CHAPTER ELEVEN

ENVIRONMENTAL IMPACT ON MAINTENANCE OPERATIONS

SECTION 1. INTRODUCTION

11-1. PREPARATION

Regardless of the area of employment of the division, the key functions of maintenance must be performed. Detailed discussions of operations in these environments may be found in FM 9-207, FM 20-22, FM 90-3, FM 90-5, FM 90-6, FM 90-11, TB 43-0239, and FM 90-10.

The first step in preparing for maintenance support operations is an analysis of the mission. Time, tools, skills, and repair parts (Class IX supply) are important to maintenance operations.

A detailed analysis of the area of operations to identify lines of communications will play a major part in determining how maintenance support operations will be conducted.

In hostile environments, it is probable that lines of communications will be limited. Airfields, good roads, and railroads will be the exception rather than the rule. Airdrop of supplies and equipment is an effective alternative to air-landing. Airdrop is a rapid means of delivery and makes deliveries to isolated units possible without further transhipping. Armored-infantry-mechanized (AIM) divisions have no organic airdrop support so they rely on corps units for this support.

Maintenance unit commanders must keep themselves informed at all times about user requirements and their own maintenance capabilities.

11-2. DESERT OPERATIONS

Maintenance support for desert operations requires understanding the environment. Temperatures vary according to latitude and season from over 136°F to the bitter cold of winter. In some deserts, day to night temperature fluctuation can exceed 70°F. Some species of animal and plant life have adapted successfully to desert conditions where annual rainfall may vary from zero to 10inches. Desert terrain also varies from place to place; the sole common denominator is lack of water and little, if any, vegetation. This environment can profoundly affect military operations.

Location. Desert locations are seldom close to normal lines of communication. The effects of the environment on equipment are severe, requiring increased levels of support to maintain a standard level of efficiency. Distance between units and lines of communication are long and, due to the importance of maintenance support units, are primary targets.

Security. Enemy ambushes on MSRs are a threat in desert operations. Enemy patrols may lay nuisance mines on routes, especially at critical points. Certain actions can be taken to minimize the threat to supply routes. They include--

- Route patrols before immediate use and at irregular intervals when the route is not being used. Helicopters are good for this task as they

are cost effective in personnel and time. If the route is patrolled by surface vehicles, they must have maximum protection against mine blasts. MP patrols also provide a resource for continuous monitoring of supply routes.

- Observation posts can maintain a constant presence along the route, but are relatively expensive in manpower. They should be sited so that their surveillance equipment will interlock in conditions of poor visibility.

Convoys may require armed escorts, Escort will be determined by the commander on the basis of METT. Convoys should not be scheduled at regular intervals,

Class IX Supply. There will be an increase in demand for Class IX supplies due to environmental effects on equipment and the extra maintenance effort required. Small items with high-usage rates should be held as far forward as practical. Typical high-consumption items are--

- Filter elements.
- Tires.
- Water pumps, gaskets, fan belts, water hoses, and clamps.
- All parts for ignition systems.
- Wheel and sprocket nuts and wedge bolts.
- Spare caps for all liquid containers,
- Speedometers and cables (due to dead reckoning navigation, these are critical items).
- Cleaning fluids for electronic equipment.

Mission-essential parts lists of a unit depend on its equipment, but they should be limited to only those items that would keep such equipment from performing if it failed. Heavier and larger items are carried by MSTs from the DS maintenance company, As demand varies from day to day, arrangements must be made for unexpected requirements to be moved to repair sites by air, rail, and water.

11-3. ENVIRONMENTAL EFFECTS ON EQUIPMENT

Terrain. Terrain varies from nearly flat, with high trafficability to lava beds and salt marshes with little or no trafficability. Drivers must be trained in judging terrain so that they can select the best method of overcoming the varying conditions they will encounter. Tracked vehicles are best suited for desert operations. Wheeled vehicles will go many places that tracked vehicles can go; however, their lower average speed on poor terrain may be unacceptable during some operations. Vehicles should be equipped with on-board spare fan belts, tires, and other items likely to malfunction, together with tow cables or chains (if not equipped with a winch), extra water cans, and desert camouflage nets. Air recognition panels, signal mirrors, and a tarpaulin ‘(to provide shade for crew) are very useful. Wheeled vehicles should also carry spurs, mats, or channels as appropriate to aid mobility.

