker's capabilities (winching, lifting, and towing) to complete the recovery.

Example: A 2 1/2-ton cargo truck is nosed off a narrow road and mechanically disabled. Although the apparent fleet angle of the winch cable in the figure is greater than 1 1/2 degrees, the wrecker winch has

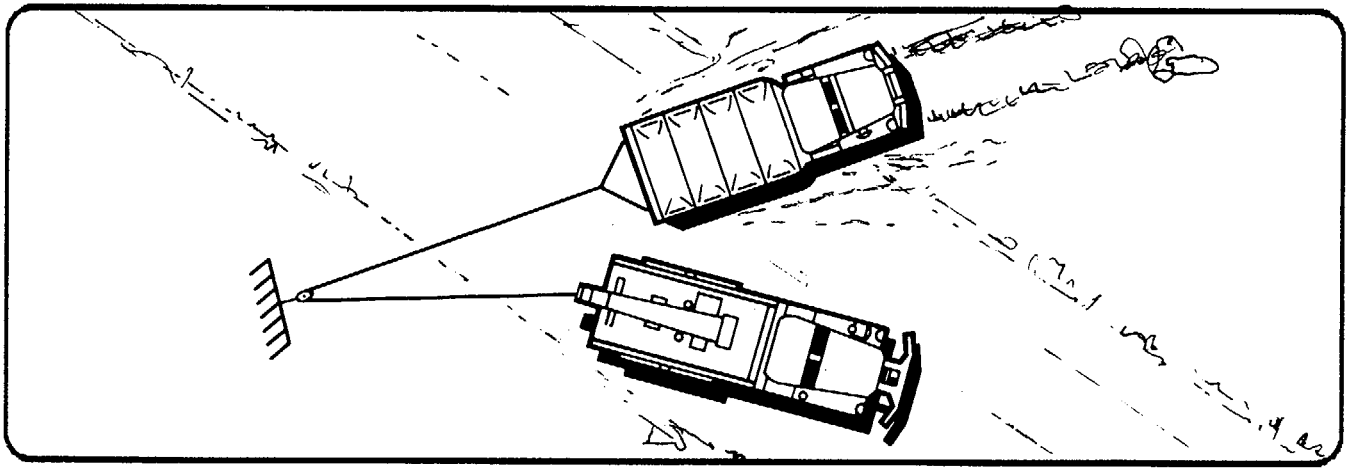


Figure 4-17. Nosed Cargo Truck

a level winding device which offsets the difference. (All vehicles with winches do not have this device.)

To perform the recovery, position the wrecker truck on the road so that the front end of the nosed truck, when pulled back up on the road, will be in line with the rear of the wrecker truck. Make a change of direction pull, using the wrecker's rear winch to pull the truck onto the road. Then, lift the front of the truck with the wrecker's outriggers in place and turn the crane to place the truck directly behind the wrecker truck to prepare for towing.

OVERTURNED TRUCK

To upright an overturned truck using the wrecker, a sling method of attachment must be used because a pulling force applied to only one point of the frame may result in a bent frame. A sling attachment is made of two utility chains.

The sling ends are attached to the front and rear lifting shackles on the high side of the overturned truck. Then the winch cable is attached to the center of the sling.

A holding effort will be required to prevent the overturned vehicle from crashing onto its wheels. The holding force could be another vehicle, the wrecker boom, or a rope block and tackle with manpower. The attachment for the holding force is a holding sling attached to the same points on the overturned truck as the pulling sling. The holding sling is then attached to the holding force with cable, rope, or chain, making sure the holding force is attached to the center of the sling. If a holding vehicle is not available, use the wrecker boom to hold the load.

Apply power gradually to the winch until the overturned truck is past the vertical position. Then, lower the truck on its wheels with the hoist winch. When this method is used, maximum use of the boom jacks and outriggers should be made where necessary. Because of the danger of igniting spilled fuel and oil, smoking or open flames are not allowed near the overturned vehicle.

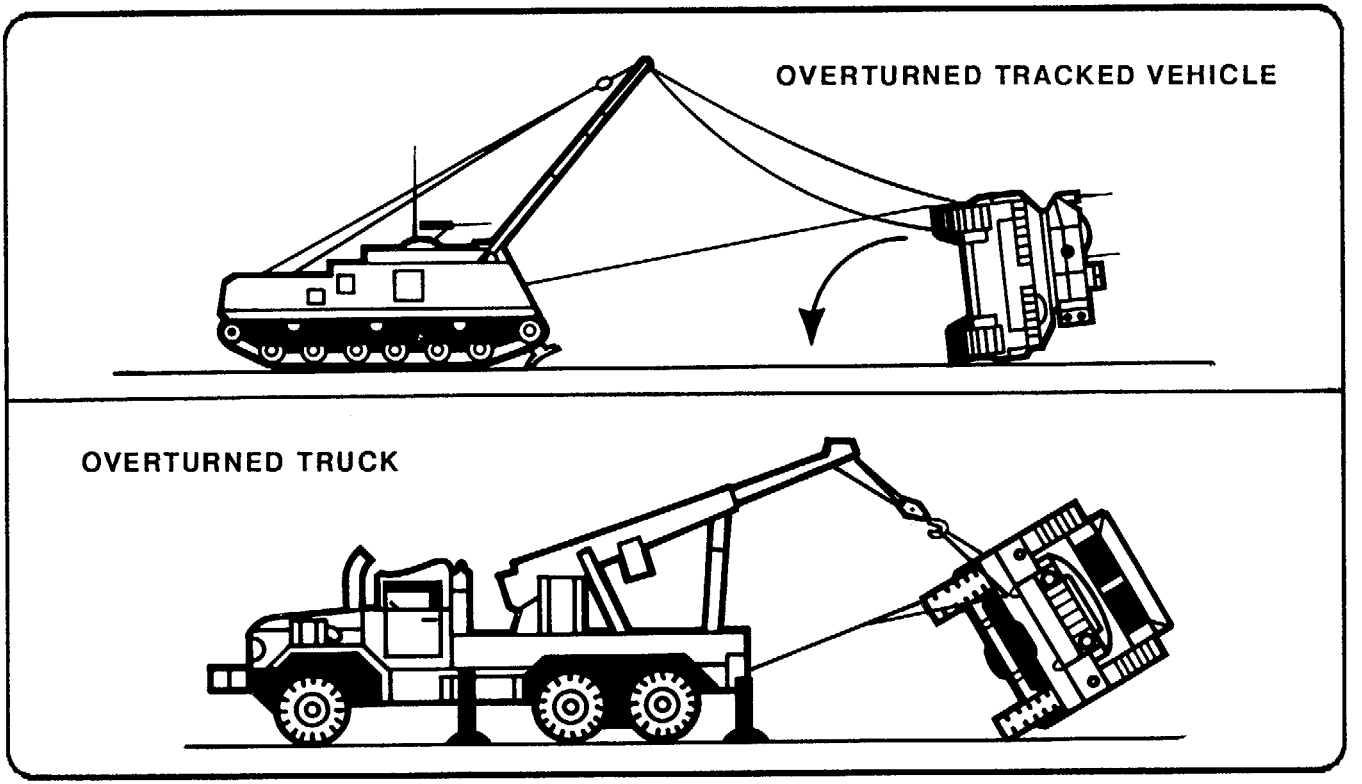


Figure 4-18. Recovery of Overturned Vehicles

OVERTURNED TRACK VEHICLE

To upright an overturned track vehicle with a recovery vehicle, position the recovery vehicle so that it is facing the bottom of the overturned vehicle. It should be at a distance equal to the width of the overturned vehicle, plus 2 feet for safety.

For the holding source of power, rig the boom with its maximum mechanical advantage rigging, and attach its hoist block to two tow cables to form a sling. Pass the opposite ends of the sling under the track. Attach them to the front and rear tow hooks on the high side of the overturned vehicle.

For the uprighting source of power, use a utility chain to attach the main winch cable to the center road-wheel arm support housing on the high side. Apply power to the main winch until the vehicle pulls past its point of balance and is supported by the hoist rigging.

Then, by lowering the hoist winch rigging slowly, lower the overturned vehicle onto its suspension system.

FORKLIFTS

Forklifts cannot be towed and must be transported by trailer, because of the bouncing and swaying of the vehicle. They will overturn or get stuck in mud. Use the overturned vehicle recovery procedure to upright the forklift and use the mired-vehicle procedure to recover a forklift that is stuck in mud.

ARMORED VEHICLE LAUNCHER BRIDGE

When recovering the AVLB, the bridge has to be removed by another AVLB through hydraulic slave procedure. The bridge cannot be removed by the M88 hydraulic system because they are not the same. Once the bridge is removed, refer to the operator's manual for the towing and hookup procedures.

COMBAT ENGINEER VEHICLE

Make sure road wheels are blocked before disconnecting final drives. When a tow bar or cables are used, a second vehicle is required when descending a grade of 20 degrees or more. A second vehicle is also required when the road conditions dictate. CEV

should only be towed from the rear unless the blade is removed from the front of the vehicle.

MINE PLOW AND MINE ROLLER

Vehicles with mine plows and mine rollers attached cannot be towed from the front until the mine rollers or mine plows are removed. These vehicles can be towed from the rear provided the terrain and situation allows it. Once you determine how you will tow the vehicle, reference the operator's manual for towing and hookup procedures.

CRANE, WHEEL MOUNTED

This vehicle can be towed, but obtain information on road conditions and possible restrictions along the route. Use a vehicle with an air brake system capable of producing 120 psi in the system; place the boom over the front which is the most stable position for towing. If towing more than one-fourth mile, disconnect propeller shafts from the front and rear axles. Caution must be used when turning and traveling through towns.

ROAD GRADER

When towing the road grader for distances greater than one-half mile, direct support or general support personnel must remove the tandem drive chains. If the distance is less than one-half mile, it is not necessary to remove the tandem drive chains, and speeds must be below 5 MPH. If there is no support personnel available to remove tandem drive chains, the road grader must be recovered by trailers if the distance is more than one-half mile and it cannot be towed.

SCOOP LOADER

This vehicle should never under any circumstances be pushed or towed. It must be moved by a flatbed trailer. In the event of an emergency where you have to tow the scoop loader, the maximum distance the loader may be towed or pushed is one-half mile at low speeds, not to exceed 5 mph.

M9 ACE ARMORED COMBAT EARTHMOVER

When towing the M9 ACE, it must be towed from the rear. The final drives must be disconnected, to prevent damage to steering unit. When turning, turn in a wide arc to prevent undue strain on the suspension of the disabled vehicle and tow bar. Make sure the disabled vehicle is in the SPRUNG position.

NOSED TRACK VEHICLE

Various factors must be considered before recovering a track vehicle nosed in a deep trench or ravine. If the terrain behind the nosed vehicle is level, recover by towing. If the terrain is not suitable for towing, perform a winching operation.

If the recovery vehicle cannot be safely positioned behind the nosed vehicle, move the recovery vehicle

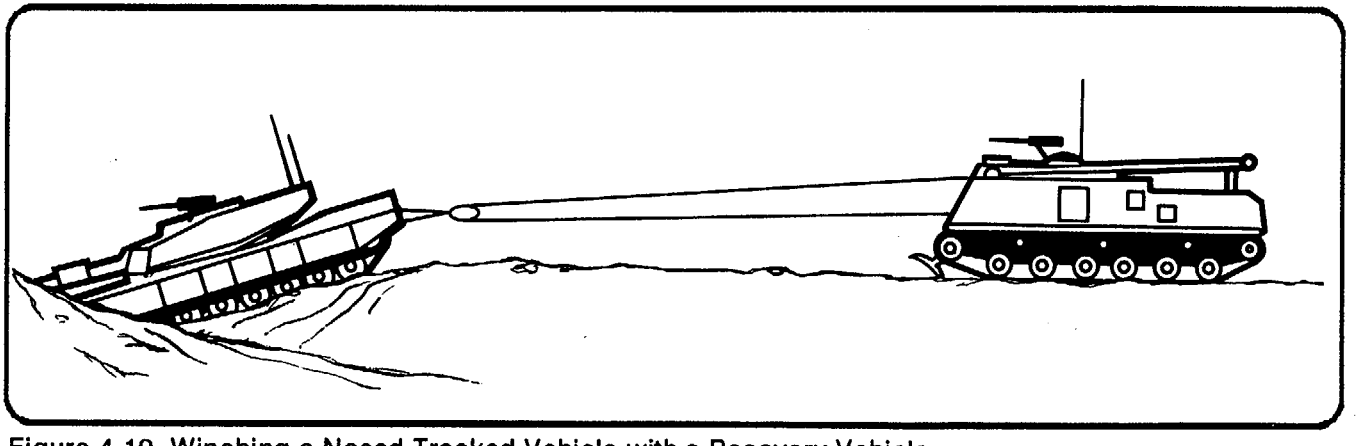


Figure 4-19. Winching a Nosed Tracked Vehicle with a Recovery Vehicle

NOSED VEHICLES MAY BE RECOVERED BY TOWING, WINCHING OR LIFTING OPERATIONS

to the opposite side of the ditch. Using the recovery vehicle's boom with its maximum mechanical advantage rigging, attach its hoist block to the front lifting eyes on the nosed tank with a V-chain.

Lift the vehicle horizontally and pull it to the opposite side of the ditch where towing or winching can complete the recovery. If the tow hooks are accessible on the nosed vehicle, use rigging to attach them

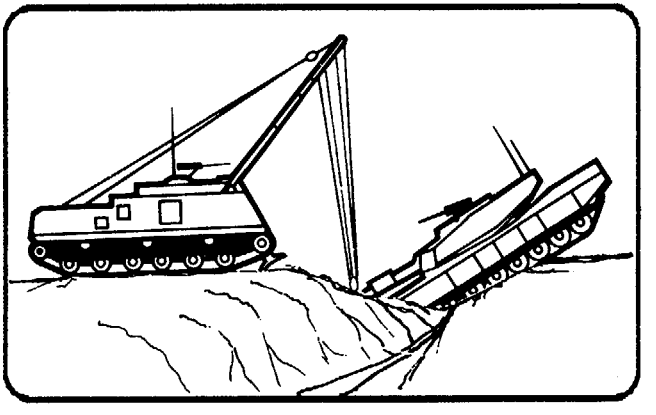


Figure 4-20. Lifting Operation

to the winch. Recover the nosed vehicle with a combination of winching and hoisting. Control the weight and movement of the disabled vehicle during the entire recovery operation by coordinating the hoist winch and the main winch.

WARNING:
Because of the spilled oil, fuel, ammunition, and battery acid normally present, do not permit smoking or open flames near overturned or nosed vehicles.

SELF- AND LIKE-VEHICLE RECOVERY

SOURCES OF EFFORT

The amount and type of equipment used as the source of effort during any recovery operation depends on the level of recovery. Drivers and crews should try to carry out the recovery before calling on support from a higher level. During combat, it may be imperative that cargo reach its destination at a definite time, that the personnel or cargo be picked up at a given time, or that a combat vehicle be at a given place at a specific time.

The use of similar vehicles is usually the quickest method of recovery because they are readily available. Call for recovery support only when self- or like-vehicle recovery techniques cannot be used. A mired vehicle with no winch may be able to free itself by using recovery expedient measures discussed previously.

Combat vehicles which need fuel, ammunition, or repairs not related to mobility (for example, a fire control malfunction) can tow disabled vehicles to the

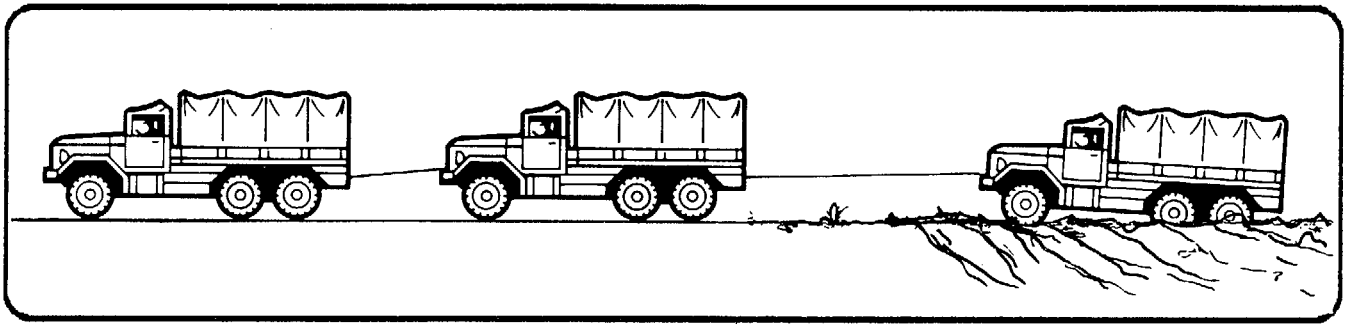


Figure 4-21. Recovery of a Mired Cargo Truck

refuel, rearm, or maintenance site. However, engaged combat vehicles should never be diverted for recovery.

RECOVERING A CARGO TRUCK FROM MIRE

Use similar wheel vehicles as the source of effort to perform recovery by towing and winching. For vehicles not equipped with lifting shackles, attach a tow chain to the main structural members. Before towing or recovering a disabled vehicle, check the vehicle's technical manual to ensure that all physical and safety features are considered (for example, automatic transmissions, fail-safe braking systems, and articulation). This must be done so additional damage is not caused to the disabled vehicle.

To recover a mired truck by towing with a similar vehicle, use a tow chain, cable, bar, or rope between the towing vehicle and the mired vehicle. Attach it to one lifting shackle of the mired vehicle and the tow pintle on the towing vehicle. If a greater working distance is required to enable the towing vehicle to get better traction, use the towing device from both vehicles. Apply power slowly to prevent placing an

impact load on the towing device and lifting shackles. A chain, unlike a cable, will not stretch and can be broken easily by impact loading. If one towing vehicle cannot attain sufficient towing effort to overcome the resistance, use another towing vehicle in tandem with the first.

PROPER HOOKUP WITH A SIMILAR WHEEL VEHICLE

To recover a mired cargo truck, use a truck of equal or greater capacity to perform the winching operation. A mired 2 1/2-ton cargo truck may be winched with either a 2 1/2-ton or 5-ton vehicle. All winch-equipped trucks are authorized a single sheave snatch block and one tow chain for rigging.

First, determine if the resistance of the mired truck is greater than the winch capacity. If so, a mechanical advantage is required. If it does not exceed the winch capability, position the winching vehicle in line with the mired vehicle so the correct fleet angle is obtained.

Free-spool the winch cable from the drum and attach the free end of the cable to one of the front lifting shackles of the mired vehicle and attach the

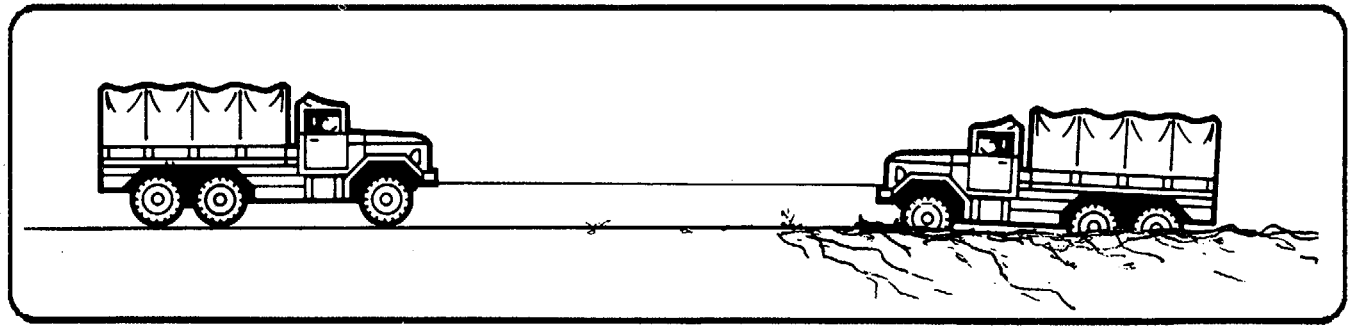


Figure 4-22. Winching with a Similar Vehicle

snatch block in the apex of the sling. Place the loop that is formed in the winch cable in the snatch block and apply power to the winch to remove the slack from the cable. At times, the winching or recovery vehicle must be anchored by more than just its weight. Place wheel blocks, chocks, or natural material in front of the recovery vehicle's front wheels.

A winch-equipped mired vehicle can perform self-recovery. Attach the snatch block to a suitable anchor and the free end of the cable to a chain sling connected to both of the mired vehicle's front lifting shackles. A fixed block will gain a mechanical advantage on a self-winching operation.

USE OF SIMILAR-TYPE TRACK VEHICLES FOR RECOVERY

The number of track vehicles required for a specific recovery depends on the resistance to be overcome, the type of disablement, and the terrain conditions. To rig for recovery, attach the tow cables to the tow hooks of both vehicles. All main battle tanks carry two tow cables. Light-track vehicles carry one tow cable.

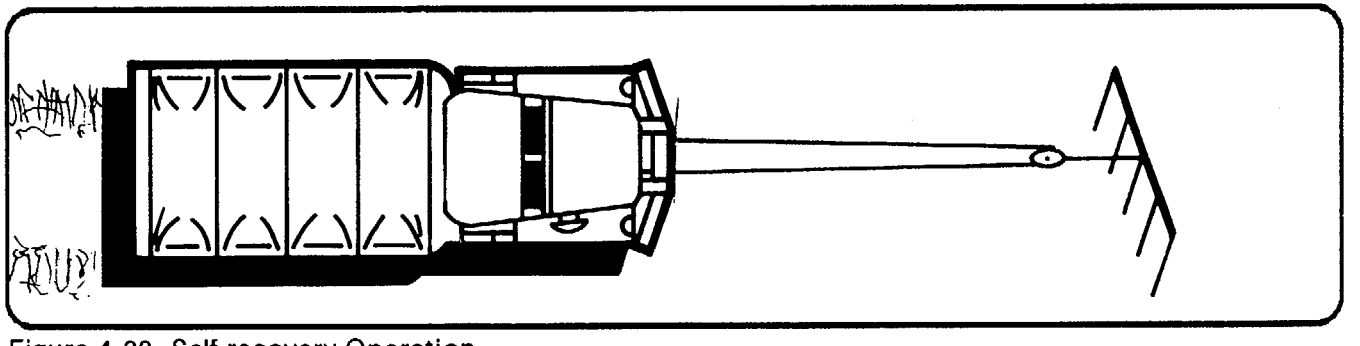


Figure 4-23. Self recovery Operation

When a vehicle with a main gun cannon tube is recovered or towed, rotate or elevate the gun tube. This prevents serious damage if the rigging fails, or the towed vehicle rams the towing vehicle.

When using two tow cables between two vehicles, make sure the cables are crossed. If a greater working distance between the pulling vehicle and the mired vehicle is required, join the tow cables together with tow hooks.

