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Field Manual
No 90-6

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HEADQUARTERS
DEPARTMENT OF THE ARMY
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MOUNTAIN OPERATIONS

PREFACE

The purpose of this manual is to describe how US Army forces fight in mountain regions. Conditions will be encountered in mountains that have a significant effect on military operations. Mountain operations require, among other things, special equipment, special training and acclimatization, and a high degree of self-discipline if operations are to succeed.

Mountains of military significance are generally characterized by rugged compartmented terrain with steep slopes and few natural or manmade lines of communication. Weather in these mountains is seasonal and reaches across the entire spectrum from extreme cold, with ice and snow in most regions during the winter, to extreme heat in some regions during the summer. Although these extremes of weather are important planning considerations, the ***variability*** of weather over a short period of time—and from locality to locality within the confines of a small area—also significantly influences tactical operations.

Historically, the focal point of mountain operations has been the battle to control the heights. Changes in weaponry and equipment have not altered this fact. In all but the most extreme conditions of terrain and weather, infantry, with its light equipment and mobility, remains the basic maneuver force in the mountains. With proper equipment and training, it is ideally suited for fighting the close-in battle commonly associated with mountain warfare. Mechanized infantry can also enter the mountain battle, but it must be prepared to dismount and conduct operations on foot.

*This publication supersedes FM 31-72, 19 May 1964.

Helicopter units of all types can operate in the mountains to support ground maneuver. However, their effectiveness may be degraded by altitude and rugged terrain as well as by weather conditions. Additionally, mountain flying produces added fatigue for flightcrews. Special training in the combined hazards of variable winds and rugged terrain is required.

Combat support and combat service support functions are further complicated by the mountain environment. Lines of communication to support heavy vehicles are limited, as are suitable firing positions for field artillery and air defense artillery units. Support areas are often fragmented along valley corridors, making coordination more difficult and increasing vulnerability to attack. In the mountains, greater dependence is placed on resupply and medical evacuation using aviation assets.

Commanders must understand how severe environmental conditions impact on the capabilities of their units. Special training will be required for all personnel; and, in many cases, special clothing and equipment may also be needed.

This manual tells commanders how to prepare for and conduct mountain operations.

Readers are encouraged to submit substantive comments and recommended changes on DA Form 2028. Submit directly to Commander, US Army Combined Arms Center, ATTN: ATZLCA-DL, Fort Leavenworth, Kansas 66027.

The word "he" or "his" in this publication is intended to include both the masculine and feminine genders and any exception to this will be so noted.

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MOUNTAIN OPERATIONS

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CHAPTER 1

THE ENVIRONMENT AND ITS EFFECTS ON PERSONNEL AND EQUIPMENT

The Environment

There is no simple system available for classifying mountain environments. The specific characteristics of each major mountain range are determined by its soil composition, surface configuration, altitude, latitude, and climatic pattern.

CONTENTS

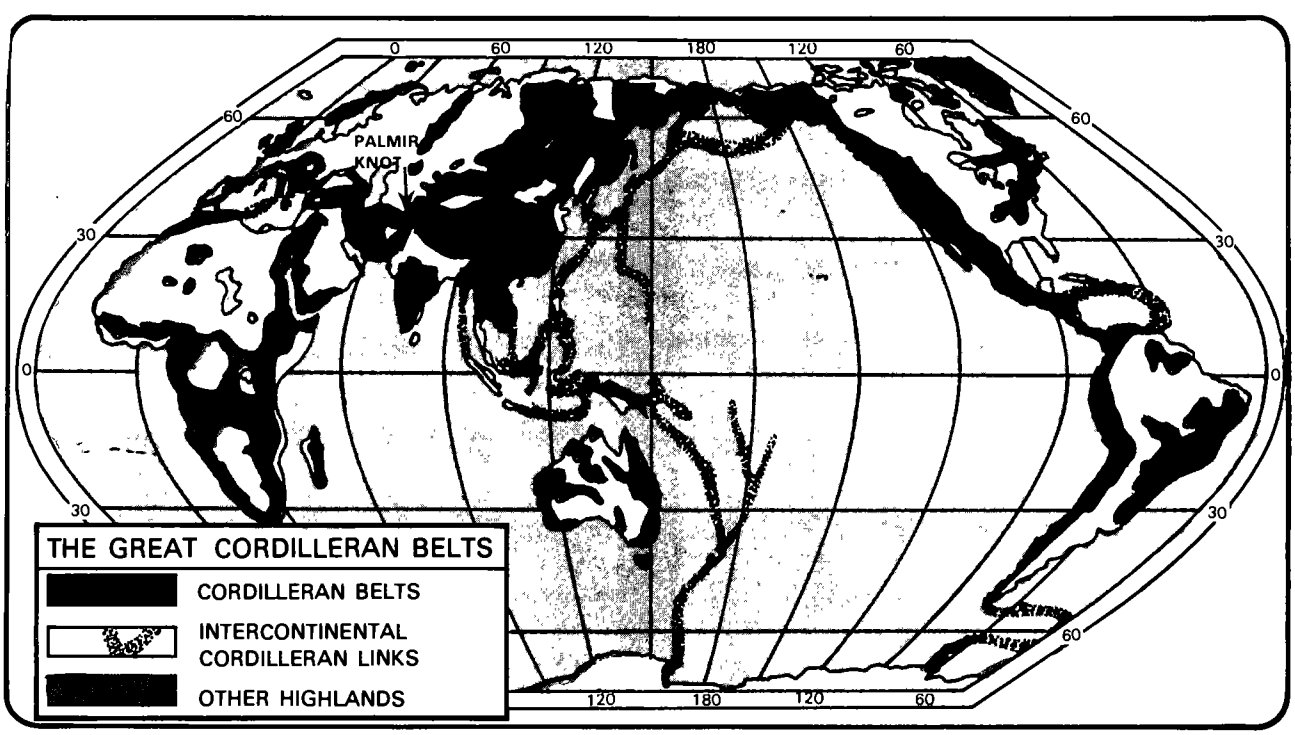
Some mountains, such as those found in desert regions, are dry and barren with temperatures ranging from extreme heat in the summer to extreme cold in the winter. In tropical regions, mountains are frequently covered by lush jungles with heavy seasonal rains and little temperature variation. High, rocky crags, with glaciated peaks and year-nd snow cover, can be found in mountain . .iges at most latitudes along the western portion of the Americas and in Asia.

The principal mountain ranges of the world lie along broad belts as shown below. Called "cordilleras," after the Spanish word for rope, they encircle the Pacific basin and then lead westward across Eurasia into North Africa. Secondary, though less rugged, chains of mountains lie along the Atlantic margins of America and Europe. Only Africa and Australia lack major mountain ranges, although there is a relatively mountainous zone in the eastern part of each land mass.

Western North America is dominated by a broad mountainous region which achieves a width of approximately 1,600 kilometers. It occupies almost all of Alaska, more than a quarter of Canada and the United States, and all but a small portion of Mexico and Central America. The Rocky Mountain Range includes extensive high plains or basins. Numerous peaks in this belt rise above 3,000 meters. Its climate varies from arctic cold to tropical heat, with the full ranges of seasonal and local extremes.

Farther south, the Andes stretch as a continuous, narrow band along the western region of South America. Narrower than its counterpart in the north, this range is less than 800 kilometers wide. However, it continuously exceeds an altitude of 3,000 meters for a distance of 3,200 kilometers.

In its western extreme, the Eurasian mountain belt includes the Pyrenees, Alps, Balkans, and Carpathian ranges of Europe. These loosely linked systems are separated by broad, low basins and cut by numerous valleys. The Atlas Mountains of North Africa are also a part of this belt. Moving eastward into Asia, this system becomes more complex as it reaches the extreme heights of the Hindu Kush and the Himalayas. Just beyond the Pamir Knot on the USSR—Afghanistan frontier, it begins to spread fanwise across all parts of eastern Asia. Branches of this belt continue south along the rugged island chains to New Zealand and northeast through the Bering Sea to Alaska.



Mountainous Regions of the World

TERRAIN

Mountains may rise abruptly from the plains to form a giant barrier or ascend gradually as a series of parallel ridges extending unbroken for great distances. They may consist of varying combinations of isolated peaks, rounded crests, eroded ridges, and high plains cut by valleys, gorges, and deep ravines. Major mountain ranges are extremely complex. No matter what form mountains take, their common denominator is rugged terrain.

Various schemes are used to classify land-surface forms. Appendix G provides a brief description of the mountainous countries of Eurasia and a listing of the principal mountains of the world. The following tables show the major classes of land surfaces and their worldwide distribution.

MAJOR CLASSES OF LAND SURFACES

Slope	Local relief*	Profile	Class
More than 90% gentle slope	0—300 ft	Any	Plains (Flat plains if more than 80% gentle slope and 0—100 ft local relief)
	More than 300 ft	More than 50% of gentle slope is in upper half of elevation range	Tablelands
		More than 50% of gentle slope is in lower half of elevation range	Plains with hills or mountains
Less than 50% gentle slope	0—1,000 ft	Any	Hills
	1,000—3,000 ft	Any	Low mountains
	More than 3,000 ft	Any	High mountains

*Local relief is the difference in elevation between valley floors and the surrounding summits.

PERCENTAGE OF CONTINENTAL AND WORLD LAND AREAS OCCUPIED BY MAJOR LAND-SURFACE TYPES

	North America	South America	Eurasia	Africa	Australia; New Zealand	Antarctica	World
Flat plains	8	15	2	1	4	0	4
Rolling and irregular plains	23	30	30	44	51	0	30
Tablelands	9	10	3	5	1	0	5
Plains with hills or mountains	18	18	11	22	19	0	15
Hills	8	5	10	11	12	0	8
Low mountains	10	11	21	13	12	1	14
High mountains	16	11	23	4	1	1	13
Ice caps	8	0	0	0	0	98	11
Percentage of world area	16	12	36	20	6	10	100

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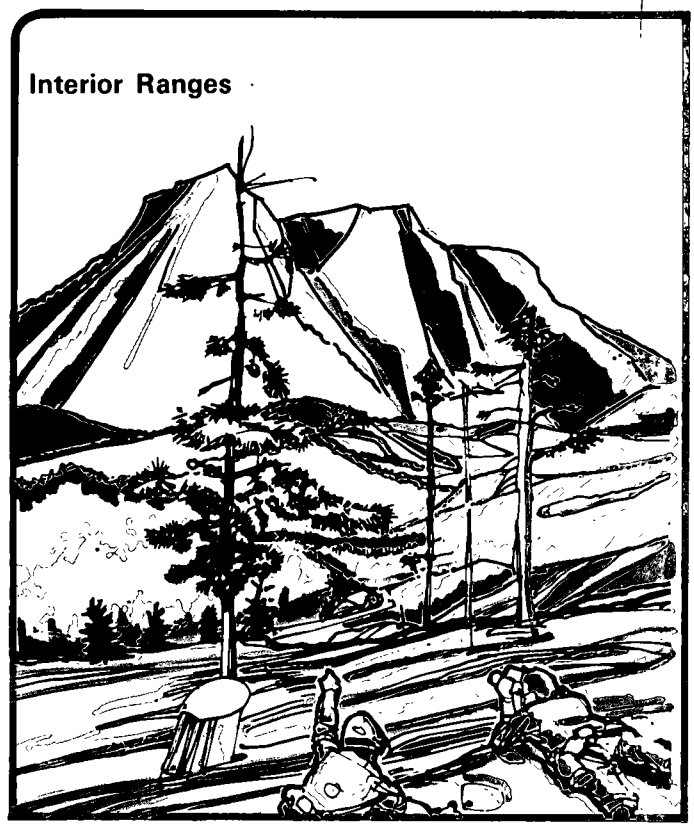


MOUNTAINS OF MILITARY SIGNIFICANCE

Although the geography of mountains is extremely complex, they may be grouped for military application into three basic categories as shown.

INTERIOR RANGES

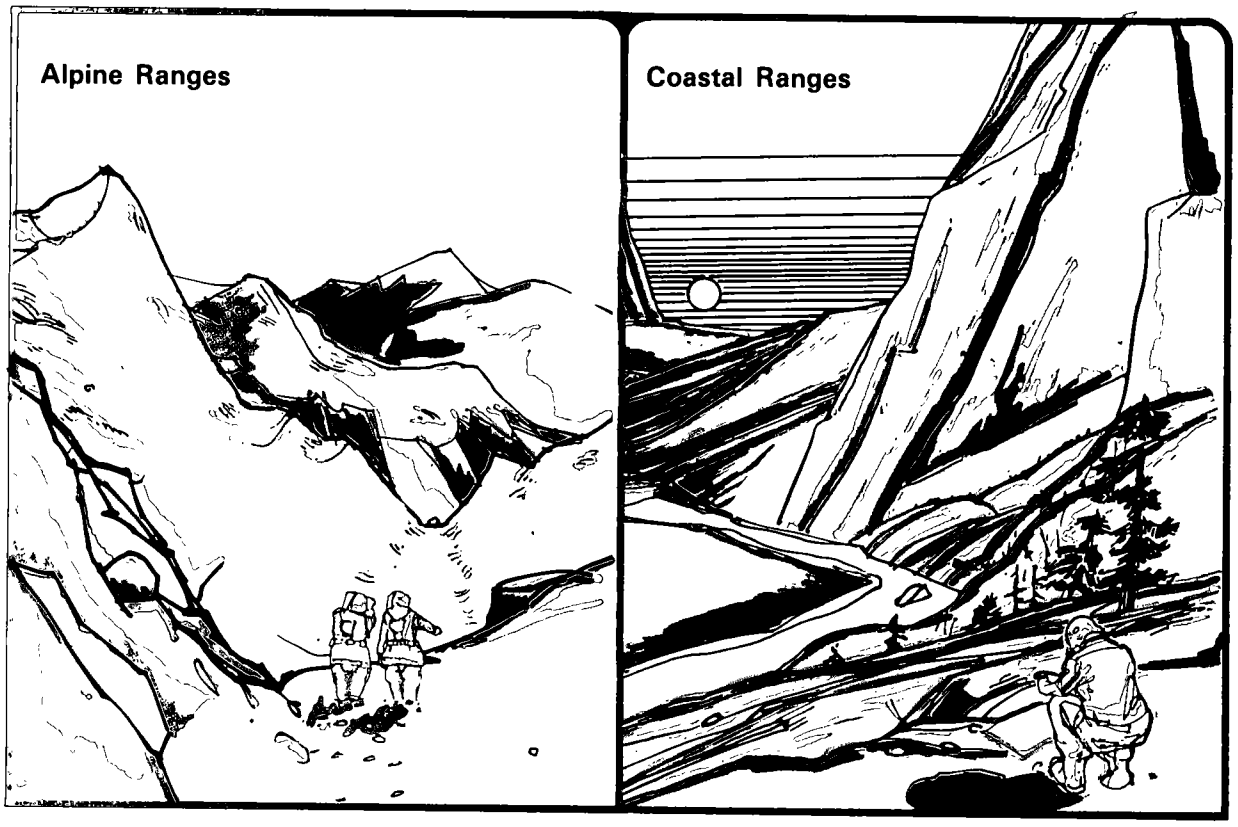
Less formidable than alpine systems, interior ranges may cover large land areas. They are normally complex and incorporate a variety of land forms. They may include large upland plains as well as isolated regions of high peaks that rise above the snowline.