The harsh environment requires a high standard of maintenance which may have to be performed well away from specialized support personnel. Operators must be fully trained in operating and maintaining their equipment. Some types of terrain can have a severe effect on suspension and transmission systems, especially those of wheeled vehicles. Tanks will often throw tracks on rocky terrain. The ASL for tires should be increased because sand temperatures of 165°F weaken rubber and reduce resistance to sharp rocks and plant spines. Items affected by mileage, such as wheels, steering, track wedge bolts and sprocket nuts, and transmission shafts, must be checked for undue wear when completing before, during, and after operation maintenance.

Heat. Vehicle cooling and lubrication systems are interdependent, and a malfunction by one will rapidly place the other under severe strain. All types of engines may overheat to some degree, leading to excessive wear and, ultimately, to leaking oil seals in the power packs. Commanders should be aware of which vehicle types are prone to overheating and ensure that extra maintenance is given to those vehicles. Oil levels must be checked frequently to ensure they are correct (too high may be as bad as too low) and that seals are not leaking. Radiators and air flow areas around engines must be kept clean and free of debris and other obstructions, and water-cooled engines should be fitted with condensers to avoid waste as steam through the overflow pipe. Cooling hoses must be kept tight (a drip a second is 7 gallons in 24 hours). Operators should not remove hood side panels from engine compartments while the engine is running as this will cause turbulence, leading to ineffective cooling.

Batteries Do Not Hold Their Charge Efficiently in Intense Heat. Battery specific gravity will have to be changed to adjust to this environment. The unit can either adjust its electrolyte to 1.200 or 1.225 specific gravity or obtain sulfuric acid with a specific gravity of 1.2085 to 1.2185. Air vents must be kept clean or vapors may build up pressure and cause the battery to explode. Voltage regulators should be set as low as practical. Stocks of dry batteries must be increased to offset high attrition rates caused by heat exposure.

Severe Heat Increases Pressure in Closed, Pressurized Systems, and Increases the Volume of Liquids. Care must be exercised to ensure that working pressure of all equipment is within safety limits and caution must be exercised when removing items, such as filler caps.

Some Items of Equipment are Fitted With Thermal Cutouts Which Open Circuit Breakers When Equipment Begins to Overheat. Overheating can be partly avoided by keeping the item in the shade and **wrap**ping it in wet cloth to maintain a lower temperature by evaporation.

Flying Time and Performance of Helicopters is Degraded as the Altitude and Heat Increase. Aircraft canopies have been known to bubble under direct heat and should be kept covered when not in use.

Ammunition Must be Kept Away From Direct Heat and Sunlight. If it can be held by bare hands, it is safe to fire. White phosphorous ammunition filler tends to liquify at temperatures over 111°F, which will cause unstable flight unless projectiles are stored in an upright position.

Wood Shrinks in a High-Temperature, Low-Humidity Environment. Equipment such as axes carried on tracked vehicles can become safety hazards as heads are likely to fly off as handles shrink.

11-4. RADIANT LIGHT

Radiant light or its heat effect may be detrimental to plastics, lubricants, pressurized gases, some chemicals, and infrared tracking and guidance systems. Items like COZ fire extinguishers, M13 decontamination and reimpregnating kits, and Redeye missiles must be kept out of constant direct sunlight. Optics may discolor in direct sunlight, so their exposure to the sun's rays should be limited.

Dust and sand are probably the greatest dangers to the efficient functioning of equipment in the desert.

Lubrication must be the correct viscosity for the temperature and kept to the absolute minimum in the case of exposed or semiexposed moving parts. Sand mixed with oil forms an abrasive paste. Lube fittings are critical items and should be checked frequently. Teflon bearings require constant inspection to ensure that the coating is not being removed. Maintenance of engines is critical due to the strong possibility of sand or dust entering the cylinders or moving parts when the equipment is stripped. It is essential to have screens against flying sand (which will also provide shade for mechanics). Surrounding ground may be soaked in used oil or covered with rocks to bind it down.

Ground handling of helicopters should be kept to a minimum in soft or sandy soil to prevent stress on the landing gear. Runups should be restricted to the minimum time and take place on rock or on oiled or wet sand if available. All apertures (pilot tubes, for example) or aircraft not in use should be covered at all times. Hovering close to the ground will lead to sand-ingestion by the engine, possible observation of dust clouds by the enemy, or disorientation of the pilot due to flying sand, particularly at night.

Dust and sand can easily cause failure of such items as cyclic microphone switches, radio and signal distribution panels, circuit breakers and collective triggers, and cause small electrical motors to burn out.