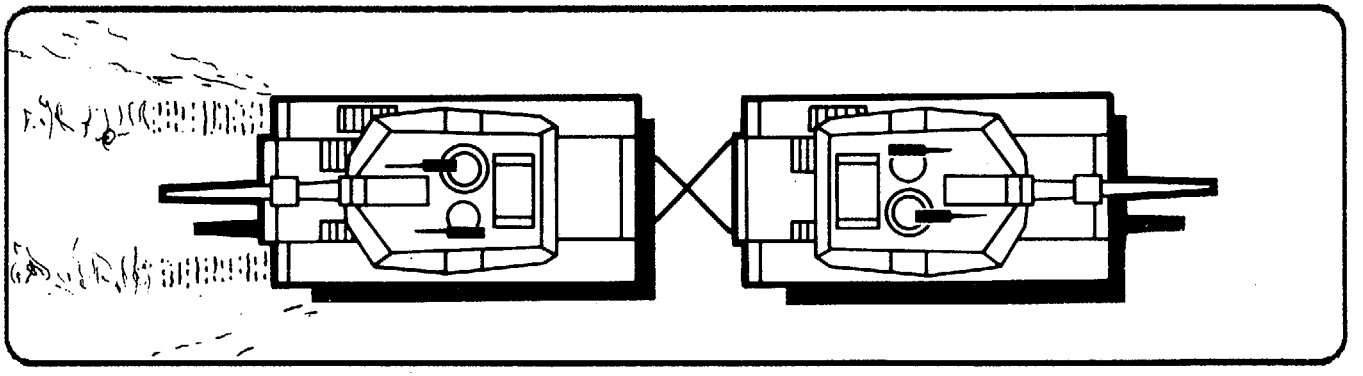


Figure 4-24. Recovery of a Mired Tank Using One Similar Vehicle

If two vehicles are required for an operation, one tow cable is enough because the strength of one tow cable is slightly greater than the pulling effort of the second pulling vehicle. However, use two tow cables, when available, to maintain alignment and equalize the pulling effort. When using two vehicles, turn the gun tube of the center vehicle to the side to prevent contact and possible damage.

RECOVERING A NOSED TRACK VEHICLE WITH SIMILAR VEHICLES

As many as three similar vehicles may be needed to recover a nosed track vehicle. This depends on the degree to which the vehicle is nosed and the terrain conditions on which the pulling vehicles must operate. In extreme instances, a source of effort may be required to lift the front of the nosed vehicle.

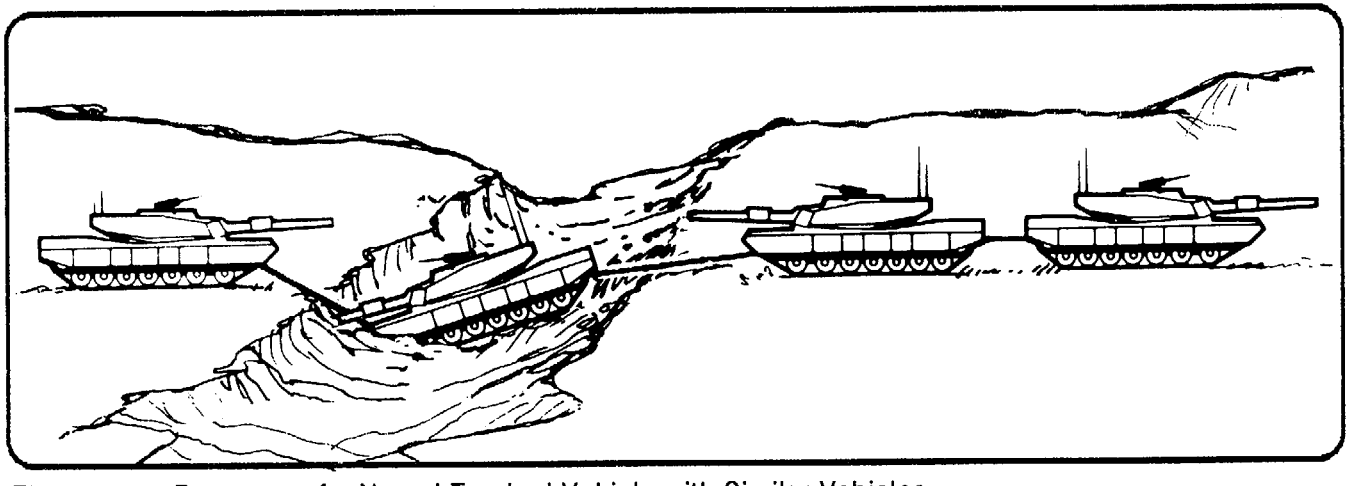


Figure 4-25. Recovery of a Nosed Tracked Vehicle with Similar Vehicles

Position the lifting vehicle to face the nosed vehicle. Connect cables of the pulling vehicles in the same way as for recovering a mired vehicle. Apply power to all assisting vehicles at the same time. The front of the nosed vehicle will rise and move toward the rear. Slowly move the lifting vehicle forward. Support the vehicle until it is recovered. If any oil or fuel has spilled in the nosed vehicle, do not run the engine until the spill is cleaned up.

RECOVERING AN OVERTURNED TRACK VEHICLE WITH SIMILAR VEHICLES

An overturned track vehicle can be uprighted by using three similar vehicles. Use one vehicle to pull the overturned vehicle upright. Use the other two vehicles to hold and retard the fall of the overturned vehicle so that it does not crash down on its suspension system.

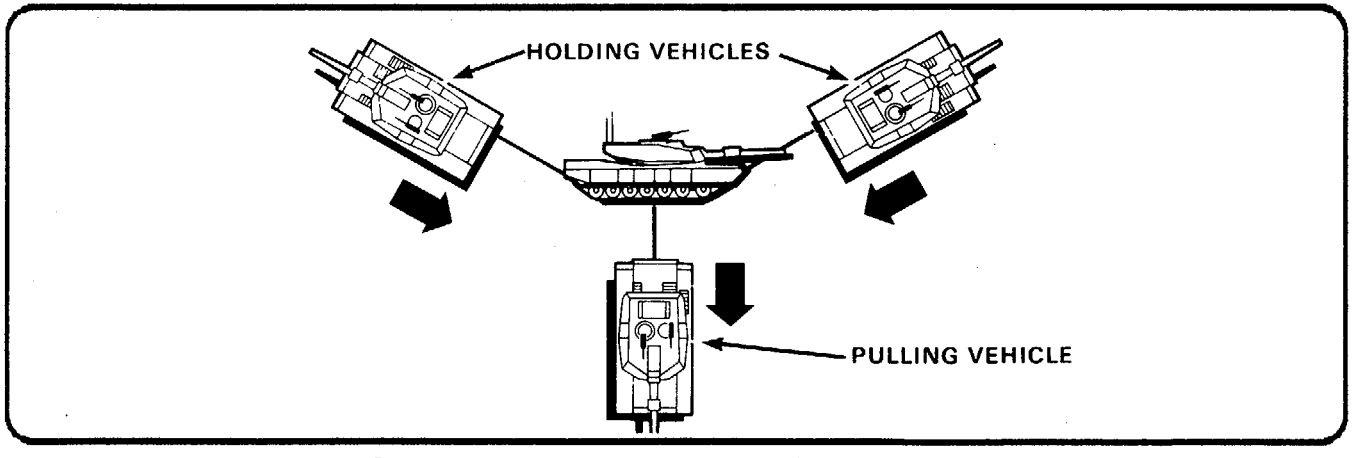


Figure 4-26. Recovery of an Overturned Tracked Vehicle with Similar Vehicles

Connect tow cables together in pairs to allow a safe working distance. Connect the cable used to upright the overturned vehicle to the nearest center road-wheel arm support housing on the upper side of the overturned vehicle. Never connect to any other part of the suspension system, turret, or the tie-down eyes.

Position the two vehicles used for holding at a 30° to 45° angle from the overturned tank with their cables connected to the tow hooks on the high side of the overturned vehicle. The holding vehicles must be positioned in this way to prevent damage to the cables, fenders, or lights of the overturned vehicle as it is uprighted.

Drivers of the holding vehicles must shift to low range. The pulling vehicle then applies power gradually in reverse, while the holding vehicles move forward only enough to keep their cables taut until the overturned vehicle passes through the point of balance. As the overturned vehicle passes through the balance point, the holding vehicles move forward slowly, supporting the overturned vehicle and lowering it onto its suspension system.

WARNING:

Because of the chance of spilled oil, fuel, or battery acid, DO NOT permit smoking or open flames near the overturned vehicle. Position the vehicles so that their exhausts always point away from the overturned vehicles.

TOWING DISABLED TRACK VEHICLES

Tow a disabled track vehicle with a similar vehicle of the same weight class, using two tow cables (a tow bar). Cross the tow cables to keep them from getting tangled with the tracks. When towing track vehicles with only one track, there will be a difference in resistance and steering capability between a complete track on one side and road wheels on the other side. As a result, the towed vehicle will pull in the direction of the side lacking the track. This pull is com-

pensated for by proper attachment of the towing cables.

A driver must be in the towed vehicle to operate the brakes. Alternate the driver in the towing vehicle and the disabled vehicle often because of exhaust gases. Check the technical manual pertaining to the towed vehicle to determine the necessary preparations and precautions to be used to prevent further damage. Never exceed the towing speed outlined in the technical manual.

If the disabled vehicle has defective brakes or its universal joints are disconnected, use another similar vehicle for holding. Use crossed cables between the holding and disabled vehicles when available. With vehicles that are issued only one tow cable, the vehicles will be connected with crossed

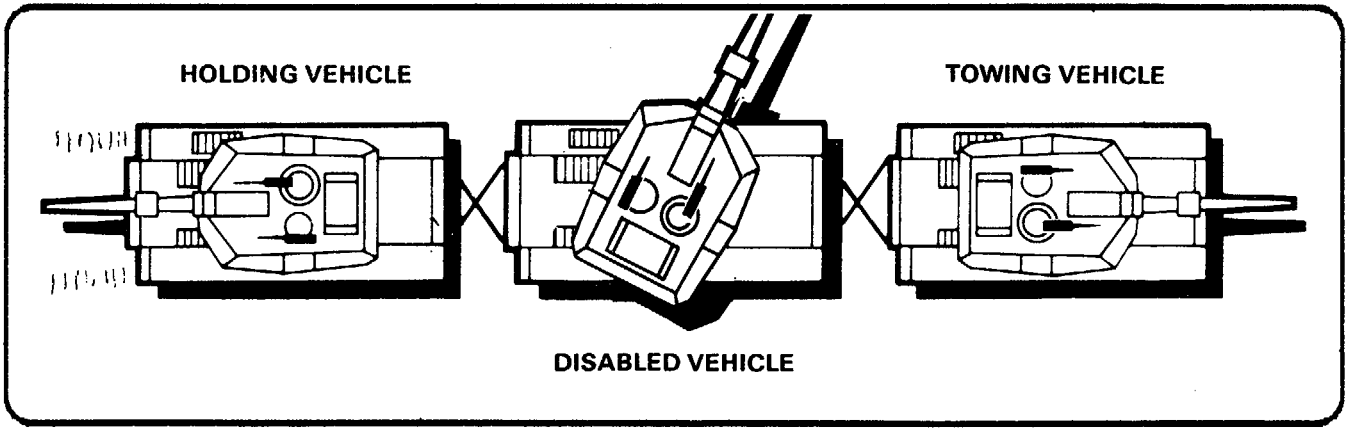


Figure 4-27. Towing a Disabled Tracked Vehicle

USE CROSSED TOW CABLES BETWEEN THE HOLDING AND DISABLED VEHICLES WHEN ENOUGH CABLES ARE AVAILABLE

cables between the towing vehicle and the disabled vehicle. Connect a single tow cable between the disabled vehicle and the holding vehicle.

WARNING:

When using a vehicle to tow other vehicles, use extreme caution, and refer to the appropriate operator's manual for further restrictions.

CAUTION:

Extreme heat is generated when using the M1 tank for towing. Damage to the towed vehicle can result. See TB 43-0001-39-1 for guidance on local fabrication of an exhaust grate heat deflector.

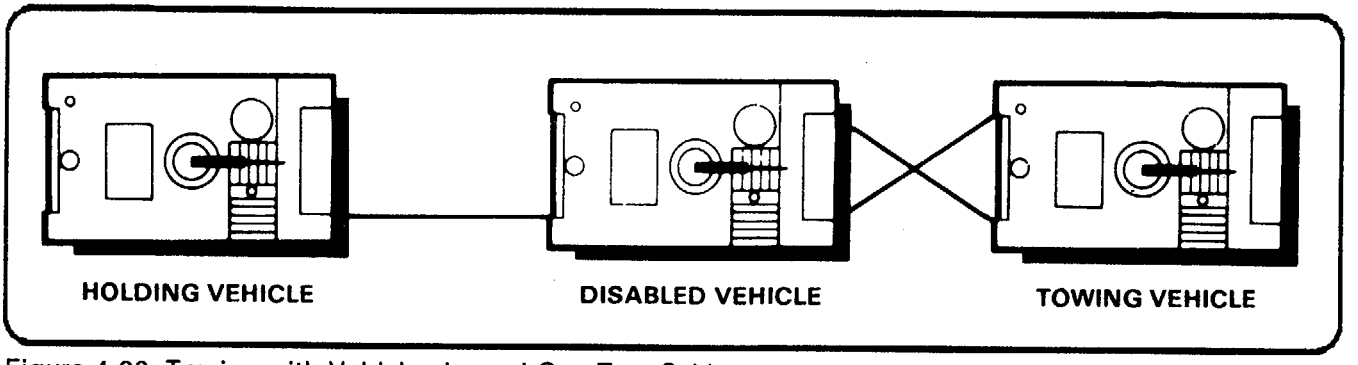


Figure 4-28. Towing with Vehicles Issued One Tow Cable

MARINE RECOVERY

INTRODUCTION

Many vehicles can now swim or ford. Some of these vehicles will fail while waterborne and will need recovery. Situations may be as simple as stalled, floating vehicles or as complex as submerged vehicles. The same methods of recovery apply to these situations, with a few more considerations.

In the case of floating vehicles, swiftly moving current can carry the vehicle and crew downstream. Water safety must be stressed to both vehicle and recovery crews engaged in these operations. Current and bottom conditions interact effectively to bury a vehicle, thereby increasing resistance to be overcome. When operating on beaches or rivers with soft

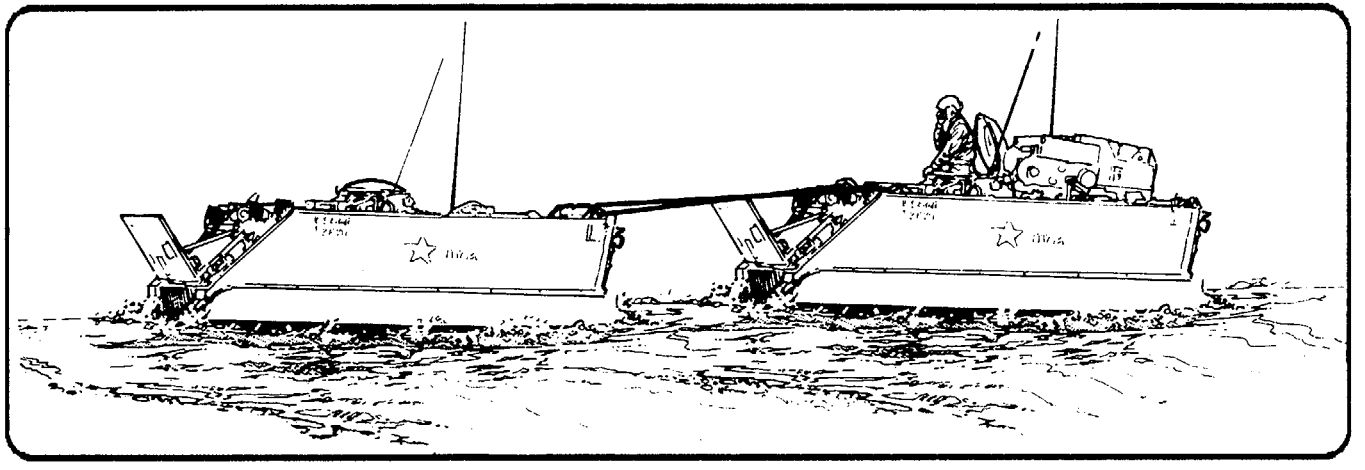


Figure 4-29. Marine Recovery with Tow Hooks and Cables Attached to Lifting Eyes

bottoms, time is critical. Recover the vehicle as quickly as possible.

SWIMMING VEHICLES

A mechanically disabled swimming vehicle offers little resistance while on water. Compared to its rolling resistance on land, it can be recovered with little effort on water. The same rigging is made to floating vehicles as with land recovery. The only exception is that the attachments are made to the lifting eyes instead of the tow lugs. This prevents the crew from having to work in the water.

Example: If a similar vehicle is used for the operation, its tow hooks are attached to the lifting eyes

before entering the water. The tow cables are attached and crossed as in the normal tow procedures until the disabled vehicle is towed to shore. The tow hooks are then reattached to the tow lugs to pull the vehicle to land.

SUBMERGED VEHICLES

If a vehicle is flooded and submerged, determine the resistance on the river bottom in the same way as on land. Consider the weight of the vehicle, the

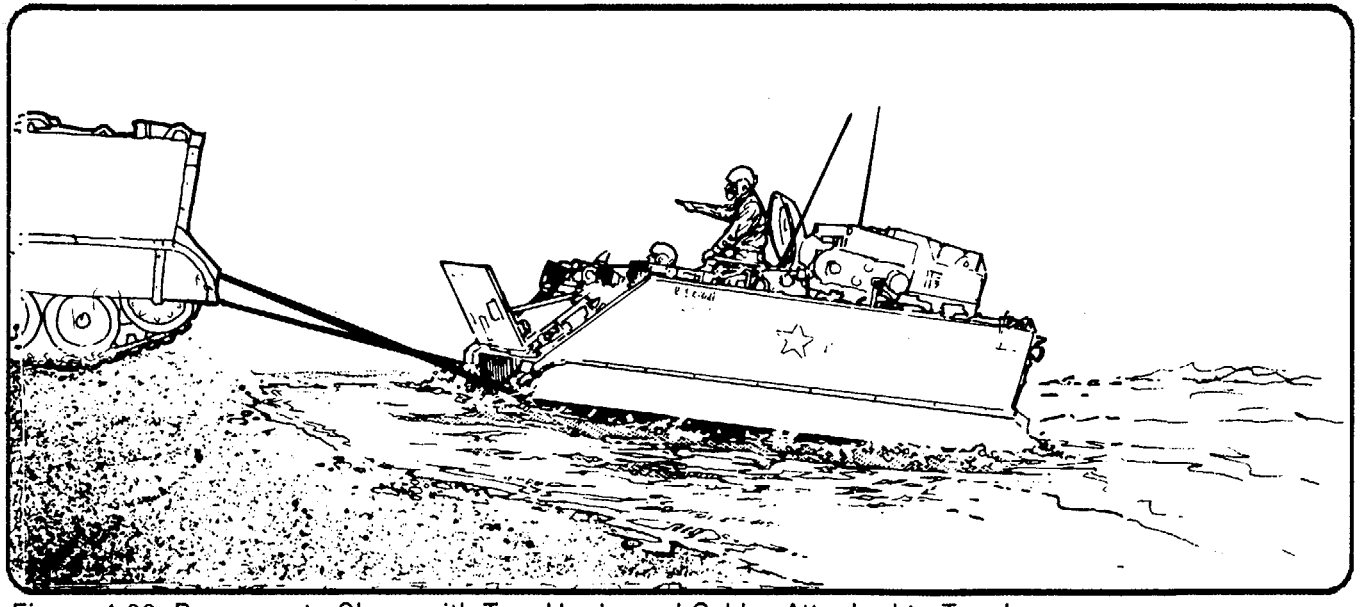


Figure 4-30. Recovery to Shore with Tow Hooks and Cables Attached to Tow Lugs

cargo, and the river bottom which may be sand, gravel, or mud. In addition, when pulling flooded vehicles from water to land, consider the weight of the water when determining the resistance. Water weight is estimated to be equal to the vehicle's weight.

Example: A track vehicle weighing 52,000 pounds sank. The vehicle is mired in the river bed (mud) to fender depth. Effort required to retrieve it is 156,000 pounds (2 x 52,000 lb mire factor + 52,000 lb water weight).

The first problem in underwater recovery is locating the disabled vehicle in the deep water. It may be easier to use dragging devices to locate the vehicle. Divers can then determine the orientation of the vehicle rigging. Use lines and floats to mark the location of the vehicle.

Special purpose vehicles, such as wrecker trucks and recovery vehicles, are readily adaptable to recovery operations on submerged vehicles. The winch cables of the recovery vehicles are long enough to allow winching operations from land to water in most situations.

WATER OPERATIONS

Most vehicles currently in the inventory of our military service all have either a swim or fording capability. Because of this, extreme care for the waterways must be considered in daily operations. Vehicles involved in fording or swimming operations sometimes become disabled either from mechanical or mobility malfunctions. A vehicle that has swim capability will usually remain afloat even if the main engine should fail. This is possible because amphibious vehicles are usually equipped with an auxiliary engine and bilge pumps.

When and if complete disablement should occur during water operations, it is imperative power be restored through use of BDAR or any means available. Amphibious vehicles are at the mercy of the surf or river current when power is lost. If left afloat without power, vehicles are at risk of sinking causing futher damage to the vehicle and serious contamination of the water.If sinking does occur, all prac-

ticable efforts should be made to avoid environmental contamination. Contamination over one gallon should be reported through the chain of command.

Should a vehicle become submerged, out of sight, it is recommended qualified scuba personnel be called to assist in locating and rigging the vehicle for recovery.

Resistance in Water

Resistance during water or land operation is determined in much the same manner. When the vehicle is fully submerged, the weight of the vehicle full of water must be considered. Vehicles that have been completely submerged for a period of time will usually be in a mired condition from sand, if in the ocean, or mud, if in a river. If in doubt, rig for the greater resistance.

Whether vehicle is upright or overturned will also be a factor on total resistance. Again, qualified divers should be used to locate and rig a vehicle for recovery. They will also be able to recommend direction of recovery depending on obstacles.

Following are some examples of resistance encountered when recovering floating type vehicles:

- Amphibious vehicle afloat, minimal - 1/64th of vehicle weight.
- Amphibious vehicles that are completely submerged - Equal to weight of vehicle. If vehicle is mired on river or ocean bottom, calculate additional resistance as you would for a land mire.
- Fording-type vehicles that have become disabled must also be considered for weight of water but, only an additional 1/8th of vehicle weight, that is, a 70-ton tank would be calculated to weigh approximately 79 tons plus any mire encountered. Mire factor in this case is figured on 79 tons.

During underwater recovery operations, air bags can be placed inside the submerged vehicle and inflated to provide buoyancy and decrease resistance. To employ air bags in this type of situation, qualified divers are recommended. The air bags or 55-gallon

UNDERWATER RECOVERY IS USUALLY LIMITED TO MANPOWER OR LEAD METHODS

drums need to be placed inside the vehicle in a location where they will not escape the vehicle or cause additional damage. Once the air bags are in position, inflate to recommended capacity.

