FM 31-25

DEPARTMENT OF THE ARMY FIELD MANUAL

DESERT OPERATIONS

HEADQUARTERS, DEPARTMENT OF THE ARMY
JANUARY 1964

FIELD MANUAL
No. 31-25

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DEPARTMENT OF THE ARMY
WASHINGTON, D.C., *28 January 1964*

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*This manual supersedes FM 31-25, 27 October 1955.

722-347°—64——1

CHAPTER 1

GENERAL

Section I. INTRODUCTION

1. Purpose and Scope

a. This manual is a guide for commanders and staffs in planning and conducting desert operations. The material contained in this manual is applicable at all levels of command but is directed primarily toward operations below division level. It discusses the characteristic effects of deserts on troops, equipment, and operations. It describes special techniques and environmental characteristics common to the desert as well as training required to prepare units for desert operations. The material presented herein is applicable without modification to both nuclear and nonnuclear warfare.

b. Users of this manual are encouraged to submit recommended changes or comments directly to the Commanding Officer, U.S. Army Combat Developments Command Infantry Agency, Fort Benning, Georgia, 31905. Comments should be keyed to the specific page, paragraph, and line of the text in which the change is recommended, and reasons should be provided to insure understanding and complete evaluation.

2. Organization

The organization of the current army division is suitable for desert operations with minor modifications. These modifications are dictated by added emphasis upon mobility, maintenance, communications, and combat service support. Items of equipment may also be added or eliminated, based upon their compatibility with desert environment. With respect to their organization and equipment, mechanized infantry and armored units are ideally suited for desert combat.

3. Command

Decentralization of command to permit maximum flexibility in the conduct of fluid, highly mobile battles is a characteristic of desert operations. The unit commander should strive to concentrate his forces in the desert with respect to time and space, while he isolates and defeats small segments of the enemy. The unit commander must be resourceful and quick to recognize opportunities to use his initiative to exploit vulnerable enemy dispositions. Desert combat demands detailed planning and preparation in training, organization, and combat service support, but once the battle is joined, tactical planning is more flexible and less detailed than in most other operations. Above all, it is essential that commanders evaluate enemy action rapidly and react immediately. The fluid, open battle presents constantly changing situations, and a commander should be well forward to take maximum advantage of tactical opportunities as they develop. Successful leaders complete assigned missions with dispatch and continue to exploit gains in absence of limiting orders. A bold, confident commander may turn a local success into a victory of larger dimensions.

4. Operations

a. The basic tactical principles established in field service regulations apply to desert operations, but these must be adapted to the peculiarities of desert terrain and climate.

b. The vastness of desert areas, the climate and lack of resources, and the flat terrain which allows relative ease of movement are conditions that often influence opposing forces against establishing continuous strong positions across a given front. Instead, key areas and installations are held by strongpoints, and other areas may be held by forces covering extended frontages, backed by strong, mobile reserves. Great reliance and emphasis is placed upon mobility. Commanders who gain a mobility advantage over their opponent and exploit this advantage by applying resourceful tactics increase their chances for success. Airmobile forces may be used by a commander to achieve this mobility advantage.

c. Offensive operations successfully exploiting assailable flanks use highly mobile forces in envelopments and turning movements. The free-

dom of movement frequently afforded by the desert permits an increase in the depth of objectives and the width of frontages of units. Weak spots in the enemy defenses are exploited. This may be accomplished by concentrating forces in a frontal attack or a penetration. Once freedom of action is gained, every effort is made to exploit the advantage. Lines of enemy communication are ruptured and supply dumps are seized or destroyed. Combat takes the form of shifting, mobile battles, often becoming tank-versus-tank engagements.

d. Open country permits a rapid concentration of forces at a decisive point, and long-range weapons of all types can provide better fire support because of the excellent observation. These conditions facilitate the use of envelopments and turning movements and dictate greater depths in defensive positions.

e. Because of the extended supply lines required for expanded frontages in deserts, provisions must be made to insure adequate supplies to sustain the desert combat mission. Frequently, success of desert operations depends on some system of mobile resupply.

f. The expanse of flat desert areas provides increased observation, excellent fields of fire, and freedom of maneuver; this expanse ideally suits the mobile defense which is aimed at destruction of the enemy force rather than retention of specific terrain. Though the terrain lends itself to mobile operations, occasions may arise where sustained area defense is required. Usually, these defenses are restricted to communication centers and/or port facilities and are located so as to use natural or manmade obstacles.[1] Nuclear, chemical, and biological weapons are especially effective against such positions.

[1] The port of Tobruk and the El Alamein position in North Africa were characteristic of areas wherein strong defensive positions were built during World War II. These defenses were aided by natural and manmade obstacles. In the Sinai campaign of 1956, the Mitla Pass provided a natural defensive obstacle in which individual positions had to be destroyed one by one.

g. Desert operations demand thorough reconnaissance and timely intelligence to enable the commander to make a quick decision. Distant tactical reconnaissance operations contribute to the gathering of vital information. Airmobile operations employed to land or airdrop individuals to accomplish these missions support other conventional operations against the enemy.

h. Air parity, if not air superiority, is necessary for continuous tactical success on the ground when conventional forces are employed in large formations.

5. Combat Service Support

a. Inherent to the success of any tactical operation is a sound logistical plan. It is especially important in the desert because the greater distances used in maneuver and deployment complicate supply procedures; other reasons are the shortage of locally available water coupled with the increased demand for it created by very high temperatures and low humidity, and the increased maintenance required to combat sand and dust damage to equipment.

b. Mobility and freedom of tactical maneuver is tied to the logistical base; consequently, to extend mobility and freedom of action in desert operations, it is often necessary to establish additional bases. When possible, supplies should be delivered directly to combat units to reduce handling. It may be necessary to establish widely separated, prestocked supply points. Such supply points should be well camouflaged, buried for protection against the desert heat, and secured against pilferage or capture. Every effort should be made to restrict centralized storage.

c. The environmental effects on supplies must be considered. Frequent duststorms, occasional torrential rains, extreme changes in temperature, and the effects of insect hordes are examples of conditions which, unless anticipated, will restrict effective logistical support.

Section II. DESERT CHARACTERISTICS

6. General

As used in this manual, desert is an area in which the seasonal or annual rainfall rate is less than the seasonal or annual evaporation rate. Meteorological conditions common to all desert regions are glaring sunlight, sudden and violent windstorms, and drastic changes in temperature. The most important deserts—politically and militarily—are the Sahara (which includes the Libyan and Nubian Deserts) in North Africa, and the

Arabian and Seistan Deserts in the Middle East. Also of importance is the Gobi Desert in Mongolia. These deserts are important because they separate two or more spheres of political and religious influence, they contain valuable mineral resources, and they have strategic implications because of their locations (fig. 1).

grass, spinafox, camel grass, and matted plants. There is seldom enough vegetation for large-scale shade, shelter, or concealment. The lack of natural concealment may cause soldiers to have a feeling of exposure and insecurity for a few days.

d. A desert may be classified according to the terrain features characteristic of that area.

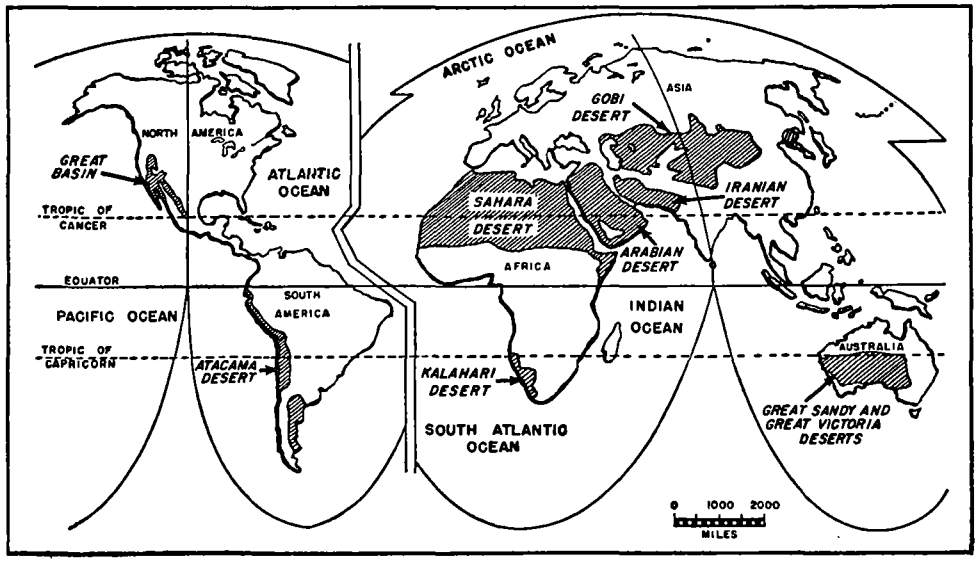

Figure 1. The most important deserts, politically and militarily, are those in North Africa and the Middle East.

7. Terrain

a. Characteristic desert terrain features include dunes and hillocks, rock-strew areas, dry lakes, salt marshes, and drywashes (often called wadis or arroyos locally). Deserts have sparse or no vegetation; large areas of sand; high mountains and broad, flat topography; sparse human habitation; and little or no surface water (except for the Gobi Desert where water can usually be found not too far below the surface). All the deserts around the Mediterranean Sea are arid regions characterized by a high evaporation rate and an average yearly rainfall of less than 10 inches.

b. Roads and trails are scarce and usually connect villages and oases. Wheeled and tracked vehicles can travel generally in any direction over most of the desert and need not be confined to roads and trails, since much of the desert area is flat and hard-surfaced and carpeted with two or three centimeters of sand (fig. 2).

c. Although most of the desert is barren, scrubby vegetation is present in some places; but it seldom attains a height of over six feet. Types of vegetation include thorny trees, low bushes, bunch

(1) *A rocky desert (hamada)* is characterized by solid or broken rock at or near the surface. This type desert varies in topography, generally from extensive flat areas to highly eroded areas with deep, steep-sided washes (fig. 3).

(2) *A mountain and basin desert combina-*

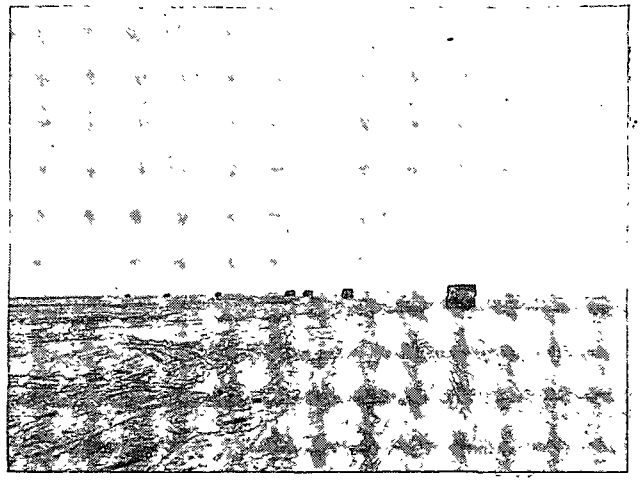

Figure 2. In flat areas of shallow sand, travel is possible in any direction.

Figure 3. Drywashes, which offer concealed positions, may become raging torrents during sudden rainstorms.

tion (*great basin*) is characterized by mountains and basin areas, or what is more commonly known as hill-and-kettle topography. The mountains are usually very rocky, jagged, and cut by deep canyons and washes which merge into desert fans. Large alluvial fans—products of erosion—project from the mountains down into the basins. These alluvial fans are, in turn, marked by formations of dry river channels (wadis). Basin areas are composed of basic sediments from the surrounding mountains and are dotted with numerous dry lakes and salt marshes (fig. 4).

(3) *A sandy desert* is characterized by flat areas with wind-made ripple marks varying height from a few centimeters (wind rows) to several meters (dunes). Dunes are usually widely separated and move with the wind, thus continually changing shape (fig. 5).

Figure 4. Alluvial fans project from the mountains and are marked by wadi formations.

8. Temperature

The desert has extreme daily temperature ranges in all seasons. The nights are so cold that heavy clothing and blankets may be needed, while the yearly average temperature during the hottest part of the day is well over 100 degrees F. In the summer, day temperatures often range between 120 and 130 degrees F. Because troops become quickly exhausted at these temperatures, large-scale operations should be timed for the winter, when practicable. For winter campaigns, troops must have warm clothing and adequate protection for sleeping because night temperatures often drop below freezing.

9. Wind

Desert winds are variable and often unpredictable. In some parts of the Sahara, light northerly or westerly breezes occur during the day and are common after sunset. Winds are generally strongest in the deserts of the Middle East where they blow constantly for a number of days at a time.[2] Storms of hurricane velocity are frequent throughout the year, and they are often accompanied by rapid temperature changes. These storms blow sand so thickly and forcibly that they can be dangerous to troops who are not trained to protect eyes and nostrils and otherwise cope with such conditions. For further discussion of the effects of wind and sand on weapons and equipment, see chapter 4.

10. Rain

Rain is infrequent in desert regions, usually averaging less than 10 inches a year. The quota for one or more years may fall all at once, however, with near-disastrous military results. The rainstorms come without warning and within minutes dry streambeds can become raging torrents. Areas of soft clay and sand turn into mud, and troop and vehicle movement becomes difficult or impossible.

[2] The Seistan Desert in Afghanistan and Iran is noted for its "Wind of 120 Days" which blows steadily from May until September.

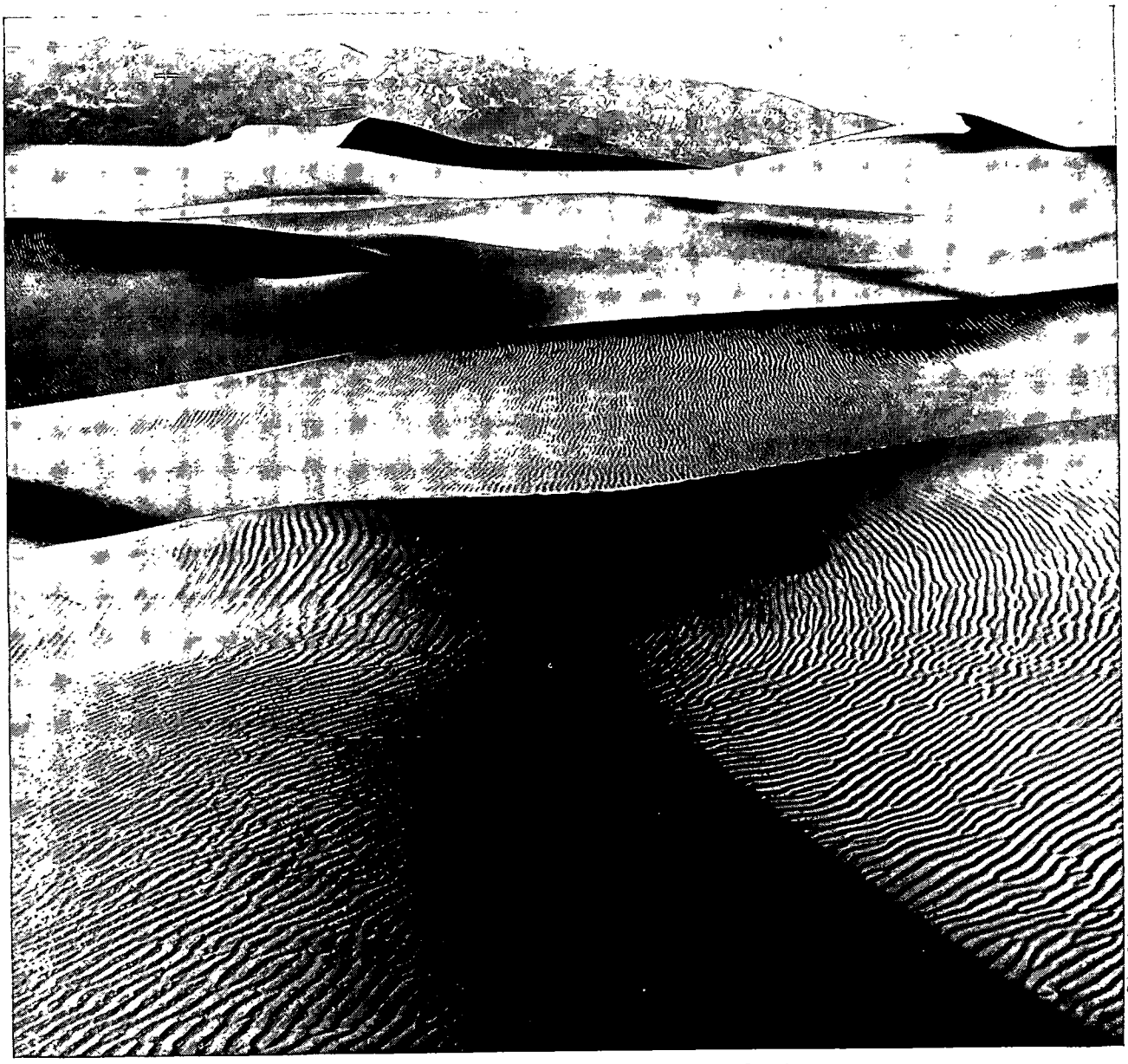

Figure 5. Dunes may reach a height of several meters.

Section III. EFFECTS OF THE DESERT ON TROOPS

11. Temperature Extremes

The extreme desert temperature adversely affects military operations (par. 8). Day operations that require great physical exertion are avoided if possible; otherwise, numerous heat casualties may result. Therefore, operations are conducted at night or during the early and late daylight hours when possible. Protective measures against the cold must be taken by troops engaged in military operations at night, and commanders must guard against the temptation for troops to throw away their warm clothing during the hot daylight hours.

12. Effect of Heat

The human body is able to remain effective in the desert heat only so long as it is able to keep its temperature within normal limits. It does this by balancing heat gain with heat loss. The body produces heat even when it is at rest; additional heat is produced during exercise. In the desert, the body also gains heat directly from the sun and

from the sand and surrounding objects that have been heated by the sun. It gains heat from a breeze or wind if the air is hotter than the body surface. Outside skin temperature (95 degrees F.) is normally cooler than internal body temperature (98 degrees F.). The body must lose heat constantly or its temperature will rise and the individual will die. The body can lose heat directly to the air and surrounding objects when these are colder than it is, as during the desert night. But when the temperature of the air, the ground, and surrounding objects is higher than that of the body, as during the desert day, the body can only lose heat by the evaporation of sweat. The skin is cooled by this evaporation and it, in turn, cools the blood which has brought the heat of the body to the blood vessels in the skin. This evaporation of sweat makes it possible for man to exist in desert heat. Salt is lost with the sweat, and the sweat and salt that are lost by the body must be replaced by an equivalent amount of water and salt if the individual is to survive in the desert.

13. Effects of Wind, Sand, and Dust

Wind, sand, and dust are particularly irritative to mucous membranes and may cause local irritation of a near-disabling nature. The wind, besides drying mucous membranes and chapping the lips and other exposed skin surfaces, carries dust and sand particles which penetrate clothing and goggles. Irritative conjunctivitis, caused by the infiltration of fine particles into the eyes, is a frequent complaint of tank drivers and others, even when they wear goggles. Obviously, these conditions can severely limit the performance of men thus affected.