Air cleaners of every type of equipment must be examined and cleaned at frequent intervals. The **exact** interval depends on the operating conditions, but should be at least daily.

Filters may be used when refueling any type of vehicle, and the gap between the nozzle and the fuel tank filler must be kept covered. Fuel filters will require frequent cleaning. Oil filters will require replacement more often. Engine oils will require changing more often than in temperate climates. Windblown sand and grit will damage electrical wire insulation over a period of time. All cables that are likely to be damaged should be protected with tape before insulation becomes worn. Sand will also find its way into parts of items such as spaghetti cord plugs, either preventing electrical contact or making it impossible to join the plugs together. A brush, such as an old toothbrush, should be carried and used to brush out such items before they are joined.

Dust affects communication equipment such as AM RF amplifiers and radio teletype sets. The latter, especially, is prone to damage due to its oil

lubrication, so dust covers should be used whenever possible. Some receiver-transmitters have ventilating ports and channels that can get clogged with dust. These must be checked regularly and kept clean to prevent overheating.

Weapons may become clogged or missiles jammed on launching rails due to sand and dust accumulation. Sand or dust-clogged barrels can lead to inbore detonation. Muzzles must be kept covered by a thin cover so an explosive projectile can be fired through the cover without risk of explosion. Missiles on launchers must also be covered until required for USC. Working parts of weapons must have a minimum amount of lubrication. It may even be preferable to have them totally dry, as any damage caused during firing will be less than that produced by the sand/oil abrasive paste.

All optics are affected by blowing sand which will gradually degrade their performance due to small pitting and scratches. It is necessary to guard against buildup of dust on optics which may not be apparent until the low-light optical performance has severely deteriorated. It may be advisable to keep optics covered with some form of cling film until operations begin, especially if the unit is near a sandstorm. Optics must be stored in a dehydrated condition using hydroscopic material. Those in use should be kept where free air can circulate around them and should be purged at frequent intervals.

Sand and dirt can accumulate in hull bottoms of armored vehicles and, when combined with condensation or oil, can cause jamming of control linkages. Sand accumulation of the air bleeder valve can inhibit heat from escaping from the transmission and result in damage.

11-5. TEMPERATURE VARIATION

In deserts with relatively high dew levels and high humidity, overnight condensation can occur wherever surfaces, such as metal exposed to air, are cooler than the air temperature. This condensation can affect such items as optics, fuel lines, and air tanks. Fuel lines should be drained night and morning, and optics must be cleaned frequently. Weapons, even if not lubricated, will accumulate sand and dirt due to condensation, another reason for daily cleaning.

Air and fluids expand and contract according to temperature. If tires are inflated to correct pressure during the night, they may burst during the day. If fuel tanks are filled to the brim at night, they will overflow as temperatures rise. Air pressure must be checked when equipment is operating at efficient working temperature and fuel tanks must be filled to their correct capacity as defined in the appropriate technical manual.

11-6. STATIC ELECTRICITY

Static electricity is common in the desert. It is caused by atmospheric conditions coupled with an inability to ground out due to dry terrain. It is particularly likely with aircraft or vehicles having no conductor contact with the soil. The difference of electrical potential between separate materials may cause a spark when contact is made, and if inflammable gases are present, they may explode or cause a fire.

A grounding circuit must be established between fuel tankers and vehicles being refueled and maintained before and during refueling.

11-7. WINDS

The velocity of desert winds can be destructive to large and relatively light material, such as aircraft, tentage, and antenna systems. To minimize wind damage, materiel should be given terrain protection and should be firmly picketed to the ground.

11-8. MAINTENANCE

General guidelines for desert repair of equipment are--

- Repair only that necessary to make the equipment combat effective (MEMO).
- Recover and then evacuate to the nearest reasonable secure site, followed by on-the-spot repair.

An SOP for recovery and repair must be established before or immediately on arrival in the theater. The SOP should include--

- Guidelines for crew level recovery and expedient repair.
- Recovery by unit maintenance.
- Recovery by DS maintenance.
- Priorities for recovery by vehicle types.

- Limitations on field expedients (for example, the distance/time over which one tank is allowed to tow another, considering the heat buildup in transmissions in this environment).

- Security and guides for recovery teams.

The recovery plan of an operation should include locations of collecting points for equipment that cannot be repaired farther forward. These points must be located where they can be reached by HETs, which may involve a longer tow by an armored recovery vehicle than would be normal in a European environment. The collection point should cover a large area to allow for dispersion of supporting units and weapons systems. An MST from the FWD maintenance unit will normally be located at the collection point to determine disposition of the equipment. Equipment that is authorized for disposal may be cannibalized to support the repair of like vehicles. When considering recovery in the desert, special attention must be paid to ground anchoring equipment since natural anchoring material is scarce (see FM 20-22).