Normally, local relief is less than that experienced in alpine mountains. Their valleys are generally below the timberline and historically have served as invasion routes.

Terrain in these regions is characterized by precipitous slopes and vertical crags rising above the timberline. Some peaks may be packed with snow and ice the year around. Deep valleys and upland meadows are usually covered with vegetation. During winter months, valleys and mountain slopes may be blanketed with snow—often making movement extremely difficult. During spring thaws or heavy rains, rivers and streams may become deep, swift torrents.

Roads and railways are few and normally follow the valleys. In general, there are wide variations in land features, climate, and vegetation with changes in altitude and latitude. There is often a lack of natural resources; hence, populations may be severely limited.

As in alpine regions, units may be fragmented in many cases by rugged terrain on the heights separating natural communications corridors. However, greater effort will be expended in these ranges fighting along the terrain overlooking the valley floors.



ALPINE RANGES

Typified by the Alps of central Europe, such ranges contain high rugged peaks and meadows or plateaus that extend well above the regional snowline. Frequently, glacial ice and snow remain on the ground throughout the year. Alpine peaks are normally unclimbable except by the most experienced climbers and only during favorable weather conditions. Abrupt slopes, sharp peaks and ridges, exposed bedrock, numerous lakes, and large masses of rock and gravel deposited by glaciers are common in alpine ranges. Valleys, separated by almost impenetrable masses of high crags, generally rise to narrow passes to form lines of communication. Such passes are often closed by snow during the winter season. In alpine regions, the battle is fought along these valleys and the terrain which dominates and controls the passes. The intervening highlands can fragment major units operating in such regions.

COASTAL RANGES

Terrain along many coastal regions has been sculptured by erosion from glacial movement, wind, and water. Examples of coastal ranges include the fjords of Norway and the mountains of southern Alaska, British Columbia, southern Chile, and the Pacific Northwest. Coastal mountains generally have less local relief than other types of ranges.

Although most peaks do not rise above the timberline, many slopes are void of vegetation because of their steepness and rocky surface. Roads and railways are normally limited. High altitudes and their associated climatic problems are seldom encountered in this category of mountainous terrain; but in the higher latitudes where weather can be extreme, there may be sufficient snowfall during the winter to close the few existing roads.

CLIMATE AND WEATHER

There is no such thing as a specific mountain climate in the same sense that climates for other regions have been classified. An almost endless variety of local climates exists within mountain regions.

Conditions change markedly with altitude, latitude, and exposure to atmospheric winds and air masses. In addition, the climatic patterns of two ranges located at basically the same latitude may differ radically.

Valleys or plateaus enclosed by major ranges differ climatically from surrounding exposed peaks; windward slopes contrast significantly with those having leeward positions; and slopes inclined toward the sun are dissimilar to those facing the opposite direction. At higher altitudes, noticeable differences in temperature may exist between sunny and shady areas or between those exposed to wind and those that are protected from it.

Mountain weather can be extremely erratic, varying from strong winds to calm, and from extreme cold to relative warmth within a short span of time or minor shift in locality. The severity and variance of the weather causes it to have a significant impact on military operations.

Every effort must be made to anticipate the weather and be prepared to use it to best advantage. Personnel who are properly trained, clothed, equipped, and supplied may often convert mountain weather into an ally.

TEMPERATURE

Normally, a temperature drop of 3 to 5 degrees Fahrenheit per 300-meter gain in altitude will be encountered. In an atmosphere containing considerable water vapor, the temperature drops about 1 degree Fahrenheit for every 100-meter rise in altitude. In very dry air, it drops about 1 degree Fahrenheit for every 50 meters. Frequently, however, on cold, clear, calm mornings when a troop movement or climb is started from a valley, higher temperatures may be encountered as altitude is gained. This reversal of the normal situation is called *temperature inversion.*

At high altitudes, there may be differences of 40 to 50 degrees Fahrenheit between the temperature in the sun and that in the shade. Besides permitting rapid heating, the clear air at high altitudes also favors rapid cooling at night. Consequently, the temperature rises swiftly after sunrise and drops quickly after sunset. Much of the chilled air drains downward so that the differences between day and night temperatures are greater in valleys than on slopes.

WIND

In high mountains, the ridges and passes are seldom calm; by contrast, strong winds in protected valleys are rare. Normally, wind velocity increases with altitude and is accentuated by mountainous terrain.

Winds are accelerated when they are forced over ridges and peaks or when they funnel through mountain passes and canyons. Wind may blow with great force on an exposed mountainside or summit. Mountain winds cause rapid temperature changes and may result in blowing snow, sand, or debris which impairs movement and observation.

PRECIPITATION

Precipitation in mountains increases with height. Maximum cloudiness and precipitation generally occur near 1,800 meters elevation in middle latitudes and at lower levels approaching the poles. Usually, a heavily wooded belt marks the zone of maximum precipitation.

Both rain and snow are common to mountain regions. Rain presents the same challenges as in lower regions, but snow has a significant influence on all operations. Snow is classified as either *powder* or *compact* snow. Powder is snow in its early stages and is further classified as *new* snow or *settling* snow. Compact snow has passed through the settling stage. Attention to the type of snow is important because some forms are quite hazardous.

The snow is subject to various modifications during its transition from dry new snow to glacier ice. Temperature, humidity, and wind are important modifying factors in this transition. The following phenomena are important to the mountain soldier:

- ***Sun Crust***—Any snow that has had the superficial layer melted by heat and has subsequently refrozen. Sun crust commonly overlies powder snow.

- **Wind Crust** or ***Windpacked Snow***—Usually found on windward slopes, it is anchored firmly to the underlying snow. Wind crust is generally safe and unlikely to result in an avalanche.

- ***Wind Slab***—Formed from snow transported and deposited by winds. While the slabs themselves are well compacted, they are loosely anchored to the underlying surface and generally will have an air space between the slab and the underlying snow. Wind slabs are extremely dangerous because they often provide the platform for subsequent avalanches (see appendix F, Avalanches).

FOG

The effects of fog are the same as in lower regions; but, because of the topography, fog occurs more frequently. The high incidence of fog makes it a more significant consideration in planning than would normally be the case.

THUNDERSTORMS

Although thunderstorms are local in nature and usually of short duration, they can handicap operations in the mountains. In alpine zones, thunderstorms are often accompanied by driving snow and sudden wind squalls. Ridges and peaks become focal points of dangerous electrical activity. Statistics show that lightning is not one of the major hazards of mountaineering, but it should not be ignored and normal precautions should be taken promptly.

TRAVELING STORMS

The most severe weather condition in the mountains—storms involving strong winds and heavy precipitation—are the result of widespread atmospheric disturbances which generally travel in an easterly direction. If a traveling storm is encountered in the alpine zone during winter, expect low temperatures, high winds, and blinding snow. Specific weather conditions will vary, depending on the path of the storm. However, when colder weather moves in, clearing at high altitudes is usually slower than the onset of cloudiness, and stormy conditions may last several days longer than in the lowlands.

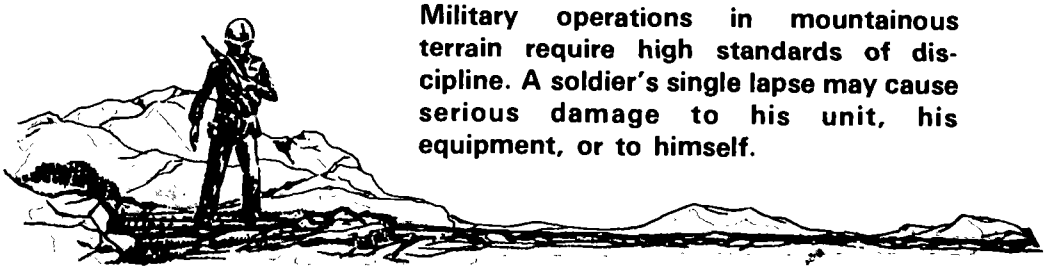
The following table highlights the possible effects of various weather conditions in mountainous regions.

POSSIBLE WEATHER EFFECTS COMPARISON

Weather Condition	Normal Effects	Possible Mountain Effects
Sunshine.	None.	• Increased potential for snow blindness and sunburn. • Avalanches (annex F). • Severe temperature differences between sun and shade.
Rain.	• Reduced visibility. • Cooler temperatures.	• Reduced visibility. • Cooler temperatures. • Land slides. • Flash floods.
Snow.	• Reduced mobility. • Increased incidence of cold weather injury. • Reduced visibility. • Snow blindness. • Blowing snow.	• Severely reduced mobility. • Increased incidence of cold weather injury. • Avalanches. • Snow blindness. • Reduced visibility. • Blowing or driven snow.
Wind.	• Windchill. • Blowing debris.	• Severe windchill. • Blowing or driven snow or debris causing reduced visibility.
Fog.	• Reduced mobility. • Reduced visibility.	• Reduced mobility. • Reduced visibility.
Cloudiness.	None.	• Greatly decreased visibility at higher altitudes.
Storms.	• Rain/snow. • Reduced visibility. • Lightning.	• Heavy, blinding rain/snow. • High winds. • Severely reduced mobility/visibility. • Lightning. • Extended duration.

Environmental Effects on Personnel

The mountain environment is one of the specialized operational areas of the world which present the commander and his troops with unique physiological and psychological challenges. The mountain environment is essentially neutral, affecting both sides equally; however, the side whose soldiers are best prepared for mountain operations has a distinct advantage.



Military operations in mountainous terrain require high standards of discipline. A soldier's single lapse may cause serious damage to his unit, his equipment, or to himself.

CONDITIONING AND ACCLIMATIZATION

If soldiers are subjected to heavy work following rapid transport from sea level to an elevation of 4,200 meters, it is likely that 60 percent of them will become ill and may become ineffective. After months in a high-altitude environment, 70 percent of sea level work capacity standards *may* be attained by acclimatized troops. For operations above 2,500 meters, acclimatization is required. A training program of graduated physical exercises of various types, including marches and climbs which require increased stamina and endurance, is mandatory. With such training, men acquire increased confidence and ability to safely negotiate terrain which they had previously considered impassable.

There are two different types of acclimatization in mountain environments. Psychological as well as physiological adjustment is required. Complete acclimatization occurs only when personnel realize their own limitations and those of their equipment.

BEHAVIORAL EFFECTS AND PSYCHOLOGICAL ADJUSTMENT

High altitude often affects people mentally. Listed below are some of the behavioral effects that may occur in unacclimatized personnel:

- O Increased errors in performing simple mental arithmetic.
- O Decreased ability for sustained concentration.
- O Deterioration of memory.
- O Decreased vigilance.
- O Increased irritability.

Self-evaluation is also impaired, and during the first few days in high altitudes leaders will find it difficult to maintain coordination and discipline. Errors in judgment that would never occur at lower altitudes are common.

Many of the psychological adjustments that must be made are due to preconceived notions about the supposedly harmful effects of high altitudes. These adjustments are made easier by a well-planned period of acclimatization and conditioning, coupled with educational programs on high-altitude effects.

SUN, SNOW, AND WIND EFFECTS

SUNBURN

Sunlight in moderate amounts is not injurious to health, but harmful effects can be produced by excessive exposure to ultraviolet radiation. Exposure to ultraviolet light at high elevations is generally greater than that at sea level because of the clear atmosphere and the reflection from glaciers and snowfields. Soldiers at high altitudes must therefore take special care to prevent sunburn. Whenever possible, exposure should be gradual to permit natural tanning and thickening of the skin. For some light-skinned individuals, adequate tanning is impossible. Prevention of sunburn requires frequent and liberal application of Army-issued sunscreen lotion. However, soldiers must remember that excessive sweating and wiping of the neck and face tend to remove applied lotion. The nose, cheeks, neck, and ears are most frequently sunburned. Sunburn can result in painful blistering and can lead to other forms of illness.

SNOW BLINDNESS

Snow reflects about 75 percent of the sun's rays. Excessive exposure to the sun's rays can result in snow blindness. During the actual period of exposure, there is no sensation other than brightness to warn the soldier. However, when symptoms do occur, moving and blinking of the eyes is extremely painful and exposure to normal light may also cause pain. A severe case of snow blindness may be completely disabling for several days.