14. Water

a. General. A critical factor in desert operations is the inadequate water supply. Water sources are few and are usually inadequate for sizable military forces; they often contain excessive concentrations of harmful mineral salts; and they are usually polluted or, at best, disagreeable to the taste. Such water must be purified before it is drunk. Subsoil water may be found in limited quantities; engineers are equipped to bring it to the surface. Usually, water for military forces must be transported from sources outside the desert and stored in organic and specially authorized tanks and containers; therefore, soldiers must be thoroughly trained in the practice of water discipline. Men should be taught not to waste water, but their bodies cannot be conditioned to require less water than is lost by sweating. Filtering and sterilizing water will not always make it safe to drink in the desert.

b. Requirements. The potable water requirements per man will vary according to the man's physical activity, type of food rations, and his environmental temperature. At high temperatures during the day, a man who is resting may lose as much as a pint of water per hour by sweating; if he is working, his water loss (and requirement) will increase. Hard-working units, labor battalions, and units on the march may require more than 24 quarts of drinking water per man per day. A man physically active at hard work for 8 hours per day in a daily mean temperature of 120 degrees F. will require approximately 25 quarts per day; at 100 degrees F., approximately 15 quarts per day; and at 60 degrees F., approximately 3.5 quarts per day. When an individual has no water, his survival time at 60 degrees F. is approximately 18 days; at 120 degrees F., he may survive only one day. Water loss of about 5 percent of body weight is considered to be the point where operational effectiveness would be impaired. Some time will elapse before a hydrated individual becomes dehydrated to the point of inefficiency. For short periods of time (one to three days), reduced quantities of water may be furnished; that is, 11 or 12 quarts a day at 100 degrees F. daily mean temperature.

c. Restrictions of Intake. Any restriction of water below the amount needed for efficient cooling will result in rapid loss of efficiency, reduction in work ability, and deterioration of morale. If water restriction is continued for hours, body temperatures will rise and heat exhaustion will occur. There is no advantage in the use of thirst quenchers such as chewing gum or fruit drops. For a given amount of work under high temperature, water consumption is substantially the same whether water is taken only at mealtimes or whenever one is thirsty. Those who delay drinking until mealtime may experience considerable discomfort without any apparent advantage in water economy. The greatest benefit will be obtained and maximum efficiency will result if water is taken at short, rather than long, intervals. Drinking in small amounts, when thirsty, is the best practice. This will avoid the danger of cramps

resulting from drinking large quantities of water at one time. When the water supply is limited, unit commanders should economize in the use of water by having their organizations perform the required heavy work and strenuous training during the early morning or evening, or at night when possible, rather than during the hottest part of the day. Up to 40 percent of the daily water requirement may be saved in this manner.

d. Use of Nondrinkable Water. There are times when water that is not fit for drinking may be used for various other purposes. The purpose of this is to save drinking water. In emergencies, nondrinkable water may be used to wet the clothing so that the body may be cooled by its evaporation. In this way, the body can save the water it otherwise would lose as sweat. To prevent confusion between nondrinking water and drinking water, containers for drinking water must be clearly marked DRINKING WATER ONLY.

e. Water Discipline. Water discipline must become a part of a soldier's daily life. He must be trained to conserve water and not to waste it, to drink only from approved water sources, and not to pollute such water sources as are available. When rationing is necessary, water should be issued to individual soldiers under close supervision of noncommissioned and commissioned officers. If there is insufficient water for bathing, then an occasional damp rubdown is substituted.

15. Salt

a. Requirements. Sweat contains salt as well as water. This salt is the same as ordinary table salt. Salt is as necessary for survival as the water that is lost in sweat. The ordinary diet contains enough salt to replace salt lost in sweat when a person's water intake is less than four quarts a day. If the daily water intake is increased to six quarts a day, it is possible to take in enough salt by adding extra salt to the food *if a full diet is eaten.* In hot climates, if a full diet is not eaten while troops are performing strenuous duty, there will be a salt shortage in the body. The salt requirements of the body must then be replenished by adding salt to the drinking water or by taking salt tablets. Unacclimated individuals should take in additional salt during the first few days of exposure to heat. All individuals should take in additional salt when sweating heavily.

b. Salt Tablets. Coated salt tablets do not cause the nausea sometimes felt after taking plain salt tablets. They should be swallowed whole and should be taken for every quart of water consumed.

c. Salt Water. A convenient way to provide adequate salt intake for large numbers of personnel is to assure that all drinking water has a concentration of 0.1 percent (table I).

Table I. Preparation of 0.1 Percent Salt Solution

Table salt	Diluting water
2 10-grain salt tablets---dissolved in--	Canteen.
¼ teaspoonful----------do----	Do.
1⅔ level messkit spoons--------do----	5-gallon can.
9 level messkit spoons (0.3 pound). do----	Lyster bag (36 gallons).
1 level canteen cup----------do----	250 gallons (in water trailer).

d. Water Shortage. If there is a shortage of water, extra salt should not be taken.

16. Acclimation

Troops are in danger of heat exhaustion or heatstroke if they are required to perform heavy work or rigorous training before they have gone through the period of acclimation—nature's way of adjusting the cooling system of the body to meet the strain imposed by desert heat. This is true even though troops are in good physical condition. The acclimated soldier is alert, performs his work energetically, and is without abnormal symptoms. In contrast, the unacclimated soldier who is working too hard in the heat may become dull and apathetic, perform his work poorly, and to varying degrees, show symptoms of heat exhaustion. Two weeks should be allowed for acclimation even though the major part will take place in five to seven days if the workload and the exposure to the heat are increased gradually by a schedule of alternating work and rest periods. During the first two or three days, the work periods should be set mainly for the cooler hours of the morning and the afternoon. After this, amounts of work during the hot part of the day should be gradually increased. FM 21–10 contains suggested work schedules for acclimation to desert conditions.

17. Physical Condition

The soldier who is physically fit becomes acclimated more rapidly and is capable of more work in the heat than a soldier who is in poor physical condition. It is not possible, however, to shorten the period of acclimation, or to increase the ability to work in the heat by continued training in cool environments beyond that required to attain physi-

cal fitness. The physically fit soldier will also maintain his acclimation at a higher level and over a longer period of time. The risk of heat injury is much greater for persons who are overweight, fatigued, sick, sunburned, or convalescing from sickness. Persons who use alcohol to excess, have had heatstroke, or have diarrhea are also more susceptible to heat injury.

18. Training Schedules

Training and work schedules must be tailored to fit the climate, the physical condition of personnel, and the military situation. These schedules must be closely supervised by responsible commanders and medical officers to achieve maximum work output with minimum heat injury (ch. 4 and TB MED 175).

19. Disabilities Caused by Heat

a. General. All heat injuries except heatstroke result from a deficiency of water or salt, or both, caused by inadequate intake during heavy sweating. Heatstroke results from a failure of the sweating mechanisms. Heat injury is prevented by increasing the resistance of exposed troops and by reducing the exposure of troops to heat as much as is practicable. Every individual must be aware of the dangers of heat exposure. Commanders instruct their personnel in the serious results of heat injury and in the prevention, recognition, and treatment of heat cramps, heat exhaustion, and heatstroke. Unit surgeons assist commanders in this instruction and in the development of heat injury prevention programs (TB MED 175).

b. Heat Cramps. Heat cramps are caused by excessive loss of salt from the body of an individual who has been sweating heavily. Cramps are painful spasms of the muscles—usually those of the legs, arms, and abdominal wall—and can be either mild or severe, with little relation to body temperature. Heat cramps are relieved by drinking large amounts of salt water (par. 15*c*).

c. Heat Exhaustion. Heat exhaustion is caused by the excessive loss of water and salt from the body of an individual who has been sweating heavily. The skin is cold and wet with sweat. There may be a slight rise in body temperature. There may be loss of appetite, headache, dizziness, mental confusion, and weakness. Heat exhaustion may occur suddenly or over a period of time; it may occur in even the best acclimated individuals if the work is heavy enough and the heat is severe. Mild cases are seldom fatal, but severe cases may prove fatal if untreated. A stricken individual should be placed in the shade; the return of blood to his heart should be assisted by elevating his feet and massaging his legs; and he should be given adequate quantities of salted water to drink (par. 15*c*). Following this first-aid treatment, the victim should be evacuated to the nearest medical installation.

d. Heatstroke. Heatstroke, or sunstroke, occurs when the body loses its ability to cool itself by sweating and the skin is hot and dry. This is in contrast to heat cramps and heat exhaustion when the skin is cool and moist. The body temperature is 105 degrees F., or higher. Heatstroke is particularly apt to occur in individuals who are not acclimated to the heat and in those who are overweight. It may follow physical exercise, the excessive intake of alcohol, and diarrhea. Heatstroke may occur within a few minutes after sweating has stopped. All personnel must be instructed to watch for the absence of sweating while doing work that normally causes sweating. Soon after sweating has stopped and the temperature has risen, the individual may be exhilarated and unaware of the dangerous condition which is developing. He may collapse suddenly or there may be headache, dizziness, mental confusion—and even delirium—before the onset of unconsciousness and convulsions. *Heatstroke is a true emergency and all untreated cases will die.* The objective of treatment is to lower the body temperature to a safe range as quickly as possible. The patient should be placed in the shade, his clothing removed, his body sprinkled repeatedly with cool water from head to foot, and the evaporation increased by fanning to speed the cooling. The arms and legs should be massaged to stimulate the circulation. Cold or cool water should be given by mouth if the patient is able to drink. As soon as possible, he should be evacuated to the nearest medical installation, with treatment continued en route. Individuals who have once had heatstroke are more susceptible to further attacks.

e. Sunburn. Severe and even fatal skin burns may result from short periods of exposure to the desert sun. Persons with fair skin, ruddy complexion, and red hair are especially susceptible. Sunburn may be prevented by appropriate protective measures. Individuals who sleep outdoors during the day should sleep only in the shade and should never sleep in an isolated spot away from the remainder of the unit.

CHAPTER 2

OPERATIONS

Section I. OFFENSE

20. General

Fundamental doctrine contained in basic field manuals applies in desert operations. This chapter highlights techniques and tactics peculiar to operations in flat, sandy desert areas. Commanders must modify operational tactics and techniques in all cases to suit the particular terrain in which they are operating.

21. Forms of Maneuver

All forms of maneuver are applicable in desert operations. Many opportunities are offered for conduct of the envelopment at all levels, and extended frontages occupied by a defender often will facilitate execution of the penetration. Frontal attacks may more readily result in penetrations. The turning movement, although a particularly advantageous maneuver in desert operations because of its nature, is not commonly executed at brigade and lower units. The mechanized or armored brigade is well suited, however, as a turning force for a division. When employed in this role, it is provided with combat and combat support units to permit it to operate independently (FM 100–5 and FM's of the 7- and 17-series).

22. Planning and Preparation for the Attack

a. The influence of terrain on tactical operations is just as decisive in the desert as in other environments, but it is difficult to take advantage of the peculiarities of desert terrain. Since there is an acute lack of forests, cultivated areas, and villages, it is seldom possible for troops to advance and assemble under cover. But the desert does offer some opportunities for advantageous use of terrain features such as ravines and valleys to conceal and cover troop assemblies from direct ground and air observation and fires. In the attack, a significant consideration is to reconnoiter the terrain carefully. Importance is attached to choosing ground which can be easily traversed by vehicles, and which offers a covered approach through use of defilade. The desert surface is easily traversed by vehicles, so it is easy to advance on a broad front as well as to make wide enveloping and turning movements. There are few limitations to freedom of movement caused by terrain restrictions; therefore, it is possible to maneuver freely.

b. During an attack, the tank battle usually occupies the foreground. Failures of attack often can be attributed to unfavorable ground, lack of air superiority, or unresponsiveness of logistical support (fuel and ammunition). In addition to the usual considerations in planning an attack, commanders must recognize the need to carry an ample supply of water and to consider the difficulties of orientation and navigation. Available maps are often inadequate. Practically no reference points exist; thus, all navigation has to be done by compass. Aircraft may be used to assist in providing directional control. Though anticipated in training, the glare of the sun, which can make contours unclear and objects difficult to identify, is a phenomenon troops must become accustomed to.

c. Plans for the attack in the desert follow the same sequence as those for normal infantry or armor operations in other terrain. These plans are based on the mission. Significant differences in plans for desert battle are concerned with techniques rather than tactics. For example, because of the extremely good observation the desert affords, commanders employ ruses and attempt to alter their maneuver to confuse the enemy. Plans are imaginative and their execution is bold.

d. In organizing for combat, the commander normally forms tank-heavy task forces. He anticipates tank-versus-tank engagement, or that tanks will play the predominant role in affecting the outcome of the battle. Consideration is given to the need for infantry to seize and hold an objective, to mop up bypassed resistance, and to contain a large force in the rear. Tanks and mechanized

or motorized infantry move together—not in an integrated formation, but usually in line formations with tanks followed by infantry. Each element attempts to retain freedom of action and still capitalize on the other's capabilities. The desert lends itself to rapid concentration and dispersal of forces.

e. While the commander and staff are formulating the plan of attack, concurrent actions are taken to prepare the appropriate unit for its offensive role. Individuals are readied for the attack; weapons are prepared; refueling is accomplished; and vehicles are moved to dispersal areas or assembly areas pending further instructions. Class I, III, and V supplies are provided, based on the requirements foreseen in the plan of attack. Ideally, mobile resupply is built into the organization for combat; if all the necessary logistical support (normally class III, V, and maintenance support) cannot accompany the tactical forces, plans are made to locate fuel and ammunition dumps in proximity to the area of operations. Maximum use is made of aerial resupply to provide a sustained capability to conduct lengthy desert operations.

23. Advance To Contact

a. Because of the nature of desert terrain, opposing units are occasionally separated by great distances. In any event, the normal situation in the desert is that opposing units have a larger degree of separation than in other operations, and frequently an advance to contact is made to engage the enemy.

b. The commander determines the probability of contact and directs that combat readiness be achieved accordingly. The organization for combat consists of the tailored formation which facilitates speed and provides security to meet unexpected enemy armor and infantry attacks from any direction. As the open desert lends itself to advancing on a broad front, security of the flanks is a significant problem; but flank security is also more easily checked in the desert. Early warning is gained through continuous observation and visible dust clouds. Because column formations are vulnerable to flank attacks, security forces move on both flanks and orient their movement and speed on that of the main body. A covering force often provides forward security. This may be provided and/or controlled by a higher headquarters which clearly coordinates with Army and Air Force aircraft providing air cover.

24. Reconnaissance

a. Ground Reconnaissance. Since in desert operations the main force is usually preceded by some form of covering or forward security element, emphasis is placed upon testing the enemy's position and strength by reconnaissance in force. Reconnaissance missions in the desert are usually executed at greater distances than in other terrain. They may have the mission of determining location of enemy positions and weapons or of obtaining possible indications of the enemy's future actions by observation of vehicle tracks in the sand or dust clouds on the horizon. Usually, the reconnaissance force is large enough to fight an engagement, but its mission is to evaluate the enemy's positions and troop dispositions, and to attempt to gage the enemy's reaction or probable course of action. An armored brigade, reinforced by additional mechanized infantry and the appropriate mix of combat support elements, provides an ideal force for such a mission.

b. Aerial Reconnaissance. Closely coordinated with ground reconnaissance elements (or those units leading the advance to contact) is aerial reconnaissance performed continually by USAF aircraft and Army aircraft or drones.

25. Conduct of the Attack

a. Because of the excellent observation in the desert, the attacking force moves as rapidly as possible from assembly areas and crosses the line of departure at the time of attack. The terrain seldom permits halting the force in an attack position. Artillery and other supporting weapons plan to fire initially in position and then quickly displace to support or rejoin the moving force. Some form of deception may be performed by armored cavalry units or reserve tank and mechanized units creating a diversion; for example, raising dust or conducting firing demonstrations on another front or flank. Supporting fires may be withheld until the two forces are engaged. In this way, some element of surprise is gained by holding fire and maneuver until the enemy has prematurely shown his intentions or reacted to previous actions. The distance to the objective and size of the force may require halts in forward areas of deployment (assembly areas forward of the line of departure). The main body establishes

a temporary perimeter defense until the lead elements have developed the situation. Based on the degree of success of the lead element in developing the situation and containing the enemy, the main body will either exploit this action or continue toward the main objective—destruction of enemy mobile reserves and lines of communication in the rear. The force commander moves near the forward elements to continually assess the situation. Because of the lack of terrain restriction, commanders can change the direction of attack, alter the plan, or shift a supporting attack to the main attack, or vice versa, with greater facility than in other areas. Smoke is as useful for the attacker in the desert as in other terrain.

b. Attacks are characterized by quick engagements, decisive tank battles, rapid shifting of mobile forces closely engaged, and frequent and rapid disengagement. Aggressiveness in conducting small attacks and raids, and bold use of combat patrols against enemy outposts, detachments, and logistical bases will force the enemy to pull into his base areas and lose the initiative. He must then conduct a passive defense or employ numbers disproportionate to the results accomplished. On a wide battlefield, attacks are frequently decentralized; this necessitates small-unit actions. Battalion and smaller units become engaged in a series of isolated actions. The force commander normally controls the battle from a mobile command post. His personal presence and timely, on-the-spot direction of action can affect the outcome of the battle.

c. Long drawn out battles are avoided because they are unnecessarily wasteful and they accent the difficulties encountered in providing sustained logistical support.

d. When attacking a fortified defensive position, the attack sequence described in FM 31–50 is followed.

26. Exploitation and Pursuit

a. Once the integrity of the enemy's main defensive position has been disrupted, unobstructed desert terrain often permits rapid exploitation. Exploiting forces seize deep objectives to cut enemy lines of communication and disrupt enemy command and control facilities. In some desert areas, terrain may restrict a withdrawing enemy force, reducing its freedom of maneuver, canalizing its elements, and delaying its movement. Frequently, a withdrawing enemy force must move extended distances before reaching terrain suitable for an organized defense and close enough to a base that can support the defense. Once begun, the exploitation is executed relentlessly in the attempt to build momentum, create confusion and apprehension throughout the enemy command, reduce his capacity to react, and destroy his capability to engage in an orderly retrograde movement or to reconstitute an organized defense. Speed is essential for exploiting and pursuing forces to deny the enemy any respite from offensive pressure.

b. As enemy forces disintegrate under relentless pressure, an exploitation may develop into a pursuit. Direct pressure against retreating forces is maintained relentlessly. Enveloping or turning forces are employed at every opportunity to cut the enemy line of retreat. Continuity of combat service support is vital to the success of the pursuit and deserves special consideration in desert operations.

27. Infiltration

The infiltration technique of maneuver may be facilitated in the desert by increased dispersion. Long-range desert patrols are infiltrated to gain intelligence, cause the enemy to maintain large security forces, and destroy critical enemy headquarters and support installations. Mobile forces conducting long-range reconnaissance frequently can either infiltrate the enemy's forward positions or move around them to infiltrate rear areas. This action is usually most successful at night.

28. Night Attack

Attacking at night may provide a psychological advantage since troops lose their fear of overexposure (prevalent in the desert in daylight) and gain confidence in their capabilities during the hours of darkness. Surprise, so important in any operation, is enhanced by night operations. See FM's 7- and 17-series for detailed explanation of night attack techniques and control measures.

29. Tactical Cover and Deception

Tactical cover and deception include such activities as feints, ruses, demonstrations, diversions, and holding attacks. A commander considers the employment of these techniques to conceal his main attack, to achieve surprise, and to cause the enemy commander to move with hesitation and caution. Smoke and the dust raised by movement

of vehicles and mounted forces in a show of force are tactical deception devices. Control of communication, light and noise discipline, and camouflage prior to and during the attack are effective passive measures. The use of dummy positions is a means of deceiving the enemy. Airmobile feints (limited-objective attacks with infantry) are another way of throwing the enemy off balance while the main body moves forward quickly to attack the enemy's main position.