Methods of Rigging

The methods of rigging for underwater recovery are normally restricted to the manpower and lead methods. Towing from water is recommended only if disabled vehicle is located in very shallow water. The method of rigging depends upon distance from disabled vehicle, type of disabled vehicle, type of recovery vehicle available, equipment available (floats, air bags, tackle), and condition of disabled vehicle.

Lead method. The lead method of rigging is performed the same in water as on land. If in deep water, a boat or amphibious vehicle can transport tackle to the disabled vehicle. If the water is shallow, the tackle can be manually carried to the disabled vehicle.

Manpower method. The manpower method is much the same regardless of water or land. However,

floatation devices can be attached to cable every few feet or to snatch blocks and other tackle to aid in getting the recovery equipment to the disabled vehicle.

Water Recovery

Water resistance occurs when submerged vehicles are pulled from water to land. Water resistance is estimated as additional resistance equal to the vehicle weight. Therefore, a vehicle weighing 25 tons (including cargo) would require 50 tons of effort to winch it from the water. In the same situation, resistance would increase if the vehicle went down in the surf, and the sand was partially covering the vehicle.

Swimming vehicles. A mechanically disabled swimming vehicle offers very little resistance. On water it can be towed with a small amount of effort compared to rolling resistance on land.

Fording vechicl.: Vehicles become mired, nosed, and overturned during operations just as they do during land operations. As a result, estimate resistance in the same way by considering vehicle weight and type of disablement.

CHAPTER 5

FIELD EXPEDIENTS

An expedient measure is any method by which a task is accomplished using materials that are on hand. For example, vehicles may be required to operate in remote areas where assistance is not readily available. Under these conditions, the driver or crew must attempt self-recovery by using methods like those described previously in this chapter.

In addition, the crew can perform makeshift repairs on a mechanically disabled vehicle using field expedients, described later. Even crew members with limited mechanical training can apply expedient repairs with enough accuracy to restore at least partial operation to a disabled vehicle. However, expedient repairs are to be used as a last resort in emergency situations only. They must never be used in lieu of normal maintenance repair procedures. Permanent repairs should be made as soon as possible.

RECOVERY EXPEDIENTS

PRY BAR

A pole can be used to pry a lightweight truck out of a ditch. Lift the front end of the truck with the pole. Apply power to the truck in reverse gear.

SUBSTITUTE JACK TO REMOVE FRONT AND REAR WHEELS

To raise the front wheel of a cargo truck, secure a timber about 5-feet long to the front bumper at an angle with a chain or rope. Place the bottom of the timber in a shallow hole. Move the vehicle forward until the timber is in a vertical position and the wheel clears the ground. Set the brakes and chock the wheels.

Figure 5-1. Pole Used as a Pry

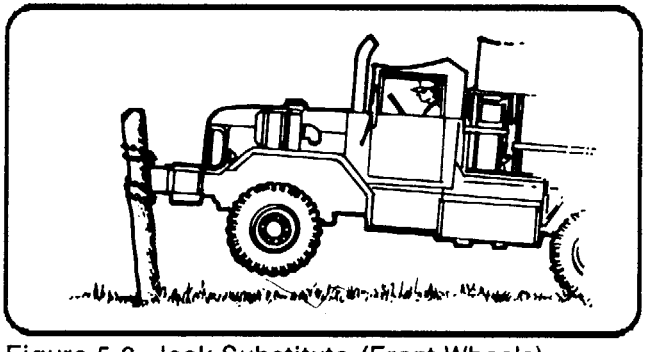


Figure 5-2. Jack Substitute (Front Wheels)

When an outside rear dual tire is flat and a jack is not available, run the inside dual wheel up on a small log or rock. This takes the weight from the outside wheel which can then be removed for replacement.

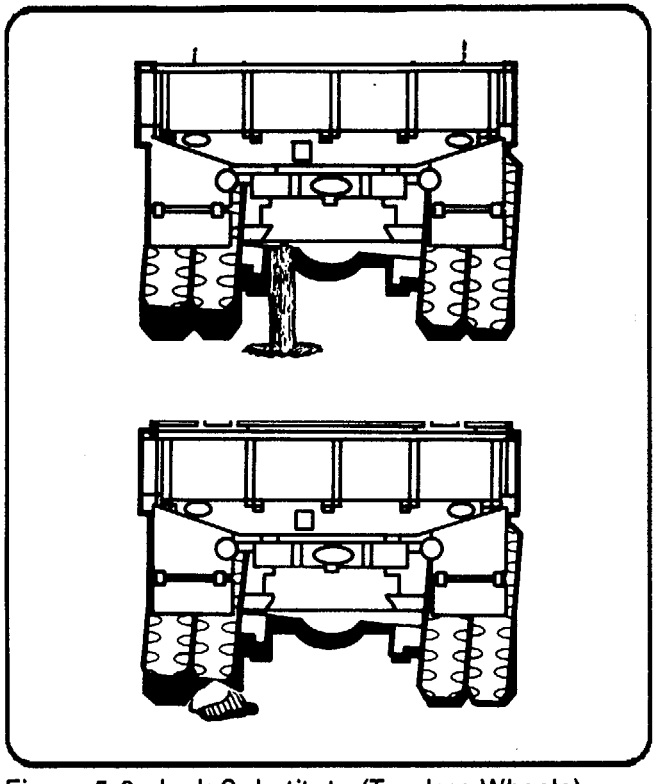


Figure 5-3. Jack Substitute (Tandem Wheels)

Another substitute for a jack is a piece of timber which is longer than the distance from the axle to the ground. Place one end of the timber against the axle at an angle and the other end in a shallow hole. Drive the vehicle onto the timber. Set the brakes and block the vehicle securely.

DUAL WHEEL WINCHING

On dual-wheel vehicles not equipped with a winch, use the rear wheels to aid in recovery. Fasten one end of the rope to the wheel hub and anchor the other end. Run the end of the rope fastened to the wheel's hub between the duals and through one of the holes in the wheel disk. Take care not to place the rope through a hole in the wheel disk where the valve stem is located. Tie a knot in the end of the rope and slip over the hub. Tie a second rope in the same way to the dual wheels on the other end of the axle. Place the vehicle in reverse gear. The ropes will wind between the two duals and cause the vehicle to move rearward.

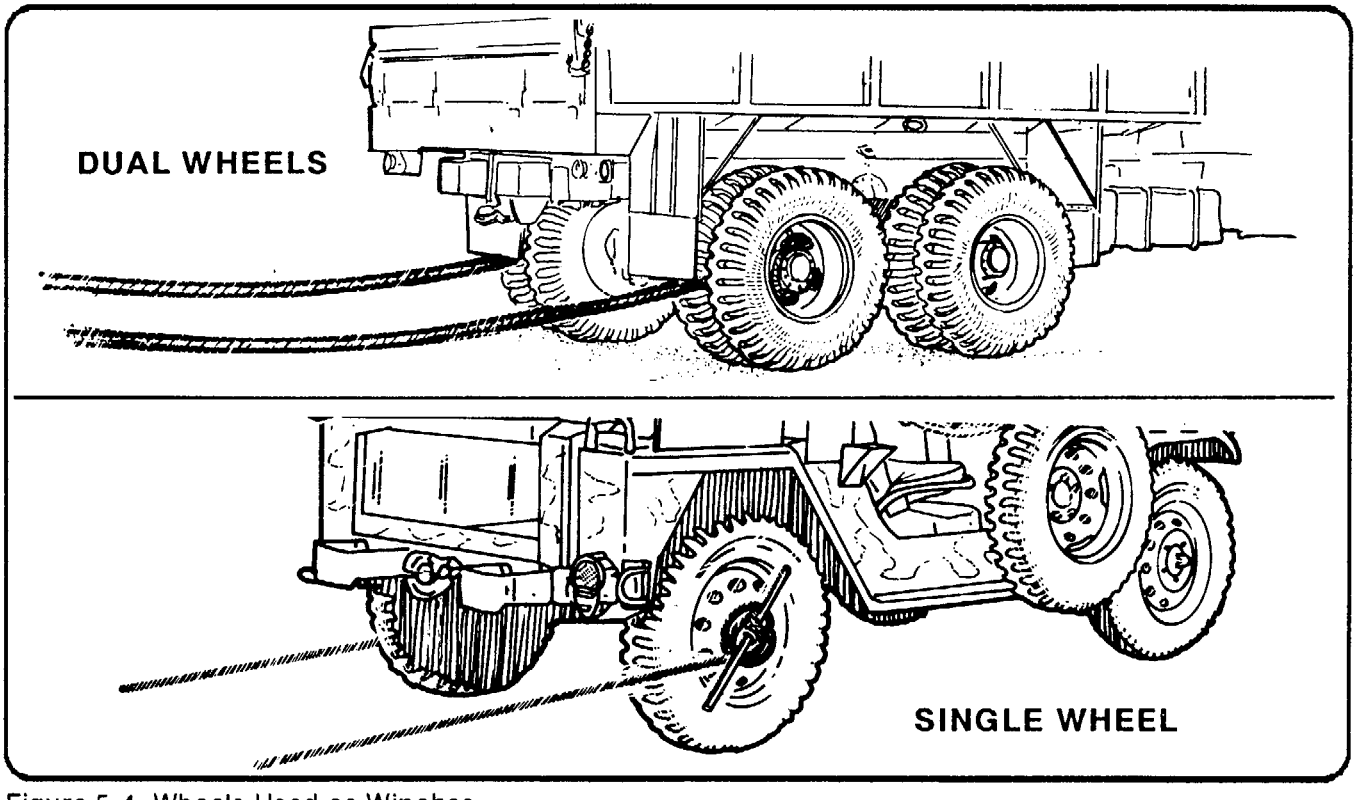


Figure 5-4. Wheels Used as Winches

SINGLE-WHEEL WINCHING

If the truck has single wheels, place a bar through the hole in the end of the axle flange. Attach a rope to the wheels on each side of the vehicle by fastening them to the bars with figure-eight hitches. Apply pressure to wind the ropes around the hubs and move the vehicle.

USING AN A-FRAME

Frequently, a truck will become nosed in a shell hole or narrow ditch where both lifting and pulling forces are required to make the recovery. If the nosed truck is equipped with a winch, use the winch to supply the pulling force and an A-frame for the lifting force.

To build an A-frame, use two long poles. Lash the poles together at the top by a figure-eight or girth hitch. Place the lower end of the poles in the ground 10-12 inches deep to prevent them from sliding when power is applied. Then lay the upper end of the A-frame against the front of the vehicle. Attach the A-frame.

A NOSED TRUCK'S WINCH AND AN A-FRAME CAN SUPPLY THE LIFTING AND PULLING FORCES NEEDED TO RECOVER THE TRUCK

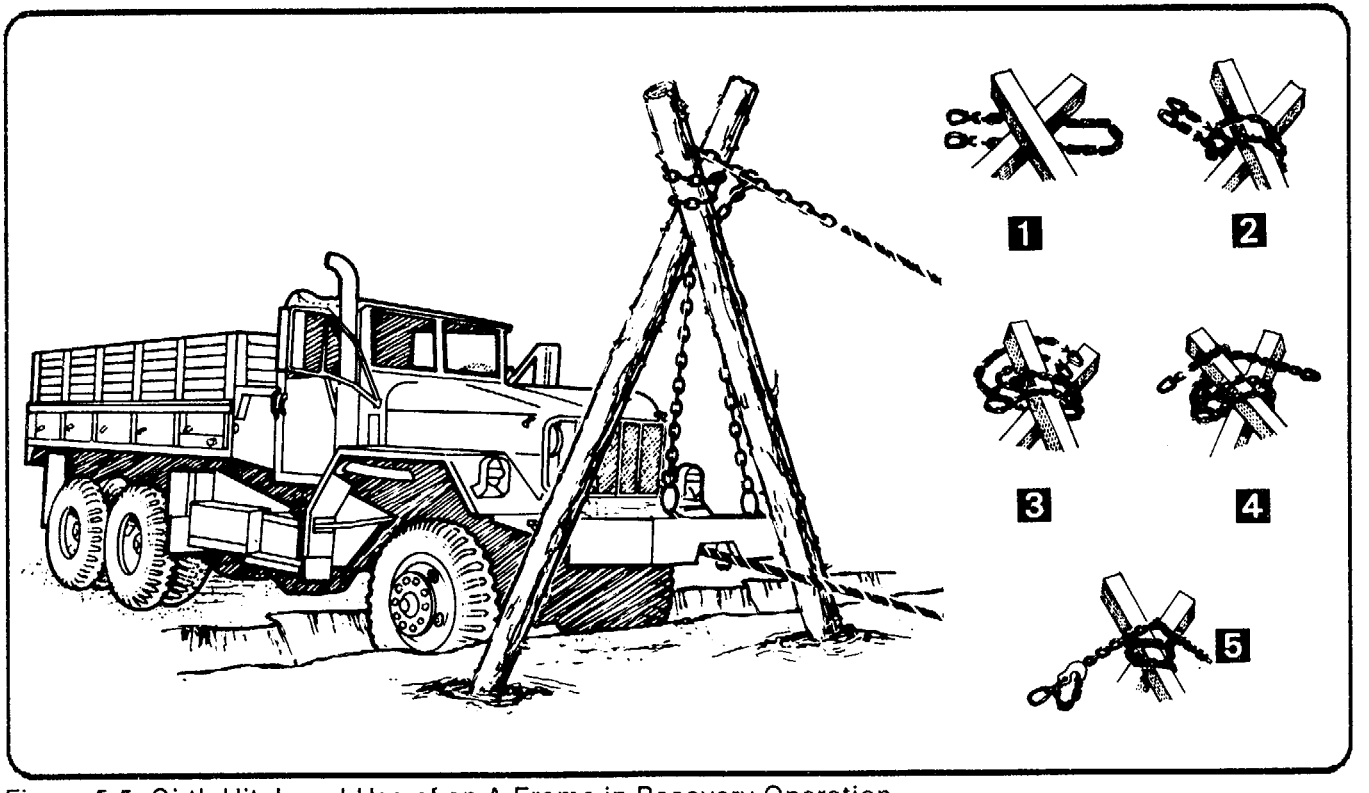


Figure 5-5. Girth Hitch and Use of an A-Frame in Recovery Operation

Rig the winch cable for a 2:1 mechanical advantage. Secure the end of the cable to the apex of the A-frame.

As the winch is wound in, the A-frame lifts and pulls the truck forward. Suspend the truck over the ditch or hole. Then fill the ditch with rocks, dirt, or other material so that the vehicle can be driven forward or backward.

ANCHORING TRACKS

Vehicles often become bellied (high-centered) on stumps, rocks, dry ridges, or mire, and are immobilized by lack of traction.

To recover a bellied vehicle, obtain a log long enough to span the width of the vehicle and of sufficient diameter to support the vehicle weight. Place

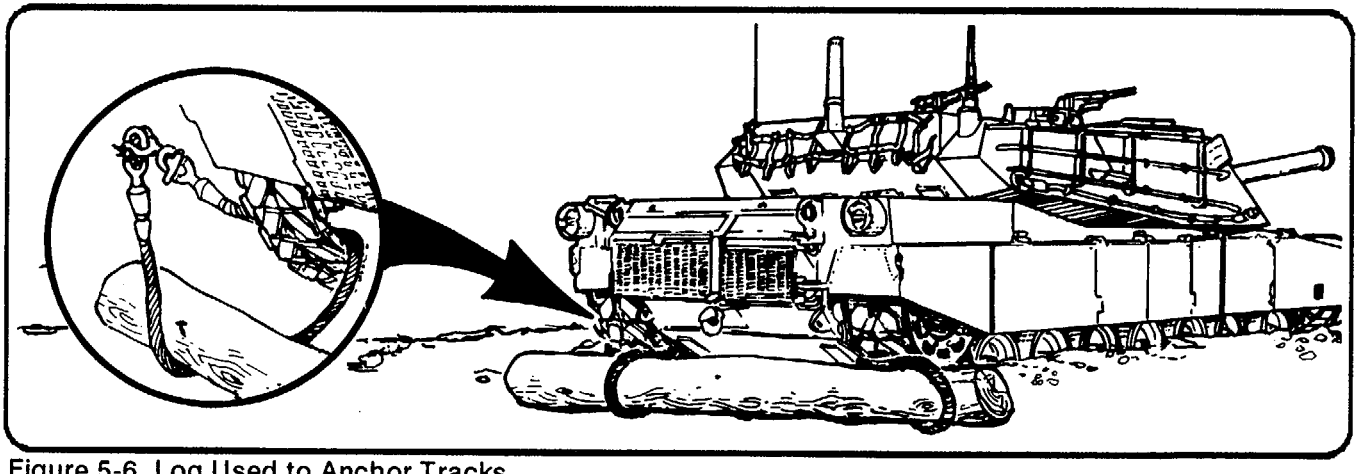


Figure 5-6. Log Used to Anchor Tracks

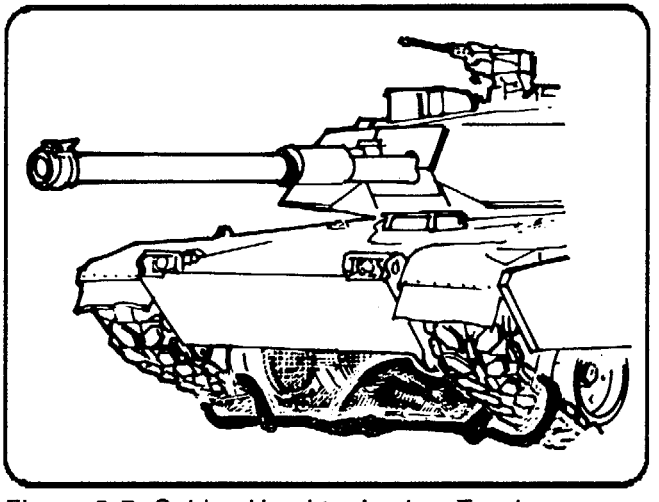


Figure 5-7. Cables Used to Anchor Tracks

the log against both tracks. Place a tow cable so that one end of the cable goes over the log and through the tracks from the inside. Place the other end of the tow cable underneath the log and connect the ends of the cable together with a tow hook on the outside of the track to make disconnecting easier.

Follow the same procedure to attach the log to the track on the opposite side of the vehicle. Take up the slack in the tow cable by gradually applying power to the tracks. This pulls the log underneath the tracks until it comes in contact with the obstacle, anchors the tracks, and causes the vehicle to move.

CAUTION:

To prevent damage to the fenders and tow cables, stop the vehicle before the log reaches the fenders or the cable reaches the drive sprocket.

For a bellied disablement other than mire, anchor the tracks by using two tow cables. Connect the tow cables together with a tow hook and attach the cables to both tracks by passing the ends of the cables through the tracks from the outside and attaching them to the standing parts of the cables with tow hooks. When power is applied to the tracks, the cable will contact the obstacle and anchor the tracks.

MOVING A VEHICLE WITH BOTH TRACKS BROKEN

When both tracks are thrown, they may need to be separated before the vehicle can be moved to remount the tracks. Break one track and attach a cable from the drive sprocket hub to an anchor. This will support the vehicle so that the other track can be separated. Chock the vehicle to keep it from rolling out of control. Apply engine and steering power to

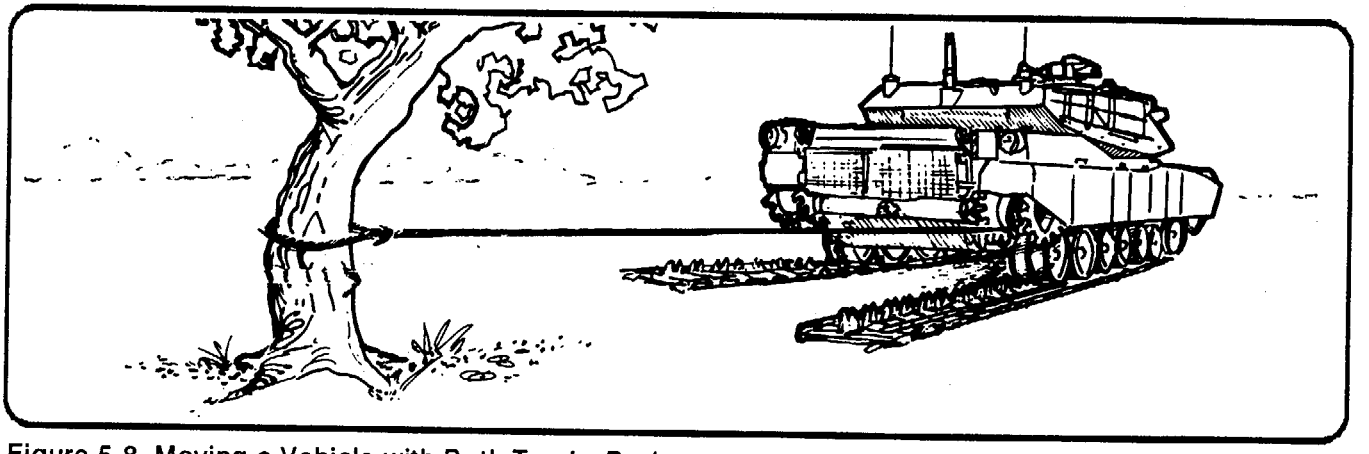


Figure 5-8. Moving a Vehicle with Both Tracks Broken

A PLANK SERVING AS A RAMP CAN BE USED TO MOVE A VEHICLE ONTO A TRACK

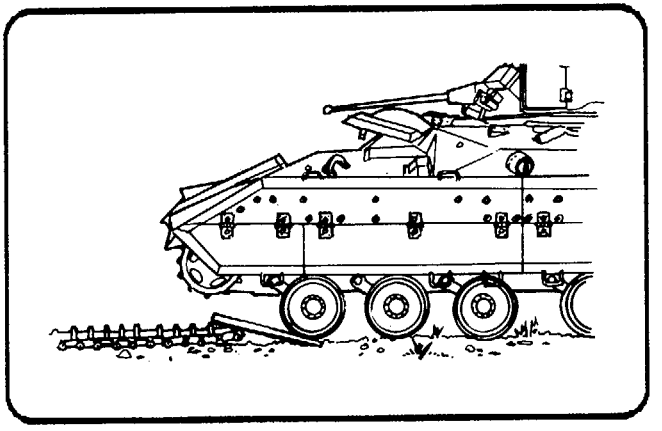


Figure 5-9. Moving a Vehicle onto a Track

the drive sprocket attached to the cable. When this is done, the vehicle will move by the winching action of the drive sprocket hub.

MOVING A VEHICLE ONTO A TRACK

Align the vehicle with the track and position a plank-type ramp on the end of the track. When a ramp is not available, dig a shallow ditch in which the end of the track can lie.

INSTALLING A TRACK

Align the track with the road wheels so the center guides will pass between the road wheels when the vehicle is moved. Stop the vehicle so that the rear road wheel is resting forward far enough for all the track to pass over the sprocket.