Snow blindness can be prevented by consistent use of proper sunglasses or goggles. If sunglasses are used, they should be large and sufficiently curved to block most of the reflected light coming from below and from the sides. Aviator sunglasses are not adequate for this purpose. If proper glasses or goggles are not available, soldiers can improvise slitted glasses from cardboard, thin wood, tree bark, or any other available material.

FROSTBITE

The freezing of some part of the body caused by exposure to extreme temperatures is a constant hazard when the wind is strong. Frostbite injuries are not peculiar to the mountain environment. However, high altitude increases the chance of frostbite by reducing the flow of blood to the extremities. Soldiers must wear proper clothing for protection against cold and wind. The face especially must be protected in high winds and when exposed to aircraft propeller or rotor blast. Also, soldiers must make every effort to keep their clothing and bodies dry. They must avoid perspiring excessively. For heavy work, outer layers of clothing should be removed and then replaced as soon as work is stopped.

The "buddy system" is one of the prime preventers of frostbite. Soldiers must watch each other for signs of frostbite and provide mutual aid if frostbite occurs.

WINDCHILL

The following chart shows the coupling effect of wind and temperature on the human body. Commanders at all levels should take this effect into consideration when planning or conducting operations under such adverse conditions.

WIND SPEED		COOLING POWER OF WIND EXPRESSED AS "EQUIVALENT CHILL TEMPERATURE"																				
KNOTS	MPH	TEMPERATURE (°F)																				
CALM	CALM	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	-50	-55	-60
3- 6	5	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	-50	-55	-60	-70
7-10	10	30	20	15	10	5	0	-10	-15	-20	-25	-35	-40	-45	-50	-60	-65	-70	-75	-80	-90	-95
11-15	15	25	15	10	0	-5	-10	-20	-25	-30	-40	-45	-50	-60	-65	-70	-80	-85	-90	-100	-105	-110
16-19	20	20	10	5	0	-10	-15	-25	-30	-35	-45	-50	-60	-65	-75	-80	-85	-95	-100	-110	-115	-120
20-23	25	15	10	0	-5	-15	-20	-30	-35	-45	-50	-60	-65	-75	-80	-90	-95	-105	-110	-120	-125	-135
24-28	30	10	5	0	-10	-20	-25	-30	-40	-50	-55	-65	-70	-80	-85	-95	-100	-110	-115	-125	-130	-140
29-32	35	10	5	-5	-10	-20	-30	-35	-40	-50	-60	-65	-75	-80	-90	-100	-105	-115	-120	-130	-135	-145
33-36	40	10	0	-5	-15	-20	-30	-35	-45	-55	-60	-70	-75	-85	-95	-100	-110	-115	-125	-130	-140	-150
		LITTLE DANGER					INCREASING DANGER (Flesh may freeze within 1 minute)						GREAT DANGER (Flesh may freeze within 30 secs)									

MEDICAL CONSIDERATIONS

The mountain environment can lead to unique illnesses and injuries. See chapter 5 for a detailed description of causes, symptoms, treatment, and preventive measures.

NUTRITION

Success of operations in mountains will be affected by proper nutrition. Because higher altitudes have curious effects on eating habits, precautions must be taken. At least one hot meal per day should be served. Increased fatigue from working at high altitudes may cause soldiers to be disinterested in heating combat rations. Decreased consumption because of unpalatability of cold rations may result in malnutrition. Commanders should attempt

to see that heat tablets are issued with combat rations, or that natural materials for heating rations are used if the tactical situation permits. An increase in rations may be desirable. An effort should be made to provide palatable foods such as soup, fruits, fruit juice, sweetened beverages, and candy. Dehydrated soups make an excellent ration supplement, especially in cold/wet climates. Loss of weight during the first few days is characteristic because of loss of appetite, dehydration, and changes in metabolism. Below 4,500 meters, carbohydrate foods are preferred to noncarbohydrate foods.

DEHYDRATION

Dehydration may occur in the mountains. Thirst is not an adequate warning of dehydration as the sensation may not be felt until there is a body deficiency of 1 to 2 quarts of water. The sensation of thirst may be blunted at high elevation. Very dark urine is often a warning of dehydration. Soldiers do not always drink their water requirement readily and may require encouragement or coercion to drink more than they think necessary (1 quart every 3 hours).

Approximately 75 percent of the human body is fluid. All chemical activities in the body occur in a water solution which assists in the removal of toxic body wastes and plays a vital part in the maintenance of an even body temperature. A loss of 2 quarts of body fluid (2.5 percent of body weight) decreases efficiency by 25 percent, and a loss of 12 quarts (15 percent of body weight) is usually fatal.

Snow, mountain streams, and lakes may provide sources of water. Purification must be accomplished, however, no matter how pure or clear the snow or water appears. Fruits and fruit juices may be used to supplement water intake.

Soldiers cannot adjust permanently to a decreased water intake. If the supply is insufficient, there is no alternative but to reduce physical activity. Any temporary deficiency should be made up if maximum efficiency is to be retained. It is better to take smaller quantities of water often than large quantities occasionally.

All water that is to be consumed must be potable. Drinking water must be taken only from approved sources to avoid disease or the possible use of deliberately polluted water. Nonpotable water must not be mistaken for drinking water. Water that is unfit to drink, but not otherwise dangerous, may be used for other purposes (for example, washing).

Soldiers must also be trained to avoid wasting water. Water that has been used for washing socks, for example, is perfectly adequate for a vehicle cooling system.

SALT

Salt in correct proportions is vital to the human body. The more an individual sweats, the more salt he loses. The issue ration has enough salt for a soldier drinking up to 4 quarts of water per day. Unacclimatized soldiers need additional salt during their first few days of exposure to the mountain environment, and all soldiers need additional salt when sweating heavily. Soldiers frequently do not realize that they sweat heavily in cold weather and when the humidity is low.

If the water intake needed to balance sweat loss rises, extra salt must be taken under medical direction. Salt in excess of body requirements, however, may cause increased thirst, sickness, and can be dangerous. To avoid this, these general rules should be followed:

- Extra salt should only be taken in proportion to the available extra water.
- The quantity taken, in any form, must be strictly controlled according to medical advice.
- Salt tablets should not be used unless dissolved in a liquid solution.

When directed by medical personnel, a 0.1 percent salt solution for drinking can be made by adding crushed salt tablets or table salt to water. The following quantities of salt should be used:

	Salt	Amount of Water
NOTE The container must be vigorously stirred or shaken after adding the salt.	2 ten-grain crushed salt tablets or 1/4 teaspoon salt	1-quart canteen
	4 ten-grain crushed salt tablets	2-quart canteen
	1 1/3 level messkit spoons salt	5-gallon can
	9 level messkit spoons or 3/10 pound salt	36-gallon lister bag
	1 pound salt	100-gallon tank
	1 level canteen cup salt	250-gallon water trailer

HYGIENE AND SANITATION

Hygiene is covered in detail in **FM 21—10, Field Hygiene and Sanitation.** It is important, however, to highlight some of the points that are of special concern to the commander in the mountains.

PERSONAL HYGIENE

Proper standards of personal hygiene must be maintained not only as a deterrent to disease but also as a reinforcement to discipline and morale. Daily shaving should be stressed as beards add little insulation and collect ice from moisture in the breath. A beard may also mask the presence of frostbite or lice. Weekly bathing is desirable and armpits, crotch, and feet must be washed daily. If regular foot washing is impossible, socks should be changed at least daily and feet massaged, dried, and sprinkled with footpowder. Underwear should be changed at least twice weekly. When operating in areas where vehicle resupply is impractical, a complete change of clothing (shirt, trousers, underwear) should be carried by each soldier. If laundering of clothing is impractical, garments should be shaken and aired. Sleeping bags must be clean and aired out regularly.

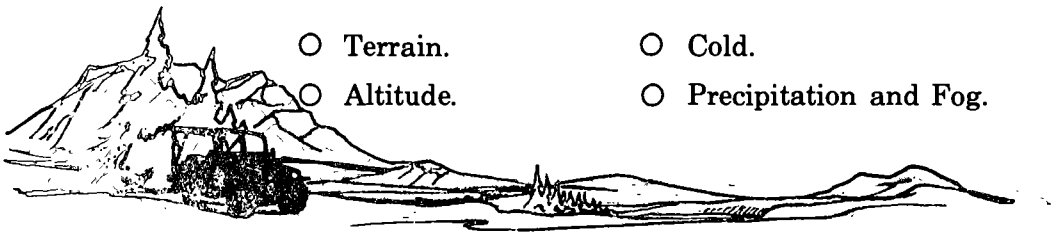
Teeth should be cleaned regularly. If a toothbrush is not available, a clean piece of gauze or other cloth wrapped around a finger may be used to rub teeth and gums. The end of a twig chewed into a pulp may be used in place of a toothbrush.

SANITATION

In rocky or frozen ground, it is often impossible to dig latrines. In freezing conditions, a latrine area should be designated downwind from the position but not so far as to encourage soldiers to break sanitary discipline. Excreta will freeze and can be covered with snow or pushed down a crevasse or precipice. In rocky areas above timberline, waste may be covered with stones.

Environmental Effects on Equipment

The following characteristics of mountain environments may adversely affect equipment and, consequently, have a significant impact on operations:



- Terrain.
- Altitude.
- Cold.
- Precipitation and Fog.

The relative importance of each characteristic varies from winter to summer among different mountainous areas. A discussion of some of the effects on equipment follows.

VEHICLES

TERRAIN

To the unprepared soldier, mountain driving can be difficult and hazardous. An appreciation of vehicle limitations caused by the terrain can greatly assist drivers in safely operating their equipment. Moving up or down steep grades requires skillful use of the transmission as well as the brakes. Placing the vehicle in the proper gear before descending or ascending helps insure safe passage.

Careful reconnaissance and the use of guides should be encouraged when crossing difficult terrain. Unless the driver is thinking ahead and anticipating potential dangers, it is very easy to become boxed in or to get in a precarious position. A driver who fails to negotiate a hairpin curve because of poor judgment can jeopardize not only his vehicle but also the entire column as well. Be sure that the road is clear before proceeding since it may be impossible to turn around at an impasse.

Care must be exercised when a tracked vehicle is required to cross a hillside that contains loose rock. Tracked vehicles are susceptible to sliding or slipping in this kind of terrain. Unless care is taken, serious problems can occur, such as the vehicle losing its tracks or even overturning.

Heavy wheeled vehicles and tractor-trailer combinations are seldom able to negotiate narrow unimproved mountain roads or to move cross-country over rugged terrain. However, small lightweight vehicles have the ability to maneuver along narrow roads or between and around rocks while traveling off roads.

Even though there may be no snow in a valley, snow is likely at higher elevations. Wheeled vehicles must have serviceable tire chains available for all drive wheels at all times. Snow-covered roads coupled with high winds can make driving extremely hazardous. Vehicles towing a load are most vulnerable when descending a slope. Care must be taken to prevent the towed load from slipping and jackknifing. In especially hazardous situations, it may be necessary to put chains on the wheels of the towed load in order to keep the load straight. However, this is effective only when the towed load has brakes. Another expedient is to attach

another vehicle to the rear of the towed load to keep the load straight until the bottom of the hill has been reached.

Tires, tracks, transmissions, and brakes require constant driver and supervisory attention.

ALTITUDE

All Army vehicles are presently powered by air-breathing engines. Since atmospheric pressure decreases with altitude, the principal effect of higher altitudes on engines is a reduction in the amount of air available to support combustion and provide cooling. This effect can be reduced by recalibrating fuel metering devices (e.g., installing smaller jets in the carburetor). The engine will run better and fuel economy will be improved. Since the fuel consumption rate is lower, power output also will be lower, but the vehicle will at least be operable. Power losses of 10 to 25 percent can be expected at altitudes above 1800 meters.

At high altitudes, individual vehicle performance changes will be reflected by slower acceleration, reduced gradability, lower maximum speed, and smoky exhaust. Prolonged operation will generate reliability problems from frequent failure of spark plugs and fuel injectors.

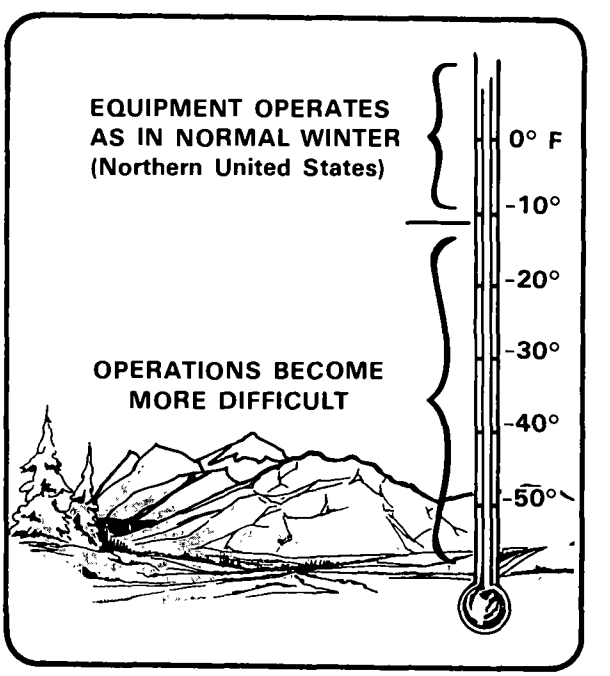
COLD

In order to function properly, equipment must be maintained and operated in accordance with special procedures. Operation of equipment in temperatures down to -10 degrees Fahrenheit is similar to operations in the northern portion of continental United States during the winter. However, in temperature ranges from -10 degrees Fahrenheit to -40 degrees Fahrenheit, operations become more difficult.