30. Encirclement

Frequently, troops and installations can be encircled in the desert. This is aided by rapid development of the situation before a force can encircle the enemy or prevent its own encirclement. Once surrounded, the encircled force should immediately prepare to break out. The preparation to break out is coordinated with an attempt by friendly forces to accomplish a relief. The urgency of the need for relief depends upon the tactical situation and the physical condition of the encircled force. On the other hand, when an enemy force is surrounded, the fires of the encircled force can be devasting, can cause disorganization, and can severely restrict attempts to destroy it. If the encircled force is nonmechanized or nonmotorized, a friendly force possibly can be left to contain it, forcing a battle of attrition. The decision to destroy the encircled force or continue an advance depends upon the capability of the trapped force to sustain itself, the strength of its defensive position, its capability of gaining resupply, attrition forced on the attacker by repeatedly striking the surrounded force, and the objective or mission of the attacking-encircling force.

Section II. DEFENSE

31. General

In defensive operations, emphasis is placed upon mobile defense except when specific terrain must be retained. Increased visibility and excellent fields of fire, in conjunction with increased freedom of maneuver found in desert operations, dictate positions in greater depth. A mobile defending force can take advantage of the attacker's blinding smoke or its own screening smoke to execute surprise counterattack maneuvers. Commanders must expect the enemy to strike at any time from any direction (FM 7- and 17-series). Organized defense of logistical bases is necessary at all times.

32. Area and Mobile Defense

a. Area Defense. Area defense is oriented toward the retention of specific terrain. This type of defense normally will be conducted when there is a requirement to retain key communication centers, port facilities, or other militarily significant terrain features.

b. Mobile Defense. Mobile defense is ideally suited to the desert; however, this defense must be modified to meet the conditions of the type of desert defended. Linear defensive positions are not normally prepared because of the ease with which they can be outflanked. Usually, units form into a series of echeloned perimeters to provide all-round defense and depth. No attempt is made to tie-in forward elements in a continuous linear band of emplacements except when fighting in mountainous terrain where defiles and valleys exist, or in terrain where units can anchor into natural or manmade obstacles. Normally destruction of the attacking force is the primary aim of the defender in any mobile defense posture.

33. Planning and Preparing the Defense

Defense emphasizes use of artificial obstacles (mines, antitank ditches, tactical wire) and long-range fire support. These, combined with large mobile reserves, are normal requirements. In most cases, the fact is accepted that one or both flanks are exposed. This necessitates the holding of the forward areas echeloned to the most serious threat, while the reserves are retained in depth and oriented to exposed flanks. Mines are used extensively to give a defensive position some cohesiveness and to attempt to force an attacker into an exposed position. Defensive positions are dug in flush with ground level. Enemy mechanized forces will try to turn a flank to destroy the pattern of the defense. Defensive plans are aimed at engaging the enemy at long range, taking advantage of the vast territory the desert presents, using covering forces and delaying positions to cause his premature deployment and expenditure of time and materiel. Friendly forces move to meet him on occasion or create diversions, causing him to hesitate and slow his attack. When the

attacker has deployed his forces, a swift maneuver by the defender can enfilade the attacker's main force from a flank.

34. Forms of Defense

a. General. Because of the unusual characteristics of desert terrain, certain forms of defense are more common to desert fighting. These forms fall within the broader application of area and mobile defense discussed in paragraph 33. The open country generally dictates a type of mobile defense as most desirable. The forms of defense discussed below may be used. These forms apply to battalion and lower units and are based upon existing operational and terrain conditions.

b. Perimeter Defense. This form of defense is the most common in the desert for battalion and lower units. Often, when battalions break off battle, they will form a perimeter defense or act as strongpoints within a mobile defense by a larger unit. This insures cohesiveness and better control and reduces infiltration.

c. Fortress Defense. Desert fortresses are built level with the ground. They have low wire obstacles, communication trenches which should be reinforced with concrete, and strong antitank ditches.[1] Antitank ditches are partly covered with light boards and a thin layer of sand and stones so that their outlines cannot be seen from close distances. The position consists of several shelters reinforced with concrete when available. The shelters are connected by communication trenches with combat positions for machineguns, antitank weapons, mortars, and individual firing positions. Like the antitank ditches, the communication trenches are also covered with boards and a thin layer of earth so that they may be easily opened at any desired point. The position is surrounded with strong wire obstacles. Reserve positions are constructed in the same manner.

d. Reverse Slope Defense. Desert operations provide classic opportunities for reverse slope defense. Some desert areas consist of rolling, hilly terrain, or large, sweeping dunes which may permit the conduct of an effective defense from reverse slope positions. In these areas, the employment of the reverse slope defense may be adopted to surprise the enemy and deceive him as to the true location of the defenses. At other times, the adoption of this defensive posture may be necessary to maintain the integrity of the defensive position. In any event, it is the forward elements of the main defensive position that cover the reverse slope. This type defense is particularly effective when friendly flanking fire can be directed on the forward slope of the reverse slope defense positions. These positions are echeloned in depth. Friendly security elements occupy positions just forward of the crest, prepared when possible to withdraw through a saddle or around a flank. Efforts are made to combat the tendency of troops to "crown the heights" to see farther into the country ahead. Ideally, terrain to the front and flanks of the position should be difficult to traverse; however, this terrain condition is seldom found in the desert.

[1] Typical of these fortress-type defenses were the coastal harbors of Tobruk, Bardia, and Mersa Matruh in North Africa during World War II. El Alamein, due to its right flank being on the sea and anchored on the left by an impassable (to vehicles) salt marsh (the Qattarra depression), was also considered a fortress.

35. Defense Considerations

a. In the desert, the commanding terrain is not always selected as the best tactical position because of the sheer rock and shale walls which may be encountered. The commander may conclude that ground on a lower level will better aid him in the accomplishment of his mission. After a tactical position is selected, it may be best to have the unit remain in a decoy area or position and then move into the selected position after dark. This causes the enemy to concentrate his efforts on a false position while friendly units will have moved to the primary position.

b. Dispersion in the desert is greater during daylight hours than at night. After dark, dispersion is reduced depending upon the brightness of the moonlight and the difficulties of defending and camouflaging the position. Ability to accomplish the mission is the primary consideration in determining the degree of dispersion. This may often mean ability to secure the area.

c. Most desert terrain offers good fields of fire. Occasionally, drywashes in front of a unit's defensive position will limit grazing fire. In cases of this nature, fires of direct-fire weapons are placed down the drywash which is also covered with artillery and mortar fire. It is more difficult to sight tank guns and other direct-fire weapons because heat waves will partially obscure small targets.

d. The nature and strength of the terrain and the degree of importance attached to the defensive position, as indicated in orders directing the de-

fense, dictate the additional means taken to strengthen a defense and the priority of accomplishing various defensive tasks. These considerations are in addition to supporting fires and maneuver forces.

(1) *Obstacles.*

(*a*) *Mines.* Antitank mines are used extensively as obstacles to tanks and other vehicles. They take the place—to a degree—of natural terrain obstacles which are often not present. In most cases, the soil permits easy laying of mines and the wind obliterates any telltale marks. Over longer periods, however, the wind may eventually expose the mines, or windblown sand may bury them so deeply that they lose their effectiveness. In the desert, special measures are necessary to comply with standard requirements for marking minefields, and old minefields are especially difficult to locate and clear, even with initially accurate location data.

(*b*) *Antitank ditches.* Where possible, antitank ditches are tied into natural obstacles such as salt marches in flat terrain or terrain defiles in mountainous terrain.

(2) *Field fortifications.*

(*a*) In building field fortifications, an effort is made to keep the upper slope at ground level in order to prevent the enemy from recognizing the position. Special difficulties arise in constructing firing positions for antitank weapons or other weapons with high silhouettes. These positions may have to be located on reverse slopes. Where this is not possible, the weapons can be held in mobile reserve or in supplementary positions and brought forward or to firing positions as required.

(*b*) It is extremely difficult to prepare field fortifications in the desert steppes. Wherever the ground in the steppes is stony, there is a hard-surfaced layer of so-called "surface chalk." Under this surface layer, the ground is especially soft and therefore easier to work. In construction field fortifications, it is first necessary to blast away the surface chalk layer. Work of this kind can only be done if sufficient time is available. If a hasty defensive system is being established, stones and rocks may be piled to form emplacements. When defending on steep slopes or ravines, the softer sublayer may be easy to reach and digging also is relatively easier.

(*c*) Foxholes and shelters can be dug easily in the loose loam or clay of depressions. Because of the absence of timber, construction work may present difficulties. Materials that can be used to revet vertical surfaces are sandbags, earthfilled ammunition boxes, and shell cases.

(*d*) Difficulties with underground water must be expected in the salt marshes. Even when the surface is dry, there is salt water at a depth of about one meter.

(*e*) Fortifications require a great deal of time and material. Dried up cisterns (indicated on maps of North Africa by the word "Bir") dating from Roman times may be used as command posts, ammunition dumps, and shelters for the troops. These cisterns are large square caves of about 100-square meters or more in area having only a small influx hole in the upper chalk layer. The roofs consist of a layer of surface chalk one or two meters thick and do not require support for a length of 35 meters. During World War II they withstood heavy artillery bombardments and air raids.

36. Conduct of the Defense

a. Long-range forward and flank security is mandatory in the desert. This may be provided by air or ground means—usually both. Ground security will take the form of vehicular and, occasionally, dismounted patrols. The latter is more common between forward outpost positions. Security forces, including tanks and self-propelled artillery, attempt to move out to great distances to see the approaching enemy. This forward security, as visualized for a general outpost in conventional operations, is usually provided by brigade or division units. Often, a battalion may send out long-range security forces to obtain information of the enemy and give early warning of his approach. These forward secu-

rity forces do not necessarily engage the enemy unless so directed. If the mission dictates that they engage the enemy, they do so at the maximum range of weapons. This engagement is aimed at causing the enemy to deploy prematurely, and to deceive, delay, and disorganize him. Thus, this desert security force combines the mission of a combat or general outpost in conventional operations with some of the attributes of a long-range combat patrol. Tanks and artillery are the principal weapons which provide this forward security element with the long-range firepower it needs. Small mechanized and/or airmobile infantry forces also are well suited for forward security missions. These elements withdraw and accomplish delay in zone, if so directed.

b. Within the main defensive position, some of the positions are deceptive dummies. Fires from the rear of these positions give the impression that the dummy positions have fired. Dust-raising devices further confuse the attacker.

c. Defending commanders continuously assess the situation to determine the time and opportunity for counterattack. Mobility advantage and battle initiative are always sought. Airmobile forces, including transport helicopters protected by armed helicopters, are ideal for long-range counterattacks. They may be directed to strike the enemy's followup echelon (preferably reinforcing elements, supply train or higher headquarters command installation). The long-range attack by airmobile forces may be tied in with a conventional armored counterattack and designed for early link-up in the enemy rear. When using airmobile forces, commanders must realize that personnel are most vulnerable on the ground unless their transportation remains or plans to return soon. The desert lends itself to airmobile operations because of freedom of action and landing facility. Conversely, these aircraft are vulnerable to ground and fighter aircraft fire because of the lack of terrain cover and concealment.

Section III. RETROGRADE OPERATIONS

37. General

a. In desert operations, both the advantages and the difficulties inherent in retrograde operations are magnified. Normal existence of long-range observation and excellent fields of fire favor the defender until he attempts to disengage from the enemy. However, when the defender begins to move in order to break contact, he must expose himself to the attacker's observed long-range fires. While the mobility afforded by the desert enables the disengaging force to move rapidly to the rear, it also enables the attacker to react promptly to exploit and pursue. For these reasons, contact should be broken during darkness whenever it is possible to wait until conditions are favorable. The new position to be occupied is selected farther away from the old position, and intermediate delaying positions are organized ahead of time, in order to stop the enemy pursuit.

b. Retrograde operations are characterized by detailed centralized planning and decentralized execution. Communications and control become increasingly difficult. Subordinate commanders must have detailed knowledge of the overall plan so that they may properly conduct independent actions when communication with higher or adjacent units is lost. Retrograde planning for desert operations is influenced by desert terrain and its effect on the mobility of the force concerned. Lack of obstacles and barriers dictates a speedy, organized withdrawal. Dependable navigation and orientation methods are necessary. The use of smoke, dust clouds, deceptive feints or demonstrations, and concealment afforded by complete darkness can facilitate withdrawal without enemy pressure. See FM 7- and 17-series for detailed discussions of retrograde operations.

38. Delaying Action

a. General. Long-range observation and fires—desirable delay characteristics—are prevalent and effective in the desert. Delaying forces must be constantly poised to withdraw quickly to new positions to prevent envelopment and/or decisive engagement.

b. Conduct. Delaying actions in the desert differ from delay on normal terrain because of the many approaches an attacking force may take. Delaying forces are formed around tank units which provide lang-range fire and covering protection for infantry. If withdrawal has been timely and complete disengagement has been accomplished, planned nuclear fires may be used. These fires can neutralize or severely impede large armored formations. Even though the enemy

formations are dispersed, nuclear weapons can be employed effectively to slow or stop them. In general, more latitude for the use of nuclear fires is provided in the desert because of the open country and lack of civilian population. Civilian populations and critical installations are scattered in the desert area and are normally clustered around a water source or communication center, leaving the great majority of the desert free for battle.

Section IV. AIRBORNE OPERATIONS

39. General

Airborne operations in the desert are conducted as prescribed in FM 57–10, FM 57–35, FM 57–38, and FM's of the 7- and 17-series.

40. Airmobile Operations

a. Because of the operational need, the simplicity of planning, and the versatility of Army aircraft, airmobile operations have great possibilities in the desert. Availability of landing sites (zones) pose no problem in the desert expanse, but the effectiveness of contour flying is reduced.

b. In planning desert airmobile operations, emphasis is placed on conditions peculiar to the environment. Additional consideration must be given to the problems confronting the operation of Army aviation (par. 48).

(1) *Security.* The lack of terrain features and vegetation increases the problem of assembling the necessary aircraft without their being detected. Loading sites are located well to the rear and are widely dispersed. No attempt is made to move or assemble units in a single location. All elements of the force are dispersed and maximum preparation is completed before the aircraft arrive at the loading sites. Upon arrival of the aircraft, loading is accomplished in the minimum possible time. Serials then assemble in the air from several departure areas in the same general vicinity.

(2) *Vulnerability.* The desert environment increases the vulnerability of aircraft in flight. The lack of terrain features exposes even low-flying aircraft to long-range visual observation and detection by electronic devices. Aircraft in flight are easily spotted by enemy aircraft and successful evasive action is more difficult due to the lack of protecting terrain. This vulnerability may be reduced by advantageous use of the spaciousness of the desert and by increased night operations. The use of screening smoke assists in concealing the exact location of aircraft. Flight routes are carefully selected to avoid enemy strengths and provide deception. Multiple routes complicate movement control and fire support, but they may be necessary to reduce vulnerability. In addition to the normal fire support provided an airmobile force, increased means of suppressing ground fires during the air movement must be provided the force commander. Airlifted forces may be protected by armed aircraft, including helicopters under the centralized control of, or on call by, the airmobile force commander. Escort helicopters may consist of observation-, utility-, or transport-type helicopters armed with machineguns, free rockets, guided missiles, or other weapons. The type armament employed depends upon the nature of the known and suspected type of enemy targets to be attacked. Generally, as a minimum, escort aircraft are armed with machineguns and free rockets to provide a capability to neutralize enemy fires or destroy enemy surface forces. Guided missiles are used against enemy armor or fortified positions. Additionally, escort helicopter forces assist in providing security during the loading phase and join-in to provide supporting fires on the objective area and protection from enemy low-performance aircraft. Protection from enemy high-performance aircraft and suppressive strikes against enemy antiaircraft are provided by high-performance Air Force aircraft.

(3) *Navigation.* When the airmobile force is flying nap-of-the-earth, aircraft at higher altitudes may be required to provide directional control for the force. Guidance for aerial navigation is contained in paragraph 48*d*.

(4) *Antitank defense.* Because of their limited ground mobility and firepower in the objective area, airmobile forces are particularly vulnerable to enemy armor. Plans must provide for rapid linkup with other attacking ground forces or for disengagement and withdrawal prior to the time the enemy can mount a coordinated armored attack against the airmobile force. Organic antitank weapons are augmented with additional light antitank weapons, antitank guided missiles, and antitank mines. During the assault, air support is the primary defense against enemy armor. Aircraft attack any enemy targets that appear, attempt to disperse them, and delay the enemy buildup. Throughout the operation, enemy armor is attacked at long distances from the forward edge of the battle area and is maintained under observation and attack as long as it poses a threat. In the objective area, emphasis is placed upon developing the antitank defense by taking maximum advantage of natural obstacles such as drywashes or boulder-strewn areas, augmented by minefields, tank traps, and similar artificial obstacles. Antitank weapons are located in depth throughout the objective area.

c. Consideration must be given to the use of pathfinder detachments. Pathfinders are well suited to operations in remote areas. They provide navigational and terminal guidance for airmobile operations and augment the aerial navigation facilities (FM 57–38).

Section V. OTHER TACTICAL OPERATIONS

41. Patrolling

Patrolling in the desert is normally by aerial or vehicular patrols. These will normally be formed from reconnaissance and armored cavalry units because of the mounted patrol capabilities of these organizations, and may be short- or long-range patrols of combat or reconnaissance types. In fortress-type defenses (par. 34*c*), occasions may arise where a dismounted patrol is required for liaison, contact, or security missions. Generally, vehicle patrols often become long-range operations (because of the normal radius of action) which scout the enemy positions and attempt to obtain possible indications of the enemy's future actions.

42. Counterguerrilla Operations

Counterguerrilla forces (ranging from small raiding groups to brigade-size or larger forces) attempt to keep the guerrilla on the run, ultimately isolating and then destroying him. Methods of accomplishing this mission include destruction or seizure of water points (key objectives in this type of operation), base(s) of operations, and strongpoints protecting a water point or base of operation; splitting enemy relationships with the local populace; and disrupting intelligence and supply channels. If water points are destroyed, friendly indigenous personnel are supplied from a controlled water source. Because of their lack of mobility, their inferior forces and arms, and their fear of piecemeal defeat in isolated outposts, the guerrilla elements normally operate in separate groups away from the open desert and in the protected valleys (wadis) and more mountainous areas where cover, concealment, and water can be found. They resort to mingling with and forcing local civilians to become a part of the operation. This may reduce the feasibility of aerial or missile attack of a guerilla stronghold (or area), because friendly civilians may be killed or maimed. Because of the nature of guerrilla operations, counterguerrilla operations are frequently decentralized in order to be more effective. For example, while one locale is being hit, another guerrilla force strikes elsewhere. Frequently, the best method to counter guerrilla operations is to operate similarly. Small parachute or airmobile groups may be landed in separated locations in known guerrilla territory. These small groups join together and establish a base of operations to which airmobile support (men and equipment) is sent. These units may have the task of destroying a water point, locating a guerrilla base, establishing communication to lead larger forces, or directing fires into guerrilla strongholds. For detailed information on guerrilla warfare and operations against irregular forces, see FM 31–15, FM 31–16, FM 31–21, and FM 31–22.

Section VI. ROLE OF THE ARMORED CAVALRY REGIMENT IN DESERT OPERATIONS

43. Armored Cavalry Regiment

The armored cavalry regiment is uniquely designed for desert warfare because of its great mobility and integrated combined arms teams. It will participate in all aspects of the operations described in this chapter. Of particular importance is the armored cavalry regiment's capability to organize long-range patrols. Elements of the armored cavalry regiment operating independently are particularly suited for the conduct of raid operations against airfields and logistical dumps. These installations, when located in the open desert, are vulnerable to high-speed raids by mechanized units employing cavalry tactics and techniques.

CHAPTER 3

SUPPORT

Section I. GENERAL

44. Introduction

Combat, combat support, and combat service support units are provided to the forward infantry, mechanized, or armored brigades and battalions as required to assist in the accomplishment of the mission. These units may be organic, attached, in support of, or under operational control of the brigade or battalion. For the purpose of this chapter only, those units normally assisting the brigade or smaller units in combat will be covered.