Tie a rope to the center of the track pin on the rear track link. Pass the rope over the center guide groove of the sprocket hub, around and between the rear support roller wheels, and back around the sprocket hub, making two turns.

As power is applied to the sprocket, and the free end of the rope is held taut, the end of the track is pulled up to the sprocket. Once the sprocket has engaged a minimum of three track links, stop the sprocket, lock the brakes, and shut off the vehicle's engine. Remove the rope from the sprocket hub and extend it forward over the compensating idler wheel. Then, restart the vehicle and move forward. When the end of the track has passed over the compensating idler, connect the track.

AS POWER IS APPLIED TO THE SPROCKET, AND THE FREE END OF THE ROPE IS HELD TAUT, THE END OF THE TRACK IS PULLED UP TO THE SPROCKET

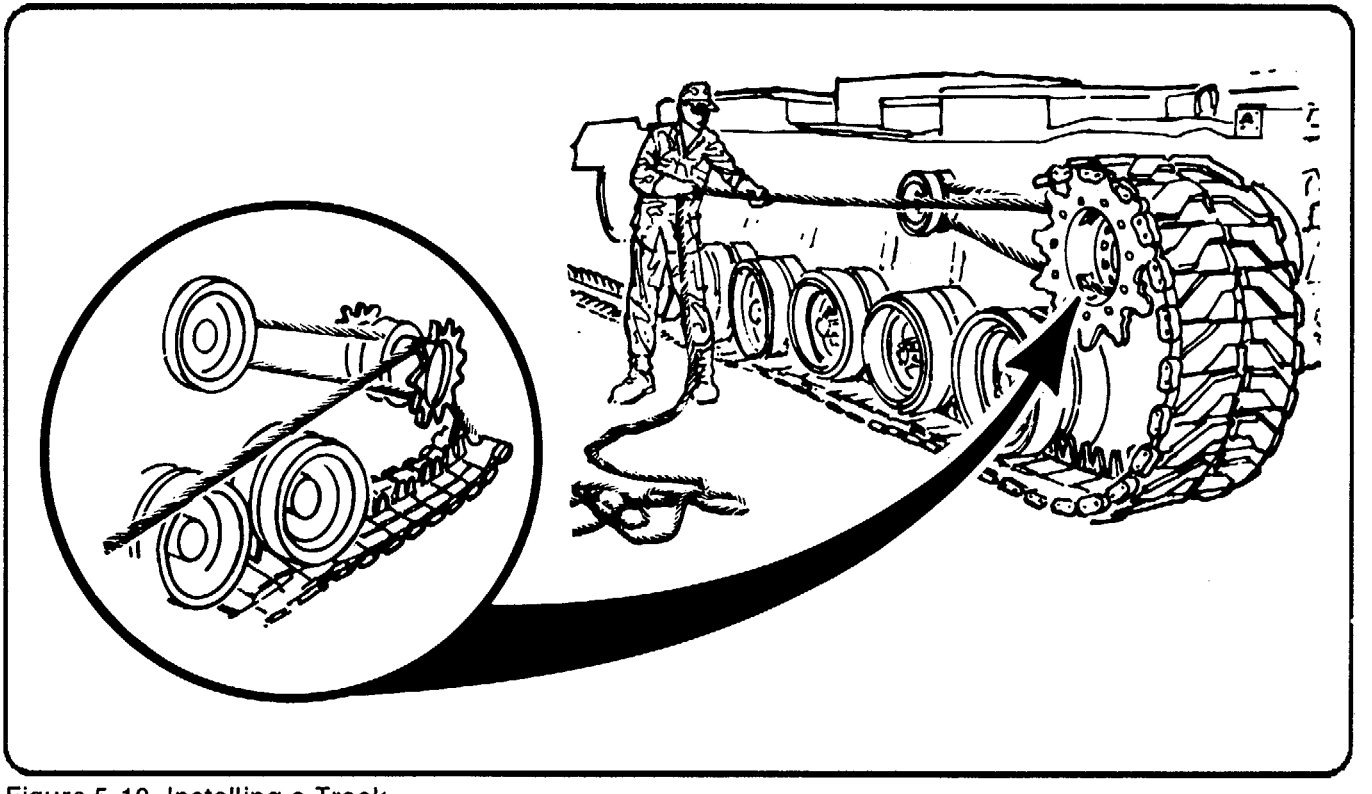


Figure 5-10. Installing a Track

EXPEDIENT REPAIRS

DEFECTIVE TANDEM AXLE

A tandem axle with a burned-out bearing or damaged wheel can disable a vehicle or cause further damage if operation continues. Move the wheel of the disabled axle onto a rock, log, or similar object, to raise the wheel as high as possible.

While the wheel is raised, tie the axle as tightly as possible to the frame by using heavy wire or a tow chain. Do not let the chain or wire cause damage to the brake lines. If the wheel bearing is burned out, or for some other reason the wheel does not turn, remove the axle shaft from the axle housing. Stuff the

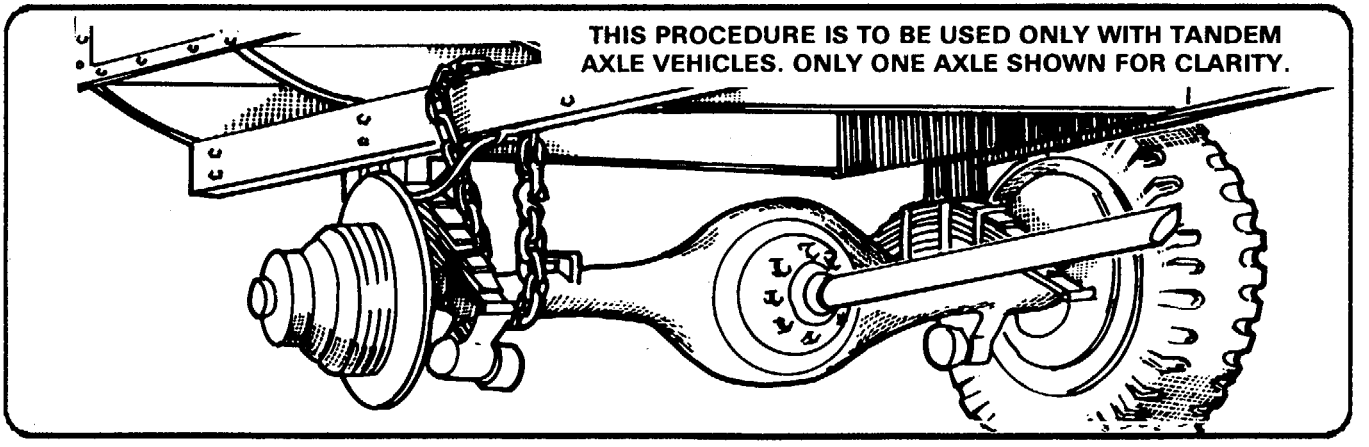


Figure 5-11. Attaching Tandem Axle to Frame

hole in the hub with rags to keep out foreign matter. This expedient method allows the other wheels to drive.

Use the same technique on both ends of the axle if both wheels are defective. Since both ends of the axle are tied up, do not load the vehicle too heavily.

DEFECTIVE DIFFERENTIAL

If the defect is in the differential of a 4x4, 6x6, or 8x8 vehicle, remove the propeller shaft and drive axles. For example, if the front rear differential is defective and the rear propeller shaft is removed, the vehicle can still be powered by the front wheels. When the axle shafts are removed, cover the openings securely to keep out dirt and foreign matter.

LOOSE BATTERY CLAMP

When a battery cable clamp becomes loose and cannot be tightened, use a nail or wedge to make contact between the battery post and the battery clamp. Loosen the clamp, insert the wedge between the battery post, and tighten the clamp.

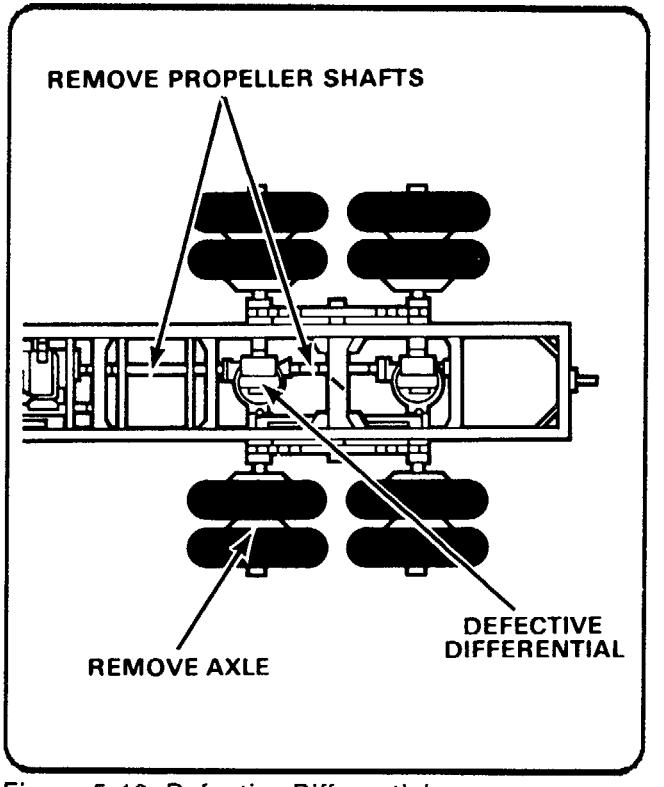


Figure 5-12. Defective Differential

WARNING:

When working around batteries and battery clamps, take care to prevent tools and jewelry from arcing. This could cause damage to vehicle electrical components and personnel injury. DO NOT smoke or permit an open flame near the batteries since the gas from battery acid is explosive.

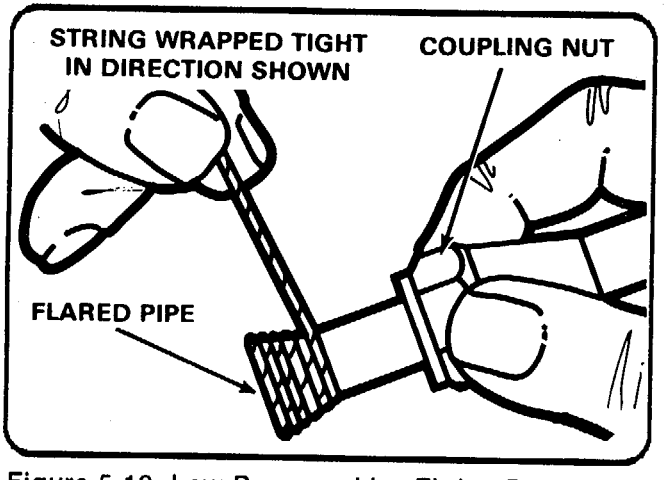


Figure 5-13. Low Pressure Line Fitting Repair

LEAKING LOW-PRESSURE LINE FITTING

To repair a leaking low-pressure line fitting, wind a string or rag tightly around the line behind the flare. Wind the string clockwise in the same direction the coupling nut is turned to be tightened. Slide the coupling nut over the material, screw it onto its connection, and tighten it securely against the packing string with a wrench. The string will act as a gasket and seal the leak.

CRACKED LOW-PRESSURE OIL OR FUEL LINES

Cracked low-pressure oil or fuel lines usually are caused from vibration or defective metal. If this occurs, stop the leak by wrapping the line tightly with friction tape held in place by wire. The wire helps the tape withstand pressure and usually stops the leak until a permanent repair can be made.

COLLAPSED FLEXIBLE FUEL LINE

Make a support for the inside of the fuel line by wrapping a thin welding rod or wire around a pencil

or another object slightly smaller than the flexible line inside diameter. Place the coiled rod or wire into the flexible line. Fuel will be able to flow and the fuel line will not collapse.

REPAIR OF A PUNCTURED FUEL TANK

Use a piece of hose about the size of the punctured hole in the fuel tank, a bolt, nut, and two flat washers. Assemble the washers and hose on the bolt and screw the nut down snugly. Enlarge the hole in the fuel tank, if necessary, so that the assembled bolt and hose passes into it and fits snugly. Hold the hose to prevent its turning and tighten down the bolt. This causes the piece of hose to expand in the hole and seal the leak.

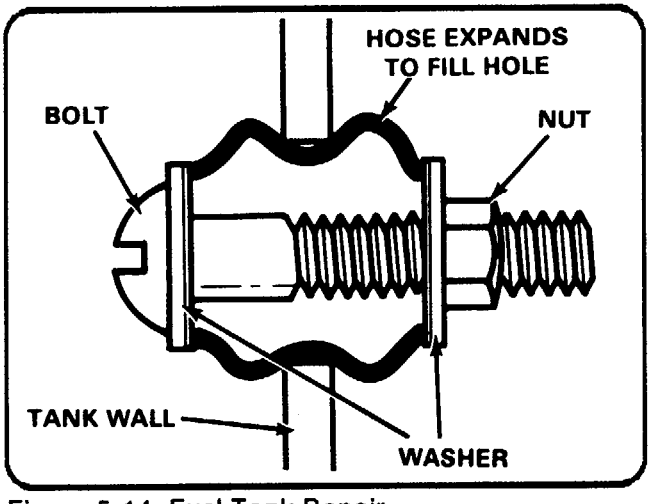


Figure 5-14. Fuel Tank Repair

LEAKING RADIATOR OR HEATER HOSES

To repair a leaking radiator or heater hose, allow the engine to cool so that the hoses can be safely handled. Patch the leak by wrapping it with standard issue electrical or reinforcing tape. Refill the radiator with coolant and leave the radiator cap loosened. Operate the vehicle at a reduced speed until the hose can be replaced.

PUNCTURED TUBE-TYPE RADIATOR CORE

Radiators are often punctured when vehicles are operating in wooded or combat areas. When this

happens, cut the cooling fins and push them away from the leaking tubes. Cut the leaking tube in half and fold the ends of the tube back about three-fourths of an inch. Close the tube ends by pressing them flat with pliers. Cooling system efficiency is reduced when several tubes are cut, causing the engine to overheat. When field expedient repairs on the radiators are made, loosen the radiator cap. This keeps the radiator pressure from building up and breaking the repair.

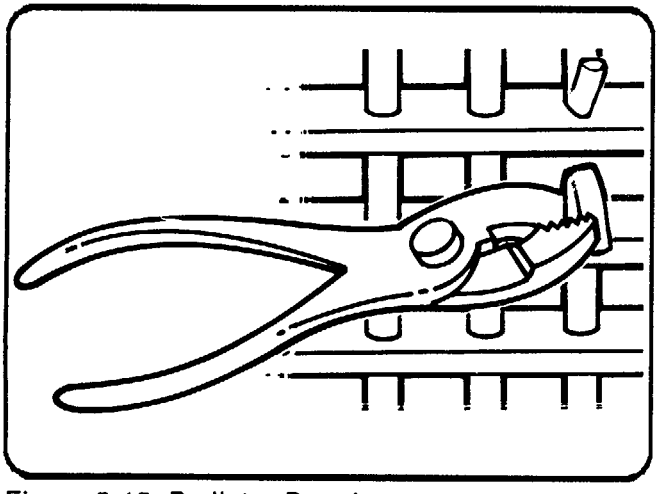


Figure 5-15. Radiator Repair

BROKEN FAN BELT

When a fan belt breaks and a replacement is not available, mend or substitute it. To mend, punch holes in both ends of the broken belt and put a small gage wire or boot lace through each hole. Secure the wire or laces. Replace the belt with just enough tension to drive the vehicle accessories.

Use fiber rope from the vehicle tarpaulin or a piece of field telephone wire as a substitute for the broken fan belt. Loop the wire or rope around the pulleys several times, pull as taut as possible, and tie with a square knot.

In both cases, operate the engine at low speed to keep from losing or breaking the substitute belt.

BROKEN FAN BLADES

A broken fan blade will cause the engine to vibrate and make it dangerous to operate. On fans with an equal number of blades equally spaced, remove the

remainder of the broken blade, and then remove the blade opposite the removed blade. The vehicle can then be operated, but be careful that it does not overheat. On fans with unequally spaced blades, the entire fan can be operated under the light load for short periods of time.

DAMAGED FRONT AXLE BRAKE SYSTEM

When damage has occurred to the front axle brake system, close the line at the junction block to the axle. This assists the driver in maintaining steering control while braking and allows pressure buildup in the rear brakes.

DAMAGED ROAD WHEEL COMPONENTS

NOTE: The following damaged road wheel expedients do not apply to the M1.

To operate a vehicle with a damaged road wheel, spindle, or road-wheel arm, tie the arm up out of the way. To tie the road-wheel arm up, remove the torsion bar by positioning the vehicle across a ditch. It should be narrow enough to permit the front and rear road wheels to support the weight of the vehicle and deep enough to permit the track to sag away from the defective road wheel.

If a ditch is not available, dig a trench. This allows the road-wheel assembly to sag and removes the tension from the torsion bar. Then remove the torsion

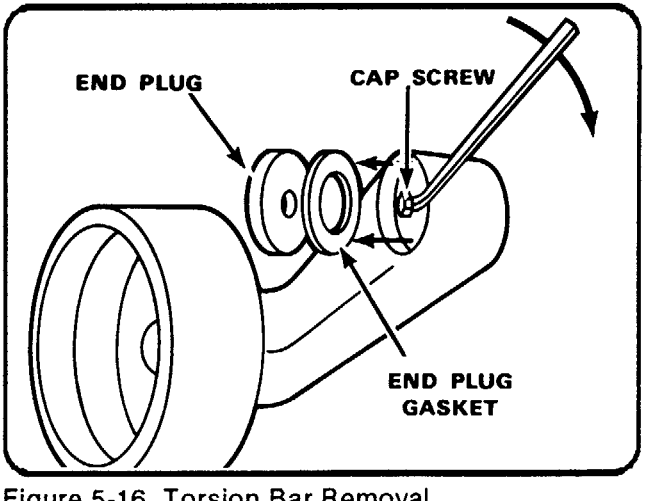


Figure 5-16. Torsion Bar Removal

bar by removing its cap screw and end plug, replacing the cap screw in the torsion bar, and prying behind the cap screw head with a tanker's crowbar.

Reposition the vehicle on level ground. Remove the road wheel: position a tanker's crowbar across two torsion bar support housings and, using a rope from the vehicle tarpaulin, tie the road-wheel arm to the tanker's crowbar. Use this expedient method with intermediate road wheels only.

DAMAGED SUSPENSION COMPONENTS

To give the vehicle better stability, move the number 3 road wheel (with arm) to the rear road wheel position as in the example shown. Due to the absence

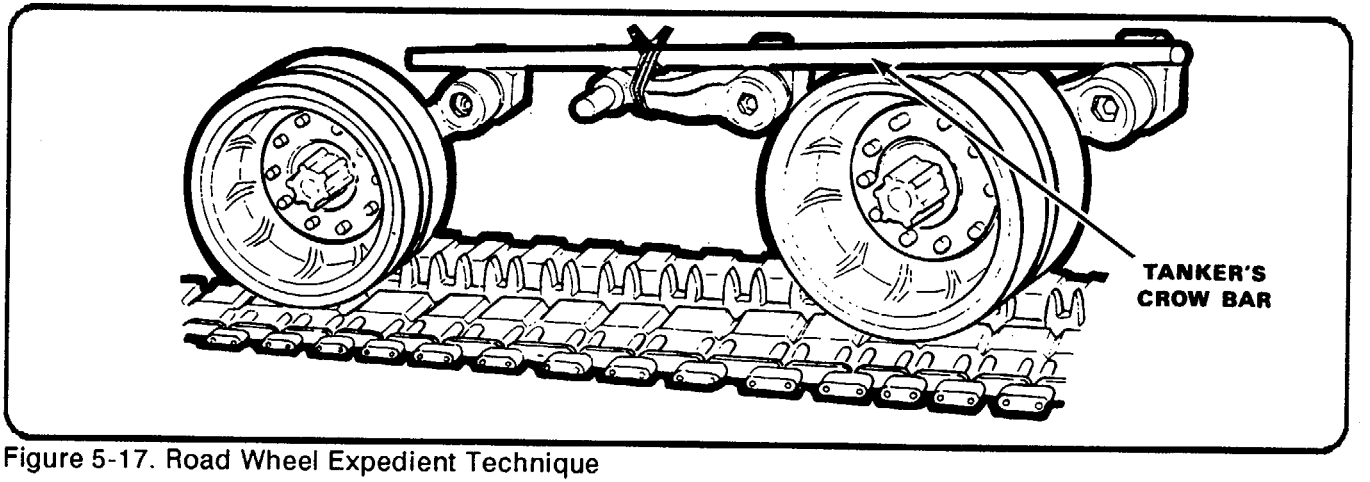


Figure 5-17. Road Wheel Expedient Technique

of the idler wheel, sufficient track blocks must be removed to permit the track to be connected.

A track vehicle with a damaged track, rear road-wheel arm, or idler wheel can be operated by using the short track expedient method. However, the hull must not interfere with the shortened track as with M60-series tanks. To apply this expedient, remove the companion components to the damaged suspension parts, such as the rear shock absorber, track adjuster, road-wheel arm, and torsion bar. Before applying short track expedient methods on M1-series vehicles, you must check procedures outlined in TM 9-2350-255-BD.

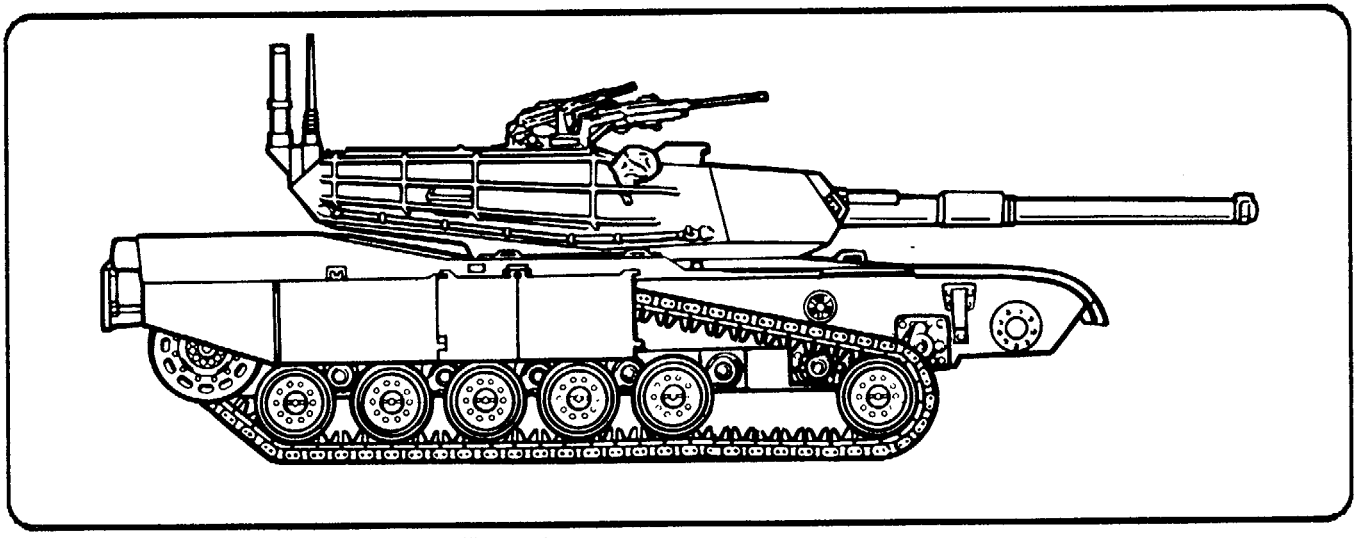


Figure 5-18. Short Track Expedient Technique

SHEAR PIN SUBSTITUTE

Make a substitute for a broken shear pin by punching out the remains of the broken shear pin, cutting the remains in half, and inserting the two shear pin halves with a short, wooden dowel between them. Wrap friction tape around the shaft to cover the shear pin hole and prevent the end of the substitute shear pin from dropping out. Do not use a steel bolt, spike, nail, or screwdriver blade as a substitute shear pin because it could damage the winch and cable.