Engines, metal and rubber parts, steering, brakes, suspension, cooling, and lubrication systems are all vulnerable to the cold. Typical problems which can occur are:

- Engines fail to start.
- Inadequate power from batteries.
- Improper lubrication because of thickened oil.
- Seals and hoses leak or crack.
- Fuel filters and lines clog up with ice crystals.
- Suspension systems fail as metal becomes brittle.
- Cooling systems freeze.
- Tires become rigid, causing flat spots or cracks in sidewalls.

To prevent failures in subzero weather, equipment must be maintained in the best possible mechanical condition. See **FM 90—11, Cold Weather Operations (TBP)** and **FM 9—207, Operations and Ordnance Materiel in Cold Weather,** for considerations and detailed instructions for operation of equipment in cold weather.



Temperature Effects on Equipment.

CLOTHING AND EQUIPMENT

High altitudes, rough terrain, and the extremely unpredictable weather in the mountains are conditions which dictate special clothing and equipment. Mountain operations require equipment suitable for climbing and movement in rugged terrain. Further, high altitudes require that personnel be equipped for cold weather and movement over snow. See appendix B for a listing of cold weather and mountain clothing and equipment.

TERRAIN

Army fatigues and combat boots wear out rapidly in rugged rocky terrain. Rubber-soled combat boots tend to slip on rocks, and leather uppers often tear away from the sole. Also, sharp rocks easily tear or snag fatigue trousers and shirts. Field trousers and jackets are less likely to tear. Regardless of the type of clothing and equipment used, rocky terrain requires that adequate stocks be available for replacement of damaged items.

PRECIPITATION AND FOG

Most clothing and individual equipment is designed to withstand a certain amount of moisture. However, wet clothing loses its insulating value. Water conducts heat 25 times more effectively than air. As a result, when a soldier's clothing becomes wet, he loses body heat quite rapidly. Extra dry clothing, preferably woolen, must be available to the soldier for protection from ground moisture and rain.

BATTERIES

COLD

All types of batteries show decreased power capacity at low temperatures. Cold has its most serious effect on dry batteries which are used, for instance, to power man-carried portable radios. The capacity of conventional dry cell batteries begins to decrease as the temperature drops below 70 degrees Fahrenheit and rapidly loses efficiency at low temperatures. At 0 degrees Fahrenheit, a dry cell battery is 40 percent effective; at -10 degrees Fahrenheit, 20 percent; and at -30 degrees Fahrenheit, only 8 percent effective.

Whenever cold temperatures are anticipated, cold weather batteries should be used. Batteries should also be stored at supply points in which temperatures range from 10 degrees to 35 degrees Fahrenheit. Upon removal from storage and prior to use, batteries should be heated slowly to a temperature of 70 degrees Fahrenheit. Warm batteries will give good results if used promptly upon exposure to cold. If kept warm, dry batteries will deliver a satisfactory service life. Carrying batteries inside clothing or using insulated containers or heating devices will assist in keeping batteries warm until needed. Battery vests designed for wear under outer clothing should be used with man-packed radio sets during extreme cold.

Storage batteries are adversely affected by cold temperatures. Those with low specific gravities will freeze, causing rupture of the casing and internal parts. However, a fully charged battery will not freeze in extremely cold climates. Special emphasis, therefore, must be placed on the proper care of electrical systems to assure efficient operation. See **FM 9—207** and appropriate operator manuals for detailed instructions in the care and use of batteries.

COMMUNICATIONS, FIRE CONTROL, AND OTHER PRECISION EQUIPMENT

COLD

When equipment is exposed to extremely cold temperatures, the following can occur:

- O Contraction of single material components.
- O Differential contraction within components made of two or more materials.
- O Cracking of material which has become brittle.
- O Freezing of moisture on/in components.
- O Thickening of lubricants on moving components.

The following are examples of what might occur if proper maintenance and other precautions are not taken by the operator:

Radios: Upon exposure to extreme cold, radio receivers and transmitters adjusted for operation in a relatively warm place may exhibit a change in the frequency selection circuit. This may prevent communication on designated frequencies until adjustment can be made

Microphones: Moisture from the breath may freeze on the transmit button and the perforated cover plate, thus preventing operation. Use of standard microphone covers will prevent this.

Missiles: Guidance system components on antitank missiles may operate stiffly and sluggishly.

Rifles: Soldiers being transported by helicopter may find that moisture from the air inside the helicopter will freeze on their weapons when exposed to cold outside temperatures. Freezing of the rifle bolts may be prevented by proper lubrication.

Acclimatization to the cold, extensive training, and proper maintenance procedures will prevent most equipment problems related to cold weather.

PRECIPITATION AND FOG

Radios, telephones, microphones, and other communications equipment are designed to withstand moisture. However, cracks in housings and insulation can allow water damage. Moisture can short out equipment, cause interference, or condense and freeze, thus preventing operation. Care in handling equipment, operator maintenance, and the use of cellophane or thin vinyl coverings will assist in keeping moisture out.

CHAPTER 2

PREPARATION FOR MOUNTAIN OPERATIONS

Specific features of mountain environments have been described in the previous chapter. Because US forces do not routinely train in such an environment, extensive preparations are necessary to insure individual and unit effectiveness.

CONTENTS

This chapter deals with the training requirements for operations in mountain environments. The areas addressed are designed to identify for commanders and staffs the elements of unit and individual training that will enhance effectiveness.

Factors to be Considered

When a unit is alerted for operations in a mountain environment, the commander must consider or find answers to some or all of the following questions:

- What are the climatic and terrain conditions of the area of operations?
- By what date must the unit be ready to move?
- What areas in the United States most closely resemble the area of operations?
- Are predeployment training areas and ranges present and available? If not, what alternative arrangements can be made?
- Will the unit be taking its own equipment overseas? If so, when will the equipment be deployed?
- If unit equipment is being sent overseas and any items require modification (including camouflage painting), when is this work to be done and how long will it take?
- What special equipment does the unit require for mountain operations? What arrangements need to be made for this equipment to be delivered and when will it arrive?
- What special maintenance is required for weapons and equipment before deployment to or upon arrival in the area of operations?
- What large force will the unit be with? Do they have any special standard operating procedures (SOPs) for mountain operations? If not, are they producing any?
- What assistance is available for training?
- What additional personnel will be necessary to accomplish the training and operational missions?
- What instructors are available from outside the unit?
- What training aids are needed and what is available?
- Are there personnel in the unit who:
  are mountain warfare instructors;
  have experience in mountain conditions;
  can speak the language of the host country and, if so, with what proficiency? (Is there any requirement that their number be increased and can it be done in the available time?)
- Are all personnel physically fit? (This will affect the acclimatization period.)
- How many soldiers are nondeployable? They must be replaced.
- What information is available about the enemy's strength, organization, equipment, and tactics?
- What information is available about allied forces in the area of operations?
- What types of operations are expected?
- What is the composition of the advance party and when do they leave?

Once these questions have been answered, the commander must develop a program to bring his unit to a level where it will be fully capable of operating successfully in harsh mountain conditions. To do this, it is first necessary to establish priorities for training. The training requirements listed below are shown as a guide only. They can be modified as necessary, depending on the state of readiness of the unit when it is alerted for mountain operations, and the time and facilities available.

Training Requirements

As with all military operations, training significantly influences success in the mountains. Addressed here are some of the areas of training which require special consideration.

SPECIAL CONSIDERATIONS				
TRAINING REQUIREMENTS	ALL	STAFF AND LEADERS	TEAMS AND CREW MEMBERS	SPECIALISTS
Physical Conditioning and Acclimatization	●	●	●	●
Living in Mountains	●	●	●	●
Mountain Navigation	●	●	●	●
Weapons Training	●	●	●	●
Survival, Evasion, and Escape	●	●	●	●
Communications and Communications Security	●	●	●	●
NBC Training	●	●	●	●
Camouflage and Concealment	●	●	●	●
Equipment Operating Techniques	●	●	●	●
Medical Considerations: First Aid Casualty Evacuation	● ●	● ●	● ●	● ●
Military Mountaineering: Basic Movement Skills	●	●	●	●
Operational Area	●	●	●	●
March Planning		●	●	
Scouting, Surveillance, and Patrolling		●	●	
Air Defense		●		
Obstacles and Barriers		●	●	
Tactical deception		●		●
Enemy Organization and Tactics		●		
Enemy Equipment Recognition		●		●
Language Training				●
Driver Training			●	
Advanced Military Mountaineering:				●

ALL PERSONNEL

PHYSICAL CONDITIONING AND ACCLIMATIZATION

In addition to acclimatization, physical conditioning is critical to success in mountain operations. Particular emphasis should be placed on exercises designed to strengthen leg and back muscles. Frequent marches and climbs with normal equipment loads will enhance conditioning and familiarize the soldier with rhythmic marching techniques.

MOUNTAIN LIVING

As with any new environment, successful mountain living requires that personnel adjust to special conditions, particularly terrain and weather. Some of the more important considerations include:

- O Temperature extremes.
- O Air (dehydration and breathing).
- O Hygiene and sanitation.
- O Extensive clothing requirements.
- O Limited living space (difficulty of bivouac).

In addition to these considerations, training should be conducted as realistically as possible, preferably under severe conditions so the soldier will gain confidence. Exercises of extended duration will test support facilities and expose the individual to the isolation common to mountain operations. The mountain battlefield can be harsh, and training should be designed to make that fact clear.

MOUNTAIN NAVIGATION

Navigation in the mountains is made more difficult because of inaccurate mapping, magnetic attraction affecting compass accuracy, and the irregular pace. Individuals must be trained to use a variety of equipment and techniques including compass, altimeter, maps, terrestrial navigation, terrain association, dead reckoning, resection, and artillery marking.

WEAPONS TRAINING

With minor adjustments, basic weapons training applies to mountain operations. Range estimation in mountain terrain is difficult. Firing downhill will normally cause the shooter to fire high, while firing uphill has the opposite effect. The problem is compounded because the thin air causes projectiles to travel farther. Practical training will help overcome these tendencies. Weapons should be rezeroed after ascending to higher altitudes.

SURVIVAL, EVASION, AND ESCAPE.

Convincing the soldier that he is capable of surviving in a high mountain environment will strengthen his self-confidence, resulting in improved effectiveness. Although **FM 21—76, Survival, Evasion, and Escape** does not specifically address mountain environments, much of the information applies. Training should include: locating water supplies, shelter construction, land navigation, health hazards, and techniques of obtaining food.

CAMOUFLAGE AND CONCEALMENT

The principles of camouflage and concealment also apply in mountain operations; however, certain elements must be adjusted to suit the situation. For example, with snow on the ground, standard camouflage nets and paint patterns are unsuitable. Throughout the year, camouflage above the timberline requires special equipment which must be obtained.

EQUIPMENT OPERATING TECHNIQUES

Nearly every piece of equipment with which the soldier is familiar will be affected to some degree by the mountain environment. The purpose of training in equipment operating techniques is to teach the soldier to overcome the environmental impact on his equipment. Training must be oriented toward the expected operational area and should include:

- Expected effects on the unit equipment as described in chapter 1.
- Suggested means of reducing environmental effects.

MILITARY MOUNTAINEERING (Basic Movement Skills)

Basic movement in the mountains requires techniques different from those used on flatter terrain. Common to all techniques are certain fundamentals which insure coverage of the greatest distance with the least effort. These fundamentals are:

- Use a two-meter interval to avoid bunching.
- Walk so as to keep the weight on the full flat of the foot, not just the toes. This will reduce strain on leg muscles.
- Place the sole of the boot flat on the ground with each step.
- Keep the pace on steep ground regular and rhythmical, with equal distance and time interval between each step. On very steep slopes, shorten the stride. To increase speed, lengthen the stride without breaking the established rhythm.

Communications and Communications Security are described in chapter 4.

Medical Considerations are described in chapter 5.

Nuclear, Biological, and Chemical (NBC) considerations are described in appendix E.

LEADERS AND STAFF

The leaders and staffs of organizations designated for mountain operations must familiarize themselves with and be prepared to train their subordinates in the idiosyncrasies of mountain operations.

OPERATIONAL AREA

The analysis of an area of operations can be divided into two parts, one general and one specific. The general analysis should include:

- Geographic description.
- Climate.
- Language.
- Cultural customs and behavior.
- Armed forces.

The specific analysis, limited to the area of operations, should include as a minimum:

- Road networks.
- Communication links.
- Terrain.
- Allied troops.

An effective initial analysis will facilitate logical decisions in all subsequent planning phases.

MARCH PLANNING

Limited road networks and restricted off-road mobility significantly increase the importance of march planning. Questions that should be considered when moving in mounted columns include:

- How fast can the march be conducted?
- Will there be other traffic on the route?
- Are there any potential rest stops which would allow the column to get off the road and seek cover?

Movement by dismounted troops is essentially the same as on flatter terrain except that physical stress reduces the pace, increases the demand for rest stops, and lengthens movement times.

SCOUTING, SURVEILLANCE, AND PATROLLING

Training in scouting, surveillance, and patrolling should emphasize:

- Identifying potential infiltration routes. Infiltration and exfiltration are relatively easy in mountainous terrain. This fact constitutes a significant threat to the maneuver elements and their support units.
- Trafficability (route classification).
- Potential drop zones or landing areas.
- Likely defensive positions.

OBSTACLES AND BARRIERS

Obstacles and barriers assume added importance because of the already limited road and trail networks. It is easy to create obstructions in mountains by cratering roads or inducing avalanches, but commanders and staffs should remember that clearing these same obstacles may be extremely difficult. Minefields can be effectively used to inhibit infiltration, canalize the enemy, or support a defensive position in off-road areas. Careful consideration must also be given to the enemy's ability to create similar obstacles and minefields.