11-9. COLD WEATHER OPERATIONS

One of the major problems for units operating in cold weather conditions is the lack of personnel with adequate training in cold weather operations and maintenance. If troops stationed in temperate climates must move to cold climates and perform their mission, cold weather training is of the utmost importance. Much time and energy in cold weather areas is expended in self-preservation, which reduces the efficiency of personnel in the operation and maintenance of materiel. Maintenance personnel must learn how to live and work in cold regions.

Location. Operation of materiel in temperatures to -10°F presents few problems. Conditions are similar to those in the northern portions of CONUS during the winter. From -10°F to -40°F, operations become difficult. Figure 11-1 shows how levels of difficulty increase as temperatures drop.

Proper training will prevent failures of materiel and injuries to operating personnel. When the temperature is below -40°F, operations become increasingly difficult. At temperatures near -65°F, the maximum efforts of well-trained personnel are required to perform even a simple task with completely winterized materiel.

Security. Enemy ambushes are always a threat in snow-covered terrain. Camouflage can be a basic weapon to help defeat the enemy, since units must furnish their own security, reconnaissance, and surveillance, In the absence of issued camouflage

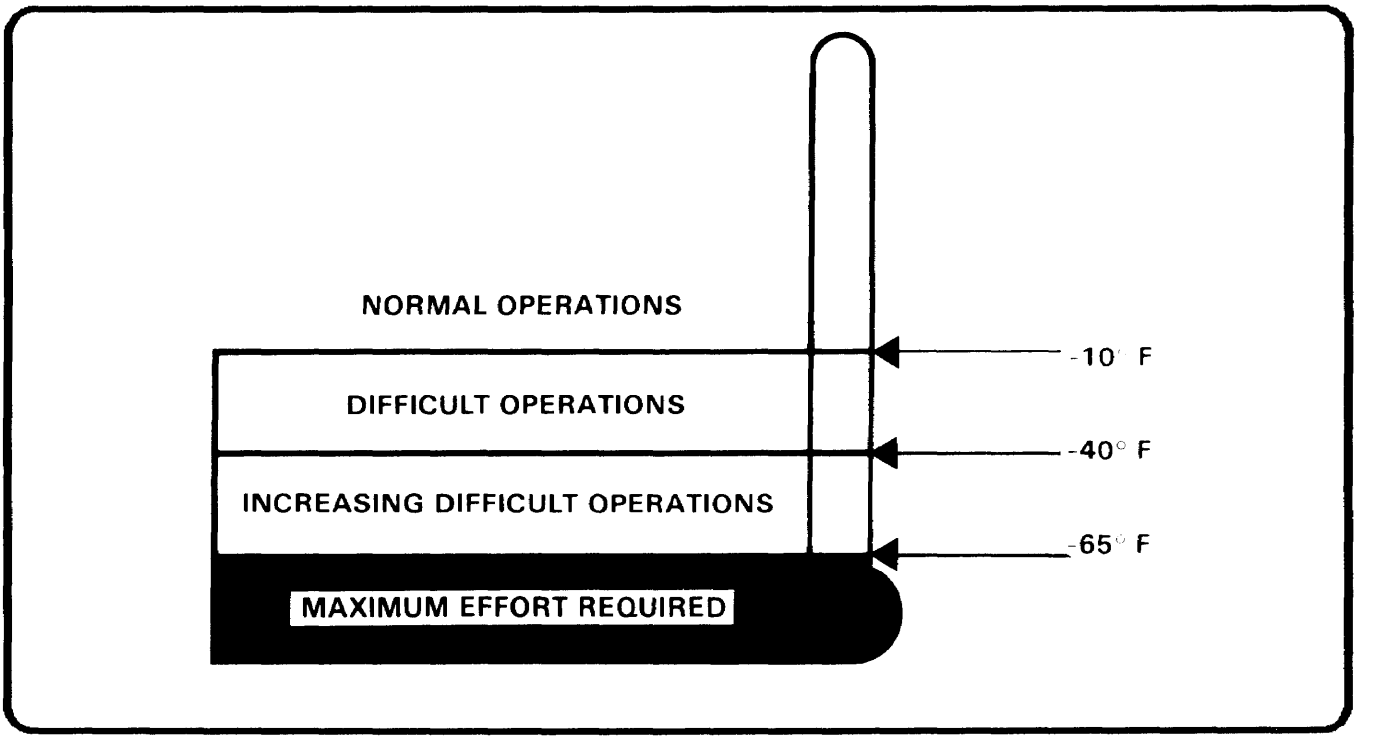

Figure 11-1. Levels of difficulty v.s. temperature ranges,

uniforms, the soldier may improvise a camouflage suit, adapting its color and pattern to the terrain background.