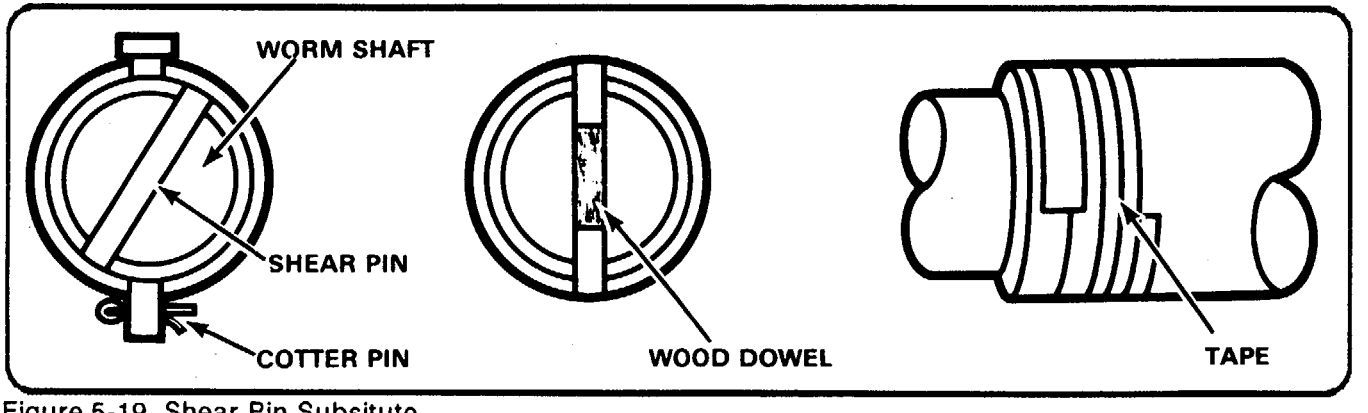


Figure 5-19. Shear Pin Subsitute

CHAPTER 6

BDAR PROCEDURES

BDAR procedures apply at all levels from crew through DS maintenance, depending on the extent of the damage, time available, skills required, parts, components, tools, and materials available. Within these limits, each maintenance level will act rapidly to restore the vehicle to the combat-ready condition required to continue the mission.

Crew/operator BDAR kits consisting of essential tools and materials should be carried on board each vehicle to enable the crew to fix the simplest and most common types of damage and random failures rapidly.

PRINCIPLES OF BDAR

To be effective, BDAR should follow certain guiding principles. Remember standard maintenance is the first choice. Decisions on BDAR versus standard maintenance will normally be based on availability of parts and METT-T.

ACCURACY OF BDA

BDA is the necessary first step. If not done correctly, time, manhours, and parts will be wasted. The objective of BDAR is to get a system safely back into operation quickly. The assessment determines the extent of damage as well as the time and materials required for repair.

ECONOMY OF MAINTENANCE EFFORT

Maintenance assets will be heavily taxed on the battlefield. The shortages of people, tools, and parts make it vital that maintenance resources are not wasted.

MULTIFUNCTIONAL SKILLS MUST BE TRAINED

Personnel shortages and battlefield casualties mandate that maintenance team members have some knowledge of each other's jobs. Lack of knowledge or lack of key repairmen must not deter a team from performing battlefield repair. Whenever possible, cross training of personnel should be done.

REPAIR ONLY WHAT IS NEEDED

The old saying "If it ain't broke, don't fix it" applies here. On the battlefield, the objective is to get the system back into the battle with enough capability to get the job done.

Cosmetic repair is not necessary and is a waste of time. Good looks are wasted on the enemy.

BE FLEXIBLE

Priorities of repair; lack of personnel, parts, and time; a chaotic battlefield; change of mission; lack of a weapon systems crew, and a host of unforeseen circumstances demand a flexible approach to BDAR. It is possible that specific repair techniques may not be in manuals. Ingenuity must be the byword of the soldier doing BDAR.

BASIC RULES OF ASSESSMENT

THINK SAFETY!

Personnel must be on the lookout for fuel/oil spills, damaged electrical cables and wires, live/loaded ammunition, and damaged weapons and ammunition. Look for unexploded ordnance in the area. Do not move or otherwise disturb unexploded ordnance or any ammunition which has been fixed, armed, ignited, or involved in an accident until qualified personnel have rendered it safe. When possible, use EOD personnel to make this determination. Check the area for chemical contamination when appropriate, such as damage from unknown enemy weapons. Check the area for possible depleted uranium contamination, (radiac meter) such as from damaged ammunition or armor that contains depleted uranium.

All practical efforts should be made to aviod environmental contamination spills of fuel or oil of over one gallon should be reported through the chain of

command to the unit's logistical element, such as the batallion S4.

BEWARE OF BOOBY TRAPS!

If equipment was abandoned in enemy territory and was unsupervised by friendly forces, the possibility of booby traps is high.

THE SENIOR MAN PRESENT DECIDES WHEN AND IF TO DO BDAR

His decision is based on what resources are available (tools, personnel, parts), the time available, and the tactical situation.

DO ASSESSMENT FIRST

Do not attempt to operate systems or subsystems until an assessment has been made. Further damage to equipment or personnel may result.

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 damage. This is the first priority. If the vehicle is not capable of self-recovery, use any vehicle, including other combat vehicles, to recover the vehicle or to conceal it. If this is not possible, then turn the turret (if the vehicle is so equipped) in the direction of engaging fire in order to limit damage and return fire. BDAR assessment forms are provided in BDAR TMs to permit a systematic assessment by crew and maintenance personnel. Assessment checks include:

- Inspecting damaged parts and systems. Performing a self-test.
- Making tests with organizational test equipment, if required.
- Performing additional vehicle operational tests, if necessary.

Based on the METT-T, the MT using this information will--

- Determine what must be repaired or replaced.
- Determine sequence and priority of repair actions.

TABLE 6-1. SUMMARY OF BDAR TIME GUIDELINES

LOCATION	ELEMENTS PERFORMING BDAR	TIME (IN HOURS)
Breakdown Site	1.Operator/Crew	2
	2. Co/Bn Maint TM	
	3. DS MST from Fwd Spt Co	
Battalion Trains	1. Bn Maint Plt	6
(UMCP)	2. MST from Fwd Spt Maint Co	
	3. MST from Maint Bn	
Brigade Support Area	1.FSB Maint Co	24
(BSA)	2. MST from Maint Bn	
	3. MST from COSCOM	
Division Support Area	1. Maint Bn 36	
(DSA)	2. MST from Corps Support Command (COSCOM)	
COSCOM	1. COSCOM Maint Co	96

- Estimate repair times for each repair task.
- Total the repair task times if the repairs can be performed in the time available.

Determine repair location and, if other than on site, arrange for recovery of the vehicle to the repair site. See Table 6-1.

Make the following safety checks to identify any obvious hazards:

- Is there an ammunition round in the tube?
- Are any ammunition rounds in a critical state due to shock, fire, or physical damage?
- Have any combustibles such as fuel, hydraulic fluid, or oil accumulated?
- Does wiring appear to be safe? Could arcing to stored ammo or leaking combustibles occur?
- Is the fire-extinguishing system operational? If not, station a crew member in the vehicle, either with a hand-held fire extinguisher or prepared to operate the on-board fire extinguishing system manually. Station a second crew member outside the vehicle with the other fire extinguisher and be prepared to actuate the engine compartment fire extinguisher manually.

For systems with built-in, self-test procedures, perform a functional/operator test on those systems which appear undamaged.

THE VEHICLE COMMANDER

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

THE PLATOON LEADER

The platoon leader will respond with directives and, if required, will call a Company Maintenance Team to the location of the damaged vehicle for assistance. If possible, he will provide sufficient information to enable the CMT to bring any needed repair parts, special tools, or recovery assets to the site.

THE CREW

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

MAINTENANCE PROCEDURES AND BDAR

The operator/crew makes the initial damage assessment and reports to the platoon leader. They describe the inoperable conditions to include NBC condition and circumstances. When the inoperable equipment is subjected to or in danger of hostile fire, another vehicle can be used to recover it to a secure location. The operator/crew makes an estimate of the situation and what maintenance support is required. Self-recovery, BDAR, and other technical assistance are considered as options. If repairs are beyond their capability, they must request assistance as per unit SOP.

If this is not possible, a recovery vehicle may need to be employed or BDAR techniques used. Equipment that is damaged, but mobile, may be used to move disabled equipment. If recovery vehicles are not available, and as the tactical situation permits, like vehicles may be used to recover disabled equipment (that is, an M1A1 towing an M1A1).

When the platoon/section leader determines that repairs are beyond the crew/operator capability, he will contact the company executive officer or first sergeant. That person in turn will contact the BMO or maintenance sergeant, who will dispatch an MT or MST. Organizational maintenance personnel will assess the equipment to verify the operator/crew's assessment of damage. Based on the MT assessment, the decision will be made to attempt an on-site repair or to request recovery assets to move the vehicle to a forward maintenance collection point. Repair time guidelines will determine whether on-site repair or evacuation is necessary.

Unit and DS repair teams will perform BDAR, using approved ground vehicle BDAR kits and any other field-expedient material on hand. Since standard maintenance repairs usually offer the best repair, maintenance personnel will strive to perform such repair if time, resources, and the tactical situation permit.

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. If the damage exceeds the repair capability of the MT, and time is available for a Maintenance Support Team on-site fix, the MT will call the MST.

If time for an MST on-site fix is not available, but the vehicle is reparable, the MT will recover the vehicle to a designated collection point.

If the vehicle is not reparable, the MT will provide--

- Recovery to a maintenance collection point for evacuation to the rear.
- On-site stripping (cannibalization), if approved by the commander and coordinated with support maintenance.
- Other needed replacement parts.
- If the vehicle is contaminated, the MT will mark the vehicle with contamination markers and arrange for recovery to a decontamination site.

RECORDING BDAR REPAIRS

Attach a DD Form 1577 (or similar conspicuous tag) to all vehicle components (Figure 6-1) which are repaired using BDR or other expedient techniques. It is not necessary to fill out the form. The purpose of marking the parts is to enable mechanics to recognize them quickly when the equipment is subsequently returned for permanent repair, if required.

Since it is impractical to attach tags to expediently repaired parts located on the outside of the vehicle, note the fix on a DD Form 1577 or similar tag. Store this tag in the compartment normally reserved for the equipment record folder.

Place a tag conspicuously in the vehicle commander or driver position when a BDAR procedure has resulted in a degraded operating capability. Mark this tag "BDAR," and note its specific limitations or cautions.

When a component is cannibalized from a reparable vehicle, attach a tag in the space created

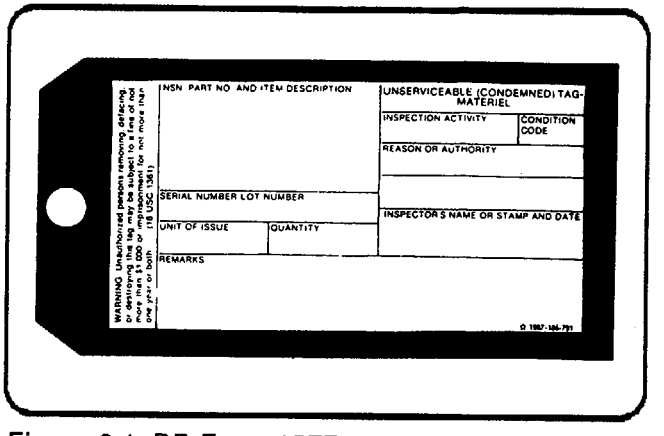
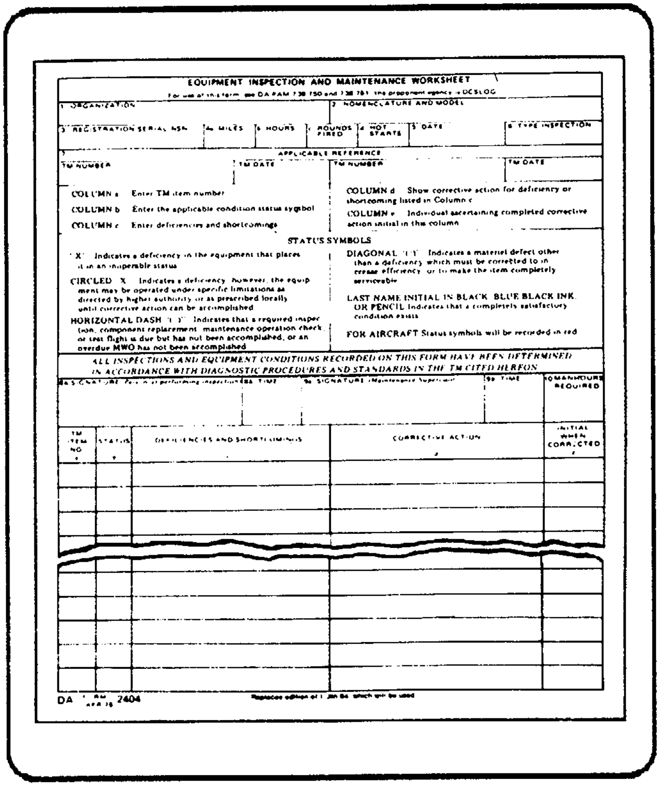


Figure 6-1. DD Form 1577

by the missing part and near the master power switch to alert downstream repair personnel readily that the part has been removed.

When the vehicle is recovered/evacuated for permanent "standard" repair, and DA Forms 2404 (Figure 6-2) and 2407 (Figure 6-3) are used, add the notation "BDAR" in the space provided for description of deficiencies.



EQUIPMENT INSPECTION AND MAINTENANCE WORKSHEET

COLUMN a Enter TM item number

COLUMN b Enter the applicable condition status symbol

COLUMN c Enter deficiencies and shortcomings

COLUMN d Show corrective action for deficiency or shortcoming listed in Column c

COLUMN e Individual ascertaining completed corrective action initial in this column

STATUS SYMBOLS

CIRCLED X Indicates a deficiency, however, the equipment may be operated under specific limitations as directed by higher authority or as prescribed locally until corrective action can be accomplished

HORIZONTAL DASH Indicates that a required inspection, component replacement, maintenance operation check, or test flight is due but has not been accomplished, or an overdue MWO has not been accomplished

DIAGONAL Indicates a materiel defect other than a deficiency which must be corrected to increase efficiency or to make the item completely serviceable

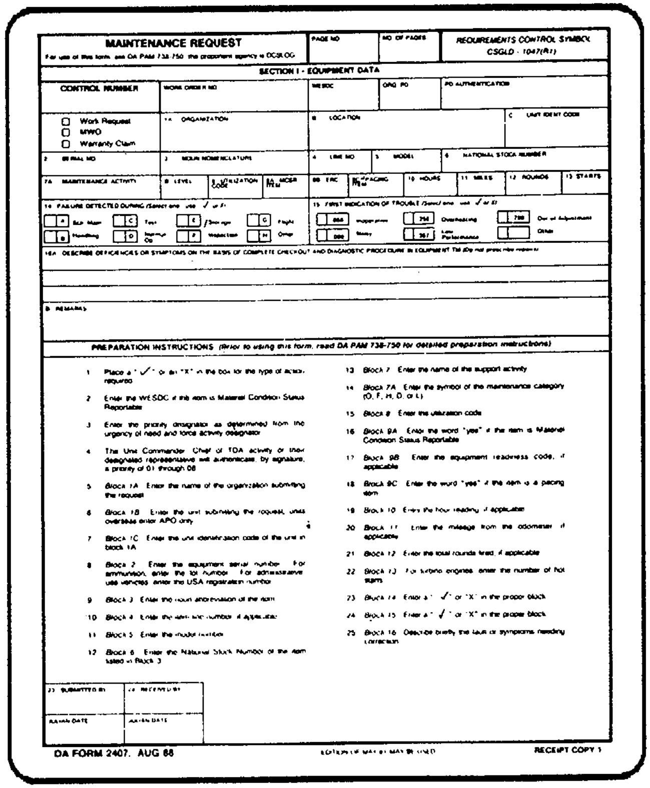
LAST NAME INITIAL IN BLACK, BLUE BLACK INK, OR PENCIL Indicates that a completely satisfactory condition exists

FOR AIRCRAFT Status symbols will be recorded in red

ALL INSPECTIONS AND EQUIPMENT CONDITIONS RECORDED ON THIS FORM HAVE BEEN DETERMINED IN ACCORDANCE WITH DIAGNOSTIC PROCEDURES AND STANDARDS IN THE TM CITED HEREON

DA 2404

Figure 6-2. DA Form 2404



MAINTENANCE REQUEST

SECTION I - EQUIPMENT DATA

CONTROL NUMBER

Work Request

MWO

Warranty Claim

PREPARATION INSTRUCTIONS

DA FORM 2407, AUG 88

RECEIPT COPY 1

Figure 6-3. DA Form 2407

Communication Damage Report Form, DA Pam 738-750, Maintenance UPDATE, (refer to Figure 1-1) provides for disposition of DA Form 2404 and Copy 3 of DA Form 2407 (Figure 6-3). When "BDAR" is noted on these forms, mail them to:

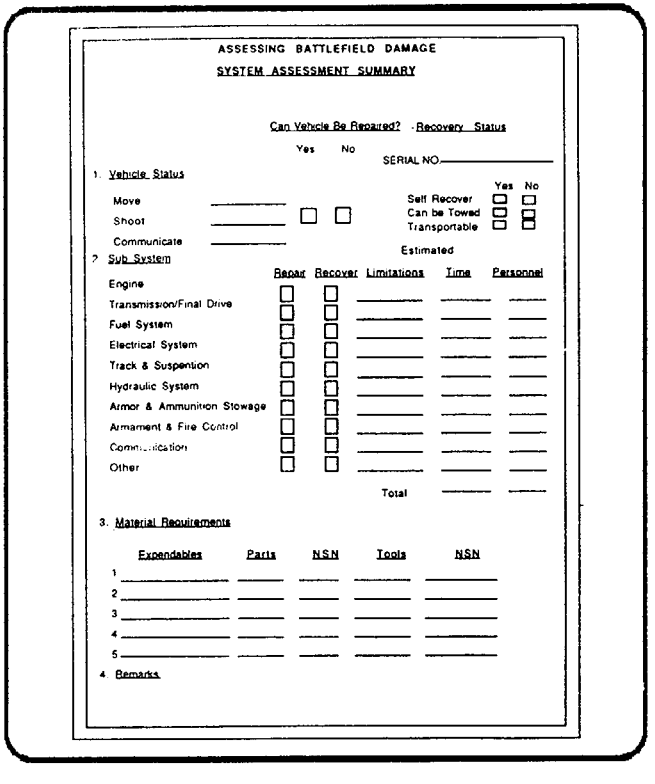
Survivability/Vulnerability
Information Analysis Center,
WL/FIVS/SURVIAC,
BLDG 45,
2130 8th Street,
Suite 1,
Wight Patterson AFB,
Dayton, Ohio 45433-7542.

The information on these forms will provide data for designing vehicles to be less susceptible to combat damage and easier to repair when damaged.

BATTLEFIELD DAMAGE ASSESSMENT AND REPAIR FORMS

This section illustrates and describes the forms used in BDA. These forms are designed to assist personnel in rapidly assessing battlefield damaged

BY RECORDING BDAR REPAIRS, DATA CAN BE ACCUMULATED TO HELP DESIGN VEHICLES LESS SUSCEPTIBLE TO COMBAT DAMAGE AND EASIER TO REPAIR WHEN DAMAGED



ASSESSING BATTLEFIELD DAMAGE

SYSTEM ASSESSMENT SUMMARY

Can Vehicle Be Repaired? · Recovery Status

Yes No

SERIAL NO._____

1. Vehicle Status

		Yes	No
Move	_____		Self Recover
Shoot	_____		Can be Towed
Communicate	_____		Transportable

2. Sub System

	Repair	Recover	Limitations	Estimated Time	Personnel
Engine					
Transmission/Final Drive					
Fuel System					
Electrical System					
Track & Suspention					
Hydraulic System					
Armor & Ammunition Stowage					
Armament & Fire Control					
Communication					
Other					
			Total		

3. Material Requirements

	Expendables	Parts	NSN	Tools	NSN
1					
2					
3					
4					
5					

4. Remarks

Figure 6-4. System Assessment Summary Form

equipment, systematically assessing equipment to determine which subsystems are affected, and the time, personnel, and materials required for repair.

These forms will also assist in performing "vehicle triage." Vehicle triage is a system of deciding in which order battlefield damaged equipment will receive repair. This determination is based on time, urgency, material, and personnel required to accomplish the repair.

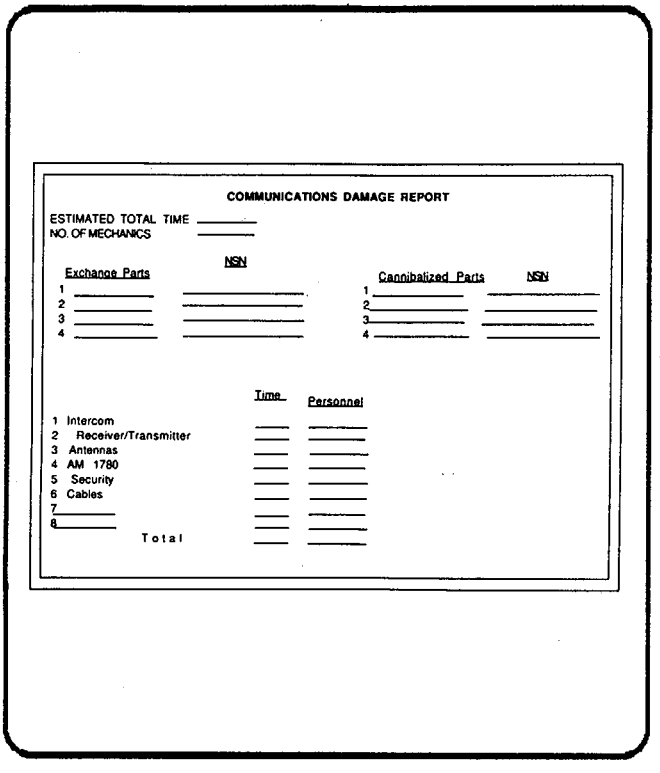
The forms illustrated are to be used in assessing battlefield damage (Figures 6-4 through 6-8). Assessment forms can be found in all BDAR TMs.