ENEMY ORGANIZATION AND TACTICS

In addition to general threat considerations, leaders and staffs must become familiar with enemy mountain organizations and tactics. What size unit can we expect to face? What will be the probable composition of enemy forces? These general questions should be followed by an analysis of the specific organizations known to be located in the anticipated area of operations.

ENEMY EQUIPMENT RECOGNITION

The majority of enemy equipment encountered in mountain operations will be the same as that found elsewhere; however, it is necessary for everyone to be familiar with enemy equipment and/or tactics related to mountain operations.

DRIVER TRAINING

As described in chapter 1, driving in mountains is extremely difficult. To be successful, a driver must be familiar with the limitations of his equipment. Training should center around practical exercises in mountainous terrain which gradually introduce drivers to more complex situations.

Air Defense is described in chapter 4.
Tactical Deception is described in **FM 90—2, Tactical Deception.**

SPECIAL TRAINING

Mountainous terrain presents opportunities for operations which require specialized skills. Language training, advanced mountaineering, and skiing are a few examples of training which should be considered for specialists. Reconnaissance teams should also receive intensive training in hand-to-hand combat, silent weapons employment, terrestrial navigation, and demolitions. Properly utilized, specially trained troops can have a positive impact disproportionate to their numbers.

APPENDIX C

EMPLOYMENT OF MOUNTAINEERS

Military mountaineering provides access to otherwise inaccessible rugged mountainous terrain. In such terrain, the mountains, the weather, and the enemy are all adversaries. These adversaries can, however, be overcome by troops with specialized training who are skilled in the use of mountain-climbing equipment and techniques.

When preparing for mountain operations, ***all*** soldiers should be trained in basic military mountaineering. ***Selected*** personnel should undergo more detailed and rigorous mountaineering training. Mountaineering training is presently conducted primarily by the Northern Warfare Training Center (NWTC) at Fort Greely, Alaska, and by the Mountain and Survival Skills Training Committee at Fort Carson, Colorado.

Training Requirements

BASIC MOUNTAINEERING

Basic military mountaineering training provided for all unit members should include at least the following subject areas:

- Hazards of movement in mountainous terrain.
- Rope care and management.
- Knots.
- Mountain walking techniques (includes route selection).
- Free climbing.
- Rappelling.
- Use of mountaineering installations.
- Mountain medical evacuation.

This listing serves as an example only and refers specifically to training in military mountaineering. Normal training would be conducted in conjunction with mountain training and should lean heavily toward physical conditioning and acclimatization while stressing—

- Land navigation in the mountains.
- Cold weather and mountain bivouacs.
- Communications.
- Patrolling.
- Adjustment of supporting fire.
- First aid.

ADVANCED MOUNTAINEERING

Highly motivated soldiers who are in superior physical condition should be selected for more advanced military mountaineering courses conducted at appropriate facilities. These soldiers would act as cadre and instructors for the unit in garrison or while in training. Once the units deploy or enter advanced training, the soldiers who have completed intensive mountaineering courses should be employed as installation party members, guides, observers, and patrol members. The intensive training courses provided for these soldiers include—

- O Hazards of movement in mountainous terrain.
- O Rope care and management.
- O Knots and tightening systems.
- O Mountain walking techniques.
- O Free (balance) climbing.
- O Relays and relay positions.
- O Placement of protective devices and use of climbing equipment.
- O Roped (party) climbing.
- O Rappelling.
- O Direct aid climbing.
- O Natural and artificial anchors.
- O Construction of mountaineering installations.
  - One-, two-, and three-rope bridges.
  - Fixed rope.
  - Vertical hauling line.
  - Suspension traverse.
- O Roped movement over glaciated terrain.
- O High angle snow and ice climbing.
- O Mountain medical evacuation.
- O Mountain rescue techniques.
- O Avalanche rescue techniques.

Capabilities of Climbers

INSTALLATION PARTY MEMBERS

Skilled mountaineers may be used as installation party members. These teams can be dispatched along lines of deployment ahead of regular forces to erect aids which would facilitate the passage of less qualified soldiers over difficult terrain.

For example: One installation party might erect a three-rope bridge over a turbulent glacial stream. Farther along the route, a fixed rope—a handrail for heavily laden combat troops—could be established up a steep rock face. In conjunction with the fixed rope, a vertical hauling line might be constructed for rapid elevation of a crewserved weapon and heavy equipment.

If a commanding ridge is then occupied by the unit, a suspension traverse might be constructed for rapid evacuation of casualties to the valley below.

Construction teams should, in most situations, consist of six highly skilled climbers since this number is sufficient for the construction of most installations. If the number is increased, it must be kept to an even number to facilitate roped climbing—or added to in three-man increments when operating on crevassed glaciated terrain.

Following construction of an installation, the team should remain on site to provide guides and to make repairs during its use. After passage of the unit, or when the installation is no longer needed, the team will then disassemble the installation and be redeployed as needed.

FIXED ALPINE PATHS

Fixed paths are designed for use in a more stable combat situation. They are engineer tasks. Supporting engineer units should receive intensive training for such construction along the same general lines previously described for construction of mountaineering installations by combat units.

GUIDES

Guides are used primarily to assist troops over minor rock obstacles encountered in normally broken terrain. They have excellent route-finding and pace-setting abilities and a thorough knowledge of the general practice and theory of mountaineering. As advisors they should—

- Suggest best routes of march.
- Inform unit commanders of natural dangers and obstacles likely to be encountered.
- Be prepared to estimate the time and means necessary for the movement of troops or equipment between any two given points.

In assisting troops, they should—

- Maintain a steady pace at the head of the column to prevent bunching and straggling.
- Help maintain proper march discipline with respect to pace, cadence, and distance.
- Be stationed at obstacles along the line of march, directing troops and indicating alternate routes over bottlenecks.

OBSERVERS AND SCOUTS

The rules for the selection of scouts and observers as described in **FM 21—75, Combat Training of the Individual Soldier and Patrolling,** hold true in the mountains. To the characteristics and abilities normally required of a scout, agility and thorough training in military mountaineering must be added. The scout should also have a thorough grasp of mountain terrain and terminology so that he can make accurate sketches and reports of his observations.

Scouts ordinarily will function in pairs. When a scouting mission requires the crossing of precipitous terrain, appropriate climbing equipment will be carried.

Observers must be trained to ascend, with all their equipment, the most difficult and commanding terrain.

PATROLS

Patrol members must also be fully trained in all mountaineering techniques. Most often, in mountainous terrain, the enemy will leave unoccupied those areas thought to be unassailable, making it possible for patrol members to effect passage of enemy lines; penetrate enemy defenses; set up observation posts on the highest points; and, in many cases, occupy terrain best suited to ambush or enemy-killing avalanche.

RECONNAISSANCE PATROLS

Reconnaissance patrolling over precipitous rock terrain may best be accomplished by small patrols of one or two pairs of trained climbers. Such patrols may expedite the movement of flank security elements over difficult rock terrain. One or two climbers should be attached to each element, depending on the size of flank elements and the difficulty of movement.

When ruggedness of terrain is likely to dictate a rate of march on the flanks that is slower than that of the main body, flank security personnel should be grouped near the advance party. Smaller elements are then detached as necessary to reconnoiter and hold dominant terrain features on the flanks of the line of march. Flank outposts join the main body and proceed forward to rejoin the pool of flank elements.

COMBAT PATROLS

A climber team should be the nucleus of patrols operating over steep mountainous terrain. Nonclimbers may be added in varying proportion according to the estimated climbing difficulty and mission. If more than one point of attack is to be used, or a more powerful patrol is needed, additional climbing teams can be employed.

The patrol leader, in addition to being a trained climber, should be familiar with the abilities and limitations of each man in the company. Nonclimbers should be selected with careful consideration of their natural agility and endurance.

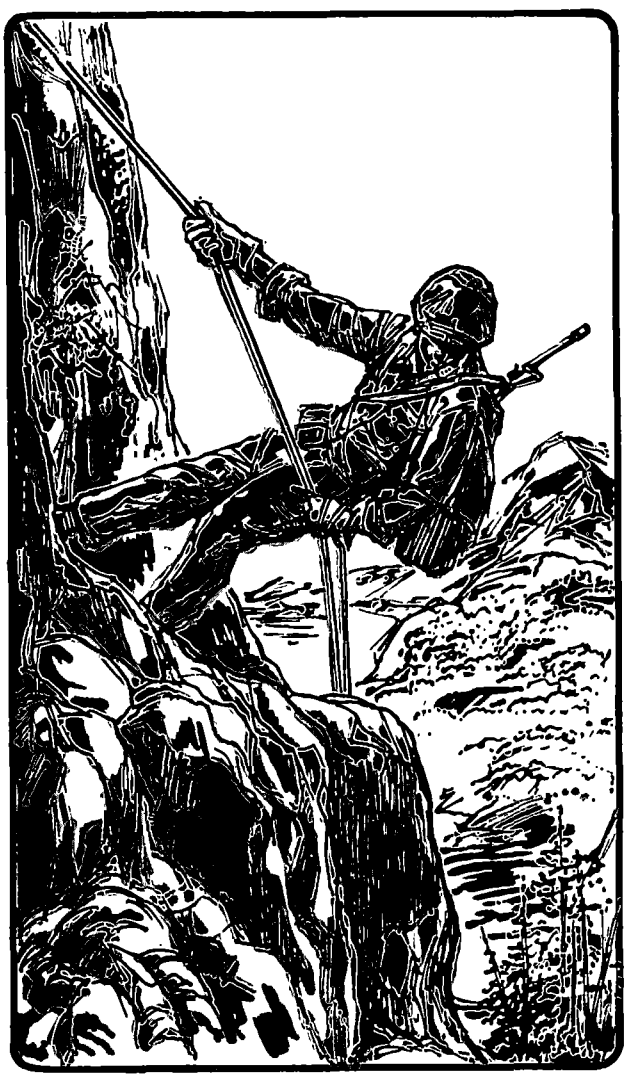
ASSAULT CLIMBERS

During WW II, assault climbers were used to great advantage in several campaigns.

Soldiers selected for further training as assault climbers must be the unit's most highly motivated and skilled mountaineers. Their equipment and weapons must be lightweight and extremely durable.

Soldiers to be assigned as assault climbers should also undergo training in the use of specialized mountaineering equipment such as chocks (used in lieu of pitons) and jumar ascenders (a mechanical rope climbing device). Their training should be slanted toward speed and silence and should include extensive training in communications, demolitions, use of special weapons, silent killing techniques, medical treatment, and mountain rescue techniques (as opposed to low-level mountain medical evacuation).

Operating in two-man teams on rock, ice, and snow, or in three-man teams on glaciated terrain, assault climbers may be dispatched, ahead of attacking elements, in sufficient numbers to set up fixed ropes under cover of darkness or during inclement weather. They may also be committed to attack and occupy, on their own, certain enemy strongholds. The use and employment of assault climbers is governed only by the commander's imagination and good judgment.



Utilization of Climbers

Requirements for qualified climbers will be governed by many variables. Normally, the first units to be committed to operations in mountainous terrain will be those whose personnel have received this specialized training and have qualified mountaineers assigned or attached as advisors. Depending upon the availability of qualified personnel, a number of experienced climbers should be assigned to each platoon-, company-, or battalion-size unit prior to the planned operations.

Since the availability of trained climbers is likely to be limited, commanders should limit assignment of skilled climbers to:

- Scout platoons.
- Ground reconnaissance troops.
- Forward observer parties.
- Communications sections.

Based upon the advanced levels of training discussed in this appendix, the commander can expect his climbers to be familiar with and capable of:

- Assistance in unit movements in the mountains such as route selection, navigation, and techniques applicable to the rugged terrain.
- Installation of communications relay sites.
- Balance and party climbing.
- Rope installations such as fixed ropes, use of anchors, vertical hauling lines, suspension traverse, and rope brigades.
- Techniques of crossing mountain streams and swift currents.
- First aid and evacuation techniques.
- Individual cooking techniques above and below timberline.
- Shelters and bivouacs.
- Snow characteristics and safety precautions against avalanches.
- Assistance in movements over glaciers.
- Characteristics of weather, especially protection from the sudden changes in temperature, high winds, blizzards, thunderstorms, and other adverse effects.

APPENDIX D

ARMY AVIATION

The mountain environment—particularly its severe and rapidly changing weather—impacts on aircraft performance capabilities, accelerates crew fatigue, and requires special flying techniques. Any operation whose success depends on continuous aviation support is extremely risky.

This appendix outlines factors which may limit the full effectiveness of army aviation when operating in a mountain environment. It focuses on the employment of helicopters since they provide the bulk of the aviation support received by the ground maneuver commander. Where appropriate, factors affecting fixed-wing aircraft are also provided.

Operational Considerations

ATTACK HELICOPTER OPERATIONS

Attack helicopter units are equipped with a variety of ordnance. They are the commander's most mobile maneuver force in mountain warfare. During stable weather conditions, attack helicopters can rapidly engage targets beyond the range of other weapons or those masked by intervening crests. Employment times and fuel consumption will normally be increased because of the few direct routes. Terrain compartments which limit aircraft maneuverability and force smaller flight formations may impact on target-engagement techniques. If terrain precludes placement of fuel and arming points in the forward area, turnaround time will increase and on-station time will decrease. Since ground-to-air communication is degraded by intervening terrain, in-flight operational control over extended ranges may be difficult.

COMMAND, CONTROL, AND COMMUNICATIONS OPERATIONS

The use of command and control (C&C) aircraft can assist the commander in overcoming ground mobility and communications restrictions which would otherwise limit his ability to direct the battle.