For use in snow-covered terrain, there is a white garment designed to blend with a white or mottled white and black background. The snowsuit does not conceal the small patches of shadow that surround a human figure, but this is not necessary since snow country usually contains numerous dark spots and shadows. If certain snow areas are all white with absolutely no shadows, use is made of defiles and natural folds in the ground.

Class IX Supply. The effect of cold weather on Class IX supply makes handling and storage of materials of prime importance. Supplies are delivered as far forward as weather, terrain, and tactical situation permit. However, supply requirements will vary significantly from those encountered in temperate climates.

Metals become brittle in extremely low temperatures, so parts cannot withstand the shock loads that they sustain at higher temperatures.

Extreme care must be taken in handling rubber-covered cables at low temperatures. If the rubber jackets become hard, the cables must be protected from shock loads and bending to prevent short circuits caused by breaks in the covering. Neoprene jackets on cables become very brittle and break readily at low temperatures.

Tires become rigid in cold, causing flat spots on portions that come into contact with the ground during shutdown periods. At extreme low temperatures, sidewalls become brittle and crack.

Plastics expand and contract much more than metal or glass. Any parts or materials made of plastic must be handled carefully.

Glass, porcelain, and other ceramics should perform normally at low temperatures if handled carefully. Cracking may result if heat is applied directly to cold windshields or vehicle glass,

Fabrics retain their flexibility even at extremely low temperatures provided they are kept dry.

Maintenance. Personnel must be aware of the importance of maintenance, especially PMCS. Maintenance of mechanical equipment is exceptionally difficult during cold weather. Shop maintenance cannot be completed with normal speed because the equipment must be allowed to warm up before maintenance personnel can make repairs. Personnel need additional time to perform routine tasks. This time lag cannot be overemphasized and must be included in all planning. Personnel efficiency is reduced by the bulky clothing that must be worn at all times, The resulting loss of the sense of touch further reduces efficiency. Even the most routine operations, such as handling latches or opening engine enclosures, become frustrating and time-consuming when they are performed with protected hands. At temperatures below -20°F, maintenance requires up to five times the normal amount of time. Complete winterization, diligent maintenance, and well-trained crews are the keys to efficient cold weather operations (See FM 9-207) .

Requirements affecting maintenance planning and preparation before a cold weather operation should be undertaken as follows:

- Shelter for materiel requiring maintenance.
- Proper clothing and tools for maintenance personnel.
- Ground cover (plywood or canvas) for personnel to lay on when under vehicles.
- Adequate portable heaters.
- Suitable methods to store and issue antifreeze materials, fuels, hydraulic fluids, and lubricants.
- Sufficient lighting equipment.
- Supply of repair parts for equipment.
- Sufficient equipment for removal of snow and ice.

WARNING

Care must be taken for proper ventilation to avoid the danger of carbon monoxide poisoning caused by the operation of engines or from contaminated hot air from defective heaters. Do not use heaters that produce contaminated hot air in buildings or maintenance tents where personnel are present.

Buildings and Shelters. Heated buildings or shelters are needed for cold weather maintenance. Main-

tenance of many components requires careful and precise servicing. Without use of heaters, the increase in maintenance man-hours will be from 25 to 200 percent above normal requirements.

When buildings are not available, maintenance tents are a temporary expedient. When possible, wooden flooring should be laid inside all tents. Tents should be heated by portable duct heaters or tent stoves.

WARNING

When vehicles, generators, and POL containers are brought into warm storage from the cold, the fuel tanks/container should only be filled three-quarters full, If this procedure is not followed, the expansion of the cold POL products in the fuel containers could cause spillage and a serious fire hazard.

WHEN BUILDINGS ARE NOT AVAILABLE, MAINTENANCE TENTS ARE A TEMPORARY EXPEDIENT. WHEN POSSIBLE, WOODEN FLOORING SHOULD BE LAID INSIDE ALL TENTS. TENTS SHOULD BE HEATED BY PORTABLE DUCTS OR TENT STOVES.