NOTE: These forms can be reproduced locally.

BDA forms are designed to ensure that all necessary aspects of combat capability are evaluated during assessment.

All assessment procedures follow this sequence:

- Inspect (repair, if necessary).



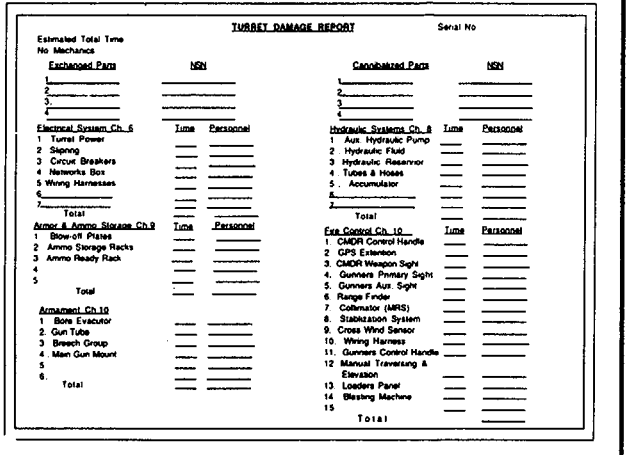
COMMUNICATIONS DAMAGE REPORT

ESTIMATED TOTAL TIME _____
NO. OF MECHANICS _____

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

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

Figure 6-5. Communications Damage Report Form



TURRET DAMAGE REPORT Serial No

Estimated Total Time
No Mechanics

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

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

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

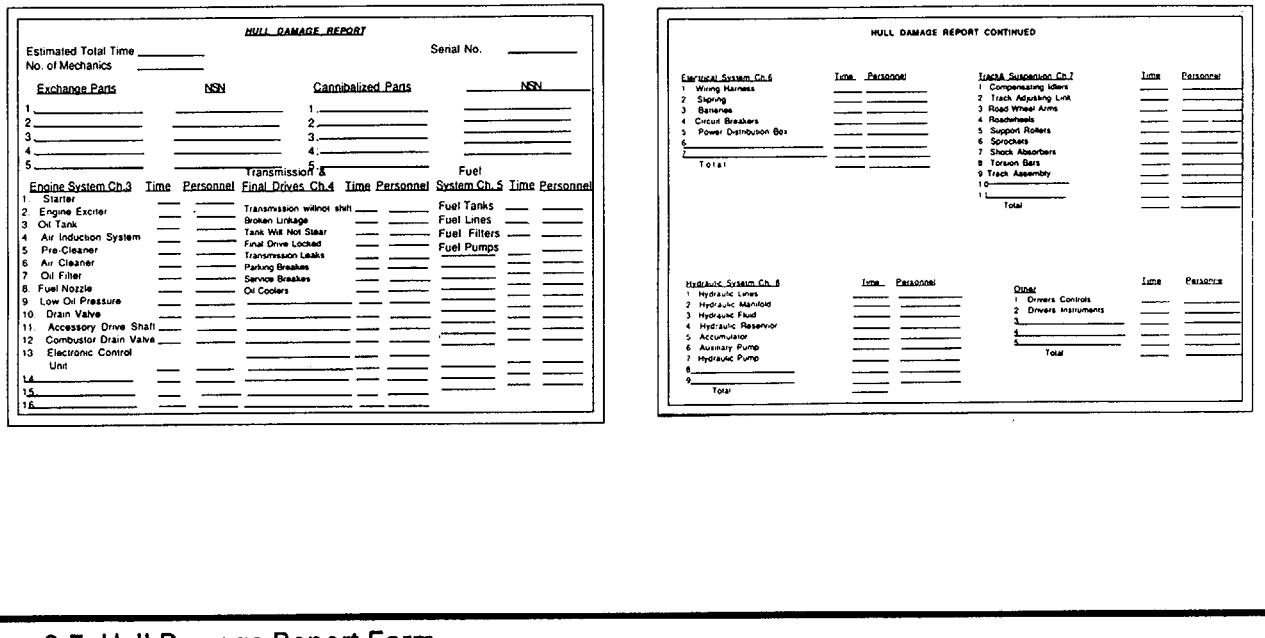
Armor & Ammo Storage Ch 9	Time	Personnel
1 Blow-off Plates		
2 Ammo Storage Racks		
3 Ammo Ready Rack		
4		
5		
Total		

Armament Ch 10		
1 Bore Evacutor		
2 Gun Tube		
3 Breech Group		
4 Main Gun Mount		
5		
6		
Total		

Hydraulic Systems Ch. 8	Time	Personnel
1 Aux. Hydraulic Pump		
2 Hydraulic Fluid		
3 Hydraulic Reservoir		
4 Tubes & Hoses		
5 Accumulator		
6 _____		
7 _____		
Total		

Fire Control Ch. 10	Time	Personnel
1. CMDR Control Handle		
2 GPS Extension		
3. CMDR Weapon Sight		
4. Gunners Primary Sight		
5. Gunners Aux. Sight		
6. Range Finder		
7. Collimator (MRS)		
8. Stabilization System		
9. Cross Wind Sensor		
10. Wiring Harness		
11. Gunners Control Handle		
12 Manual Traversing & Elevation		
13. Loaders Panel		
14. Blasting Machine		
15		
Total		

Figure 6-6. Turret Damage Report Form



HULL DAMAGE REPORT

Estimated Total Time _____ Serial No. _____
No. of Mechanics _____

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

Engine System Ch.3	Time	Personnel	Transmission & Final Drives Ch.4	Time	Personnel	Fuel System Ch. 5	Time	Personnel
1 Starter								
2 Engine Exciter			Transmission without shift			Fuel Tanks		
3 Oil Tank			Broken Linkage			Fuel Lines		
4 Air Induction System			Tank Will Not Steer			Fuel Filters		
5 Pre-Cleaner			Final Drive Locked			Fuel Pumps		
6 Air Cleaner			Transmission Leaks					
7 Oil Filter			Parking Brakes					
8 Fuel Nozzle			Service Brakes					
9 Low Oil Pressure			Oil Coolers					
10 Drain Valve								
11 Accessory Drive Shaft								
12 Combustor Drain Valve								
13 Electronic Control Unit								
14								
15								
16								

HULL DAMAGE REPORT CONTINUED

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

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

Hydraulic System Ch. 8	Time	Personnel
1 Hydraulic Lines		
2 Hydraulic Manifold		
3 Hydraulic Fluid		
4 Hydraulic Reservoir		
5 Accumulator		
6 Auxiliary Pump		
7 Hydraulic Pump		
8		
9		
Total		

Other	Time	Personnel
1 Drivers Controls		
2 Drivers Instruments		
3		
4		
5		
Total		

Figure 6-7. Hull Damage Report Form

- Functionally test (repair, if necessary).
- Assess the performance.

The assessment and field fixes will enable the vehicle to continue the mission or self-recover. They will typically be more useful to the MT/MST for scheduling and accomplishing both BDAR "quick fixes" and fix-forward repairs. BDA will provide the commander with the necessary information for timely decisions on whether to continue to "fight the vehicle" or recover it at the appropriate level.

Report battlefield damage in accordance with local SOP.

The System Assessment Summary Form is used to determine the following:

- Are the vehicle's systems operable?
- What subsystems are affected?
- Is the damage reparable?
- If reparable, are there limitations?
- What is the estimated repair time?
- What is the estimated number of personnel needed to effect repair?
- What materials are required?
- Recovery status. (Is a recovery vehicle required or can the vehicle self-recover?)

BDAR AND RECOVERY IN SPECIAL OPERATING ENVIRONMENTS

FMs cover doctrinal information in special operating environments. BDAR techniques will be more difficult in certain environments, such as cold climates. For example, certain molecular compounds may be difficult to apply in a cold environment. The instructions for these compounds specify special operating conditions for their use.

BDA will be used to determine the time required to repair a system, and whether repairs can be done on site or if recovery is necessary. Whenever possible, standard maintenance repairs should be attempted. If that is not possible, then BDR is applied to allow equipment to self-recover or continue the mission even though it may be at a reduced level of capability. Upon completion of the mission and at the first practical opportunity, more complete, standard repairs will be undertaken to return the equipment to as fully mission capable status as possible. Whether to use cannibalization or controlled exchange is a decision made by the commander owning the equipment.

Supervised battlefield cannibalization and controlled exchange may be employed when parts are not available. Conditions for cannibalization are usually strictly controlled by local policy and will be employed when addressed in an operations order by higher headquarters.

Cannibalization is the authorized removal of serviceable and unserviceable parts, components, and assemblies from materiel authorized for disposal. One possible source of cannibalization is captured or abandoned enemy equipment.

Controlled exchange is the removal of serviceable parts, components, and assemblies from unserviceable, economically reparable equipment. These parts are for immediate use in restoring a like-item of equipment to a combat capable or serviceable condition. Cannibalization and controlled exchange can be done only when authorized by the commander.

BDAR IN JOINT OPERATIONS

Army units can expect to deploy as a component of a joint force. Army maintenance personnel should work closely with other services to make collective use of tools and supplies to perform BDAR. Despite differences in equipment and doctrine, there is much that the services have in common and can be shared. Navy Seabees, Air Force maintenance activities, and most Navy ships have a machine shop fabrication capability that would prove useful in supporting Army units. Prior joint-service agreements should be developed to make use of this capability between the

services. The same cooperation can be developed with allied nations. Most armies have a BDAR program. Much of their tools, materials, and techniques are similar to our own. In addition, some foreign armies use our equipment, especially vehicles, and are a possible source for repair parts if cannibalization is allowed by the host nation. Host nation agreements should outline what BDAR and other maintenance services can be provided and the procedures for obtaining support.

BDAR TOOLS AND EQUIPMENT

TACOM and Aviation Logistics Support Command have developed a variety of repair kits specifically designed for BDAR. Appendix A lists the various components of current ground repair kits. The ground kits were designed as stand-alone kits to allow a mechanic to perform BDAR without access to other tools. These kits will be allocated to MTs and MSTs. Aviation kits will be restricted to AVUM and AVIM units.

When possible, BDAR should first be performed by the crew using the crew/operator BDAR kit BII, COEI, AAL, and ESM list. Maintenance personnel will have access to the same items available to the crew as well as unit/DS BDAR kits, unit mechanic tools, and DS contact maintenance truck tools. Crew and mechanics are limited only by their imagination and local policy when applying BDAR.

In wartime, BDAR may have to be liberally applied at the direction of the commander. In peacetime, local command policy will direct the degree of BDAR to be applied and when standard maintenance will be used.

Ground Equipment BDAR Kits

BDAR kits were designed to allow repair in several critical areas: fuel, hydraulic, cooling, tires, and electrical systems as well as hull repair. While the contents of BDAR kits vary somewhat, their contents may be broken down into the areas mentioned previously.

Polymer Kit

It is critical to maintain hull integrity, especially during fording operations and when faced with an NBC threat. The super metal and fiberglass kit will ensure hull integrity for small-to-medium-sized holes and can be used anywhere on a vehicle to include radiators and gas tanks. When using this kit, it is important that you relieve water and/or fuel pressure before attempting the repair.

Hydraulic Fittings

The fittings in the BDAR kits enable the mechanic to repair low- and high-pressure lines in wheel and track vehicles. These same fittings can also be used on other ground equipment such as generators and compressors. Using the hacksaw, reamer, wrenches, hydraulic fittings, and extra hose, low- and high-pressure lines can be fixed in a short time. The heavy-duty wrenches in the BDAR kits were intended to act as vises.

Electrical Connectors

Simple electrical repairs can be accomplished with the multimeter, electrical pliers, electrical tape, connectors, sixteen-gauge wire, and velcro strips and wire ties. A continuity check can be made quickly with the multimeter to check for breaks in electrical wire. The pliers act as a wire cutter, crimper, small bolt cutter, and wire stripper. The velcro and wire ties will hold wire in place during repair. It is important to disconnect vehicle power before working on any electrical wire.

Tire Repair Kit

The tire repair kit will usually be found in the M88 and M2/3 generic kit. The kit includes a hand-insertion tool, hand rasp, tube of cement, and 50 "plug-it" inserts. Fast and efficient tire repair can be accomplished with this kit if the hole was due to a nail or like item. If the tire damage was from shrapnel, a better method of repair (melt plastic from MREs in the hole) will need to be determined.

In peacetime, as a safety precaution, a whole tire should be dismounted and inspected off the wheel to ensure the damage is reparable.

Other Systems

Fuel cell patches are provided to patch holes in fuel tanks. The V-belt is for fan and alternator belts. Unit personnel are encouraged to add other items they feel are needed in their units' kits. Army personnel are only limited by their imagination and unit funding.

Electrical Repair Kit

This kit consists of four component kits (test kit, electrical; repair kit, wire (emergency); kit, wire repair; and electrical kit, maintenance). All four cases contain all the tools, test equipment , and consumable materials necessary to repair more than 85 percent of the connectors used in current Army aircraft.

Fluid Line Repair Kit

The two cases of this kit contain the tools and hardware required to repair more than 86 percent of the fluid lines on current Army aircraft. This kit utilizes flexible 3000 psi hoses, flareless fittings, and reducers.

Fuel Cell Repair Kit

The single case of this kit contains mechanical and rubber/epoxy patches capable of rapidly making temporary fuel cell repairs. The mechanical repair allows for a one-time evacuation flight, while the rubber/epoxy repair allows for 100 flight hours.

APPENDIX A

BDAR KITS

OPERATOR/CREW BDAR KIT

NSN	NOMENCLATURE	QUANTITY
4730-01-327-5172	CLAMP, HOSE 3/8-IN TO 4-IN	4 EA
4730-00-277-7133	CLAMP, HOSE 1 1/16-IN TO 2 IN	4 EA
8030-00-889-3534	TAPE, ANTI-SEIZING PIPE PLUG, TEFLON, 1/2-IN WIDE	1 EA
7510-00-802-8311	TAPE, FILAMENT REINFORCED 3/4-IN 50 -YD ROLL	1 EA
6145-00-152-6499	WIRE, WIRE SZ, #14 25-FT ROLL	1 EA
6145-00-435-8618	WIRE, WIRE SZ, #18 25-FT ROLL	1 EA
8040-00-831-3403	ADHESIVE, EPOXY 1 PT	1 EA
8030-01-299-1762	ADHESIVE, SEALANT,SILICON RUBBER (6B) RTV 103	1 EA
8040-00738-6429	ADHESIVE, EPOXY (RESURCH)	1 EA

4720-00-623-9178	HOSE, NONMETALIC1/4-IN ID X 2-FT	1 EA
4720-00-169-5112	HOSE, NONMETALIC1/2-IN ID X 2-FT	1 EA
4720-00-288-9873	HOSE, NONMETALIC3/4-IN ID X 2-FT	1 EA
5970-00-815-9818	TAPE, ELECTRICAL 3/4-IN ROLL	1EA
3030-00-445-0424	BELT, V 3857 2 -FT SECTION	2 EA
9505-00-221-2652	WIRE LACING, NON-ELECTRIC ROLL	1 EA
5140-00-473-6256	BAG, TOOL	1EA
4020-00-291-5901	TWINE, BALL	1 EA
5120-00-494-1911	VISE-GRIPS, 8 1/2-IN CUTTERS	1 EA
5110-00-927-1063	BLADE, HACKSAW	3 EA
5120-00-223-7397	PLIERS, LONG-NOSE W/CUTTER	1 EA
5120-00-288-6520	CUTTER, TUBE	1 EA
NA	NON-PRESSURE COUPLING, HOSE 3/8 1/2 5/8 1 1/4 1 1/2-IN	4 EA
NA	PRESSURE COUPLING, HOSE HYDRAULIC 3/8 1/2 5/8-IN	4 EA
5640-00-103-2254	TAPE, ROLL	?

M2/3 GENERIC BDAR KIT

NSN	NOMENCLATURE	QUANTITY
2510-01-327-6145	KIT, REPAIR, POLYMERIC	1 EA
5110-00-289-9657	FRAME, HACKSAW	1 EA
5110-00-277-4588	BLADE, HACKSAW	5 EA
8030-00-889-3534	TAPE, THREAD SEAL	1 EA
5970-00-815-9818	TAPE, ELECTRICAL	1EA
9505-00-293-4208	WIRE, NON-ELECTRICAL	1 EA
5110-00-528-9000	FILE, HALF-ROUND	1 EA
5110-00-903-2506	TOOL, DEBURRING	1 EA
7920-00-223-8005	BRUSH, ACID SWABBING	2 EA
7920-01-195-5355	BRUSH, WIRE	1 EA
5110-00-162-2205	KNIFE	1 EA
5975-00-225-8722	STRAP, TIE-DOWN	10 EA
5120-01-131-1864	PLIERS, CHANNELLOCK	1 EA

7510-00-684-8803	TAPE, ALUMINUM	1 EA
5110-1-327-5171	HACKSAW, MINI	1 EA
8030-01-299-1762	RTV BLUE	1 EA
4730-00-497-9343	CLAMP, HOSE 2-IN	2 EA
4730-00-327-5172	CLAMP, HOSE 1-IN	2 EA
5120-00-997-2858	SCREWDRIVER	1 EA
5120-00-473-6476	WRENCH, SPUD	1 EA
5120-01-021-5730	PLIERS, LINEMAN	1 EA
8315-01-115-7617	HOOK, VELCRO 9-IN	1 EA
5120-01-327-5170	TOOL, CRIMPING	1 EA
5940-01-347-0008	21-18 RED BUT	24 EA
5940-01-079-1375	16-24 BLUE BUT	24 EA
5940-01-144-1548	12-10 YELLOW BUT	24 EA
5940-01-727-5351	12-10 YELLOW FORK #10	24 EA
5940-01-087-0284	12-18 RED FORK #8	24 EA
6140-00-347-1171	WIRE, PRIMARY 16 GA	1 EA

8040-01-346-1339	PATCH, SUNREZ	1 EA
8040-00-776-9605	FIBER RESIN	1 EA
5120-00-494-1911	VISE GRIPS	1EA
5110-00-570-6896	SAW, HAND FINGER GRIP	1 EA
6850-00-598-7311	LEAK PREVENTIVE	1 EA
6625-01-342-8935	MULTIMETER, MODEL SP5	1 EA
5110-00-903-2506	REAMER	1 EA
2640-00-404-0754	KIT, TIRE PATCH, MEYERS	1 EA
4730-01-327-8836	KIT, FITTING, TUBE	2 EA
4730-01-327-6743	FITTING	2 EA
4730-01-327-6742	FITTING	2 EA
4730-01-327-6745	FITTING	2 EA
4730-01-327-6744	FITTING	2 EA
4730-01-327-6740	FITTING	2 EA
4730-01-327-8553	ADAPTER	1 EA
4730-01-327-8554	ADAPTER	1 EA

4730-01-327-8550	ADAPTER	1 EA
4730-01-327-8552	ADAPTER	1 EA
4730-01-327-8551	ADAPTER	1 EA
4730-00-771-1009	ADAPTER	1 EA
4730-01-327-8556	ADAPTER	1 EA
4730-01-327-8557	ADAPTER	1 EA
3030-00-224-0424	V-BELT, 3/8-IN X 67-IN	1 EA
3030-00-224-8358	V-BELT, 1/2-IN X 67-IN	1 EA
2910-01-328-0262	KIT, FUEL CELL PATCH	1 EA
5120-01-347-4947	TOOL, V-BELT	1 EA
2910-01-328-0261	KIT, FUEL CELL PATCH	1 EA
2910-01-328-0263	KIT, FUEL CELL PATCH	1 EA
8315-01-115-7617	LOOP, VELCRO 9-IN	1 EA

M88 BDAR KIT

NSN	NOMENCLATURE	QUANTITY
2510-01-327-6145	KIT, REPAIR, POLYMERIC	1 EA
5110-00-289-9657	FRAME, HACKSAW	1 EA
5110-00-277-4588	BLADE, HACKSAW	5 EA
8030-00-889-3534	TAPE, THREAD SEAL	1 EA
5970-00-815-9818	TAPE, ELECTRICAL	1EA
9505-00-293-4208	WIRE, NON-ELECTRICAL	1 EA
5110-00-528-9000	FILE, HALF-ROUND	1 EA
5110-00-903-2506	TOOL, DEBURRING	1 EA
7920-00-223-8005	BRUSH, ACID SWABBING	2 EA
7920-01-195-5355	BRUSH, WIRE	1 EA
5110-00-162-2205	KNIFE	1 EA
5975-00-225-8722	STRAP, TIE-DOWN	10 EA
5120-01-131-1864	PLIERS, CHANNELLOCK	1 EA
7510-00-684-8803	TAPE, ALUMINUM	1 EA

5110-1-327-5171	HACKSAW, MINI	1 EA
8030-01-299-1762	RTV BLUE	1 EA
4730-00-497-9343	CLAMP, HOSE 2-IN	2 EA
4730-00-327-5172	CLAMP, HOSE 1-IN	2 EA
5120-00-997-2858	SCREWDRIVER	1 EA
5120-00-473-6476	WRENCH, SPUD	1 EA
5120-01-021-5730	PLIERS, LINEMAN	1 EA
8315-01-115-7617	HOOK, VELCRO 9-IN	1 EA
5120-01-327-5170	TOOL, CRIMPING	1 EA
5940-01-347-0008	21-18 RED BUT	24 EA
5940-01-079-1375	16-24 BLUE BUT	24 EA
5940-01-144-1548	12-10 YELLOW BUT	24 EA
5940-01-727-5351	12-10 YELLOW FORK #10	24 EA
5940-01-087-0284	12-18 RED FORK #8	24 EA
6140-00-347-1171	WIRE, PRIMARY 16 GA	1 EA
8040-01-346-1339	PATCH, SUNREZ	1 EA

8040-00-776-9605	FIBER RESIN	1 EA
5120-00-494-1911	VISE GRIPS	1EA
5110-00-570-6896	SAW, HAND FINGER GRIP	1 EA
6850-00-598-7311	LEAK PREVENTIVE	1 EA
6625-01-342-8935	MULTIMETER, MODEL SP5	1 EA
5110-00-903-2506	REAMER	1 EA
4730-01-825-7304	ADAPTER	2 EA
4730-00-781-6089	ADAPTER	2 EA
4730-01-242-2840	ADAPTER	2 EA
4730-01-297-0221	ADAPTER	2 EA
4730-01-077-1009	ADAPTER	2 EA
4730-01-189-8621	ADAPTER	2 EA
4730-00-834-4521	ADAPTER	2 EA
4730-00-937-0234	ADAPTER	2 EA
4730-00-051-4709	ADAPTER	2 EA
4730-00-952-0038	ADAPTER	2 EA