In the mountains, terrain masking, while making flight routing more difficult, may provide the degree of protection needed to allow an increased use of aircraft. To avoid radar or visual acquisition—and to survive—C&C aircraft must use the same terrain flight techniques employed by other tactical aviation units. This flight method will often degrade frequency modulated (FM) communications and reinforce the requirement for radio relay or retransmission sites.

INTELLIGENCE

Terrain masking can limit the effectiveness of airborne standoff intelligence collection devices such as side-looking airborne radar (SLAR) in the mountains. Dead space must be covered by either high-altitude tactical air reconnaissance assets or army aviation. Enemy air defense must be suppressed for low-level coverage by army units. All aircrews, regardless of their primary mission, should be trained to routinely gather terrain and enemy information.

MOBILITY

The helicopter is the principal vehicle for rapidly moving forces in the mountains. During the offense, air assault operations may be conducted to infiltrate forces into the enemy's rear area and to bypass or envelop his defenses. In the defense, reinforcements and reserves can be rapidly moved by helicopter.

LOGISTICS

Supplies can be moved by helicopter with little hindrance from natural or artificial obstacles. Personnel, cargo, support weapons, and ammunition can be moved faster and more efficiently than by any other means.

Environmental Considerations

Flying in the mountains requires special training. Both terrain and weather influence basic flight techniques and operational planning.

TERRAIN

Rugged mountainous terrain complicates flight route selection. Direct routes can seldom be flown without exposing aircraft to an unacceptable risk of detection and destruction by the enemy. Tactical flight routes follow valley corridors where it is possible to obtain cover and concealment while maintaining the highest possible terrain flight altitude. Fixed-wing aircraft will normally be restricted to flight routes along major terrain compartments. Terrain flight in the mountains may preclude the use of closed formations. Multi-helicopter operations will normally be flown in "loose" or "staggered trail" formations with increased spacing between aircraft.

Airfields for fixed-wing aircraft and multiple helicopter landing zones (LZs) in mountainous regions are limited. When only single aircraft landing zones are available, in-flight spacing between helicopters must be significantly increased. This places an additional navigational load on each crew.

Although helicopter landing zones should be located on the windward side of ridges or peaks to take advantage of the

more stable winds, concealment from enemy observation is the most important factor in site selection in forward areas. Mountain LZs frequently require little preparation since the ground is usually firm enough to support helicopters. Loose material must be cleared from the LZ. During the winter, snow must be compacted to prevent whiteouts. Similarly, sand or dust should be dampened with oil or water.

Landing zones must be as level as possible since slope is a limiting factor. As a general rule, helicopters cannot land safely on slopes which exceed the following guidelines: AH-1, 8.5 percent slope; OH-58 and CH-47, 17.6 percent slope; and UH-1 and UH-60, 26.8 percent slope.

When it is impossible to land, personnel and equipment can be lowered by rope while the helicopter hovers. However, this may increase turnaround times and aircraft vulnerability.

Since the availability of landing sites is limited, the enemy can be expected to target likely locations. A landing site should not be used until the terrain which dominates it is secured. Extensive suppression of enemy air defense weapons will normally be required during air assault or supply operations.

WEATHER

Rapidly changing and severe weather common to mountainous regions may interrupt or delay aviation operations. Even weather which appears to be stable has significant impact on the use of army aviation, particularly helicopters. The effects of fog, frontal systems, and storms are readily discernible. High altitude, wind, and ice require special consideration.

ALTITUDE

The most important meteorological factor affecting aircraft performance in the mountains is density altitude. Temperature, relative humidity, and pressure altitude are used to calculate this factor which, in turn, provides the basis for determining lift capability. In essence, an increase in any of the three basic elements increases density altitude and decreases lift capability. For a given load, this means longer runways are required for fixed-wing aircraft. For helicopters, increased torque or power is required.

In the mountains, density altitude can vary significantly between pick-up points and landing zones and also at different times during a 24-hour period. For example, density altitude will normally peak in the late afternoon and reach its low point at dawn.

WIND

The principal weather hazard experienced in the mountains is wind. Even moderate winds (11 to 20 knots) can produce significant turbulence as they pass over mountain ridges. Predicting wind conditions is difficult, if not impossible. On the windward side of mountains, the direction of air flow is normally steady even though its strength may vary. On the leeward side of crests, wind is turbulent with strong vertical currents. Aircrews require special training to minimize the hazard produced by wind. Turbulence may preclude assault landings and require aircraft to be flown at higher altitudes, increasing the risk of detection and destruction.

ICING

Weather conditions such as low clouds or fog, which limit visibility, may also lead to the formation of ice on aircraft. Army helicopters are not capable of flight in severe icing conditions. As ice forms on rotor blades, it results in a significant loss in lift. Since ice does not break off of rotor blades in a uniform manner, severe rotor blade imbalance can occur. Ice can clog engine intake ports.

APPENDIX E

NUCLEAR, BIOLOGICAL, AND CHEMICAL (NBC) CONSIDERATIONS

FM 21—40, NBC Defense, provides doctrine and guidance for the commander and his staff for NBC defense. It also furnishes technical information necessary for personnel assigned NBC defense duties who must evaluate NBC situations and advise their commander. This appendix describes NBC considerations requiring increased emphasis because of the special nature of the mountain environment.

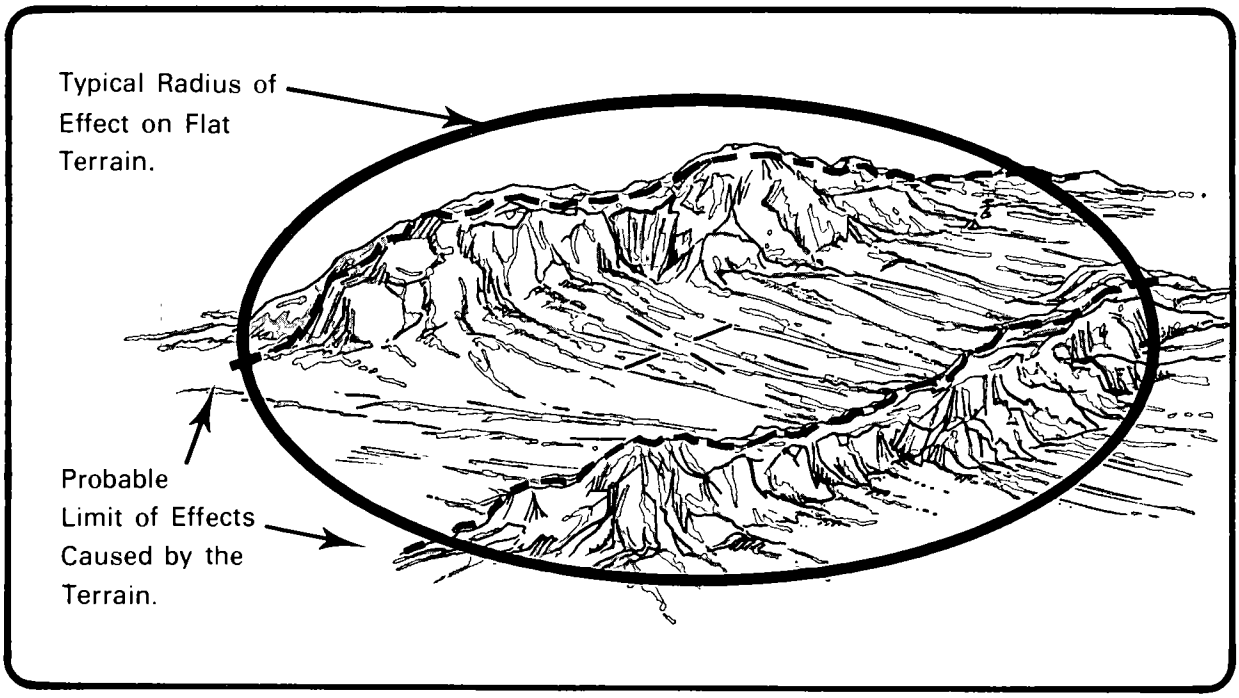
NUCLEAR

Current nuclear effects data contained in the **FM 101—31** series of nuclear weapons employment manuals apply to flat or gently rolling terrain. The mountain environment can amplify or reduce these effects and distort the normal circular effects pattern associated with nuclear blasts. These irregular patterns will reduce the accuracy of collateral damage prediction, damage estimation, and vulnerability analysis.

Air blast effects will be amplified on the burst side of the mountains. Mountain walls will reflect the blast waves which can reinforce each other as well as the shock front. Therefore, it is possible that both overpressure and dynamic pressure, and their duration, will increase. An added danger will be the creation of rockslides or avalanches. On the other hand, there may be little or no blast effects on the side of the mountain away from the burst.

Thermal radiation will be blocked by the hills and mountains and attenuated by trees and other defense foliage. Low clouds, fog, and falling rain or snow can absorb or scatter up to 90 percent of a burst's thermal energy. During colder weather, the heavy clothing worn by soldiers in the mountains provides additional protection. Thermal radiation effects, however, may be amplified by reflection from snow and by the thin atmosphere of higher elevations. Snow melted by thermal radiation could result in flash flooding.

As with the other effects, the pattern of initial and induced nuclear radiation may be modified by topography and the height of the burst, as illustrated in the following figure.



Radiation Pattern is Affected by Terrain.

Strong variable winds (in speed and direction) will make fallout prediction unreliable. Additionally, melting snow will contribute to the residual radiation pattern. Streams should be checked for radiation before using them for drinking or bathing.

BIOLOGICAL

Sunlight destroys most biological agents. Above the timberline there is little protection from the sun and thus the effectiveness of a biological attack will be reduced.

Downwind coverage will be generally greater because of the more frequent occurrence of high winds. Additionally, inversion conditions favor the downwind travel of biological agents.

Temperature and humidity also affect the survivability of biological agents. Generally, cool temperatures favor survival, and higher humidity increases the effectiveness of the agents. Snow deposited over a contaminated area can increase the period of the hazard.

CHEMICAL

The generally cooler daytime temperatures in mountainous terrain will slow the evaporation process, thus allowing a potential contamination hazard to remain longer. Midday temperatures favor the employment of persistent and/or blister-type agents since unsupervised personnel are more likely to remove protective clothing for comfort.

High winds and rugged terrain will cause chemical agent clouds to act similarly to radioactive fallout. Because of terrain and winds, downwind travel of a toxic-agent cloud cannot be accurately predicted.

APPENDIX F

AVALANCHES

The danger of avalanches must be carefully considered when military operations are being conducted in snow-covered mountains. History records numerous military disasters resulting from avalanches. For example, in World War I, at least 40,000 troops died as a result of avalanches in the province of Tyrol located in western Austria and northern Italy. It has been estimated that during fighting on the Austro-Italian front in 1916, as many as 9,000 to 10,000 troops were killed in a single avalanche of 2 day's duration.

Causes of Avalanches

There are only two basic causes of avalanches:

- Large amounts of snow.
- Steep slopes.

These two causes, acting together, can produce an avalanche independent of other factors.

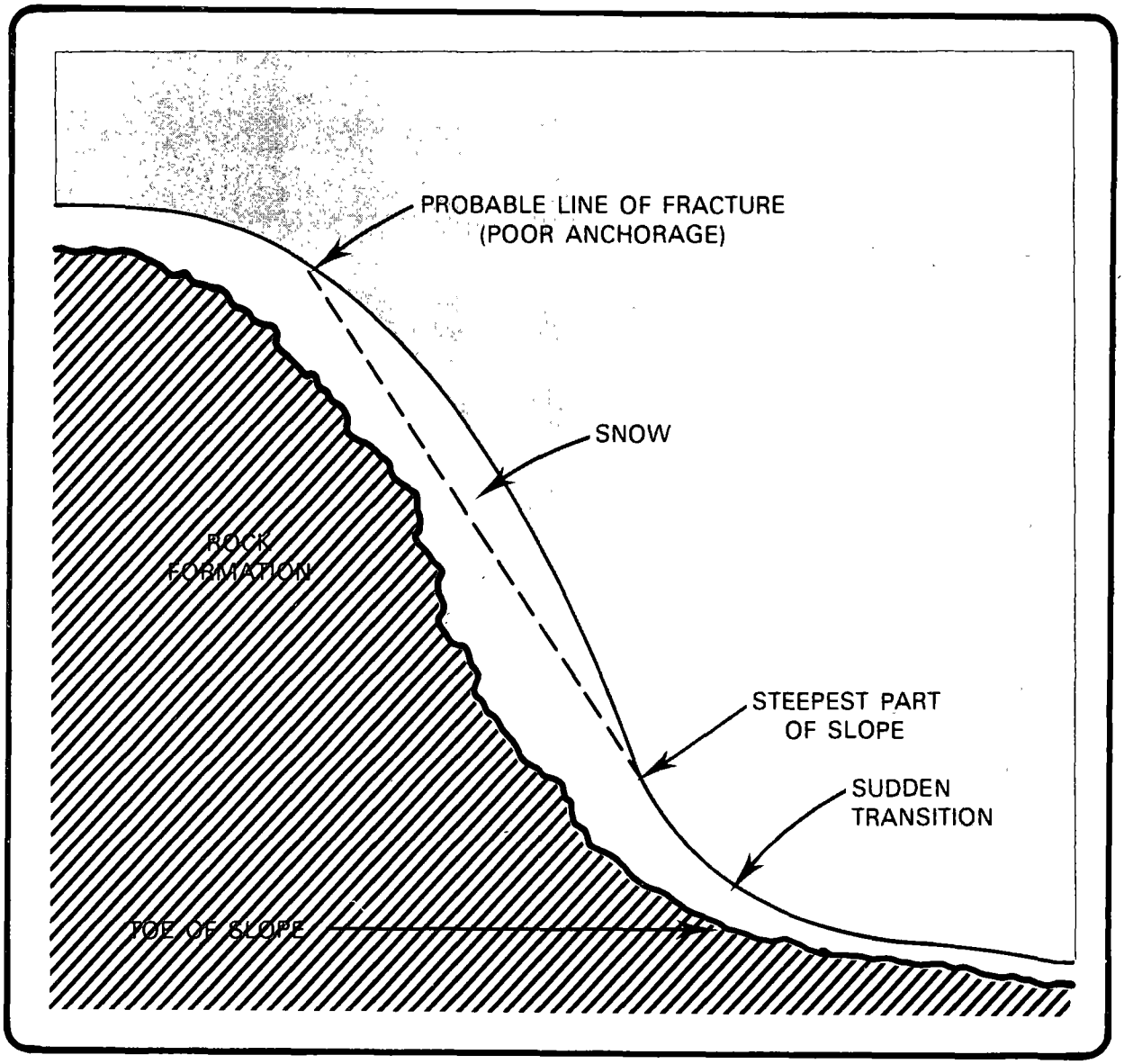
TERRAIN

Surface conditions have considerable effect on snow and its tendency to adhere to surface configuration. A broken, serrated, or boulder-strewn surface usually provides a good anchorage for a snowpack. Slides breaking off at ground level are unlikely on such a surface.