In the absence of buildings or maintenance tents, tarpaulins may be used as a field expedient to create overhead shelter and wind breaks. The tarpaulin can be supported on a framework of poles erected around the vehicle. Parachutes can also be used as temporary shelters. The parachute should be deployed over the vehicle, securely staked down at the bottom, and then inflated by the air from a portable duct heater. If parachute shelters are used, extreme care should be taken to avoid carbon monoxide poisoning.

WARNING

Personnel must **be constantly on the alert to detect vehicle deficiencies that expose personnel to carbon monoxide poisoning. Passenger and crew compartments of wheeled and tracked carriers must be inspected and tested at regular intervals to detect any signs of air contamination from exhaust gases caused by leaking gaskets, improper exhaust installation, cracked exhaust pipes, defective personnel heaters, and auxiliary generators.**

Lighting Equipment. Sufficient equipment must be available to furnish lights for maintenance services. Lights with ample cable extensions, attachment plugs, connectors, and spare bulbs are essential.

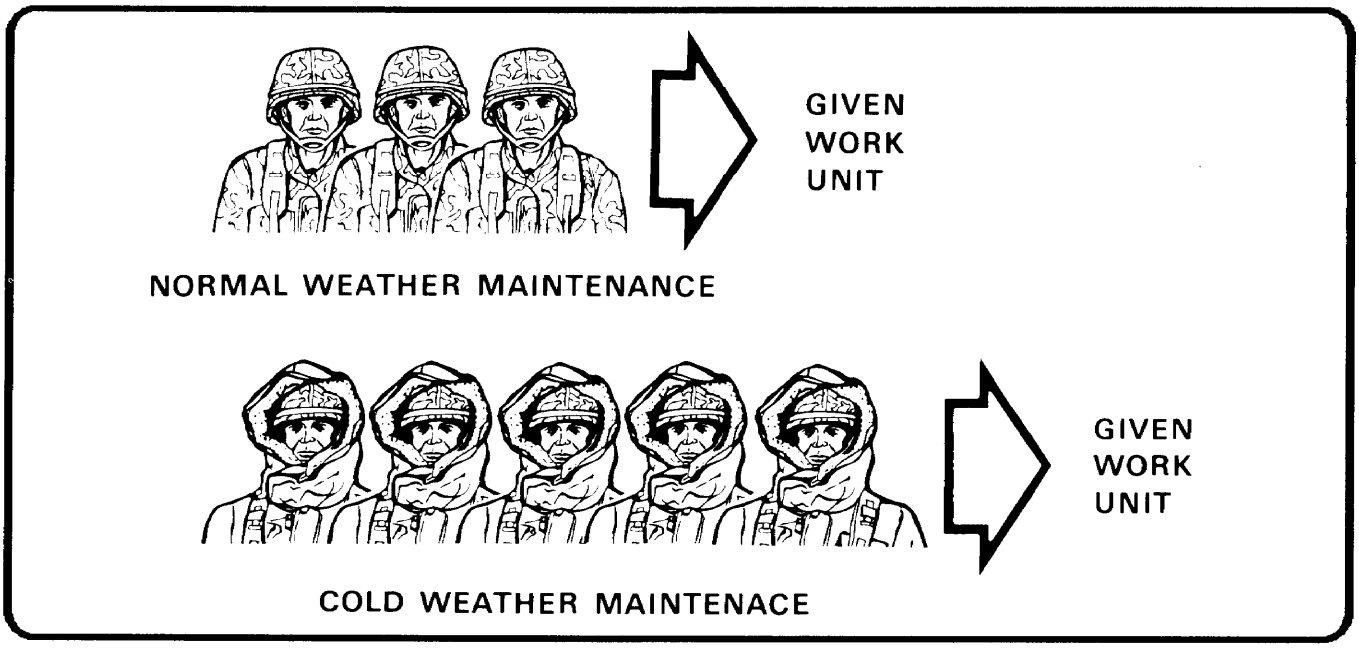

Figure 11-2. Normal v.s. cold weather maintenance.

Maintenance Personnel, Tools, and Equipment. An increase in the number of mechanics will be required to maintain equipment in cold weather operations. As a minimum, a highly organized, more intensive, effort is required of personnel on hand. It must be remembered that the amount of work performed under cold conditions is considerably less than work accomplished in moderate temperatures (see Fig 11-2).

An additional supply of battery chargers must be available to meet the heavy requirements for battery maintenance in subzero temperatures, Hydrometers and testers must be on hand to check the state of charge of batteries. The tools provided in the various tool chests are adequate for maintenance at subzero temperatures.