4730-00-472-2611	ADAPTER	2 EA
4730-00-374-6454	ADAPTER	2 EA
4730-01-327-8558	FITTING ASSY	2 EA
4730-01-054-1698	FITTING ASSY	2 EA
4730-01-296-2947	FITTING ASSY	2 EA
4730-01-327-6741	FITTING ASSY	2 EA
4730-00-863-9324	FITTING ASSY	2 EA
8315-01-115-7617	LOOP, VELCRO 9-IN	1 EA
NSN NOT AVAILABLE	TOOLBOX (LOCAL PURCHASE)	1 EA

M1 BDAR KIT

NSN	NOMENCLATURE	QUANTITY
2510-01-327-6145	KIT, REPAIR, POLYMERIC	1 EA
5110-00-289-9657	FRAME, HACKSAW	1 EA
5110-00-277-4588	BLADE, HACKSAW	5 EA
8030-00-889-3534	TAPE, THREAD SEAL	1 EA
5970-00-815-9818	TAPE, ELECTRICAL	1EA
9505-00-293-4208	WIRE, NON-ELECTRICAL	1 EA
5110-00-528-9000	FILE, HALF-ROUND	1 EA
5110-00-903-2506	TOOL, DEBURRING	1 EA
7920-00-223-8005	BRUSH, ACID SWABBING	2 EA
7920-01-195-5355	BRUSH, WIRE	1 EA
5110-00-162-2205	KNIFE	1 EA
5975-00-225-8722	STRAP, TIE-DOWN	10 EA
5120-01-131-1864	PLIERS, CHANNELLOCK	1 EA
7510-00-684-8803	TAPE, ALUMINUM	1 EA

5110-1-327-5171	HACKSAW, MINI	1 EA
8030-01-299-1762	RTV BLUE	1 EA
4730-00-497-9343	CLAMP, HOSE 2-IN	2 EA
4730-00-327-5172	CLAMP, HOSE 1-IN	2 EA
5120-00-997-2858	SCREWDRIVER	1 EA
5120-00-473-6476	WRENCH, SPUD	1 EA
5120-01-021-5730	PLIERS, LINEMAN	1 EA
8315-01-115-7617	HOOK, VELCRO 9-IN	1 EA
5120-01-327-5170	TOOL, CRIMPING	1 EA
5940-01-347-0008	21-18 RED BUT	24 EA
5940-01-079-1375	16-24 BLUE BUT	24 EA
5940-01-144-1548	12-10 YELLOW BUT	24 EA
5940-01-727-5351	12-10 YELLOW FORK #10	24 EA
5940-01-087-0284	12-18 RED FORK #8	24 EA
6140-00-347-1171	WIRE, PRIMARY 16 GA	1 EA
8040-01-346-1339	PATCH, SUNREZ	1 EA

8040-00-776-9605	FIBER RESIN	1 EA
5120-00-494-1911	VISE GRIPS	1EA
5110-00-570-6896	SAW, HAND FINGER GRIP	1 EA
6850-00-598-7311	LEAK PREVENTIVE	1 EA
6625-01-342-8935	MULTIMETER, MODEL SP5	1 EA
5110-00-903-2506	REAMER	1 EA
4730-01-825-7304	ADAPTER	1 EA
4730-00-781-6089	ADAPTER	1 EA
4730-01-242-2840	ADAPTER	1 EA
4730-01-297-0221	ADAPTER	1 EA
4730-01-077-1009	ADAPTER	1 EA
4730-00-055-5689	ADAPTER, STRAIGHT	1 EA
4730-00-982-9736	ADAPTER STRAIGHT	1 EA
4730-01-022-3151	ADAPTER STRAIGHT	1 EA
4730-00-889-2478	ADAPTER STRAIGHT	1 EA
4730-00-017-8234	ADAPTER STRAIGHT	1 EA

4730-00-720-1171	ADAPTER STRAIGHT	1 EA
4730-01-316-9228	ADAPTER	1 EA
4730-01-303-5932	ADAPTER STRAIGHT	1 EA
4730-00-811-3640	ADAPTER	1 EA
4730-01-026-9144	ADAPTER STRAIGHT	2 EA
5110-00-927-1063	BLADE, HACKSAW, TUNGSTEN	10 EA
8315-01-115-7617	LOOP, VELCRO	1 EA

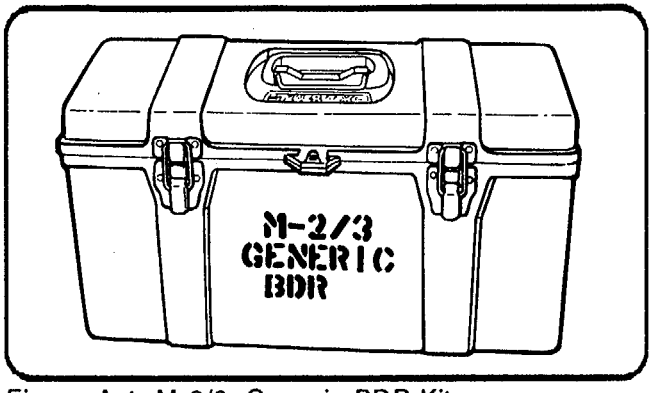


Figure A-1. M-2/3, Generic BDR Kit

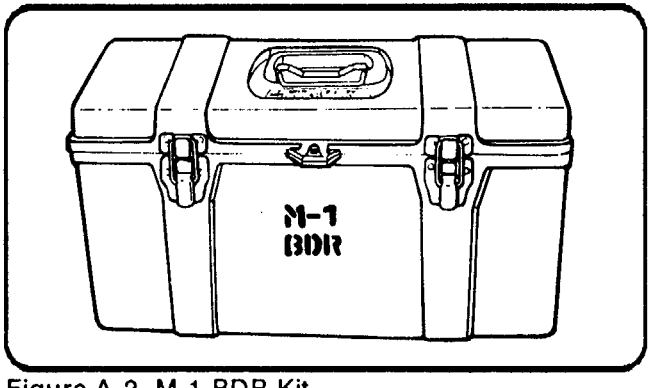


Figure A-2. M-1 BDR Kit

EACH UNIT IS EXPECTED AND ENCOURAGED TO MODIFY ITS BDR KITS TO SUIT ITS SPECIAL OPERATIONAL NEEDS AND GEOGRAPHIC ENVIRONMENT

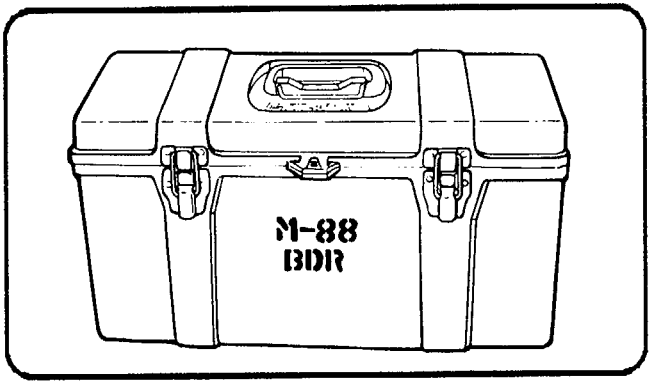


Figure A-3. M-88 BDR Kit

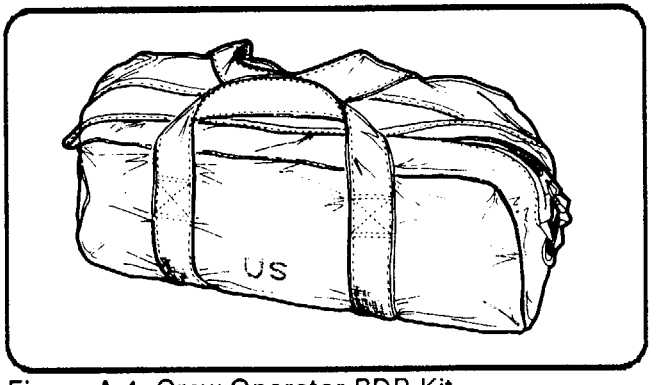


Figure A-4. Crew Operator BDR Kit

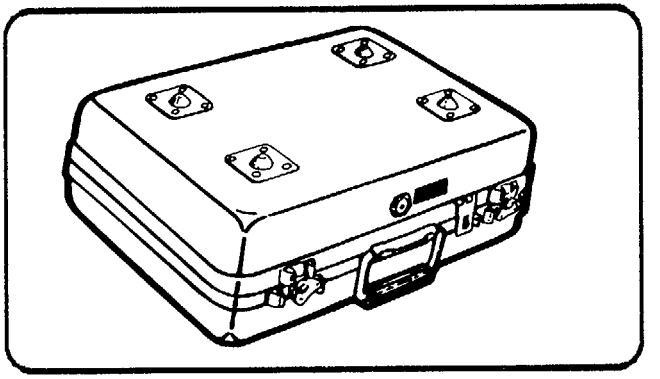


Figure A-5. Fuel Cell Repair Kit

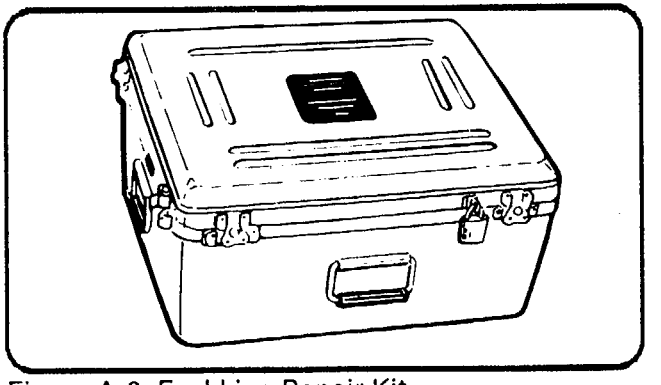


Figure A-6. Fuel Line Repair Kit

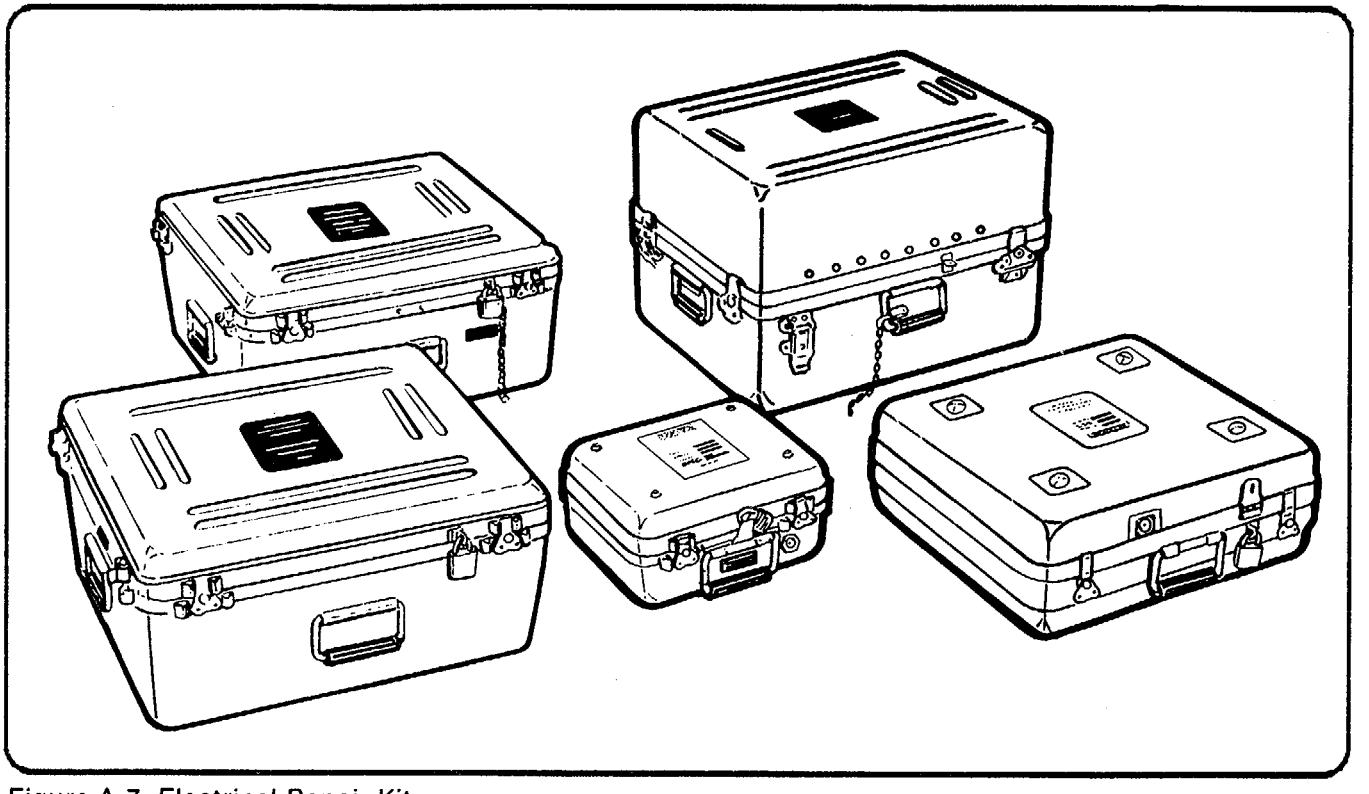


Figure A-7. Electrical Repair Kit

APPENDIX B

COMBINED AND MULTINATIONAL RECOVERY AND BDAR OPERATIONS

Army missions increasingly call for combined and multinational recovery and BDAR operations to be part of a multinational force. For Recovery and BDAR (R-BDAR) managers and operators, this means that there will be many opportunities and requirements to recover C&M vehicles. It also means they will recover our vehicles. This appendix provides guidance for making coordination for such operations and for actual execution of such operations. It also briefly covers R-BDAR operations concerning captured or abandoned enemy equipment.

COORDINATION CONSIDERATIONS CHECKLIST.

When faced with an operation in which US R-BDAR assets may be used to support C&M assets or vice versa, check for existing STANAG and SOPs. Then make contact with the affected C&M unit to exchange key information. Although coordination at the initial phases of a C&M operation will start at the highest level, as the relationship matures coordination or information exchanges should routinely happen at tactical unit levels. This should be encouraged until routinization is such that information exchanges happen at the operator level wherever possible. During that process, as much as possible should be established as SOP. Here is some critical information that needs to be exchanged or critical understandings that need to be established:

- Where recovered assets should be towed to. Potential C&M supporting units need to have US MCP locations and US forces need to have MCP locations or other collection points established in accordance with the C&M unit they may support.
- A POC for questions and guidance. Establish one for C&M forces to contact as well as one for US forces to contact. R-BDAR elements should be able to contact these POCs via radio or wire communications.
- Clearly establish command and control. Does a US R-BDAR element revert to C&M command and control for the duration of support to that C&M unit or does the US parent unit maintain command and control? Who establishes priorities for a R-BDAR asset in an area where more than one
- R-BDAR mission exists regarding C&M assets? These types of questions will become mission detractors if not clearly resolved prior to initiation of R-BDAR missions.
- Establish the extent to which BDAR can be applied to C&M units.

- Identify peculiarities regarding primary vehicles each nation might recover for the other. Exchange technical information regarding automotive preps required prior to towing, preferred hookup locations for winching or overturning, and any other information that would help avoid unsafe or damaging R-BDAR actions. Also exchange information regarding special actions to be taken to secure sensitive items such as radios, maps, Signal of Instruction (SOI), or high cost or scarce components.

- What is C&M unit doctrine regarding the use of the disabled crew on the site? C&M doctrine may be different from US doctrine which requires crews to help in R-BDAR operations as well as provide local security.

- What coordination will be required regarding passage of lines, if required? Clearly establish who must be contacted for such passage.

- Exchange operational plans and graphics as required to preclude inadvertent distraction to combat operations or placing R-BDAR assets in undue danger.

- Clearly establish recognition signals. These include challenges and passwords as well as identifying vehicle markings. Having recognition markings is especially important in operations where C&M units and enemy forces use the same vehicles or in which the enemy may be using US vehicles.

- Any special operational hazards, such as the use of NBC or minefields. As necessary and where possible, arrange for C&M guides or provide guides to C&C R-BDAR supporting elements.

- If possible, provide C&M R-BDAR units with US BDAR kits for effecting BDAR on US vehicles.

- Arrange for mutual training or orientation sessions with R-BDAR personnel, if time and situation permit.

- Try to arrange for translators to be at the R-BDAR site. An even better arrangement would be to have the technical advisor from the nation owning the equipment available.

EXECUTION CONSIDERATIONS CHECKLIST

Of prime consideration is getting equipment back into battle as quickly as possible while creating as little collateral damage as possible. Of equal importance is your surviving to complete the mission. Here are some execution considerations. The considerations discussed involving approach to the site, local security, camouflage, and actions to be taken on contact apply to these operations as well.

- Prior to commencing R-BDAR operations on C&M vehicles, make sure authorization has been given and obtain any necessary guidance.
- Try to get a member of the crew or a technical representative to provide technical guidance.
- Obtain applicable manuals to try to determine the proper R-BDAR actions to take.Even where language is a problem, pictures and diagrams may prove useful.
- Do not begin any operations until you have gathered as much technical information as possible. Acting too quickly or prematurely might cause inadvertent and unnecessary damage.
- Report the completion of the mission to the US chain of command. The US chain of command will pass that information to the C&C chain of command at the LNO level.

SECURITY OF SENSITIVE ITEMS AND SALVAGE OF DAMAGED EQUIPMENT

Only divisional or higher commanders have the authority to order destruction of equipment. In OP orders, this authority is usually delegated to subordinate commanders.

When a piece of equipment is destroyed, it must be reported through proper command channels.

Demolition Plans. Standing operating procedures for all using organizations should include a master demolition plan. Plan should include the following:

- Establish priorities of equipment for destruction.
- Establish priorities of components for destruction on each piece of equipment as well as repair parts.
- List ideal with alternate methods of destruction applicable to all equipment, the tactical situations in which applicable, and any limitations.
- Time estimates for destruction of each piece of equipment by method and total time based on all equipment should be computed.
- Assign personnel to specific destruction tasks.
- List any and all safety hazards or necessary precautions, for example, depleted uranium.

Demolition plans are only guidelines based on ideal conditions. In other than ideal situations, destroy as effectively as possible.

SAFETY CONSIDERATIONS

Hazards that exist on the battlefield from fires will also be present during demolition of equipment, for example, toxic fumes. Safety is an important consideration; become completely familiar with all aspects of your equipment. TMs, for your specific equipment, list warnings and hazards throughout.

Classified Documents. Classified documents, notes, and instructions of any kind should be removed from the vehicle prior to demolition. These classified materiels must be rendered completely useless to the enemy.

APPENDIX C

HAND AND ARM SIGNALS

VOICE CONTROL

Ground guides controlling all tracked vehicle recovery operations will use electronic voice means when available supplemented by minimal hand and arm signals as the primary means of ground control during recovery and lift operations. Until a wireless system is developed, units will use CVC cable (NSN 5995-00-434-5755) to link the ground guide with the vehicle operator via the vehicle intercom system for operations within 30 feet of the recovery vehicle.

An alternative means, especially for operation in excess of 30 feet of the recovery vehicle, is to connect a TA-312 (utilizing an optional headset for hands free operations) to the 1780 control box via WD-1 field telephone wire. If voice means cannot be established, then hand and arm signals will continue to be used.

The restrictions are:

- Units acquire extended CVC cord and/or items needed to use.
- Units conduct familiarization, stressing potential for extended cord or WD-1 to become snagged or severed during operations. The ground guide must take care not to get cord or

wire wrapped or entangled while moving. Therefore, if the movement of components is required, the wire or cord should be disconnected during such movement and reconnected when the ground guide is finally positioned.

- Warn crew that if voice operation cannot be established or fails at anytime they will return to hand and arm signals.

- CVC cable assembly can be connected to any C-2298 box in vehicle, except for driver's, to support ground guide being in most effective location.

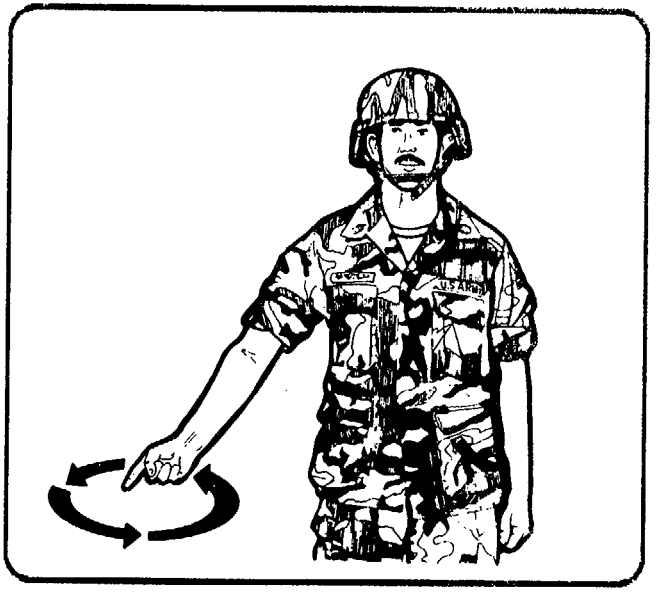
- When using either CVC cord or WD-1 in winching operations, the length must be such that the ground guide can be located sufficiently outside any hazard area as required and defined in FM 20-22.

- Voice communication between the operator and the ground guide will make safer lift operations by removing doubt associated with hand signals. This would be especially safer and more effective for limited visibility and night operations. It also removes doubt as to who is controlling the operation.

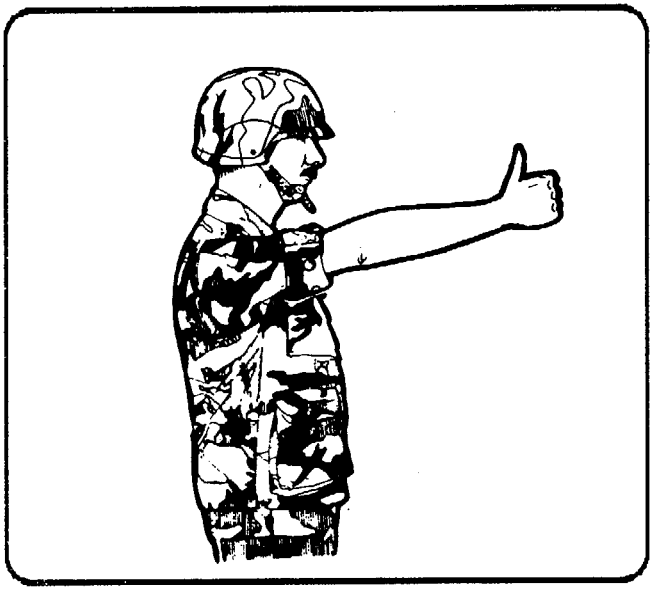
HAND AND ARM SIGNALS

Only hand and arm signals that apply to specific recovery vehicles are illustrated in this appendix. For hand and arm signals that apply to driving, refer to **FM 21-305** or **FM 21-306**.