Smooth, even slopes of bare earth, solid rock, or shale favor massive ground-level avalanches which are typical of the high alpine areas. Mountain contours influence an avalanche; terraces, old rockfalls, basins, and outcrops are effective barriers. They either divert the moving snow or give it room to spread out and lose momentum. Gullies collect and channelize the descending snow, making favorable slidepaths which must be carefully avoided. On the other hand, ridges lying parallel to the slidepath are relatively secure.

Convex slopes provide favorable conditions for avalanches because the snow layers settling upon them are placed under tension. Avalanches usually fracture at the sharpest point on the curve, get up to full speed instantly, and pulverize rapidly. The steepest part of a convex slope is generally

X

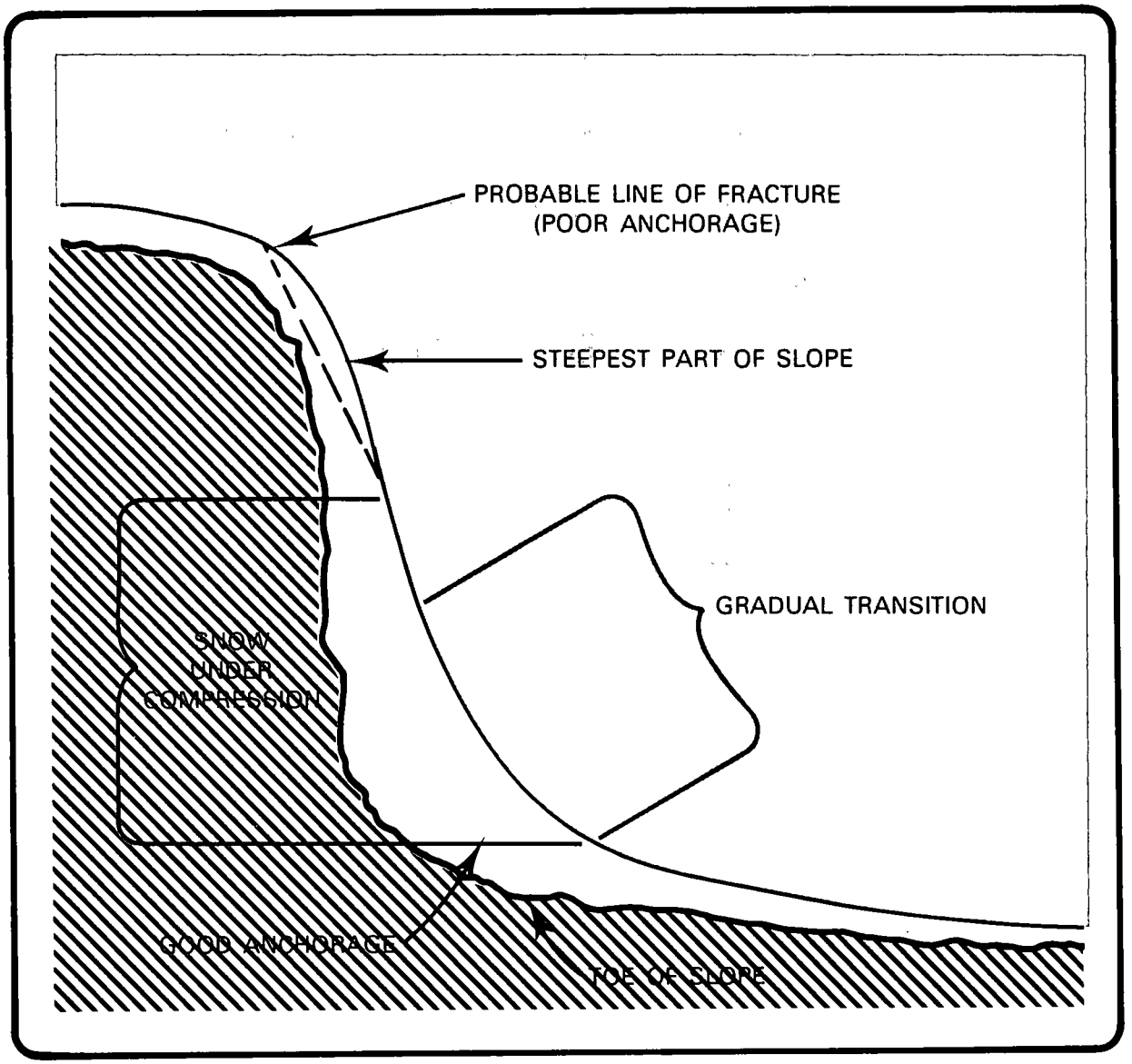


Convex Slope.

near the bottom, leading to a sudden transition and poor anchorage at the toe of the snow layer.

On a concave surface, snow is under compression. The steepest part of the slope is generally near the top; the transition is more gradual, and the anchorage at the toe is better than that of a convex slope. The dimensions of the slope (length and width) are other factors that contribute to the size and destructive power of avalanches.

All the terrain features mentioned above are less important than grade. The steeper the slope, the more likely it is to slide regardless of any other conditions. ***The minimum angle favorable to avalanches is 25 degrees.*** Slopes from 25 degrees to 35 degrees may avalanche, es-

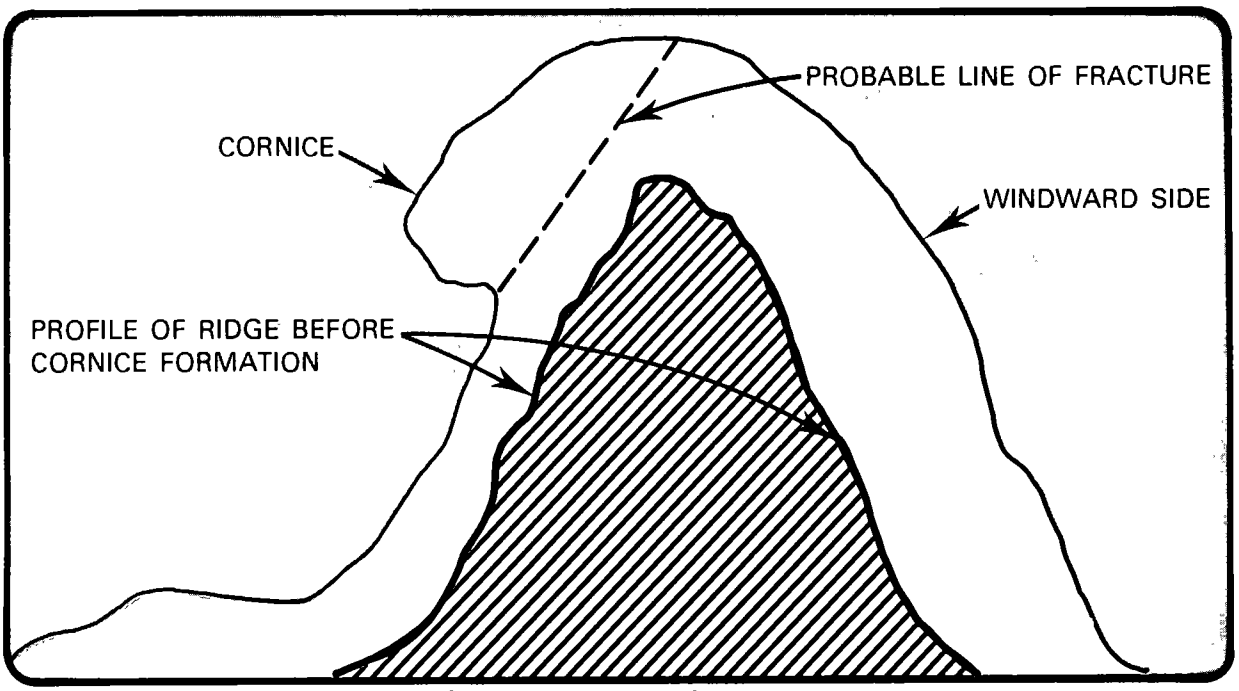


Concave Slope.

pecially if disturbed by artillery fire or some other factor. ***The critical zone lies above 35 degrees.*** From this angle to the point where snow can no longer cling, except by windpacking, slopes are apt to slide in some fashion with every storm.

CORNICES

A cornice is a snow formation allied with the slab. Cornices build up on the lee side of crests and ridges which lie at or near right angles to the wind. Occasionally they are straight-walled, but their characteristic shape is that of a breaking wave. The obvious hazard from cornices is caused by fractures of the overhang from simple



Composition of a Cornice.

overloading, or weakening due to temperature, rain, or sun erosion. These falling blocks are generally large enough to be dangerous by themselves, and they may also cause the release of avalanches on the slopes below.

VEGETATION

Vegetation of any kind, except grass, has a restraining effect on avalanches. The existence of heavy forest cover is an indication that slides in the location are rare or of minor importance. It is a mistake, however, to consider all forested areas safe. Scattered timber is no particular deterrent. Slopes where the timber has been destroyed by fire offer good potential for snowslides.

EXPOSURE

Slopes facing the sun favor avalanches produced by thawing. Loose snow avalanches are more common on slopes that are opposite the sun, and frequently, cornices are formed along ridges and crests lying at right angles to the prevailing wind. Lee slopes are the most probable locations for overloads of wind-driven snow and formation of slab. On the other hand, snow is transported from the wind-beaten slopes, and that which remains is packed and stabilized.

CLIMATE AND WEATHER

In addition to the terrain factors, climate and weather are the other basic ingredients of the avalanche phenomenon. Storms which deposit up to 1 inch (2.5 centimeters) of new snow per hour are not uncommon. Temperature fluctuates widely and rapidly

in the mountains. Prolonged spells of extremely low temperatures occur with occasional intrusions of warm air masses, usually in connection with storms.
Temperature greatly affects the cohesion of snow; a rise in temperature retards settlement of the snow mass and increases the brittleness and tension of a slab formation. Rainfall may occur in the coastal zones and create avalanche conditions.

AVALANCHE TRIGGERS

A loose snow slide usually occurs during or immediately after a storm or some other weather situation that creates instability. A slab avalanche may come as a delayed action. In any case, every avalanche must have a "trigger." There has to be some final nudge, some force or combination of forces to account for the release of masses of snow at a particular time and place. Avalanche triggers include:

OVERLOADING

Weight is probably the most frequent cause of avalanches. New snow piles up until it overcomes cohesion, and the structure collapses of its own weight and begins to slide.

SHEARING

Shearing can be applied in various ways—the slicing action of a pair of skis, snow falling out of trees or over a cliff, or any exterior force that cuts the bond. A slide in motion has a shearing effect on the snow beneath.

VIBRATION

Vibration is related to shearing, but is treated separately. Unlike the other triggers, it can operate at long range. Avalanches may be released by thunder, shock waves from high-speed aircraft, explosions, earthquakes, and by other loud or sharp sounds—vibrations transmitted through the earth and snow by the movement of tanks, bulldozers, or heavy machinery. They can also be triggered by the primary or reflected blast waves resulting from the detonation of nuclear weapons.

TEMPERATURE

Temperature triggers avalanches by its effect on the cohesion of snow. A rise in temperature weakens the bonds, while a fall in temperature retards settlement of the snow mass and increases the brittleness and tension of a slab.

Avalanches constitute a serious hazard to units deployed in high mountain or alpine terrain. Accurate prediction of an avalanche either in time or location is impossible. The factors described in this appendix, coupled with advice of trained mountaineers and local guides, will provide an indication of the probability of avalanches.

Types of Avalanches

Avalanches may be classified based upon the type of snow involved, the manner of release, or the size. For simplicity, classification according to the type of snow involved is normally used. All slides are divided into two general groups: loose snow and packed snow avalanches.

Loose snow avalanches always start from a point or narrow sector on the surface. From the starting point, they tend to grow in a fan-shaped manner, expanding in both width and depth. Their speed and the manner of development depend on characteristics of the moving snow—dry, damp, or wet.

Dry loose snow avalanches normally travel at high speed on a gradually widening path, increasing in size as they descend. A dry loose snow avalanche is always shallow at the start and depends for volume on the snow it can pick up during its run. Thus, a dry snow avalanche of dangerous size can only occur on a long slidepath, or from a large accumulation zone which funnels into a constricted outrun.

Damp and wet snow avalanches resemble dry snow avalanches in that they start at a single point, and gradually become wider. Their mass, however, is much greater than that of dry snow avalanches, and their speed is much slower. The wet avalanches of spring, caused by deep thawing either from rain or prolonged temperatures above freezing, often involve enormous masses of snow and have tremendous destructive force.