45. Other Specific References

For a detailed discussion of combat support of infantry and armor elements, see the FM's of the 7- and 17-series. A detailed description of combat service support functions is contained in chapter 3 (secs. III, VI, and VIII) and appendix II, FM 101–5.

Section II. COMBAT SUPPORT

46. General

This section generally covers organic and normal supporting units of mechanized infantry and armored brigades. Nonorganic combat support units available to brigades in the support role include tactical air support; Army aviation; and artillery, chemical, engineer, and ground transportation units. An appropriate number of mechanized infantry battalions and tank battalions are attached to the brigade headquarters according to the operation plan.

47. Tactical Air Support

a. General. The flexibility and long-range striking power of tactical air makes it an important means of destroying the enemy. Superiority in the air, or at least relative freedom of action, is a predominant factor in securing success in desert operations. Tactical air power has three general missions: gaining air superiority, interdicting the battle area, and providing close support. These are inherent in joint air-ground operations and apply equally to desert operations. Since desert areas produce little upon which a military force can survive, extensive supply transportation is necessary. The entire enemy transport network is analyzed as a target system and attacked accordingly. Attacks are directed against rail centers, locomotive repair installations, and ports, if they exist. When the function of these transportation facilities is reduced, and the flexibility of the system is thus impaired, attacks are made on the means of transport such as locomotives (with rolling stock) and surface shipping. Then attention is directed to the last link of the transport system—motor convoys and transshipment installations.

b. Close Support Operations. The lack of concealment, great distances involved, and mobility of forces—each characteristic of desert operations—necessitate increased emphasis on the employment of tactical air in close support of ground operations. The lack of natural cover and concealment makes for ease of target location and provides better than normal conditions for high-level bombing. Installations stand out due to the contrast between regularly shaped objects and the open barrenness of the desert. Movement is readily apparent from the air because of the dust created and the prominence of shadows. Low-level attacks are handicapped by lack of covered approaches; however, this is offset by the increased visibility which enables aircraft to initiate their firing runs from a greater distance. This improved visibility, coupled with the rapid movement, lack of prominent terrain features, and the fluid situations characteristic of desert operations, necessitates positive action to identify friendly

forces to tactical aircraft. Display panels are normally used to identify friendly positions, columns, formations, and single vehicles.

48. Army Aviation

a. General. Army aviation missions do not change when operating in desert areas. Increased emphasis is placed on the use of Army aviation for resupply of widely dispersed, fast-moving units. Factors considered in the employment of Army aviation to support combat operations are the same as for normal operations; however, navigation, aircraft maintenance, allowable cargo loads, and provision of security for landing fields are constant problems. Planning should emphasize maximum utilization of aircraft during the cooler night hours since the lift capability of aircraft is greatly reduced during the heat of the day.

b. Missions. Missions most frequently assigned to Army aviation in desert operations are supply of widely dispersed combat and logistical groups; tactical transport of infantry and supporting troops, adjustment of artillery fire, security and surveillance, command, liaison and courier service, and communication. Suppressive fire missions are conducted by Army aircraft equipped with rockets and light weapons systems. Unlimited visibility and the lack of natural cover and concealment facilitates target location. Antitank guided missiles on helicopters increase the antitank capability of the supported command.

c. Landing Fields (Sites). In most desert areas, the sandy or pebbly ground surface permits good selection of landing fields (sites). This includes location in the immediate vicinity of the supported unit's command post as long as command post security is not jeopardized. In those areas containing large boulders, landing strips (sites) should be carefully marked. Certain hard-packed areas formed by the evaporation of accumulated water become unusable in the event of rain. Salt marshes should be avoided. Landing strips, heliports, and aircraft parking areas can be improved (hardened or stabilized) by various chemical and engineer techniques.

d. Navigation. Lack of reference points on the ground increases navigation problems. These are compounded by the relatively long distances traveled. Aviators should have both tactical maps and aeronautical charts. Sketches are prepared by aviation personnel to supplement maps and photographs. These sketches should indicate various shades of sand, the general pattern of dunes and drifts, salt or mud flats, wreckage, craters, and other features which can be readily identified from the air. Additional navigational equipment may be required to aid aviators in locating areas under conditions of reduced visibility. Homing-in on friendly radio beams, vectoring radar, and using compass and position-indicator systems are a few of these aids. Dead reckoning supplements celestial navigation and electronic aids.

e. Aircraft Maintenance. The majority of aircraft maintenance problems are caused by sand and dust. Aircraft create great clouds of dust and sand when taking off and landing. Sand and dust damage propellers and rotors and are drawn into engines where they act as abrasives on engine parts. Transparent materials such as plastic windows are pitted by blowing sand with a resulting reduction of visibility. Sand adheres to lubricated parts, causing excessive wear. To minimize damage to aircraft parts, landings and takeoffs should be made near parking areas and mooring points to reduce unnecessary taxiing. All openings should be covered as soon as the engine is stopped. Maintenance sites should be selected on the hardest ground available. During daylight, measures to provide shade must be taken; otherwise, tools and equipment become too hot to touch. Engines should be operated at low speeds over loose sand. Areas for engine runups and tests should be situated on rock or on oil-soaked or tarpaulin-covered sand. An unusual increase in oil consumption normally indicates internal wear of parts. Engine life is much shorter in desert environment, but an effective preventive maintenance program will indicate needed repairs before complete engine loss results. Aircraft should be moored in wheel holes to reduce the angle of attack of the wings during sudden and violent winds prevalent in the desert. Spoilers placed on the wings provide additional protection when used with wheel holes.

f. Security. Scant vegetation and lack of terrain features increase the problem of concealment. Aircraft, vehicles, and equipment are widely dispersed and well camouflaged. Improvements to landing fields (sites) which facilitate location by enemy air observation should be avoided. Aircraft in flight are easily spotted by enemy aircraft and successful evasive action is more difficult due to the lack of protecting terrain. Security of

landing fields from enemy ground action is a major problem in desert operations. Widely dispersed units, exposed flanks, and active enemy raiding parties make the local security of landing fields a prime consideration in their selection.

49. Field Artillery

a. General. The principles of employment of field artillery as contained in FM 6–20–1 are valid for desert operations; however, greater emphasis must be placed on movement, dispersion, camouflage, resupply, and maintenance.

b. Employment Considerations.

(1) The fluid nature of desert warfare will require continuous field artillery support at all levels.

(2) Field artillery must be prepared to support highly mobile forces.

(3) Normally, field artillery units will not be employed independently below battalion level.

(4) When centralized control is no longer feasible because of distances, units are attached to other combat elements—either maneuver units or other artillery control headquarters.

(5) The major problems confronting artillery during desert operations are establishment of survey control, ground observation of artillery fires, camouflage, and maintenance of equipment.

(6) The threat of hostile armor attack emphasizes the importance of emplacing pieces to provide rapid direct antitank fire.

c. Movement. Ordinary, relatively flat desert terrain presents no problem to towed and self-propelled artillery; however, mountainous terrain, salt marshes, and dunes restrict movement in some areas. To gain dispersion, wide formations are used in moving cross-country with supported units. Drivers of artillery vehicles must pick their own routes while maintaining the same relative position within the formation based on the planned route. Control is difficult under these conditions of open formations.

d. Positions. In open terrain, artillery and its vehicles are widely dispersed and well camouflaged. They take maximum advantage of all available terrain features such as folds, hillocks, and small dunes.

e. Observation. Ground observation is usually limited by the lack of elevated terrain, by heat waves, duststorms, sandstorms, and difficulty in estimating distance. The scarcity of identifiable landmarks reduces the value of maps and makes observation difficult. Air observation is more dependable than ground observation, but is also limited by some of the above factors. Maximum use is made of forward observers with leading elements, and air observers are extensively employed. Special devices such as periscopes and observation ladders can be used, and a portable observation tower is valuable when the terrain offers no natural vantage point. Sound-ranging, flash-ranging, and radar-ranging are used extensively.

f. Communication. Radio is a major means of communication in deserts because of the few terrain obstructions; also, the speed, mobility, and dispersion in desert operations would require more wire per circuit. It is relatively easy to lay wire cross-country in deserts, but the volume of cross-country tracked and wheeled vehicle traffic makes wire susceptible to being broken. When the tactical situation is stable, as when there is determined enemy opposition, wire may be preferred in forward units because of its greater security and ease of laying. It may often be possible to bury wire circuits for short distances near the area of contact. Wire may be used to supplement radio nets within battalions. Nevertheless, extensive wire nets are seldom found below corps artillery. Pyrotechnics and manual signals may be used for short distances.

g. Supply. Widely separated forces, frequent displacements, lack of roads, and danger of enemy raids on supply columns make logistics a major problem. Commanders assign security forces and weapons to protect supply vehicles operating independently.

h. Maintenance. All equipment must be protected from the abrasive action of dust and sand. Constant maintenance reduces wear on gun tubes and bearing surfaces as well as scoring and pitting of optical lenses. Care is taken to protect towed weapons from sand and dust thrown up by prime movers during movements.

50. Air Defense Artillery

a. General. The lack of natural concealment and cover increases the necessity for air defense artillery. In desert operations, a higher than nor-

mal ratio of air defense artillery units are allocated to the field army.

b. Operations.

(1) Terrain should present no problem to the movement and deployment of self-propelled weapons and mobile missile systems. However, routes and positions must be carefully selected because of the weight of the equipment.

(2) The 24-hour operations requirement poses a problem. During the day, provisions for shade screens for manning crews, protection of handling equipment from the direct rays of the sun, and short tours of duty may be used to maintain efficiency.

(3) Because of their versatility, automatic weapons units may be employed in direct-fire, ground-support roles.

(4) Surface-to-air missile units provide defense against aircraft and limited defense against tactical ballistic missiles. Vulnerability to air attack emphasizes need for efficient performance, and crews must attain a high state of training to perform efficiently under desert conditions.

c. Security. The dispersion of friendly forces requires that a large measure of local security be established for firing positions, command posts, and radar sites. Security plans, with provision for defense against infantry and armor attacks, should be coordinated with nearby friendly forces. Outposts and foot and motorized patrols furnish security in depth. If provisions for close defense against hostile ground attack are required, air defense artillery units must normally be located close to elements of the supported force.

d. Maintenance. Maintenance is continuous. All equipment must be protected from the abrasive action of dust and sand, particularly during movements. Constant movement over rough terrain increases the unserviceability factor of parts of sensitive equipment such as the missiles and radars. Therefore, a greater number of selected spare parts should be provided.

51. Chemical Corps

a. General. The chemical corps furnishes tactical, technical, and logistical support on chemical, biological, radiological operations. Extreme day and night temperatures on the desert cause extremes in the stability of the air. The strong inversion (highly stable) conditions that exist at night are ideal for the use of chemical or biological agents. Since strong lapse (highly unstable) conditions are likely to occur during midday, this is not usually a favorable time to use either type weapons or agents. Under these conditions, additional expenditure of ammunition is required. During the early morning and late evening when the inversion-lapse change occurs, neutral conditions are satisfactory for the use of chemical and biological agents. Other factors to consider when using chemical and biological agents are the vast area available for dispersing troops and the many routes of approach into enemy and friendly positions. To insure maximum results from an intergrated weapons system, the capabilities and limitations of each chemical and biological munition are weighed separately and considered in the light of other available munitions. See paragraph 85 for CBR operations and effect of weather and terrain on employment.

b. Chemical Agents.

(1) Nonpersistent agents are employed against occupied enemy targets where troop density is sufficient to warrant an area attack, or against fortified point targets where the effectiveness of high explosives is limited. Surprise is gained through the use of deception. The strong inversions at night, when low wind speeds are prevalent, keep casualty-producing concentrations effective for long periods of time. This usually results in increased casualties from imperfect gas discipline over and above the primary casualty production caused by surprise. However, the possibility of additional hazards to friendly troops is also increased, which necessitates close coordination in the use of these agents.

(2) The high temperatures during the day markedly reduce the persistence of blister agents. But high temperatures also produce high vapor concentrations which are effective against the skin as well as against the respiratory system of unmasked troops. Since troops can usually move freely in the desert, this limits the effectiveness of these agents for contamination of terrain. Prespiration increases the effectiveness of blister agents, and contamination of troops with liquid

sprayed from aircraft or delivered by massive bombs usually gives good results. Where troops are concentrated in fortified positions because of terrain features or static warfare conditions, blister agents may be used advantageously under many desert conditions for vapor effects against masked personnel.

(3) Nerve agent VX, which is persistent and relatively nonvolatile, is not significantly affected by the extremes of temperature, wind, and air stability found in the desert. It may be effectively used to attack troops well trained in CBR protective measures by circumventing the mask and attacking the skin.

(4) The use of smoke is most effective in early morning and late evening or on an overcast day when neutral atmospheric conditions exist. In addition to its primary use as a screening agent, smoke can also be used effectively for deception purposes.

c. Biological Agents. As with chemical agents, biological agents are best employed during the hours of darkness because of favorable air stability. The heat and sunlight of the desert act as effective decontaminants; also, the persistence of biological agents does not last long after sunrise.

52. Engineers

a. General. Engineer operations in the desert generally include those normal to temperate climates, but a greater effort must be expended on activities made critical by the desert's character. These operations are reconnaissance, installation and removal or destruction of antitank obstacles, development and withdrawal of water supplies, the construction of transport and port facilities, the construction of fortifications, and road development.

b. Water Supply. Water supply is the most important single mission of engineers supporting a desert operation. The search for water sources requires continuous and intensive reconnaissance. Oases occur in the desert, but they are ordinarily separated by great distances. In some areas, water may be obtained by deepening dry wells or by digging into the beds of dry watercourses. Provision should be made for storage of water at waterpoints and wells. With special apparatus for distillation, the water from salt or alkaline ponds and marshes may be made drinkable. Because troops are widely dispersed in desert operations and waterpoints are few, transportation of water over long distances becomes necessary. Sometimes pipelines are used; however, in fast-moving situations hauling water is more practical. This method requires that the engineers be supplied with additional tank trucks and trailers. Water can be moved by aircraft to remote areas in palletized loads and large collapsible containers, or it can be free-fall dropped in other appropriate containers.

c. Offensive Operations. During the offense, engineer operations and facilities are well forward and closely integrated with the supported unit. Close coordination and integration is required because of the absence of a continuous line of contact and because of the fast-moving maneuvers employed. Individual tasks are relatively small and simple. On the other hand, the combined work total exceeds normal requirements. Emphasis is on speed and control of operations over extended areas. Bridging, both fixed and floating, is required occasionally at points of terrain or along routes of communications when these areas are critical to the entire operation. Security measures are taken against enemy air and ground action. Since large minefields can be installed or altered overnight, thorough and constant reconnaissance for mines and obstacles is necessary before an attack. Antitank obstacles should be breached before an armored attack is made. Engineers should accompany the breaching force.

d. Defensive Operations. In the defense, engineer facilities are disposed in depth. Equipment available to supporting engineers such as the bulldozer, combat engineer vehicle, and scoop loaders are useful in helping troops dig in their vehicles and equipment in bivouacs within the range of enemy artillery. Trucks are dug in up to the hoods and tanks are dug in up to the top of the tracks to reduce the height of their silhouettes and provide protection from artillery fire. Lack of natural concealment requires that special emphasis be placed upon camouflage measures. Large camouflage installations defeat their own purpose, but deceptive measures such as dummy installations assume increased importance.

e. Retrograde Operations. In retrograde movements, the destruction of water sources and stocks of fuel and water is important. Wells and pipelines are destroyed, stocks of water are re-

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leased, and sources which cannot be destroyed are contaminated. The extent of destruction, as in all denial operations, is governed by the directives of higher authority which consider plans for the possible future use of the area. Engineers are prepared at all times to execute such destruction or contamination.

f. Mines and Obstacles. The comparatively small number of troops in an area, the limited number of natural obstacles, and the extended area of operations dictate the employment of mines. Not only are mines easily placed but blowing sand effectively conceals evidence of their emplacement. However, sand may adversely affect their proper functioning. Small minefields are of little use since they, like other obstacles, are easily bypassed. Extensive minefields are used to canalize enemy movements into areas where other obstacles may then prove effective. Formidable natural barriers are sometimes present in the form of rock escarpments. Major mine operations are directed toward key terrain features, manmade facilities, and natural resources critical to the enemy force.

g. Destruction or Denial of Water Sources. Destruction of the enemy's water sources can reduce his effectiveness and limit his advance more effectively than any obstacle. Known enemy water sources are top priority targets for air attack. To deny these sources, antipersonnel mines and delayed action mines may be used. Another method of denial is the salting of water sources that will fall to the enemy. One pound of salt to 10 gallons of water makes water stored in cisterns unusable. A small explosive charge is used to stir the water and assist solution. Too powerful a charge will crack the cistern and allow the water to drain away. Another denial method is to pollute the water with oil or dead animals.

h. Ground Control. A desert area normally has little or no existing ground control; and special consideration must be given to the required survey support for artillery, missile, and other using units.

53. Ground Transportation

Additional mechanized infantry and tank battalions are usually assigned to divisions operating in a desert area. When it is necessary to motorize or mechanize infantry battalions, trucks and/or armored personnel carriers are allocated. Mechanization is more suitable for desert operations because it more closely approximates the operational range of tanks. It provides protection to troops against small-arms fire and shell fragments, and it provides some protection against nuclear effects.

54. Antitank Units

a. Open terrain and lack of vegetation enhances the use of the antitank guided missile (ATGM) in the desert. The vulnerability of the crew of truck-mounted ATGM to enemy small-arms fire requires crew and weapon to move frequently. Because of this vulnerability, employment of truck-mounted ATGM is not as effective as the employment of the ATGM from the armored personnel carrier.

b. Missiles may be launched by a gunner from inside the carrier. Carrier-mounted ATGM provide these advantages: armor-protected mobility; a greater facility for carrying missiles; crew protection; and, in some cases, more versatile communications. Desert terrain permits almost unlimited possibilities for use of ATGM against enemy tanks, carriers, and other hard targets.

55. Reconnaissance and Armored Cavalry Units

a. Armored cavalry units perform reconnaissance and provide security for the unit to which assigned or attached and engage in offensive, defensive, and delaying action as an economy force. Both ground and air units are employed.

b. The inherent mobility and extensive and flexible communications of armored cavalry units make them ideally suited for long-range reconnaissance missions which will be required in desert operations. The employment and operations of reconnaissance units organic to maneuver battalions are described in appropriate FM's of the 7- and 17-series. The employment and operations of amored cavalry units are described in appropriate FM's of the 17-series.

56. Communication Support

a. General. Dust and sand, mirages, and heat hamper all types of communication and have an adverse effect on communication equipment. Duststorms damage unprotected equipment and make it difficult for personnel to work in the open. Mirages occasionally make visual communication unreliable and cause distances to be miscalculated.

b. Wire Communication.

(1) Speed, mobility, and dispersion characterize desert operations; therefore, wire communication is not used extensively except in rear areas and in stable situations. If wire commmunication is used, it is planned carefully and economically and every effort is made to avoid laying it prematurely. It is usually laid during the night. If the lack of natural supports for overhead lines makes it necessary, and camouflage measures permit, pole lines are erected. Three poles are lashed together at the top in a tripod arrangement. This prevents the lines from toppling during severe windstorms. When possible, the laying of surface lines is avoided because tracked vehicles dig into the sand and damage the wire. If the wire is buried, its location is marked and the wire routes are plotted on a map.