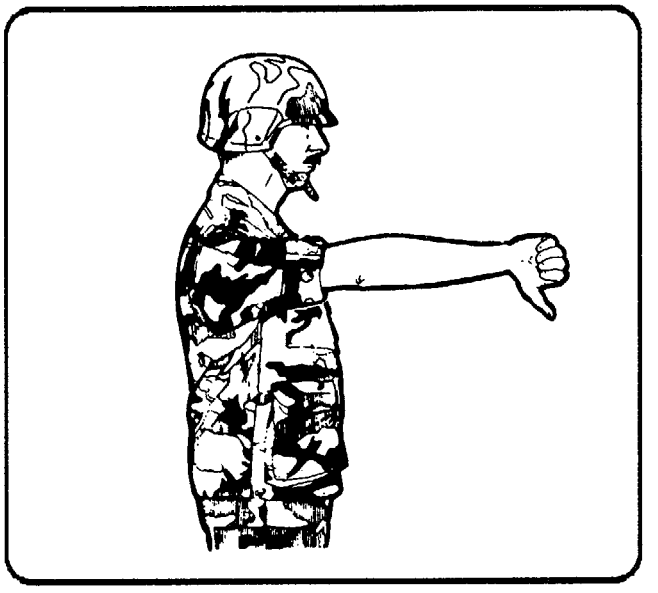
The signal to **RAISE THE HOIST CABLE** is made with the arm extended to the side and bent upward at the elbow, with the index finger extended from a fist, and the hand rotated slowly.



The signal to **LOWER THE HOIST CABLE** is made with the arm held downward and out slightly from the side, with the index finger extended from a fist, and the hand rotated slightly. This signal may be made with either hand with rotation made in either direction.



The signal to **RAISE THE BOOM** is made by extending the arm toward the operator with the fist clenched and the thumb pointing upward.



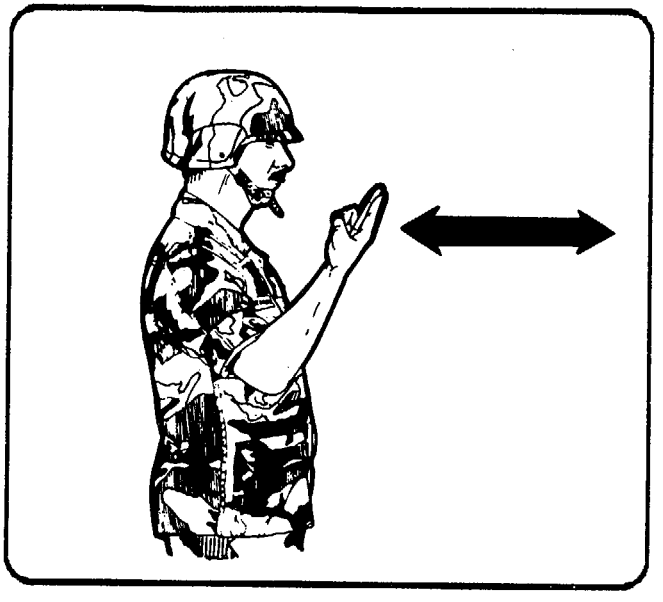
The signal to **LOWER THE BOOM** is made by extending the arm and clenching the fist in the same way, but with the thumb pointing downward. This signal may be made with either hand.

The signal to **RAISE THE SPADE** is given by first pointing at the spade with the index finger of the left hand. While pointing with the left hand, extend the right arm toward the operator, with the arm bent upward at the elbow while clenching the fist and pointing the thumb upward.

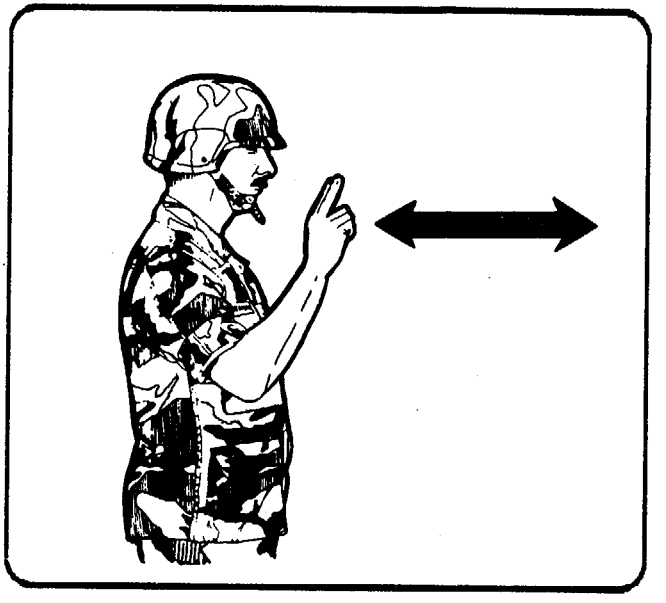
The signal to **LOWER THE SPADE** is made in the same way, but with the thumb of the right hand pointing downward.

The signal to **INHAUL THE MAIN WINCH CABLE** is made by pointing at the operator with the index finger and rotating the arm in a circular motion.

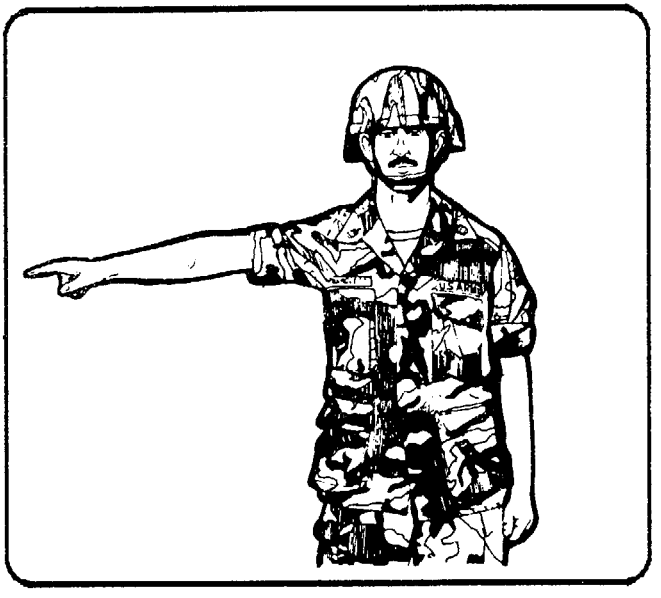
The signal to **PAY OUT THE WINCH CABLE** is made with the arm bent, bringing the hand in front of the chest. The hand is moved down and away from the body at belt level, circling back to the chest. The circular motion is continued until the signal to stop is given.



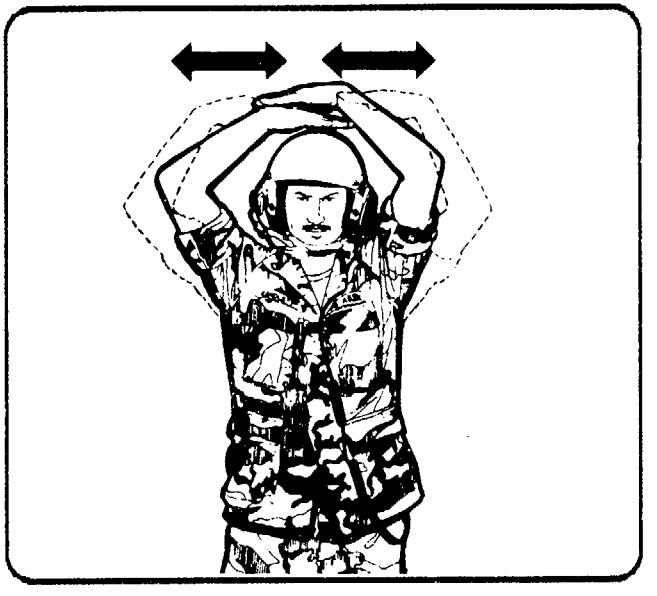
The signal to **EXTEND THE BOOM** is made with the index and center fingers extended upward, with the back of the hand facing the operator and the hand moved in toward and away from the chest by bending the elbow slowly in a pumping action.



The signal to **RETRACT THE BOOM** is made in the same way, but with the palm of the hand facing the operator.



For vehicles with a traversing boom, the signal to **SWING THE BOOM RIGHT OR LEFT** is made by extending the arm to shoulder level in the direction which the operator must traverse.



For the signal to **BUTTON UP**, place both hands on top of the helmet, palms down, one on top of the other. Place both arms back and in the same plane as the body. For the signal to **UNBUTTON**, give the button up signal; then separate the hands, moving them slightly to each side in a slicing motion. Repeat.

The signal to **STOP** any action that is being performed is given by clasping the hands together with palms facing each other at chin level.

REFER TO FM 21-305 OR FM 21-306 FOR MORE INFORMATION ON HAND SIGNALS

APPENDIX D

RECOVERY GUIDELINES FOR OPERATORS/LEADERS

Perhaps the key word to success on the battlefield will be vehicle recovery, by returning immobilized equipment to operation and continuing with the mission. Commanders take aggressive action to retrieve damaged equipment for repair and return to use. However, in order for a recovery operation to be successful, operators and leaders at all levels must be trained on recovery procedures.

INITIATION OF RECOVERY.

When the operator/crew detect an inoperable condition, they assess the damage and initiate action based on their analysis and the tactical situation.

The chain of command is informed by the crew/operator on inoperable conditions. Unit SOPs should prescribe notification procedures since these vary based on the type of unit, equipment, communications, and location of equipment.

Operator/crew should be trained to do self/like-recovery on their assigned equipment. When and if possible BDAR repairs will be used if kits are available. The repair will be limited if the tactical situation permits. This technique is particularly valuable during convoy and platoon operations. Platoon self/like-recovery will be practiced during garrison/field training exercises. Each operator -10 manual lists conditions for self/like-recovery procedures, BDAR, map reading, tactical signal communication, security, and special recovery procedures.

Operator/crew normally remain with the disabled equipment, provide local security, and wait for assistance. When maintenance personnel arrive, the operator/crew assist in the repair or recovery and stay with the vehicle until it reaches support maintenance.

The following is a list of key items operators should know prior to requesting recovery from support element.

- Location.
- Nature of disability.
- Tactical situation.
- Can BDAR be applied.
- Repair part required.
- Alternate radio frequencies.

Recovery vehicle operators are usually highly trained operators. These personnel must be skilled in the technical aspects of recovery. They must be skilled in related tasks, such as using the BII on their equipment and operating in a tactical environment. Recovery equipment operators are assigned to company maintenance teams and to the recovery support section of the maintenance platoon. Recovery personnel must be trained to check for and recognizance booby traps, and also to clear or disarm weapon systems of supported equipment.

Specific procedures for disposition of contaminated equipment, contingency plans, and any special tactical or security consideration should be covered in the unit SOP.

Recovery personnel are unit level mechanics who perform repairs when not engaged in recovery missions. The following is a list of key items operators should know:

- Oxygen and acetylene.
- Cutting torches.
- 50 machine gun.
- Communications (both radios, hand and arm signals)
- Map reading (to include a compass).
- Identify chemical agents.

Those conducting repair or recovery should have a plan for recovery operations. The unit SOP should contain detailed checklists to assist in preparing for on-site support. Preparations should include:

- Verification of location and status of disabled equipment.
- Update on the current tactical situation.
- Selection of primary and alternate routes.
- Availability of communications, to include communications checks, applicable call signs, primary and alternate frequencies.

- Individual clothing and equipment with emphasis on NBC equipment.
- Basic load of rations and ammunition.
- Selection of appropriate support equipment, vehicles, and personnel for the mission.

Recovery teams should be aware of classified communications devices, components, and other classified materials. This will help maintain proper security and reduce chances of compromise.

Platoon leaders or platoon sergeants have the responsibility for coordinating recovery assets and manpower requirements for disabled equipment. This effort is done simultaneously with the mission, and if the recovery mission interferes with combat operations, or in any way compromises security, this must be coordinated with the tactical commander.

Leaders should be trained on the same tactical procedures as recovery vehicle operators so they can periodically check the rigging and equipment for proper hookups and adjustments. Special attention must be given to weight and clearance limitations when using bridges or underpasses. In order for a leader to effectively supervise or control a recovery operation, they must be trained on command and control. Following is a list leaders should know prior to supervising or requesting recovery support:

- Equipment identification.
- Alternate radio frequencies.
- Location (map coordinates when possible).
- Alternate route (when possible).
- Nature of disabled vehicle.
- Evaluation of on site repair capability.
- Repair parts required.
- Organic recovery capability.

- Tactical situation and security requirements, risk level.

- Cargo, road, and movement restrictions.

The recovery manager and leaders must be alert to new situations and changing requirements. Planning and prior preparation are needed for continued effective recovery support.

Specific BDAR Training is as follows:

- Risk Assessment Procedures.

- BDAR Assessment Procedures.

- BDAR TM familiarization.

- BDAR kit familiarization.

- Group equipment:

- Suspension systems (short trackings).

- Electrical systems (bypassing components, wire repair).

- Cooling systems (radiator bypass and repair).

- Fuel systems (patching holes, replacing line sections).

- Hydraulic/oil systems (repair high pressure lines, repair oil lines).

GLOSSARY

SECTION I
ACRONYMS AND ABBREVIATIONS

ACE	Armored Combat Earthmover
ACR	Armored Cavalry Regiment
AE	available effort
AKERR	allied kinetic energy recovery rope
AAL	additional authorizations lists
APC	armored personnel carrier
AR	Army regulation
ARTEP	Army Training and Evaluation Program
ASI	additional skill identification
ATCOM	Aviation and Troop Command
AVIM	aviation intermediate maintenance
AVLB	armored vehicle launcher bridge
AVUM	aviation unit maintenance
BDA	battlefield damage assessment

BDAR	battlefield damage assessment and repair
BDR	battlefield damage repair
BII	basic issue items
BITE	built-in test equipment
BMO	battalion motor officer
BMS	battalion maintenance sergeant
BMT	battalion maintenance team
bn	battalion
BS	breaking strength
BSA	brigade support area
CC	combat capable
C&M	combined and multinational
CEC	combat emergency capable
CEOI	Communications - Electronics Operation Instructions
CEV	combat engineer vehicle
CFRV	contingency force recovery vehicle
CMT	company maintenance team
COEI	components of end-items
COMSEC	communications security
COSCOM	corps support command
CSS	combat service support
CUCV	commercial utility cargo vehicle
CVC	combat vehicle crewman
D	diameter
DA	Department of the Army
DA Pam	Department of the Army pamphlet

DD	Department of Defense
DISCOM	division support command
DMMC	division materiel management center
DOTLMS	doctrine, organization, training, leader, development, material, and soldier
DRMO	Defense Reutilization and Marketing Office
DS	direct support
DSA	division support area
E	effort
EOD	explosive ordnance disposal
ESM	expendable durable supplies and material
ESP	extended service program
F	Fahrenheit
FEBA	forward edge of the battle area
FLOT	forward line of own troops
FM	field manual
FMTV	family of medium tactical vehicles
FMC	fully mission capable
FRAGO	fragmentary order
FS	factor of safety
FSB	forward support battalion
ft	feet
FTX	field training exercise
FWTD	fifth wheel towing device
GS	general support
HAZMAT	hazardous material

HEMTT	heavy expanded mobility tactical truck
HMMWV	high mobility multipurpose wheel vehicle
HET	heavy equipment transporter
HNS	host nation support
HQ	headquarters
IAW	in accordance with
IMPL	initial mandatory parts list
lb	pound
LNO	liaison officer
LP/OP	listening post/observation post
LR	load resistance
LRU	line replacement unit
MA	mechanical advantage
maint	maintenance
MCP	maintenance collection point
METT-T	mission, enemy, terrain, troops, and time available
MFCC	minimum functional combat capability
MHE	materials handling equipment
MOPP	mission-oriented protective posture
MOS	military occupational specialty
mph	miles per hour
MPL	mandatory parts list
MQS	military qualification standards
MRE	meal, ready to eat
MSR	main supply route
MT	maintenance team

MST	maintenance support team
NATO	North American Treaty Organization
NBC	nuclear, biological, chemical
NBCRS	nuclear, biological, chemical recovery system
NSN	national stock number
NTC	National Training Center
OBT	on board tow bar
OPORD	operation order
OPSEC	operations security
PAG	Program Advisory Group
PDO	property disposal office
PLL	prescribed load list
POL	petroleum, oils, and lubricants
PLT	platoon
PMCS	preventive maintenance checks and services
PPS	pounds per square inch
QASAS	quality assurance specialist ammunition surveillance
QSTAG	Quadripartite Standardization Agreement
R	resistance
RO/RO	roll on/roll off
RPM	revolution per minute
RV	recovery vehicle
R-BDAR	recovery-battlefield damage assessment and repair
S-4	Supply Officer (US Army)

SALUTE	size, activity, location, unit, time, equipment
SOP	standing operating procedure
spt	support
SRC	self-recovery capable
STANAG	standardization agreement
SWC	safe working capacity
T	tons
TACOM	U.S. Army Tank-Automotive Command
TB	technical bulletin
TM	technical manual
TRAC MAT	traction mat
TRADOC	U.S. Army Training and Doctrine Command
TTP	tactics, techniques, and procedures
TVT	television tape
UMCP	unit maintenance collection point
USAOC&S	U.S. Army Ordnance Center and School
VEESS	vehicle engine exhaust smoke system
w	with
w/o	without
w/w	with winch
xo	executive officer

Section II
TERMS

Battlefield Damage (BD) - Includes all modes of equipment failures that occur during operations in wartime and peacetime which prevent the equipment from completing its mission. This includes actual battlefield damage, random failures, operator errors, accidents, and "fair-wear-and-tear" failures.

Battlefield Damage Assessment and Repair (BDAR) - BDAR is any action taken to return disabled equipment rapidly to the operational commander by expediently assessing, fixing, bypassing, or jury-rigging components to restore the minimal functional combat capabilities required for the continuation of a specific mission or to enable the equipment to self-recover. Repairs are temporary and may or may not return the system to a fully mission capable status. BDAR consists of battlefield damage assessment (BDA) and battlefield damage repair (BDR).

Battle Damage Assessment (BDA) - Battle damage assessment is the first step in the BDAR process. The crew/operator, if possible, make the initial assessment and performs the repair, if within their capability. The MT/MST, when called, will verify the crew/operator assessment and follow up with a more detailed assessment. BDA is the 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 performed.

The senior mechanic is responsible for the final assessment. The assessment process includes the following steps:

- Determine if the repair can be deferred, or if it must be accomplished.
- Isolate the damaged areas and components. - Determine which components must be fixed.

- Prescribe fixes.
- Determine if required parts, components, materials, and tools are available.
- Estimate the manpower and skill required.
- Estimate the total time (clock hours) required to make the repair.
- The priority of the fixes.
- Decide where the fix should be performed.
- Decide if recovery is necessary and, if so, to what location.

Battlefield Damage Repair (BDR) - BDR includes any action taken that returns a damaged part or assembly to a full or acceptably degraded operating condition.

These include --

- Shortcuts in parts' removal or installation.
- Installing components from another vehicle that can be modified to fit or interchange with components on the disabled equipment (cannibalization).
- Using parts from the damaged vehicle that serve a noncritical function to restore a critical function.
- Bypassing of noncritical components in order to restore combat functional capability.
- Fabricating parts from kits or readily available materials.
- Jury-rigging.
- Using substitute fuels, fluids, or lubricants.
- Substituting parts from host nation or enemy vehicles.

Maintenance Team (MT) - The MT consists of organizational mechanics who should be trained in BDAR procedures. The MT is called, if required by

crew, to inspect out-of-action equipment to confirm the crew's original damage assessment. The maintenance team's assessment determines if field repairs will be conducted or if recovery is required. Depending on METT-T, the crew will assist the MT in restoring the equipment to mission capability.

Maintenance Support Team (MST) - The MST consists of direct support mechanics and technical specialists, who are trained in assessing battlefield damage, in addition to their specialty. The MT calls the MST when equipment damage exceeds MT repair capability.

Mission, Enemy, Terrain, Troops, and Time available (METT-T) - Factors considered during the planning or execution of a tactical operation.

Fully Mission Capable (FMC) - The equipment can perform all its combat missions for which it was designed without endangering the life of the crew. To be FMC, the equipment must be complete and fully operable with no faults listed in the "equipment is not ready/available if" column of the operator's preventive maintenance checks and services (PMCS) -10 manual.

Combat Capable (CC) - The equipment meets the minimal functional combat capability requirements. The vehicle must still have move-shoot- and communication-capabilities to be combat capable.

Combat Emergency Capable (CEC) - The vehicle meets the needs for a specific tactical maneuver or firing mission; however, all systems (move-shoot-communicate) are not fully functional. Also, additional damage, due to the nature of an expedient repair, may occur to the equipment if it is used. The commander must decide if these limitations are acceptable for that specific situation.

Self-Recovery Capable (SRC) - The vehicle can move under its own power and is able to clear the battlefield under its own power. To be SRC, the vehicle must have forward and reverse gears and be able to come to a complete stop using its brakes.

Cannibalization - If the vehicle is damaged to the point where the commander feels it is un-

economical to repair, he may select it for cannibalization. Cannibalization means any use of repair parts or components from another piece of equipment. This could include equipment either damaged or of lower priority to the immediate mission. The term is used to include controlled exchange.

High-Risk Repair - Refers to BDAR that may lead to further damage to equipment and possible injury to personnel. The commander makes the decision based on METT-T. The commander must approve the use of high-risk repairs for training. The repairs must be closely supervised. Usually high-risk repairs are only performed during actual combat. Emergency operation of an engine with inadequate lubrication is an example.

Medium-Risk Repair - Refers to repairs that may lead to further damage to equipment. There is no likelihood of injury to personnel (that is, bypassing a starter relay or fuel filter, short tracking).

Low-Risk Repair - Refers to repairs which involve no likelihood of damage to equipment or injury to personnel. These are the type of repairs that are likely to be considered permanent in some cases (that is, slice electrical wire, patch a hole in a fuel tank, radiator, or radiator hose, or patch a hole in a vehicle's hull with molecular metal).

Brigade Support Area (BSA) - The BSA is a designated area in which the battalion field trains and combat service support elements from the Division Support Command (DISCOM) provide logistical support for a brigade. It is normally located 20-25 kilometers behind the forward edge of the battle area (FEBA).

Unit Maintenance Collection Point (UMCP) - The UMCP is located behind the forward line of own troops (FLOT). It is the focal point of the unit/battalion maintenance effort established by the battalion maintenance technician and is near the unit combat trains. At this spot, he organizes maintenance personnel, recovery vehicles, tool trucks, and PLL assets to support the battle. The DS MSTs are located here. Work at this location is designed to return critical weapon systems to the battle. Equipment not repaired or repairable at the UMCP is evacuated to a maintenance location where it can be repaired within acceptable time limits.

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