Gloves may become saturated with fluids when performing maintenance on fuel systems and lubricating cooling systems. This reduces the insulating value of the gloves and may result in cold injury to personnel. Personnel should, therefore, carry extra gloves when performing maintenance.

Personnel should avoid leaning on cold-soaked equipment or kneeling or lying on the ground. Rapid body cooling caused by heat transfer to the equipment or ground may result in cold injury. Some sort of insulation, such as fiber packing material, corrugated cardboard, rags, or tarpaulins, should be placed between the mechanic/repairer and the equipment.

When performing maintenance under arctic winter conditions, a box or a pan should be used to hold small parts. A tarpaulin should be placed under the vehicle to catch parts which may be dropped to prevent them from being lost in the snow.

11-10. JUNGLE OPERATIONS

Maintenance elements in a jungle environment retain the same basic mission and capabilities as in other environments. However, they must make adjustments due to terrain, weather, and vegetation.

Location. Jungle operations subject personnel and equipment to effects not found in other environments. Trafficability and security problems often affect maintenance support elements as much as maneuver forces.

The lack of an extensive all-weather transportation network in many jungle areas makes the missions of support units more difficult. Transportation difficulties may dictate that maneuver units be resupplied by air, pack animals, or human portage.

Security. Jungle combat operations are characterized by ambushes and infiltration. The security threat caused by infiltrators will require that lines of communication be patrolled frequently and convoys be escorted. Therefore, maintenance support must be performed as far forward as the tactical situation

permits. This improves response time, reduces road movement, and allows the maintenance support elements to take advantage of the security offered by combat units,

Class IX Supply. Repair parts that deteriorate or wear out faster in the jungle environment must be identified. The PLL must reflect the increased turnover of these parts,

Maintenance. Maintenance elements in the jungle function essentially the same as in other operations. The high humidity and temperature in jungle areas will increase maintenance requirements. PM on any items affected by moisture and heat is extremely important. Emphasis must be placed on on-site maintenance and the use of aircraft to transport MSTs and repair parts to unit level. The need for responsive maintenance support means the number of repair parts for immediate exchange must be increased.

Transportation. Maintenance elements should consider all types of transportation. Surface transportation facilities are poor in most jungle areas and cannot handle heavy military traffic without extensive improvements. An air line of communication can eliminate many of the problems associated with surface movement.

Human portage is a basic means of moving supplies and equipment in jungle operations, At best, this method is slow, laborious, and inefficient.

Wheeled vehicles are normally restricted to roads and wider trails and even these may prove impassable during heavy rains. Sometimes repair parts must be transported by transloading from wheeled to tracked vehicles. For example, large wheeled vehicles move the supplies as far forward as possible, where they are transloaded to tracked vehicles which move them cross-country. In rugged terrain, the supplies may have to be further transloaded to pack animals or native supply bearers.

Fixed-wing transport aircraft can usually operate at greater distances without refueling than cargo helicopters. However, use of fixed-wing aircraft to land supplies requires more landing strips than may be present. Construction and maintenance of airfields in jungles is a difficult engineering task, but a savanna may be large enough and firm enough to use as an airstrip.

Airdrop of supplies is an alternative to airlanding. Airdrop by parachute is a rapid means of delivery and makes deliveries to isolated units possible without further transloading. Disadvantages include the dispersion of supplies and the possibility of lost cargo in the jungle canopy, vulnerability to local enemy air defense, and requirements for at least local friendly air superiority.

11-11. MOUNTAIN OPERATIONS

Historically, the focal point of mountain operations has been the battle to control the heights. Changes in weaponry and equipment have not altered this fact. In all but the most extreme conditions of terrain and weather, infantry, with its light equipment and mobility, remains the basic maneuver force in the mountains. With proper equipment and training, it is ideally suited for fighting the close in battle commonly associated with mountain warfare. Mechanized infantry can also enter the mountain battle, but it must be prepared to dismount and conduct operations on foot. Conditions that have a significant effect on maintenance operations will be encountered in mountains. Because of the severity of the environment, maintenance support in mountainous areas can be somewhat difficult.

Location. Because of terrain constraints, it may be necessary to disperse support units over a wide area. Dispersion reduces vulnerability of maintenance units; however, it may cause problems with commands, control, and local security. Maintenance units will be high-priority targets and must have adequate protection against ground and air attack to ensure continuous operations. Maintenance units must be located as far forward as possible.