(2) Although standard wire and cable are well insulated against the heat, it is necessary to inspect the insulation frequently to detect when it begins to lose its protective qualities; it is also necessary to do more than normal wire maintenance.

c. Radio Communication. Radios form a major portion of the communication used during desert operations. This is particularly true during fast-moving situations. In consideration of the terrain conditions and increased distances between units, greater emphasis is placed upon the employment of air-relay or ground-relay radio installations. Pack and vehicle-mounted radios become easily damaged by sandstorms. Radio equipment covers are kept on to reduce sand damage and assist in protecting the sets against extreme temperatures. The supply of dry batteries is increased to offset the high attrition rate caused by exposure to extreme temperatures and direct sunlight. Electrical grounds are poor in desert terrain since the surface soil lacks moisture. This poor grounding reduces radio communication range unless a counterpoise is used.

(1) Radio antennas should be located on high ground above the surrounding terrain. The best communication range for 1- to 20-mc frequencies is obtained by using a counterpoise and locating the antenna near oases or subsurface water (salt marshes).

(2) Whip antennas lose one-fifth to one-third of their normal range in desert terrain. Therefore, complete antenna systems such as horizontal dipole antennas and vertical antennas with adequate counterpoises should be used.

d. Messengers. Foot messengers are normally impractical in deserts because of the great distances between units and the extreme heat. Motor and aircraft messengers are used extensively. They are trained in navigation because of the lack of recognizable landmarks.

e. Visual and Sound Communication. The possibility of distortion by mirages and poor visibility during sandstorms make visual communication difficult. The distances involved, storms, and the need for security hamper sound communications.

Section III. COMBAT SERVICE SUPPORT

57. Supply

a. A unit's tactical effectiveness in the desert depends to a large degree on the combat service support available. Equally, its vulnerability lies in its exposed lines of communications and the immobility of its bases of supply and support. One of the most important facets of desert combat service support is reduction of supply and resupply to essential requirements. However, desert operations generate additional requirements for some types of supply. As one example, personnel needs will require special items of class II and IV equipment in the form of lightweight clothing, additional water cans, and mosquito netting. The feasibility of supply by air should be considered (par. 52*b*). Highly mobile supply points should be established using supply point, truck-to-truck distribution procedures. Commanders should check ration issues closely since caloric intake needs are less in extreme heat.

b. Desert operations are characterized by rapid movement and wide frontages which require major emphasis on class III resupply. A commander plans not only for his immediate needs but for his long-range requirements at increased distances. As supply distances increase, it may be necessary

to request 5,000-gallon tankers from division. By providing mobile class III distributing points well forward, these 5,000-gallon tankers reduce the turnaround time for the 1,200-gallon tankers organic to battalions. Using the bulk facilities of the tankers for refueling is desirable, but a commander must be prepared to provide his unit with adequate class III resupply by using 5-gallon cans if necessary. This method of resupply may require additional transportation.

c. Security is a continuing problem in any supply operation. Combat service support installations and supply columns provide desirable targets and are susceptible to enemy attack. In desert operations, the lack of cover and concealment for such installations and the length of supply lines emphasize security requirements. Providing local security places greater demands on the personnel operating the installations. Commanders should give consideration to providing security reinforcements for combat service support activities, particularly in fast-moving situations. Resupply activities should be accomplished during hours of darkness where possible.

58. Maintenance

a. General. Maintenance is a most important support service in desert operations. Long supply lines and minimum stocks on hand increase the time needed to procure vital replacement items. It is imperative that proper maintenance be performed on equipment on hand and in operation (par. 78).

b. Vehicle Maintenance. The degree of mobility of a unit in desert operations depends upon how well the extreme difficulties encountered in vehicle maintenance are overcome. There are certain items that should be given special consideration.

(1) *Overheating,* Overheating is one of the major problems of operation in the desert; it can cause severe damage to a vehicle if not detected and guarded against. Drivers should be trained to observe the following precautions while operating their vehicles:

(*a*) Frequently check the temperature gage. If the engine is overheating, halt the vehicle into the wind and cool it off by operating the engine at idle speed. Caution must be taken not to halt the vehicle downwind and not to turn the engine off while it is too hot as this can cause the block to crack.

(*b*) Do not remove the side panels from the engine compartment; removal of the panels reduces turbulence of air around the engine and causes overheating.

(*c*) Keep the fan belt tension properly adjusted; keep the fan belt in good condition.

(*d*) Keep the radiator cowling and core free from any refuse.

(*e*) During maintenance inspections, check for cooling system leaks.

(2) *Air cleaner.* The purpose of the air cleaner is to keep airborne impurities out of the working parts of an engine and its accessories. Air cleaner maintenance is a *must* in desert operations if any degree of prolonged engine life is to be assured. If the oil-bath air filter is kept clean it will protect the engine. Drivers should be trained to service the air cleaners as often as driving conditions warrant.[1] When servicing air cleaners, certain items should be checked as follows:

(*a*) Check to see that all assembly and mounting gaskets are secure and in good condition.

(*b*) Inspect the filter elements for their general condition and air filtering capabilities.

(*c*) Inspect the oil-bath air-cleaner-type filters for cleanliness and oil level.

(*d*) Inspect the crankcase breather and the filler cap filters.

(3) *Servicing equipment.*

(*a*) Wipe the sand from all filler caps before removing them.

(*b*) Insure that all dispensers and containers used for servicing are clean before they are used to dispense oils and lubricants.

(*c*) Keep exposed bearing surfaces, such as constant velocity joints, free from sand and dirt. This may necessitate the construction of leather or canvas boots to cover these surfaces when operating in extremely dusty areas.

[1] In World War II desert operations, air cleaners, on certain occasions, had to be cleaned hourly.

(4) *Tires.*

(*a*) The heat, sand, and rough ground surfaces of desert areas shorten tire life. In stony areas, vehicles with dual tires collect and compress stones in the space between the tires. To prevent this from breaking the sidewalls, remove the stones as often as possible. Keep stored tires in covered, well-ventilated areas to prevent deterioration.

(*b*) Maintain tires at the air pressure which provides mobility through the most difficult terrain to be traversed during the normal day's march. Excess time is required to increase or decrease the tire pressure to meet varying terrain conditions.

(5) *Cooling system.*

(*a*) Flush and clean frequently.

(*b*) Use a corrosion inhibitor in the water. Attempts should be made to use alkali-free water.

(*c*) Inspect condition of water pumps and fan belts frequently. Observe level of water in the radiator.

(*d*) Check thermostat for opening and closing at calibrated temperatures.

(6) *Repair parts.* More vehicular repair parts are needed during desert operations than in operations on normal terrain. The maintenance experience of the unit under desert conditions will determine required stocks of repair parts. Those parts normally required include:

(*a*) Axle shafts, wheel bearings, and oil and grease seals.

(*b*) Spring shackles, shackle bolts, complete sets of front and rear spring leaves, propeller shaft universal joints, and pillor blocks.

(*c*) Water pumps and gaskets, fan belts, water hoses, clamps, and tape.

(*d*) Brake, oil, and fuel lines.

(*e*) Wheel and tire lug nuts, valve caps, plugs for oil drainage fittings, caps for gas tanks, radiators, and storage batteries.

(*f*) Panel instruments and extra speedometers and cables for vehicles that operate separately, such as reconnaissance vehicles.

(*g*) Windshields, carburetors, and fuel pumps.

(*h*) Oil filter elements and air cleaners.

c. Ordnance Maintenance Teams. Ordnance maintenance teams are made available to forward units because of the importance of maintenance in the desert. In the attack, these teams follow elements closely to insure quick repair of damaged vehicles and weapons, and they may perform controlled exchange within authorizations if necessary.

(1) A vehicle recovery standing operating procedure is established as soon as possible. The responsibility for recovering and evacuating vehicles from the battlefield is from lower units to higher. If a unit loses a vehicle and is unable to recover it, that unit reports the vehicle's location and condition to the maintenance crew of the next higher unit. Guides are furnished to the crew by the unit concerned. Security personnel accompany the crew to establish listening post and engage enemy patrols, if necessary.

(2) To facilitate the recovery and evacuation of vehicles—

(*a*) A collecting point is established from which division maintenance crews can evacuate vehicles.

(*b*) A thorough plan is made before a recovery operation is started.

(*c*) Only the numbers and types of vehicles suited for a particular job are taken along.

d. Weapons. Windblown sand damages weapons; therefore, adequate measures are taken to avoid permanent damage to their operating parts. Muzzles and other apertures are protected with suitable covers, and weapons are cleaned more often than in other terrain. Individual weapons are disassembled and cleaned with a dry cloth at least once a day. Mechanics and weapons crews inspect tubes, slides, and bearing surfaces periodically to detect abrasions. Stored weapons, which cannot be cleaned daily, are covered with a protective coating of grease. The care and cleaning of all weapons is supervised constantly.

CHAPTER 4

TRAINING

Section I. GENERAL

59. Introduction

Desert training is necessary to prepare individuals and units to live and fight effectively in desert environments. Units alerted for desert service immediately intensify training to instruct troops on how the desert affects men, equipment, and military operations. Much of the training may be accomplished in nondesert areas through conferences and small-unit orientations in order to capitalize on available facilities and time prior to movement to a desert area. Training should be progressively presented. Units should be sufficiently acclimated to the desert before being committed to combat (par. 16).

60. Training Objectives

a. The initial objective of desert training is to prepare the individual mentally and physically for the desert environment. It should include training of the individual soldier in an understanding of the desert and acclimation procedures. This training should be combined with instruction in patrolling, marches, and physical exercise.

b. The second objective is to train individuals and units in desert operations. Emphasis is placed on techniques and tactics peculiar to the desert area; the importance of small unit actions; decentralized operations accentuating initiative, boldness, and determination on the part of the commanders; self-reliance on the part of the individual soldier; and teamwork and control. The training ranges from movement and survival of the individual to the conduct of combined arms operations at the brigade level.

Section II. INDIVIDUAL TRAINING

61. General

Individuals must be thoroughly trained and prepared in subject areas peculiar to desert operations. The well-trained soldier survives and fights effectively and performs his part of the unit mission.

62. Discipline

a. Successful operations in the desert require strict discipline in all phases of daily life. Since desert climates impair the physical efficiency of men, commanders must exercise close control over their units and exhibit a high degree of leadership.

b. Troops often feel depressed and helpless due to their inability to combat the discomforts encountered in the desert. Although shaded areas are practically nonexistent, drywashes and the shadow of vehicles do provide some shade. Mental depression caused by constant dust irritation of the eyes may be countered by use of dust goggles. Morale becomes low during prolonged periods of exposure or inactivity and the intense heat limits physical exercise. All these factors contribute to an attitude that is not conducive to good discipline. The tactical necessity for keeping units widely dispersed, the lack of natural concealment, and the nature of the terrain create a feeling of insecurity among troops. Strong leadership, psychological training, and physical conditioning will help overcome these deficiencies, but discipline must be maintained at all costs.

c. The scarcity of water in desert areas, combined with its importance in maintaining proper body functions, requires that particular attention be given to water discipline (par. 14*e*). Untrained men use about 20 quarts of water per day for all purposes. By gradual training, this can be reduced to about 9 quarts per day. For further discussion or water discipline, see paragraphs 14 and 70.

63. Clothing

Standard clothing is suitable for desert operations. Extreme daily temperature changes during all seasons require warm clothing at night and clothing that offers protection from the sun during the day. Full-length trousers and long-sleeved shirts protect the skin from wounds and infections resulting from sand and dust, insects, thorn scratches, and rock bruises.

a. Headgear. The helmet liner is adequate headgear for desert use and should be worn without the steel helmet except when under attack. The liner provides sufficient airspace for air circulation and offers adequate eyeshade and neck protection.

b. Footgear. The standard combat boot is adequate for desert wear. Soles and heels wear out quickly in desert terrain. Worn soles may be temporarily reinforced with heavy cloth (canvas or sandbag material).

c. Care of Clothing. Because of the scarcity of water, it is difficult to maintain clothing properly. Socks can be washed in water that has been used for bathing. When water is lacking, airing and sunning the clothing helps kill bacteria.

64. Poisonous Reptiles and Insects

Troops stationed in a desert area should be cautioned about the hazard of poisonous snakes and insects. They should be taught to recognize poisonous reptiles and insects and should be informed of their usual habitat (FM 21–76). Troops should also be instructed in first-aid measures for stings or bites (FM 21–11). Preventive measures greatly assist in eliminating the sources of such injuries. These measures include shaking out blankets prior to retiring; checking shelter tents and surrounding area; checking latrine prior to use; shaking out boots and socks before putting them on; and exercising caution while walking among rocks and brush in the desert, particularly in the evening just after sundown.

65. Training in Geographical Orientation and Navigation

a. General. Maintaining direction and locating positions in the desert are extremely difficult because of the absence of roads, trails, and well-defined landmarks. Personnel at all levels should be thoroughly instructed in navigational methods and equipment before participating in desert operations. Commanders should stress the use of maps and the lensatic compass to insure that all personnel obtain a high level of proficiency. Proper use of both is required to determine orientation at a specific location and to maintain direction while moving. This paragraph discusses some of the fundamentals of land navigation that should be understood by all personnel engaged in desert operations. More detailed information on mapreading, use of the compass, and land navigation is contained in FM 21–26.

b. Knowledge of the Area. Early in training, commanders insure that all personnel are thoroughly briefed on the type of terrain and general environment they will encounter. Specifically, personnel should receive instruction in the following: location of water sources; landmarks or any significant terrain features that may be used as landmarks such as clumps of vegetation, mountain ranges, dry streambeds, dry lakebeds, and salt marshes; the location of friendly and enemy positions; the direction of prevailing winds; and any other information that may affect the accomplishment of the mission. Such information will assist reconnaissance elements and personnel who may become separated from their units, to navigate their way back to their units, to water if needed, or to friendly territory.

c. Navigational Equipment.

(1) The sextant, theodolite, miniature gyrocompass, and the universal sun compass are used for precision land navigation. Operation of this equipment requires specially trained navigators and is beyond the scope of this manual.

(2) A direction-and-position indicator may be authorized units operating in the desert. Installed in a vehicle, this device indicates the direction the vehicle is taking and continually plots the direction and distance traveled. Location is presented in the form of universal traverse mercator (UTM) grid coordinates. Appropriate training in the use of this device is desirable during all navigational and orientation classes.

d. Navigators. Every officer and noncommissioned officer involved in desert operations must be able to navigate using the lensatic compass, sun compass, and odometer (mileage indicator). Units that may operate independently should be assigned at least one trained navigator equipped

with the necessary instruments to determine position by astronomical means. Training in celestial navigation is also of great advantage.

e. Determining Direction Without a Compass or Map.

(1) *Daytime.*

(*a*) Shadow-tip method (fig. 6):

Step 1. Place a reasonably straight stick vertically into the ground at a fairly level spot where it will cast a distinct shadow. Mark the shadow tip with a small stone or peg. If the tip of the shadow is difficult to find, tap the end of the stick with your finger and the movement of the shadow will help you locate it.

Step 2. Wait about 10 minutes until the shadow moves a bit. Mark the new position of the shadow tip in the same way as the first. Draw a straight line through the two marks and extend this line past the stick; this is the east-west line.

Step 3. Draw a line from the stick intersecting the east-west line at right angles. (Find the shortest straight line from the base of the stick to the east-west line.) Mark an arrow at the end of this line. The point indicates north. In the southern hemisphere (and at certain times of the year in the tropics), the arrow will point south. The first shadow tip mark is always the west direction and the second mark is always the east direction.

(*b*) During daylight, a watch can be used to determine north. The procedure followed depends upon whether the individual is in the northern or southern hemisphere. In the northern hemisphere, the hour hand of the watch is pointed toward the sun. A line bisecting the smallest angle between 12 o'clock and the hour hand points south. The rearward extension of this line points north (fig. 7). To aid in alining the watch with the sun, a matchstick or similar object may be held perpendicular to the face of the watch at the point to be alined with the sun. The shadow of this object then can be used to assist in obtaining accurate

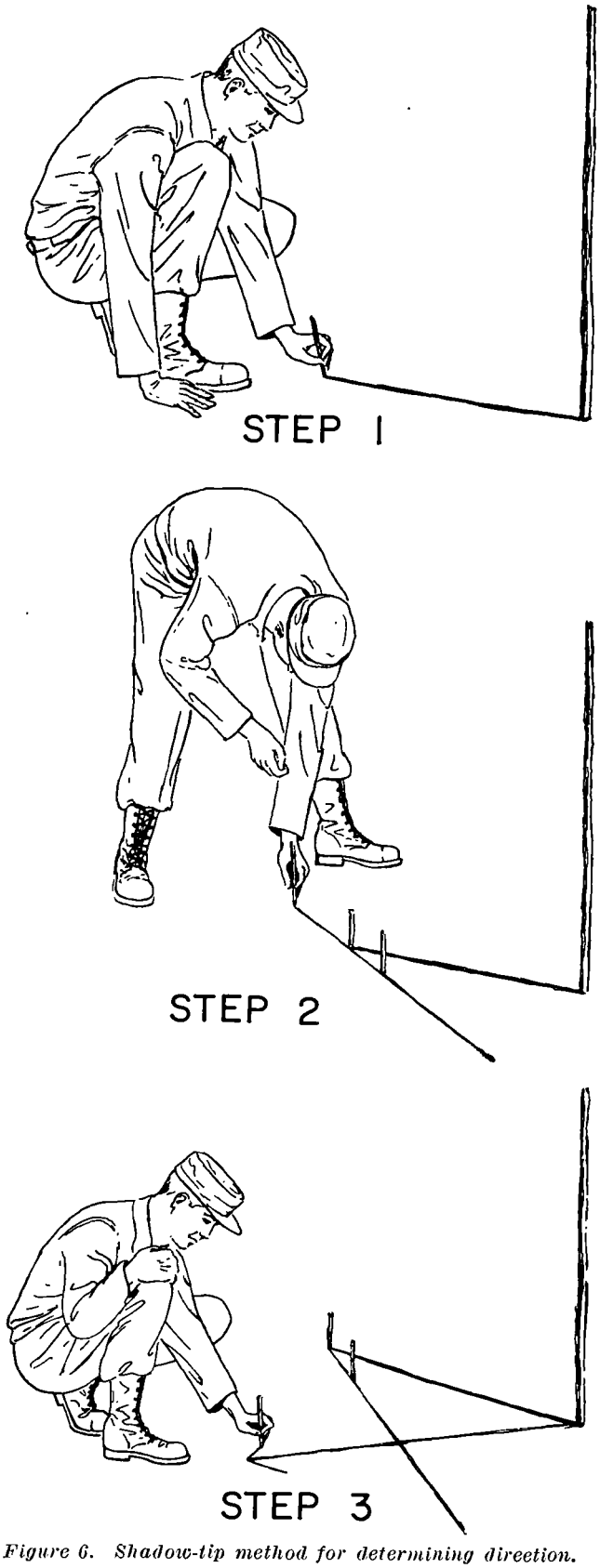

Figure 6. Shadow-tip method for determining direction.

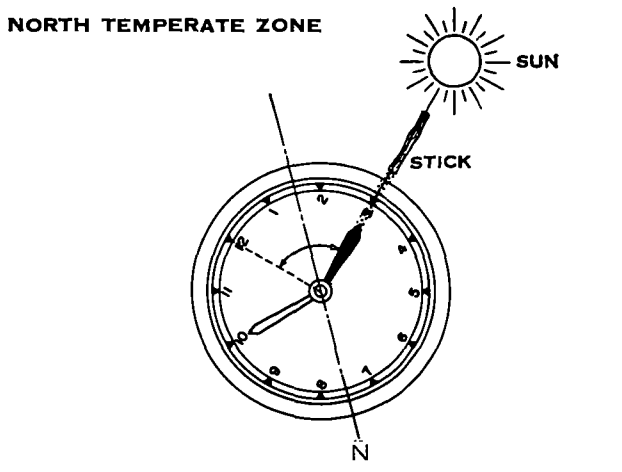

Figure 7. Watch-and-Sun method of determining direction.

alinement. This method cannot be used when the sun is directly overhead.

(2) *Nighttime.* At night, the stars may be used to find north. Again, it depends upon whether the individual is north or south of the equator. North of the equator, the North Star is used to find north. The North Star does not change position in the sky as do other stars, but remains practically stationary and in a northerly direction at all times. There are two constellations (star patterns) in the sky that are used to find the North Star. These are the Big Dipper and the Big W. Figure 8 shows the location of the North Star in relation to these constellations. The two stars that form the side of the cup farthest from the handle of the Big Dipper are known as the "pointer stars." The North Star falls on a straight line drawn through these two stars away from the bottom of the cup. The distance from the North Star to the nearest pointer star is about five times the distance between the pointer stars. The Big W may also be used to find the North Star. The center star of this constellation (the star forming the central peak of the W) points at the North Star. The two constellations, along with the rest of the stars in the sky, revolve about the North Star as a center. The Big Dipper and Big W appear in different parts of the sky at different times of the year, but the pointer stars always point at the North Star no matter what positions the constellations are in. South of the equator there is no bright star about the south axis pole. An approximate position of south can be determined by reference to the constellation commonly known as the Southern Cross. This constellation is formed by four stars as shown in Fgure 9. The approximate direction of south can be determined by measuring straight out from the foot of the cross a distance four and one-half times the length of the cross itself. This imaginary point is the general direction of south. The two stars forming the long axis of the cross are the pointers.

f. Map Orientation.

(1) The fastest and most accurate way to orient a map is with a compass. If a pivot-point protractor appears on the map, draw the magnetic north line. Place the compass over the magnetic north line in such a manner that the sighting wire in the front sight points toward the top of the map and is di-

rectly over the magnetic north line that has been drawn. Turn the map and the compass together until the north arrow of the compass is alined under the index line of the compass. The map is now oriented. For maps that do not have a pivot-point protractor, aline the sighting wire of the compass over a north-south gridline and rotate the map and compass together until the north arrow of the compass points in the same direction and amount from the gridline as shown in the declination diagram.

(2) A map may also be oriented by inspection. This is done by alining the map with visible landmarks. However, landmarks are scarce in the desert and in most cases it will be necessary to determine north prior to orienting the map. Personnel should be cautioned about orienting a map by inspection since the terrain relief may have changed through weather

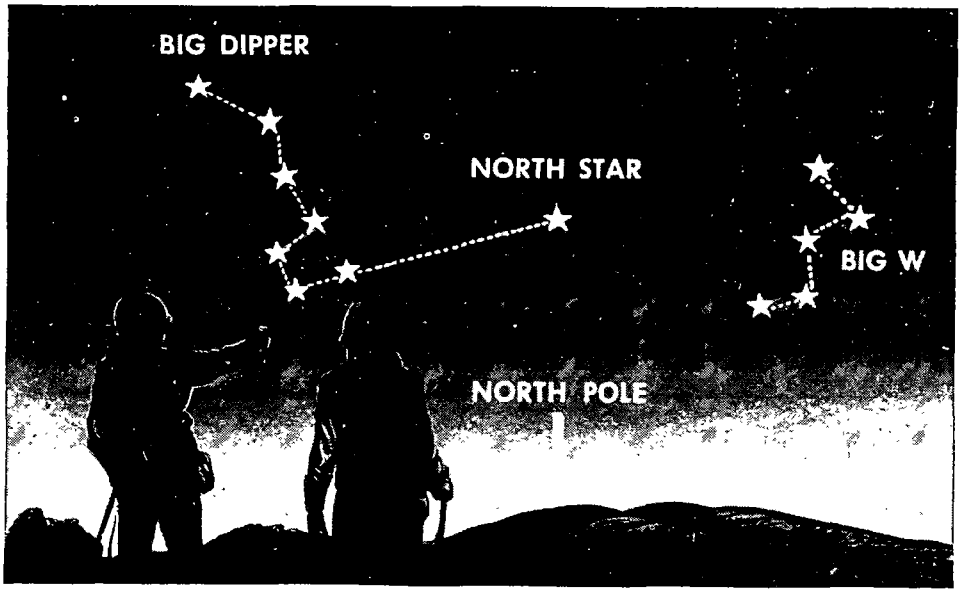

Figure 8. Finding the North Star.

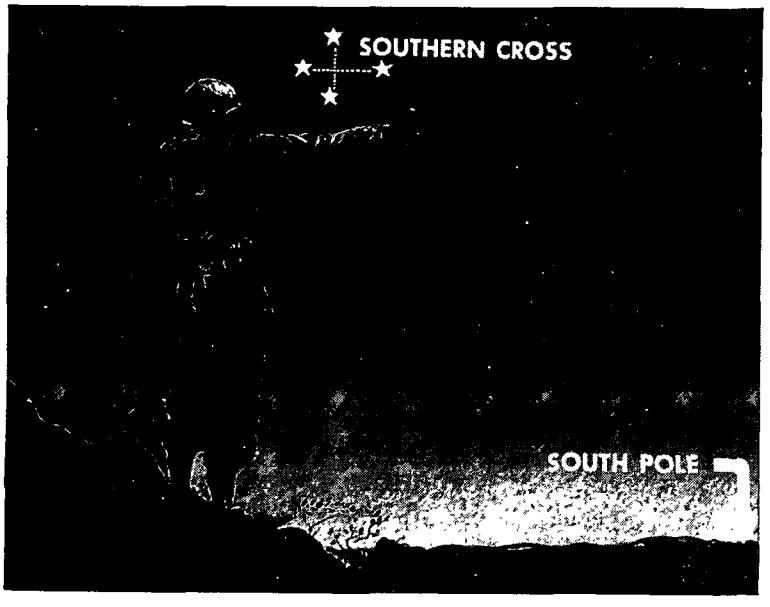

Figure 9. Finding south.

effects, and additional manmade features may have been constructed after preparation of the map.

g. Day and Night Navigation. Navigation is similar for both day and night. Ideally, a map and compass are used to complement each other. Once a map has been oriented, the direction of travel to the destination may be determined. The movable glass disc (Bezel glass) on the compass is turned until the luminous line is directly over the desired azimuth. To facilitate the march, the ground distance (map distance) is computed and recorded. Then, during the march, a pace is kept by selected persons. The distance traveled is then recorded based on a certain number of paces equaling 100 meters. Any attempt at navigating with a map when north has been determined by using the sun and stars is, at best, only an expedient. A compass is more accurate and therefore much more desirable.

h. Dead Reckoning (fig. 10).

(1) The simplest and most reliable system of navigation is known as dead reckoning. This is a means of finding where an individual is located by a continuous plotting of where he has been. More exactly, dead reckoning consists of recording and plotting a series of courses, each measured as to distance and direction from a known starting point, to provide a plot from which the position at any time can be determined. In the desert, the direction traveled is determined with a compass and the distance is measured by counting paces or by reading the odometer of a vehicle. Detailed information on navigation by dead reckoning may be found in FM 21–26.

(2) Figure 10 illustrates a typical plot of a route navigated by dead reckoning over desert terrain. The starting point is at point *A* and the objective is at point *B*. The azimuth to point *B* is 75°. See FM 21–26 for a discussion of an azimuth.

i. Steering Marks. A steering mark is any well-defined object in the direction of travel toward which a navigator may steer. It is easier to follow these marks than to steer continually by compass. A steering mark could be any feature of the terrain, a cloud formation, a wind direction, or a star. A steering mark that is moving, such as a cloud, a star, or the direction of the wind, must be charted periodically by compass. As an aid in maintaining a straight line of travel, it is sometimes helpful to look back at the tire tracks or footprints created by the unit to see if they form a straight line.

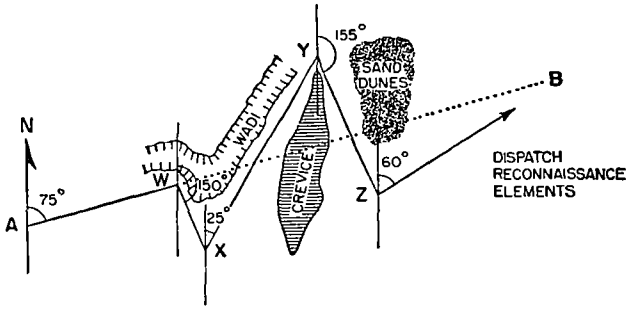

Figure 10. Plot of route navigated by dead reckoning.

j. Reporting of Locations. Due to the scarcity of prominent natural or manmade features in much of the desert, it is difficult to report or designate specific locations without reverting to coded coordinates. A checkpoint system is frequently not practical. However, at least one terrain feature is normally available as a base point from which a polar coordinate system can be established. See FM 21–26 for a discusssion of polar coordinates.

66. Visibility, Observation, and Range Estimation

a. General. Studies indicate that while visibility is almost always good in the desert, it is often very deceptive. Objects frequently appear magnified, and a distant hill may be twice as far away as it appears to be. The absence of trees and other vegetation in the desert prevents comparisons which aid in judging distances. Visibility and range estimation in the desert depend, to a certain extent, upon the time of the year and the time of the day the object or objects are observed. The sun, dust and sand, mirages, wind and moonlight—all these—affect visibility in the desert. In open terrain, sound, flash, laser, and radar-ranging are employed extensively to determine range.

b. Sun. The brilliant sunlight of desert areas reflected from the light-colored ground surface creates a strong glare. An observer with his back to the sun sees objects plainly and without the effects of their shadows. An observer looking into the sun is handicapped by glare and ground re-

flection. His depth perception may be impaired when objects cast shadows or occur in haze. During winter, when the sun is low on the horizon, these effects are magnified. Commanders should consider these effects and, whenever possible, time their attacks when the sun is to their backs.[1]

c. Dust and Sand Storms. During dust and sand storms, air observation is impossible and ground visibility is sometimes less than 100 meters. If a storm is not too heavy, it may be advantageous to conduct offensive operations during the storm to gain surprise and reduce the defender's advantage of observation. The possibility exists of moving up to, or withdrawing from, a position for future operations during a storm of this nature. Small-unit raids can also be planned and executed against enemy defensive positions under these storm conditions. Operations of this nature are similar to those conducted at night. Enemy and friendly communication lines, supply installations, supply routes, minefields, or other obstacles covered by fire can be rendered ineffective during dust and sand storms. Control, maneuver, and large-scale movements are difficult. Observed artillery fire and close air support may be impossible. This places greater importance upon preplanning and prearranged times.

d. Mirages. A mirage makes visibility and ground observation difficult. It is an optical phenomenon encountered in desert regions produced by a layer of hot air of varying density across which an observer sees reflections—usually inverted—of some distant object or objects. It normally occurs when an observer faces the sun. Mirages appear more often during the summer, although it is difficult to generalize under what conditions they will occur and what form they will take. Mirages are visible on a wide arc that increases as the sun rises in the sky, depending upon the season and the hour of the day. The general effect is to magnify objects, particularly in the vertical plane, making it especially difficult to identify vehicles. Under certain conditions, mirages obstruct accurate vision as close as 500 meters, or they distort distant vision.

e. Wind. Windborne dust and smoke created by vehicles and shellfire reduce visibility. Vehicles moving downwind may be blinded by their own dust. A withdrawing unit moving into the wind will be obscured from enemy ground observation by the dust.

f. Moonlight. Moonlight in desert areas is normally much brighter than in other regions. Nights usually are very clear with no haze or glare. Aerial and ground observation is facilitated and may be better than during some periods of the day.

67. Concealment and Camouflage

a. General. In the desert, camouflage problems are encountered that require imagination, ingenuity, and intelligence. The lack of natural overhead cover, the increased range of vision, and the bright tones of the desert terrain place emphasis upon siting, dispersion discipline, and the skillful employment of dummies and decoys to achieve deception or surprise. Shadows cast against the bright background show conspicuous contrasts. Total concealment is rarely achieved, yet proper camouflage measures can reduce the effectiveness of enemy observation and, consequently, of enemy operations. Cover from enemy direct fire may be afforded by dunes, hills, and other irregularities in the desert terrain.

b. Siting. Siting or selection of position is of critical importance in desert operations. One of the basic principles of camouflage is to fit or blend into the existing ground pattern with a minimum amount of change to the original terrain. Valley floors have sparse natural cover, yet drywashes with a thicker growth of vegetation offer opportunities for natural concealment and defilade from oblique observation. In general, it will be necessary to hide "on the pattern" rather than under or behind it, because of the low cover. Since shadows locate and identify objects, all vehicles should be parked with the rear toward the sun—never broadside to the sun. This will minimize the shadow; also, the best results can be obtained by having the shadow fall on low vegetation or rough ground.

c. Camouflage.

(1) Camouflage is especially important in the desert where natural concealment is lacking. Camouflage is used more extensively in desert areas than in normal terrain, and greater emphasis is placed upon artificial means. Camouflage from air or ground observation is extremely difficult to achieve. Movement in daytime is greatly restricted because of the lack of

[1] Effective use was made of this technique throughout the 1956 Sinai conflict.

concealment and cover from air attack; unavoidable dust clouds betray any movement.

(2) All positioned vehicles and weapons should be equipped with camouflage nets. To hide equipment, maximum use is made of shadows in broken ground, wadis, and dune areas as well as the shadows cast by vehicles and weapons. Improperly used shadows, however, will reveal the location and nature of the objects being hidden. Vehicles and weapons are dug-in to conceal, distort, and reduce their shadows.

(3) Camouflage of helicopters is particularly difficult because of their unique geometric design and the highly reflectant surface of their machined parts and skin.

d. Dispersion. Lack of concealment increases the need for dispersion in desert areas. Individuals and units disperse to the maximum extent consistent with the need for security and mutual support. The greater the mobility of a command, the greater the dispersion it can accept, provided adequate means of communication are available. Dispersion between battalion-size elements reduces their vulnerability to enemy aerial or nuclear attack by offering relatively insignificant targets. As a general rule, vehicles should be separated by at least 150 meters during daylight. The interval between vehicles may be reduced at night for security reasons, depending upon the amount of moonlight and the capability of enemy aircraft to observe convoys and installations. The commander constantly weighs his vulnerability resulting from concentration or dispersion.

e. Digging.

(1) One of the basic problems of concealment in the desert is the elimination of cast shadow. The best solution is to reduce the shadow by digging-in (on the principle that the lower the object, the shorter the shadow) and finally merging the shadow with nets or natural materials. Where these measures are not practicable, extensive dispersion is a solution.

(2) When terrain permits, digging-in is a *must* for units that are halted for more than a few minutes. This helps prevent the loss of men and materiel in the case of nuclear or surprise aerial and artillery attack. Suitable ground for digging-in should be a consideration in selecting assembly areas. Upon arrival in an assembly area, trenches should be sited near brush, along sides of rocks, on rough ground, or in the shadow of existing objects. They should be covered by brush, shelter halves, or salvage materials such as old sandbags. If a unit intends to remain in an area for a number of days, vehicles should be dug-in.

f. Vehicles.

(1) Practically all movement in the desert is by vehicle, and this creates special vehicle concealment problems. Vehicle concealment is not for personnel safety alone, nor for the preservation of an individual vehicle. If the enemy spots one vehicle, he will systematically search the area for others and may locate an entire convoy or unit, thus gaining information as to movement and intention. Possible destruction of the entire convoy or unit may result.

(2) In bare desert—either sandy or stony—and in places where vegetation is extremely sparse, the tracks left by a wheeled vehicle are so faint that they are hardly noticeable to the unaided eye beyond about 450 meters. Where the surface consists of patches of pebbles veined with bare light-colored sand, vehicle tracks can be picked out where they cross the pebble patches. This is because the vehicles push the pebbles down and leave two ribbons of light sand exposed. Generally, as long as vehicle tracks are kept dispersed, they are inconspicuous to the unaided eye, provided a number of vehicles do not follow the same tracks.

(3) Vehicles on a patternless background are conspicuous by both their tone and their shadow, while vehicles in or near a patterned background are much less noticeable. It is a case of blending the vehicle with the color and texture of the surrounding terrain. Objects placed on or close beside strongly marked parts of any pattern attract the eye less than the same objects farther removed from these strong features.

(4) Vehicle drivers must be trained to understand and apply the simple rules of concealment. Where vegetation is higher

than the vehicle, the vehicle is placed completely under it. Where a single tree or a small clump of trees does not provide sufficient concealment, the vehicle is parked adjacent to it so that the vehicle shadow is distorted by the shadow of the tree. With smaller plants, the rear of the vehicle is faced toward the sun with the front end of the vehicle touching the plant. The shadow is minimized by the cab and hood, and then further distorted by the plant. In areas where there are low shrubs, the vehicle is sited among them so that the vehicle shadow is disrupted. On broken ground, advantage is taken of the larger rocks to distort the vehicle shadow. Washes and other depressions are excellent locations for vehicles because the banks absorb the shadow. However, it must be remembered that these may become riverbeds during sudden rainstorms.

(5) Metal surfaces on vehicles are treated so that light reflection is kept to a minimum. Camouflage paint or mud is used for all vehicles and equipment. If this is not available, the application of an adhesive such as grease or oil, plus the addition of sand and dust, is a successful treatment. This also applies to the windshield and headlights. However, small openings for vision must be cleared. At halts, some form of dull-colored covering, or brush if available, is placed over the windshield and headlights.

(6) The success of an operation may depend upon the prompt recovery and repair of disabled vehicles. Disabled vehicles are vulnerable targets. If repairable, every effort is made to conceal them. If possible, they are moved to a site offering defilade and concealment. This also provides maintenance vehicles and their crews a degree of protection while working on disabled vehicles. If a disabled vehicle cannot be moved, it is camouflaged by other means, such as the skillful use of nets. It is impossible for a photographic interpreter to distinguish between real, unserviceable, and decoy material when it is concealed with a net, even though the net itself may be discovered.

(7) Numerous coverging vehicle tracks reveal the location of important installations or command posts. To avoid this, vehicles follow designated routes when they approach these areas. Passengers are discharged 300 to 400 meters from the installation, and walk. To assist deception, the main routes or trails continue through the installation. The vehicles proceed to a dispersal area or vehicle park. The paths from dispersal areas to the installation follow a devious, irregular course, through as much cover as possible. In addition to vehicle discipline, maintenance of strict night-light discipline is essential at command posts and other installations.

(8) Vehicles that make abrupt turns to avoid minefields sometimes reveal the location of these fields. Properly controlled, these tracks can deceive enemy air observers and help maintain the security of the minefields.

(9) When time and conditions permit, vehicles should be dug in and further concealed by the use of nets and/or natural materials. In any attempt to conceal a vehicle, the strong contrast of internal shadows cast within the wheel wells and and undercarriage must not be forgotten. These shadows may attract attention when nothing else does.

g. Nets.

(1) The problem of concealment in the desert is different from that of other areas because of the lack of natural cover and features which camouflage can simulate. A camouflage net that relies, as is normal, on concealment by casting irregular shadows to break up the form of the concealed object is useless in desert conditions. To be most effective in desert conditions, a camouflage net must be a COMPLETE COVER which relies on its imitation of the ground surface—both in color and texture—for its effect.

(2) The standard method of garnishing, with the normal percentage of voids, produces too dark an effect even though the garnish is a perfect match in color.

To remedy this, the nets should be garnished solid, without voids, with the garnish threated in long, straight strips. This helps give the net the necessary lightness of texture and tone. There are large areas of the desert where such a net photographs too dark because the fabric texture of the garnish strips deepens the tone. In these areas, a more reflective or smooth material must be used. Probably the most difficult supervisory camouflage task is to get troops to properly garnish the nets for the area in which they are being used.