Security. Mountains provide excellent opportunities for ambushes and attacks on vehicle traffic on MSRs. Enemy units can be air dropped or airlanded on key terrain that dominates supply routes. Maintenance units must be alert for enemy infiltration detachments that may seize important road junctions to isolate combat units from their maintenance support. Route patrols and observation posts are required to secure MSRs.

Class IX Supply. In mountain operations, rugged terrain and climatic extremes cause repair parts consumption to increase. Movement of repair parts should be expedited into and within the combat area. Parts with high usage rates should be stocked at both DSA and BSA maintenance units. Typical high-consumption repair parts are--

- Tires.
- Tie rods.

- Transmissions.
- Brake shoes.
- Tracks and pads.
- Final drives.
- Winch parts.

Isolated operations will require an increased repair parts stockage in each category; however, stockage lists should contain only those repair parts that are combat essential and are required for the mission performance of a particular piece of equipment.

Maintenance. Fixing equipment as far forward as possible is extremely important in mountain operations. Vehicle crews and maintenance personnel must be trained to evaluate accurately the damage to their equipment.

Repair should be accomplished by maintenance teams from the unit maintenance element or MSTs from the DS company.

Evacuation of equipment will be very difficult. When evacuation is required, equipment should be moved only as far rearward as the point where repairs can be made, frequently the combat trains area. Cannibalization of nonreparable equipment may also be required to maintain the maximum operational ready rate.

Transportation. Although vehicles are used to move a large share of repair parts forward, they are not always able to reach deployed units. Animals, obtained locally, or individual soldiers must often move repair parts from roads to unit positions. Whenever possible, vehicles should be used to move heavy and bulky items or repair parts.

When weather permits, helicopters can be used to move repair parts from the DSA or the brigade trains area directly to forward units. Their use speeds resupply operations and reduces multiple handling. Helicopters are good for emergency resupply and movement of high-priority supplies; they should be used whenever possible. Resupply by US Air Force aircraft is another method,

11-12. URBANIZED TERRAIN

The characteristics of the urban battlefield and the nature of urban combat do not cause significant changes in maintenance doctrine or organizations. However, they do impact on how maintenance is provided. Urbanized regions normally contain a well-developed distribution system; major portions of this network are highways, rail lines, airfields, manufacturing plants, and storage areas, Built-up areas will frequently provide suitable locations for deployment of maintenance elements. Such areas offer excellent cover and concealment and may contain easily adaptable maintenance and storage facilities. At the same time, rubbled or damaged built-up areas may be obstacles along lines of communication which are vital to the effective functioning of maintenance elements. The close and continuous nature of urban combat may modify specific maintenance and repair parts requirements and capabilities as the dominant role of the division shifts from armor and mechanized formations to infantry supported by other arms.

Location. Because of the tactical situation, maintenance units may support units in, or provide support from, a built-up area. When using built-up areas, protection and physical security become important considerations. Supplies and equipment must be protected from both enemy attack and theft. Refugees may seriously impede or block movement ***over*** routes required by MSTs or movement of equipment to MCPs. Maintenance units may take advantage of hard stands, overhead lift, installed communication systems, and maintenance facilities existing in their areas of responsibility.

Security. Buildings provide excellent opportunities for snipers and thieves to attack maintenance units. Maintenance units must be alert for enemy infiltration detachments that may move among the civilian population. Maintenance shop areas should be blocked off with patrols and observation posts, as required to secure the area.

Class IX Supply. In urban terrain operations, vehicle repair parts usage may decrease as units dismount. Consumption of repair parts for small arms and engineer equipment may subsequently rise. Maintenance personnel will have to adjust to the changing environment.

Concentrated operations will allow centralized control of repair parts in urban operations. MSTs may operate from the base company location reducing the stockage of repair parts forward.

Maintenance. Fixing equipment on site is extremely important in urbanized operations, Vehicle areas and unit maintenance personnel must be trained to evaluate accurately the damage to their equipment.

Evacuation of equipment will be very difficult. When evacuation is required, equipment should be moved only as far rearward as the point where repairs can be made. Considerations of the maintenance site must be given to--

- Sufficient area around equipment for lift/recovery vehicles to operate in.
- Use of a nearby maintenance shop or garage.
- Security,

Transportation. Although wheeled vehicles are used to move many repair parts forward, they are not always able to reach the unserviceable equipment due to rubble and blocked roads. Tracked vehicles may often move repair parts forward over the obstruction. Individuals and soldiers must often move repair parts from clear areas to equipment locations.