(3) Drape nets and drape-net sets are the most practical for use in desert terrain. The flattop nets, with the garnish thinned out toward the outer edges, cast conspicuous shadows on the ground.

68. Medical

a. Command Supervision. The protection of health, which enhances the combat effectiveness of a command, requires constant supervision by responsible personnel. Commanding officers are responsible for proper sanitation and the enforcement of sanitary regulations within the boundaries of their organizations. Unit surgeons are responsible for making recommendations for the preservation of the health of the command and for the correction of unsanitary conditions.

b. Evacuation and Hospitalization.

(1) The comparatively great distances between units during combat in deserts limit the availability of medical aidmen. Medical units should be augmented when possible and desert troops should be given additional first-aid training prior to desert operations.

(2) The large area over which a battle is fought presents special problems in the evacuation and treatment of casualties. Any number of casualties in a highly mobile unit restricts the action of that unit and may endanger it. Medical units are furnished a greater number of vehicles for operating in deserts than for operating in other terrain. Medical installations at all echelons are located farther to the rear in the desert. Air evacuation by fixed-wing aircraft and helicopters is particularly valuable because of its speed and the reduction of the load on ground vehicles.

(3) Disease in deserts may cause more than the usual amount of disability because of the added effects of dehydration. The fever that accompanies infections causes an increased loss of water, while diarrhea and vomiting cause the loss of both water and salt from the body.

c. Preventive Medicine and Sanitation.

(1) *General.* Practically every disease of known military significance may be found in the desert among its human inhabitants, animals, and insects, and in locally available water and foods. (See the Health Data Publication appropriate to the area of operations.) Practically all of the communicable diseases will be prevalent among the native population. Insect-borne diseases such as malaria, sand-fly fever, typhus, and plague may be found. The cold of the desert night, even in summer, may require warm clothing, and actual cold injury may occur during the desert winter. It is the desert sunshine, wind, and heat, however, that have the greatest effect upon military operations. The dryness of desert heat distinguishes it from the heat of the tropics and adds to the problem of coping with it. Proper preventive medicine and sanitation measures, adequate personal hygiene, avoidance of native villages and constant command supervision will reduce the incidence of disease and disability.

(2) *Eyes and skin.* The eyes may be protected from the intense sunlight and wind-driven sand by tinted goggles; however, these will not completely protect tank drivers and others constantly exposed to the sun and wind from damage to their eyes. Closed, tight-fitting goggles are required to prevent eye damage from dust. Blackening the area around the eyes reduces the effect of glare and improves distance vision and adaptation to night vision. The desert wind dries exposed skin surfaces and causes chapping of the lips and other local skin irritation of a near-disabling nature. Cuts

and scratches become infected very easily. Chap sticks and protective ointments will provide some protection against these conditions.

(3) *Water supply.* All water not received from engineer water points must be considered contaminated and unfit for drinking, bathing, or for the washing of clothing (par. 14*c*). Natural water, when it is drunk, will transmit such diseases as the dysenteries, typhoid fever, and infectious hepatitis. Parasitic diseases such as snail fever may be acquired by wading, swimming, bathing, or washing clothes in irrigation ditches or other bodies of water. See FM 21–10 for methods of water purification.

(4) *Mess sanitation.* Intestinal diseases tend to increase among men living in the desert. This may be prevented by proper mess sanitation including proper cleaning of eating and cooking utensils, adequate supervision of food handlers, proper disposal of garbage and human wastes, and protection of foods and utensils from the swarms of flies that are found everywhere. Germicidal rinses should be used for washing mess and kitchen gear when water is scarce or cannot be heated because of the enemy situation (FM 21–10). Solid wastes should be burned when the situation permits. Soakage pits should be used to dispose of liquid wastes and should be filled with soil when leaving an area.

(5) *Waste disposal.* Trench-type latrines should be used if the soil is suitable. Shallow latrines quickly become exposed in areas of shifting sands.

(6) *Insect and rodent control.* Insects and rodents must be controlled if the diseases they carry are to be prevented Preventive measures include protective clothing, clothing impregnants, insect repellants, residual and space sprays, immunizations, and suppressive drugs.

(7) *Personal hygiene.* Unit commanders must insure that the proper standards of personal hygiene are maintained. Foot hygiene must be stressed to insure daily washing of feet, changing of socks, and use of foot powder by all personnel. Daily shaving and bathing should be required when sufficient water is available. If sufficient water is not available for bathing, troops may clean themselves by sponge baths or by rubbing themselves with a damp or even a dry cloth. When water is not available for laundering, soiled clothing may still be worn if it is changed frequently and dried in the sun and wind.

69. Food

a. Type Rations. Local food sources normally do not meet military requirements in quantity or sanitary standards. Normal field and emergency rations are adequate for desert operations. The difficulty of operating a unit mess, however, makes rations designed for small-unit use more acceptable than normal field rations. Any ration issued should require only a small amount of water to prepare it. This frequently prevents the use of the dry-pack or cereal-type ration. For emergency food sources for individuals, see FM 21–76.

b. Cooking of Food.

(1) Forward combat units find unit messing difficult because of the nature of the terrain and the enemy situation. Units in rear areas may operate unit mess facilities, after consideration of the threat of nuclear and/or air attack. Normally, in forward areas, small units and individuals prepare their own meals.

(2) Every vehicle should be equipped with a small gasoline or squad-type stove, and each infantry squad should have its own stove. When unit messing is possible, salt and spices should be used with discretion, as both cause thirst. Rations issued to small units should be in cans so that troops can heat them in water from their canteens. This water can then be used to prepare coffee, tea, or other beverages. Soluble coffee, tea, or fruit concentrates can be used to flavor purified water that is brackish and disagreeable to the taste.

70. Water

a. General. The importance of water in desert operations cannot be overemphasized. During training, commanders impress their men with the

vital role water plays. Water discipline becomes a part of a soldier's life.

b. Water Discipline.

(1) Water sources in the desert usually have a high salt content. Troops condition themselves to salt water during training by drinking water containing salt.

(2) Issue periods should be scheduled so troops become accustomed to rationing their water intelligently and safely over a given period.

(3) The problem of water supply is continuous in desert operations; therefore, commanders must instill the idea of water preservation and individual discipline. Troops are oriented as to the water supply problems, methods of self-discipline, and causes of increased water consumption (par. 14).

c. Receptacles for Water. Water for the occupants of a vehicle is carried on the vehicle in five-gallon water cans. In the event of a leak, less water is lost than if the water is placed in larger containers. Each vehicle should be equipped with a funnel the nozzle end of which fits inside the neck of a canteen to prevent water wastage when pouring. If possible, vehicular racks should be installed for water cans and ration containers. These racks should permit rapid unloading if the vehicle has to be abandoned. If such racks cannot be installed, wooden cases or frames should be constructed to hold water cans and ration containers. This prevents accidental puncturing and seam opening, particularly in water cans. Large fixed water tanks are unsuitable for small units. A tank of this size is difficult to handle, requires rigid mounting to prevent tumbling or rolling in a moving vehicle, and prohibits the cleaning of sludge or deposits from the bottom. In most cases, the organic water trailers will be sufficient for holding water reserves.

71. Sleeping

Sleeping areas are easily found in the desert. Crews and personnel assigned to vehicles that are on the move normally sleep in the vicinity of, but not under, their assigned vehicle. The only great danger when sleeping is the possibility of exposure to the cold or to the rays of the sun. This danger can be lessened by supplying personnel with sufficient equipment to protect them when sleeping. During the seasonal rains, sleep is difficult except when tents are used. Sleeping during the day is difficult because of the intense heat. Individuals who sleep outdoors during the day should sleep only in the shade; unit guards can be appointed to watch over groups of sleeping men. Individuals should be warned against sleeping in isolated spots.

Section III. UNIT TRAINING

72. General

Unit training is the natural progression from individual training. Individual training continues as organized units are progressively acclimated and psychologically and physically prepared for further desert training. Training covers physical conditioning, march discipline, land navigation, weapons firing, maintenance procedures, and tactical exercises. Exercises of varied duration in all degrees and conditions of visibility are conducted. Units are trained in mounted and dismounted exercises as appropriate.

73. Physical Conditioning

The extreme daily temperatures in the desert, in conjunction with the lack of water and constant exposure to dust, quickly exhaust unconditioned troops. Commanders establish a strict physical conditioning program for their units. Physical exercises are conducted during the cooler hours of the day and are augmented by rigorous training, such as marches in open sandy terrain during the hottest periods of the day. Medical personnel assist commanders in the supervision of training during the hot hours to prevent unnecessary heat casualties. This conditioning program for all ranks is progressively lengthened and made more difficult so that the transition to the actual desert theater is made easier. Physical conditioning training continues after the unit arrives in the desert.

74. March Discipline (With Emphasis on Land Navigation)

Training in march discipline emphasizes day and night motor marches. It includes loading vehicles, movements over open terrain, long exposure without shelter, and dependence on naviga-

tional techniques to insure direction. Although motor marches are emphasized, foot marches are also conducted (FM 21–18). These marches may be tactical, and land navigation techniques (dead reckoning) are employed to train troops to realize the importance of the map and compass (par. 65).

75. Troop Welfare in the Desert

Every commander is concerned about the welfare of his personnel. This takes on added importance in the desert where no diversion exists. The maintenance of regular postal service is important. All commanders are concerned with the rapid distribution of mail to all personnel, regardless of location. A good newspaper that carries up-to-the-minute news and gives space to the problems which absorb the soldier is also indispensable. Magazines, books, and radios should be made available to alleviate boredom. Although large units can seldom be massed for theatrical performances, motion pictures, or church services, these activities should be made available to reduced numbers of personnel, and should be operated on a continuous schedule as frequently as the tactical situation permits. An active recreational-physical training program can be used to great advantage. A rotation system is required to permit soldiers to relax in a rear area away from the front line environment. Proper leadership, training, and the strengthening of the individual's mental attitude toward himself and the conditions that confront him cannot be overstressed.

76. Night-Firing Exercises

Night-firing exercises under desert conditions are emphasized prior to, and during, desert training. Combat firing involving recognition and designation of targets without binoculars or telescopic sights at maximum effective ranges is stressed. These exercises are conducted with and without artificial illumination to familiarize individuals and weapon crews with the effects of illumination on range estimation and firing accuracy. Familiarization firing with the infrared weapon sight, using both the light source of the weapon sight and other light sources, is conducted.

77. Driver Training

a. General. Because of the general absence of established roads in desert areas, desert driving calls for experience, individual skill, and physical endurance on the part of the vehicle operator. Driver training exercises should be long and arduous to expose vehicle operators to the rigors of the desert as well as to the effect fatigue has on the individual in a desert environment. The need for dispersing and avoiding the tracks of preceding vehicles—when operating over crusted surfaces or when the trail deteriorates while operating over sand (except in suspected mined areas)—is stressed. Training is directed toward providing driver proficiency in operating in dune areas, choice of the best ground, selection of proper gear ratios, and toward driver knowledge and appreciation of the exact capabilities of his vehicle. Driver skill is developed in taking maximum advantage of momentum, gear shifting, estimating and utilizing proper speeds, and in avoiding sudden driving or braking thrust.

b. Terrain Considerations. All drivers must be well trained to judge terrain over which they are driving and the best methods to overcome the varying conditions encountered. The most important single element of successful operations in dune areas is careful route selection on the basis of thorough reconnaissance.

(1) A large portion of desert terrain is flat, hard surfaced, and carpeted with two or three inches of sand. On this type terrain, both wheeled and tracked vehicle travel is unrestricted.

(2) Dunes are shifting ridges of deep, soft sand, formed by the wind, and varying in height from a few inches to several meters. The wind usually packs the surface of the dune, forming a crust about two inches in depth. This crust can support considerable weight, but it breaks under a moderately strong braking or driving force. The best time to traverse soft sand is during the very early morning hours when humidity is highest and the temperature is lowest. High humidity and low temperature are conducive to better traction in soft sand. Generally, dunes can be crossed by vehicles, depending upon the steepness of the slopes, firmness of the crust, and skill of the driver. Medium and heavy wheeled vehicles will not operate efficiently in dunes, but tracked and light wheeled vehicles will.

(3) Vehicles can be stalled and even overturned when sand is only a few inches deep. To prevent this, drivers are trained to take several simple precautions. They learn to start and stop gradually rather than suddenly, because a forceful braking or driving thrust digs the wheels into the sand. The vehicle is kept under power as long as traction is maintained and the vehicle is moving forward. Once the wheels begin to slip, use of power will only bury the wheels deeper. Turns must be wide; sharp turns can stall or overturn a vehicle. Vehicles with dual tires have a greater tendency to bog down and stall in sand than those with single tires. If a vehicle becomes stuck, the driver dismounts and reconnoiters for the nearest firm ground. Channels, mats, and spurs are used to assist in extricating the vehicle (fig. 11). A round, wooden spur is used with light- and medium-weight vehicles with dual tires, and a steel channel is used with vehicles having one tire on each rear wheel. Excavations are made in front of and behind all wheels. The excavation is extended in the direction of travel so that the slope of the channel or spur is very gradual. One end of the channel or spur is placed level with and against the bottom of the tires. The vehicle is then driven out of the deep sand and momentum is maintained until firm ground is reached. Reducing air pressure in the tires increases traction and assists in freeing the vehicle from deep sand. A vehicle resting on its frame or axles is jacked up and the holes created are filled with sand and other material. Dampening sand has the effect of creating a firmer foundation.

(4) In parts of the desert, the wind builds hillocks of sand around shrubs; these hillocks vary in height from a few inches to several meters. These areas in which sand hillocks form vary from a few acres to several square miles. They are usually so spaced that vehicle travel through them is difficult or impossible. These areas should be bypassed whenever possible. When it is not feasible to bypass these areas, trails are made through them with a bulldozer, road grader, or a heavy drag towed behind a tractor.

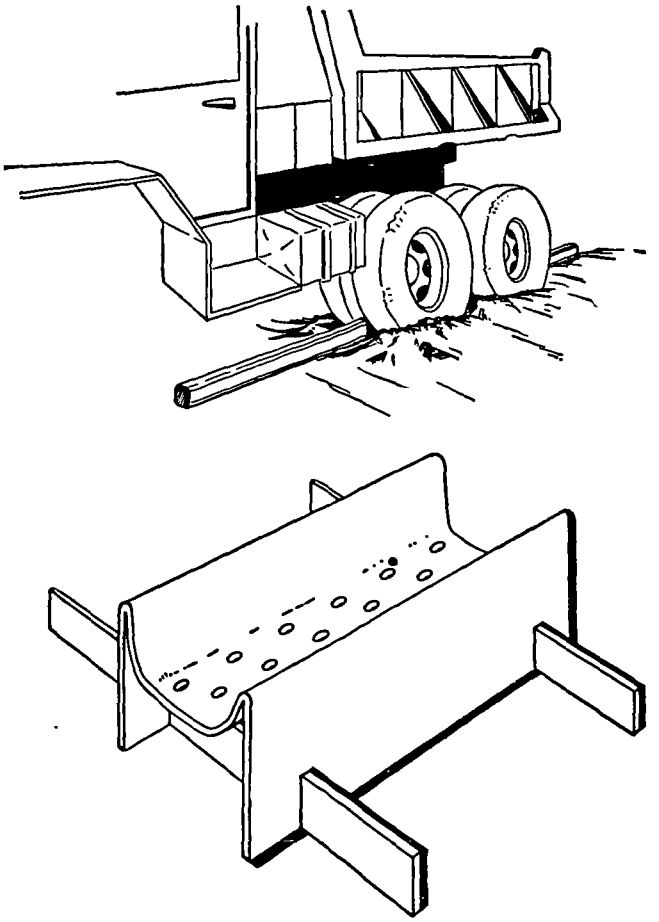

Figure 11. Channels, mats, and spurs are used to assist in extricating vehicles from deep sand.

(5) Rock- and boulder-strewn areas may extend for many miles. Often, these eroded, sharp-edged boulders vary in size and are so numerous that it is impossible to avoid any but the largest. Driving in these areas causes extreme wear on tires, tracks, and springs. Tire pressure can be reduced to eliminate the excess "bump-shock" that is transferred to both the vehicle and its load. Care should be exercised to insure that tire pressure is not reduced to a level that permits rupture of inner canvas plies when the wheel strikes a sharp rock.

(6) Salt marshes are dry lake or stream beds normally encountered along coasts and inland depressions. When the surface is powdery silt or wet, salt marshes are im-

passable. A sandy bed can be crossed by light vehicles. Roads may be built across silt beds by rolling or packing the silt after it has been moistened or by using sand fill. Whenever possible, salt marshes should be bypassed.

c. Other Training. In addition to training under varying terrain conditions, driver training stresses—

(1) Camouflage and digging-in of vehicles.
(2) Night driving and navigation.
(3) Track and dispersion discipline.
(4) Preventive and first-echelon maintenance.
(5) Recovering immobilized vehicles.

78. Maintenance and Recovery

All personnel are trained in basic vehicular maintenance because of the increased number of vehicles and the greater distances between units. A stalled patrol vehicle can result in loss of life if members of the patrol cannot correct the deficiency. Recovery teams of ordnance, infantry, engineer, and armor personnel are organized and trained together. They learn to make on-the-spot repairs, to perform controlled exchange within authorizations, and to evacuate disabled vehicles and weapons.

a. Operating Equipment Under Desert Conditions.

(1) Self-sufficiency is a prime requisite of the fighting man in the desert. This includes his knowledge of self-preservation, desert navigation, tactical principles, and the understanding necessary to operate and maintain the equipment required to accomplish a mission.
(2) Operationally, equipment is only as good as the operator. Dependency and life expectancy of equipment is limited to the degree of care and maintenance afforded; therefore, personnel must be thoroughly trained in the proper use and maintenance of the equipment concerned. The peculiarities of operation in the desert often place emphasis upon maintenance and operational responsibilities of small groups and individuals. Malpractices in the operation of equipment are costly in terms of personnel and equipment losses which adversely affect the tactical operation. Tactical consideration should be given to the nature of terrain over which equipment must travel, and the operator must know the limitations and capabilities of equipment in relation to the terrain. Common sense and careful operation of equipment is the key to extending its life and usefulness.

b. Recovery of Equipment (Field Expedients) Under Desert Conditions.

(1) Field expedients are techniques used to overcome emergencies arising from conditions of terrain, climate, mechanical deficiencies, or breakdown. These include assisting vehicles in crossing obstacles, extracting them from difficult sections of terrain, reclamation, and towing disabled vehicles. They are the means by which personnel can take action to assist themselves when more adequate aid and more qualified assistance are not available. Knowledge of field expedients is necessary for desert operations.
(2) Because of the lack of natural material and anchorages in desert terrain, it is necessary that devices for towing, winching, obtaining traction, lifting, anchoring, and means of limited repair be provided during all movement.

c. Maintenance of Equipment Under Desert Conditions.

(1) Desert terrain and weather present constant problems in maintenance and increase the maintenance time required per hour of operation.
(2) The extreme heat of the desert is a constant threat to the operation of internal combustion engines. The necessary heat dissipation through the cooling and lubricating systems is retarded by high external temperatures. The cooling and lubrication systems depend upon each other; malfunction within either will affect the other. Evaporation of liquids is rapid. The deterioration rate of plastics, rubber, synthetics, and insulation is high (par. 58).
(3) Water economy is very important. Water for cooling systems should be considered in the overall water requirements when movement is anticipated. The cooling system is checked frequently for leaks and obstructions which might impair the function of the radiator. For

each pound of pressure within a water-cooled system, the boiling point is raised 3 degrees F. It is therefore important that radiator pressure caps function properly. Fan belts deteriorate whether in use or in storage. To determine the serviceability of fan belts, remove the fan belt, turn it inside out, and compress the ends of the loop. If the belt has deteriorated, it will break or crack.

(4) Batteries must be given special consideration because of the heat of the desert. Distilled water for storage batteries should be stored in glass or canvas containers rather than in metal cans. In hot areas, the self-discharge rate of batteries is higher and sulfation rate is more rapid; therefore, batteries must be charged and the specific gravity of the electrolyte must be of a value in accordance with the pertinent technical directives. When activating dry-charged batteries, proper procedures must be strictly followed. Overcharging of batteries will evaporate the water more rapidly; regulators should be set to the lowest possible charging rate consistent with the overall requirements. Batteries are not stored near rubber products as the acid fumes are harmful to rubber.

(5) Oils and lubricants should be of proper viscosity and levels should be checked frequently.

(6) Heat from direct sunlight has adverse effects upon plastics, rubber, lubricants, and pressurized gases; for example, CO_2 (carbon dioxide) fire extinguishers must be kept out of the direct rays of the sun or else automatic discharge will occur because of the increased pressure. Sunlight has the power to discolor glass. Tires, fan belts, batteries, optical elements, and other material affected by heat are stored out of the direct rays of the sun.

(7) Depêndent upon the reflective qualities of terrain, the surface temperatures can be considerably higher than the atmospheric temperatures and, because of proximity or actual contact with hot surfaces, tires, cooling systems, lubricants within gear housings, crankcases, and moving parts are affected.

(8) Communication equipment and fire control instruments are damaged by dust, sand, and condensed moisture. Fine grit, blown by strong winds, wears off paint and other protective coating. Wire insulation is often damaged and loses its protective qualities. Optical instruments become scored and pitted when constantly exposed to the elements. Constant care is necessary to keep this equipment in good operating condition.

(9) Windblown sand and dust generated by local movement or agitation increases preventive maintenance problems. Relegated to tactical considerations, the problem of "eating the dust of others" by individual or unit within a group movement can be minimized by dispersion, increased interval, and consideration of wind direction.

(10) Air filters are checked frequently; the frequency of servicing is determined by the responsible personnel. During group movement, air filters should be checked as often as required—at least after every 75 miles of travel. All hoses and connections of the air-fuel induction systems must be tight and in good condition. Sand and dust entering the system can completely destroy an engine within less than 50 miles of travel.

(11) Every precaution is taken to prevent sand and dust from entering crankcases and gear housings and combining with the lubricant. Filler and dipstick caps and gaskets must be in place and in good condition. Oil filters and lubricants require more frequent inspection and replacement. Precautions are taken to guard against sand and dust entering into containers and dispensers.

(12) Slides, linkages, and constant-velocity joints should be oiled and wiped dry. Covers are used and, where necessary, improvised to protect exposed areas. A minimum of grease is used on battery terminals; the terminals can then be wiped clean. More frequent lubrication of moving parts through grease fittings is

necessary because of the capillary action of sand and dust. Other areas not affected by dust and sand should not be lubricated.

(13) In dry, dusty, or sandy areas the exposed surfaces of weapons, such as recoil slides, should be left dry rather than oiled since contamination of the lubricant with sand forms an abrasive paste and is far more damaging than operating with dry surfaces. Covers must be used to prevent dust and sand from entering the breech, muzzle, and operating parts.

(14) When maintenance or repair of equipment requires dismantling or opening any assembly, extreme care must be taken to protect the exposed material from sand and dust. The leeward side of natural or improvised shelter should be used to shield the equipment from dust-laden winds. Exposed material awaiting maintenance or repair must be covered to protect it from sand and dirt.

(15) One of the phenomena of the desert is the high degree of static electricity. This is caused by atmospheric conditions conducive to the induction of static electrical charges by the friction of wind, sand, and materials. Because of the dryness of the terrain, these charges may not "ground out" through ground devices. Clothing and materiel (e.g., vehicles or fuel containers) may have a difference of electrical potential or unlike charges. When contact is made between them, a spark may occur. When inflammable gases are present, ignition occurs and a fire or explosion will result. External load operations by helicopter crews are seriously hampered by static electricity. Hookup is hazardous and danger of fire and/or explosion in oil and ammunition loads exists.

(16) To eliminate the hazards of fire during refueling operations, a metallic circuit must be established and maintained between the containers before and during fuel transfer; i.e., the circuit links the container dispensing fuel to the container receiving fuel.

(17) Friction with consequent electrical discharges within a cargo can cause combustion. Friction generated by rubber tires in contact with certain materials is a common source of cargo fires. Care must be exercised when handling and moving unlike materials that might generate static electricity.

79. Scouting and Patrolling

Training in desert scouting and patrolling is difficult to duplicate in nondesert terrain. Techniques of scouting and patrolling differ in the desert although the basic principles are the same. Most patrols are motorized and conducted over extended distances. The major problem is maintaining direction because of the absence of roads, trails, and landmarks. Initial training consists of navigation, radio procedure, and the organization of various types of patrols. A unit arriving in the desert gives scouting and patrolling a high priority in its training.

80. Deception in Desert Operations

a. Deception, important in any operation, is even more important in desert warfare. Because of the complexity and difficulty of concealment, the commander is often forced to rely on the skillful employment of dummies and decoys to divert the attention of the enemy, deceive him as to the true intentions and plans, and gain the element of surprise.

b. The use of deception in desert warfare will not materially vary from deception in any other terrain except in the increased frequency of use and the greater amount of items displayed. Decoys should be used with realism, and the convincing factor of signs of activity should not be overlooked.

c. Dummy tanks and aircraft, and simulated vehicle parks, supply installations, and airfields can be used to deceive enemy observers. Both manufactured lightweight rubber dummies and locally produced dummies such as trucks disguised as tanks are excellent for deception. The locations of these dummies may be changed nightly.

81. Combat Exercises

a. Units begin training in offensive and defensive combat as soon as practicable after they arrive in the desert (par. 18). Through combat exercises, commanders determine the physical condition of their men and the unit's overall state of training. This includes day and night movements, dispersion, camouflage, march discipline,

and the capabilities of unit leaders. Initially, units may have trouble becoming accustomed to open assembly areas, terrain that is difficult to defend, exposed flanks, the possibilities of wide envelopments, and a general feeling of insecurity.

b. Combat exercises emphasize the combined movement of armor and infantry assault elements. Training stresses coordination between all arms and services to create effective infantry-tank-artillery teams. Training in both day and night movements enables units to make long, difficult moves with comparative ease and speed. Units conduct regular, frequently rehearsed drills in passing defiles, changing direction, dispersing and closing-in, deploying to attack, and establishing and occupying defensive positions. Commanders establish standard formations for subordinate units to facilitate control. Motorized and mechanized infantry units learn to dismount quickly on command and to deploy rapidly for the attack.

82. Types of Combat Exercises

Infantry and armored units are trained to use current doctrine as it pertains to offensive and defensive operations. Units train in such exercises as movement to contact, attack, defense, and retrograde operations. Techniques peculiar to the offense are stressed; e.g., exploitation after the rupture or envelopment of the enemy lines, pursuit and destruction of enemy forces and their lines of communication, turning movements, and infiltration. In defense, the fundamentals are reviewed with attention to all aspects from hasty perimeter techniques up to the more deliberate fortress-type (strongpoint) defensive procedures. Retrograde operations are conducted with emphasis upon delaying tactics. Daylight withdrawals under pressure are stressed even though night-type withdrawals are the most desirable means of disengaging the enemy. Night navigational techniques are used extensively to aid units in orientation and maintaining direction during periods of reduced visibility. Though vehicular mobility is emphasized in these exercises, dismounted operations are also conducted.

83. Mine-Laying Operations

a. General. Mine-laying procedures are integrated into all tactical exercises. Because of the characteristics of desert warfare, emphasis is placed upon slowing and canalizing the enemy in those areas where terrain permits this technique. Extensive use of mines is paramount in reinforcing a hasty or deliberately organized defense, in providing depth, and in slowing or stopping the enemy long enough to attack him with fire and maneuver.

b. Employment.

(1) Landmines are employed in desert regions much the same as in other parts of the world. The wide expanses of open terrain make the installation of minefields expensive both in manpower and equipment.

(2) The enemy can bypass minefields with ease in most desert areas due to the lack of natural obstacles that can be used to anchor the minefields.

c. Considerations. Some special desert characteristics that must be considered in laying minefields are—

(1) Expanses, distances, and lack of well defined routes of movement.
(2) Lack of natural concealment.
(3) Shifting sand in some areas.
(4) Lack of natural obstacles.
(5) Importance of surface water points.
(6) Logistical problems involved in the storage of large numbers of mines required to lay an effective barrier.
(7) Ease of detection by the enemy of mine-laying or clearing teams.
(8) Ease with which the enemy can bypass the mined area.

84. Bivouac Considerations

a. General. A bivouac in a desert, as elsewhere, is a rear assembly area where troops rest and prepare for future movement. Although the possibility of enemy attack is relatively remote—except by air, missile, and long-range artillery fire—normal security measures are taken. Troops normally will not be committed to battle from this position. While in this position, units reorganize, receive replacements, maintain vehicles and equipment, and prepare plans for future actions.

b. Characteristics. The desirable characteristics of a bivouac are—

(1) *Concealment from air and ground observation.* In the desert, where natural concealment is practically nonexistent, the use of artificial camouflage becomes a prime consideration in the location of a bivouac area. Commanders may consider

sending a large enough quartering party to the selected area to accomplish a major portion of camouflaging before the main body arrives.

(2) *Cover from direct fire.* In the desert, it is usually much easier to find cover than concealment. Even relatively small dunes can provide cover. Although cover from direct fire may be obtained, air observers, and observation posts at a higher elevation still may be able to observe the movement and actions of the unit.

(3) *Hardstand.* Because of possible lack of firm ground in desert areas caused by shifting sand and salt marshes, difficulty may be experienced in erecting camouflage or tents.

(4) *Exits and entrances.* It is absolutely necessary for commanders to insure that there is more than one entrance and exit for each bivouac area. In the desert, this poses no problem; however, the commander should emphasize this point for the protection of his unit.

(5) *Ample space for dispersion.* Normally, ample space for dispersion is available in the desert. The commander insures adequate dispersion of vehicles and equipment consistent with necessary security. Dispersion and separation of units as passive defense measures against nuclear attack are considered; however, there is a practical limit to the protection achieved. When distances between units become so great as to preclude effective control and mutual support, combat effectiveness may be reduced disproportionately to the protection gained.

c. Army Aircraft. Army aircraft inspect overhead camouflage so that deficiencies can be corrected. Aerial surveillance is maintained to provide early warning of enemy movements.

d. Organization and Occupation. Requirements for organization and occupation of a bivouac area in the desert are about the same as in any other terrain. Minor adjustments may be required to compensate for extended visibility and increased dispersion.

e. Security. Security in bivouac is obtained by dispersion, tactical disposition of troops, concealment, use of natural and artificial obstacles (including mines), local security measures, reconnaissance, and establishment of blocking positions and observation or listening posts covering all key terrain features and likely avenues of enemy approach. It may also be desirable to establish liaison and communications with forward units. The basic purpose of security while in bivouac is *to prevent surprise* by enemy attack, including a major breakthrough, patrol action, or irregular activity. The commander assigns boundaries between adjacent units on the perimeter and designates specific points at which coordination will be accomplished.

85. CBR Operations

a. General. Authority to initiate the tactical employment of toxic or incapacitating chemical agents, antipersonnel biological agents, or radioactive materials (CBR) is received through command channels. Subject to the guidance of the theater commander, there are no restrictions on the initial employment of riot-control agents, smoke agents, and flame. When the use of toxic or incapacitating chemical agents is initiated, chemical operations are integrated into the fire planning at battalion and higher levels. Authority to employ chemical agents may be retained at division level, or may be delegated to lower echelons. To employ these weapons most effectively, the commander must understand their effects and the influence that terrain and climatic conditions have on chemical and biological agents. The climatic conditions determine to some degree which agents may be employed successfully and which may not. The following paragraphs include a discussion of widely varied desert conditions and their influence on chemical, biological, and radiological agents.

b. Effects of Weather and Terrain on Employment of Chemical Agents.

(1) Weather conditions have an important bearing on any decision to use chemical agents. Although chemical attack can be launched successfully under any weather condition, the weather will influence greatly the extent, duration, location, and severity of the casualty effect. Under some conditions, the cumulative

effect of the weather may place restrictions on the maneuver plan for troop safety reasons which override the advantages from chemical fire support. Optimum conditions for chemical fire support exist when weather is fair and warm and when the atmosphere is relatively stable (or, preferably, when a slow wind is blowing into or across enemy positions). Atmospheric stability in the desert normally exists from an hour before sundown to an hour after sunup. Overcast skies may extend this period. Conditions which cause air turbulence hasten the dissipation of the casualty-producing cloud and minimize the effectiveness of chemical agents. Air turbulence exists during the sunny midday hours when weather fronts (hot or cold) pass by; it also exists during storms and in high velocity winds.

(2) Because chemical agents are heavier than air, they have a tendency to settle and linger in low places such as ravines and gullies. These areas should be avoided, if possible, during and immediately after a chemical attack.

c. Effects of Weather and Terrain on Employment of Biological Agents.

(1) Biological-agent-cloud-travel is affected by meteorological conditions in the same general manner as chemical-agent-cloud-travel. However, the following meteorological conditions have specific application to biological-agent-cloud-travel and employment:

(*a*) *Wind speed.* Biological agents with a high decay rate can be employed effectively at high wind speeds (9 to 18 knots). At these wind speeds, biological agents are exposed to other adverse environmental conditions for a shorter time, and greater area coverage is obtained during the decay period of the biological agent.

(*b*) *Sunlight.* Exposure to sunlight increases the decay rate of a biological agent aerosol, thereby reducing its area coverage. For this reason, in addition to the existence of an unfavorable temperature gradient on sunny days, the preferred time for a biological attack is at night.

(*c*) *Relative humidity.* Low humidity adversely affects the employment of wet biological agents in that it causes microorganisms to dry out and die.

(2) Biological-agent-cloud-travel is affected by terrain characteristics in the same general manner as chemical-agent-cloud-travel. Ground contamination following a biological aerosol attack is not generally considered a hazard to troops crossing or occupying the terrain because of the short life of viable agents.

d. Effects of Weather and Terrain on the Employment of Radioactive Materials. Nuclear weapons may be employed to produce radiological fallout or to contaminate an area with the intent of producing casualties and/or restricting use of the area to enemy personnel. See FM 3–12 for doctrine on operational aspects of radiological defense.

(1) Although weather conditions do not have a detrimental effect on radioactive materials, factors such as wind speed, wind direction, air stability, presence or absence of vegetation, and terrain features influence the dispersal of these agents. These factors often determine whether a lethal dose of radiation will exist in a given area or not. Where the winds are usually strong, radiation may be dispersed over a large area.

(2) Mountains and vegetation often cause irregularities in the dispersal of radiation. Hence, some areas may be void of radiation while other may have a high concentration of radiation or "hot spots."

86. Night Sensory Devices

a. Infrared. All individuals should be thoroughly trained in the use of infrared equipment. In darkness, it is possible to see plainly with the aid of infrared devices. It is possible to use infrared equipment as a guide in the desert by sending out reconnaissance elements equipped with infrared and home-in on its signal. Sand and dust storms reduce the effectiveness of this equipment. Since units are usually more widely dispersed in desert operations, there is value in using infrared to mark boundaries of units. Installed vehicular infrared equipment, weapon sights, and

metascopes also can be used to detect enemy use of infrared equipment. For further guidance on infrared devices, see TC 5–9.

b. Radars. Ground surveillance radars are used to great advantage in desert operations during all conditions of visibility. Although radar is used primarily for night operations, or under conditions of reduced visibility, it may be used effectively during daylight too. While visibility is good in the desert, it is often very deceptive (par. 66). Even under these conditions, a trained radar operator can identify moving objects and determine their range and direction. Radars assist the commander in detecting certain deceptive measures and ruses by determining the number and type of vehicles causing distant dust clouds. Lack of vegetation and terrain obstruction permits effective surveillance at maximum ranges. Radar complements other means in maintaining surveillance between widely dispersed units. When radio silence is imposed, radars can be used to communicate with adjacent units if prearranged signals are established. Field manuals of the 7- and 17-series contain detailed discussions of the capabilities and wide variety of tactical functions performed by radar.

APPENDIX

REFERENCES

AR 320–5	Dictionary of United States Army Terms.
AR 320–50	Military Terms, Abbreviations and Symbols.
FM 1–100	Army Aviation.
FM 3–5	Chemical, Biological, and Radiological (CBR) Operations.
FM 3–10	Chemical and Biological Weapons Employment.
FM 5–15	Field Fortifications.
FM 5–20	Camouflage, Basic Principles and Field Camouflage.
FM 6–20–1	Field Artillery Tactics.
FM 7–11	Rifle Company, Infantry, Airborne Infantry, and Mechanized Infantry.
FM 7–15	Infantry, Airborne Infantry, and Mechanized Infantry, Rifle Platoons and Squads.
FM 7–20	Infantry, Airborne Infantry, and Mechanized Infantry Battalions.
FM 7–30	Infantry, Airborne, and Mechanized Division Brigades.
FM 17–1	Armor Operations: Small Units.
FM 17–15	Tank Units, Platoons, Company, and Battalion.
FM 17–30	The Armored Division Brigade.
FM 17–36	Divisional Armored and Air Cavalry Units.
FM 20–32	Land Mine Warfare.
FM 21–5	Military Training.
FM 21–6	Techniques of Military Instruction.
FM 21–10	Military Sanitation.
FM 21–11	First Aid for Soldiers.
FM 21–15	Care and Use of Individual Clothing and Equipment.
FM 21–18	Foot Marches.
FM 21–26	Map Reading
FM 21–30	Military Symbols.
FM 21–40	Small Unit Procedures in Nuclear, Biological, and Chemical Warfare.
FM 21–41	Soldier's Handbook for Nuclear, Biological and Chemical Warfare.
FM 21–48	Chemical, Biological, and Nuclear Training Exercises and Integrated Training.
FM 21–50	Ranger Training and Ranger Operations.
FM 21–75	Combat Training of the Individual Soldier and Patrolling.
FM 21–76	Survival.
FM 24–18	Field Radio Techniques.
FM 24–20	Field Wire and Field Cable Techniques.
FM 30–5	Combat Intelligence.
FM 30–7	Combat Intelligence Battle Group, Combat Command, and Smaller Units.
FM 30–10	Terrain Intelligence.
FM 31–15	Operations Against Irregular Forces.
FM 31–16	Counterguerrilla Operations.
FM 31–21	Guerrilla Warfare and Special Forces Operations.
FM 31–50	Combat in Fortified and Built-up Areas.
FM 44–1	U.S. Army Air Defense Employment.
FM 55–30	Motor Transportation Operations.
FM 57–10	Army Forces in Joint Airborne Operations.
FM 57–35	Airmobile Operations.
FM 57–38	Pathfinder Operation.
FM 61–100	The Division.
FM 100–5	Field Service Regulations; Operations.
FM 100–10	Field Service Regulations; Administration.
DA Pam 108–1	Index of Army Motion Pictures, Filmstrips, Slides, Tapes, and Phonorecordings.
DA Pam 310–3	Military Publications: Index of Doctrinal, Training, and Organizational Publications.
TC 5–9	Near Infrared Night Vision and Detection Equipment and Its Application.
TM 3–210	Fallout Prediction.
TB MED 175	The Etiology, Prevention, Diagnosis and Treatment of Adverse Effects of Heat.

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NG: State AG (3); units—same as Active Army except allowance is one copy to each unit.

USAR: Same as Active Army except allowance is one copy to each unit. For explanation of abbreviations used see AR 320–50.

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