Packed snow avalanches are unquestionably the worst killers of all and are equal to wet spring avalanches in destructive force. Windpacked snow may be called windslab or snowslab. Hard slab is usually the result of wind action on snow picked up from the surface. Soft slab is usually the result of wind action on falling snow. A windslab avalanche behaves in an altogether different manner than a loose snow avalanche. It has the ability to retain its unstable character for days, weeks, and even months, thus leading to the unexpected release of delayed-action avalanches. Avalanches are often triggered by minor changes such as the addition of a small amount of new snow, skiing across a hillside, sun action, or even a minor vibration.

A windslab avalanche combines great mass with high speed to produce maximum energy. It starts on a wide front with penetration in depth. The entire slab field (top, sides, and bottom) releases almost simultaneously. In a packed snow avalanche, the main body of the slide reaches its maximum speed within seconds. Speeds of 100 kilometers per hour are not uncommon. Thus, it exerts full destructive power from the place where it starts, whereas a loose snow avalanche does not attain its greatest momentum until near the end of its run. Because of the characteristic delayed release action described above, the SLAB AVALANCHE IS THE MOST DANGEROUS OF ALL TYPES.

APPENDIX G

PRINCIPAL MOUNTAINS OF THE WORLD AND MOUNTAINOUS COUNTRIES OF EURASIA

This appendix provides brief descriptions of mountainous countries of EURASIA and a listing of the principal mountains of the world. Current and/or specific information can be obtained from The Defense Mapping Agency, The Defense Intelligence Agency, and relevant volumes of the DA Pamphlet 550 series.

PRINCIPAL MOUNTAINS OF THE WORLD

EUROPE	HEIGHT	
	FEET	METERS
Elbrus, Soviet Union	18,481	5,633
Dykh-Tau, Soviet Union	17,070	5,203
Shkhara, Soviet Union	16,594	5,058
Kazbek, Soviet Union	16,512	5,033
Blanc, Mont, France-Italy (Alps)	15,781	4,810
Rosa, Monte (Dufourspitze) Switzerland	15,200	4,633
Weisshorn, Switzerland	14,803	4,512
Matterhorn, Italy-Switzerland	14,685	4,476
Finsteraarhorn, Switzerland	14,026	4,275
Jungfrau, Switzerland	13,668	4,166

Principal Mountains of the World (Continued)

EUROPE	HEIGHT	
	FEET	METERS
Grossglockner, Austria	12,461	3,789
Teide, Pico de, Spain (Canary Is.)	12,162	3,707
Mulhacen, Spain	11,424	3,482
Aneto, Pico de, Spain	11,168	3,404
Etna, Italy (Sicily)	11,122	3,390
Perdido (Perdu), Spain	11,007	3,355
Clapier, France-Italy	9,993	3,046
Zugspitze, Austria-Germany	9,721	2,963
Coma Pedrosa, Andorra	9,665	2,946
Musala, Bulgaria	9,592	2,924
Corno, Italy	9,560	2,914
Olympus, Greece	9,550	2,911
Triglav, Yugoslavia	9,393	2,863
Korab, Albania-Yugoslavia	9,068	2,764
Cinto, France (Corsica)	8,891	2,710
Gerlachovaka, Czechoslovakia	8,737	2,663
Moldoveanu, Romania	8,343	2,543
Rysy, Czechoslovakia-Poland	8,199	2,499
Glittertind, Norway	8,104	2,470
Parnassus, Greece	8,061	2,457
Idhi (Ida), Greece (Crete)	8,058	2,456
Pico, Portugal (Azores Is.)	7,713	2,351

Principal Mountains of the World (Continued)

EUROPE	HEIGHT	
	FEET	METERS
Kebnekaise, Sweden	6,965	2,123
Hvannadalshnuker, Iceland	6,952	2,119
Estrela, Portugal	6,539	1,994
Naroda, Soviet Union	6,184	1,885
Marmora, Punta Ia, Italy (Sardinia)	6,017	1,834
Hekla, Iceland	4,747	1,447
Nevis, Ben, United Kingdom (Scotland)	4,406	1,343
Haltia, Finland-Norway	4,344	1,324
AFRICA	**FEET**	**METERS**
Kilimanjaro (Kibo), Tanzania	19,340	5,893
Kenya, Kenya	17,058	5,199
Margherita , Zaire-Uganda	16,763	5,109
Ras Dashan, Ethiopia	15,158	4,620
Meru, Tanzania	14,979	4,566
Elgon, Kenya-Uganda	14,178	4,321
Toubkal, Morocco	13,665	4,165
Cameroon, Cameroon	13,353	4,070
Thabana Ntlenyana, Lesotho	11,425	3,482
Koussi, Emi, Chad	11,204	3,415
Injasuti, South Africa	11,182	3,408
Neiges, Piton des, Reunion	10,069	3,069
Santa Isabel, Equatorial Guinea	9,868	3,008

Principal Mountains of the World (Continued)

AFRICA	HEIGHT	
	FEET	METERS
Tahat Pk., Algeria	9,952	3,003
Maromokotro, Malagasy Republic	9,436	2,876
Pico, Cape Verde Is	9,281	2,829
Katrinah, Jabal, Egypt	8,652	2,637
Sao Tome, Pico de, Sao Tome	6,640	2,240
ASIA	**FEET**	**METERS**
Everest, China (Tibet)-Nepal	29,028	8,848
Godwin Austen (K2 Dapsang),India(Kashmir	28,250	8,611
Kanchenjunga, Nepal-India (Sikkim)	28,208	8,598
Makula, China (Tibet)-Nepal	27,824	8,481
Dhaulagiri, Nepal	26,810	8,172
Nanga Parbat, India (Kashmir)	26,660	8,126
Annapurna, Nepal	26,504	8,078
Gasherbrum, Pakistan (Kashmir)	26,470	8,068
Gosainthan (Sisha Pangma), China (Tibet)	26,291	8,013
Nanda Devi, India	25,645	7,817
Rakaposhi, India (Kashmir)	25,550	7,788
Kamet, India	25,447	7,756
Namcha Barwa, China (Tibet)	25,443	7,755
Gurla Mandhata, China (Tibet)	25,354	7,728
Ulugh Muztagh, China	25,338	7,723
Tirich Mir, Pakistan (Hindu Kush)	25,230	7,690

Principal Mountains of the World (Continued)

ASIA	HEIGHT	
	FEET	METERS
Minya Konka, China	24,902	7,590
Muztagh Ata, China	24,787	7,557
Kula Kangri, Bhutan	24,784	7,556
Communism Pk., Soviet Union	24,590	7,495
Pobeda Pk., China-Soviet Union	24,406	7,439
Lenin Pk., Soviet Union	23,406	7,134
Api, Nepal	23,399	7,132
Khan-Tengri, Soviet Union-China	22,949	6,995
Kailas, China (Tibet)	22,031	6,715
Hkakabo Razi, Burma-China	19,296	5,881
Damavend, Iran	18,376	5,601
Ararat, Turkey	17,011	5,185
Djaja (Carstensz), Indonesia (New Guinea)	16,503	5,030
Klyuchevskaya Sopka, Soviet Union	15,584	4,750
Trikora Pk., Indonesia	15,518	4,730
Belukha, Soviet Union	14,783	4,506
Tabun Bogdo (Khuitun), China-Mongolia	14,291	4,356
Turgan Uula, Mongolia	14,052	4,283
Kinabalu, Malaysia (Borneo)	13,455	4,101
Hsinkao; Taiwan	13,113	3,997
Erciyas Dagi, Turkey	12,848	3,916
Kerintji, Indonesia (Sumatra)	12,467	3,800

Principal Mountains of the World (Continued)

ASIA	HEIGHT	
	FEET	METERS
Fuji, Japan	12,388	3,776
Hadur, Shu ayb, Yemen	12,336	3,760
Rindjani, Indonesia (Lombok)	12,224	3,726
Mahameru, Indonesia (Java)	12,060	3,676
Munku-Sardyk, Mongolia-Soviet Union	11,453	3,491
Rantemario, Indonesia (Celebes)	11,335	3,455
Sa'uda, Qurnet es, Lebanon	10,131	3,088
Sham, Jabal ash, Oman	9,777	2,980
Apo, Philippines (Mindanao)	9,692	2,954
Pulog, Philippines (Luzon)	9,626	2,934
Bia, Phou, Laos	9,242	2,817
Hermon, Lebanon-Syria	9,232	2,814
Packtu-san, China-Korea	9,003	2,744
Anai Mudi, India	8,841	2,695
Inthanon, Doi, Thailand	8,514	2,595
Pidurutalagala, Ceylon	8,281	2,524
Mayon, Philippines (Luzon)	8,077	2,462
Asahi, Japan (Hokkaido)	7,513	2,290
Tahan, Gunong, Malaysia (Malaya)	7,174	2,187
Olimbos, Cyprus	6,401	1,951
Kuju-San, Japan (Kyushu)	5,866	1,788

Principal Mountains of the World (Continued)

NORTH AMERICA	HEIGHT	
	FEET	METERS
McKinley, Alaska	20,320	6,194
Logan, Canada	19,850	6,050
Citlaltepetl (Orizaba), Mexico	18,701	5,700
St. Elias, Alaska-Canada	18,008	5,489
Popocatepetl, Mexico	17,887	5,452
Foraker, Alaska	17,400	5,304
Ixtacihuatl (Iztaccihuatl), Mexico	17,343	5,286
Lucania, Yukon, Canada	17,147	5,226
Whitney, California	14,494	4,418
Elbert, Colorado	14,433	4,399
Massive, Colorado	14,421	4,396
Harvard, Colorado	14,420	4,395
Rainier, Washington	14,410	4,392
Williamson, California	14,375	4,382
Blanca Pk., Colorado	14,363	4,378
Uncompahgre Pk., Colorado	14,309	4,361
Grays Pk., Colorado	14,270	4,349
Evans, Colorado	14,264	4,348
Longs Pk., Colorado	14,255	4,345
Wrangell, Alaska	14,163	4,317
Shasta, California	14,162	4,316
Pikes Pk., Colorado	14,109	4,300

Principal Mountains of the World (Continued)

NORTH AMERICA	HEIGHT	
	FEET	METERS
Colima, Nevada de, Mexico	13,993	4,265
Tajumulco, Guatemala	13,846	4,220
Mauna Kea, Hawaii	13,796	4,205
Gannett Pk., Wyoming	13,785	4,202
Grand Teton, Wyoming	13,766	4,196
Mauna Loa, Hawaii	13,680	4,170
Kings Pk., Utah	13,528	4,125
Weddington, Canada	13,260	4,042
Cloud Pk., Wyoming	13,175	4,016
Wheeler Pk., New Mexico	13,161	4,011
Boundary Pk., Nevada	13,140	4,005
Robson, Canada (Canadian Rockies)	12,972	3,954
Granite Pk., Montana	12,799	3,901
Borah Pk., Idaho	12,662	3,859
Humphreys Pk., Arizona	12,633	3,850
Chirripo Grande, Costa Rica	12,533	3,820
Adams, Washington	12,307	3,751
Gunnbjorn, Greenland	12,139	3,702
San Gorgonio, California	11,502	3,506
Chiriqui (Baru), Panama	11,411	3,478
Hood, Oregon	11,235	3,424
Lassen Pk., California	10,457	3,187

Principal Mountains of the World (Continued)

NORTH AMERICA	HEIGHT	
	FEET	METERS
Duarte, Pico, Dominican Rep	10,417	3,175
Haleakala, Hawaii	10,023	3,055
Paricutin, Mexico	9,213	2,808
La Selle, Pic, Haiti	8,773	2,674
Guadalupe Pk., Texas	8,751	2,667
Olympus, Washington	7,965	2,428
Monte Cristo, El Salvador-Guatemala-Honduras	7,936	2,419
Blue Mountain Pk., Jamaica	7,402	2,256
Harney Pk., South Dakota	7,242	2,207
Mitchell, North Carolina	6,684	2,037
Clingmans Dome, North Carolina-Tennessee	6,643	2,025
Turquino, Pico, Cuba	6,542	1,994
Washington, New Hampshire	6,288	1,917
Rogers, Virginia	5,729	1,746
Marcy, New York	5,344	1,629
Katahdin, Maine	5,268	1,606
Kawaikini, Hawaii	5,243	1,598
Spruce Knob, West Virginia	4,862	1,482
Pelee, Martinique	5,583	1,397
Mansfield, Vermont	4,393	1,339
Punta, Cerro de, Puerto Rico	4,389	1,338
Black Mtn, Kentucky	4,145	1,263
Kaala Pk., Hawaii	4,050	1,234

Principal Mountains of the World (Continued)

SOUTH AMERICA	HEIGHT	
	FEET	METERS
Aconcagua, Argentina	22,831	6,959
Ojos del Salado, Argentina-Chile	22,516	6,863
Tupungato, Argentina-Chile	22,310	6,800
Pissis, Argentina	22,241	6,779
Mercedario, Argentina	22,211	6,770
Huascaran, Peru	22,205	6,768
Llullaillaco, Argentina-Chile	22,057	6,729
Yerupaja, Peru	21,765	6,634
Incahuasi, Argentina-Chile	21,719	6,620
Sajama, Bolivia	21,391	6,520
Illimani, Bolivia	21,201	6,462
Chimborazo, Ecuador	20,561	6,267
Cotopaxi, Ecuador	19,347	5,897
Misti, Peru	19,098	5,821
Cristobal Colon, Columbia	19,029	5,800
Huila, Columbia	18,865	5,750
Bolivar (La Columna), Venezuela	16,411	5,002
Fitz Roy, Argentina	11,073	3,375
Bandeira, Pico da, Brazil	9,462	2,884
OCEANIA	**FEET**	**METERS**
Wilhelm, Papua, New Guinea	15,400	4,694
Giluwe, Papua	14,330	4,368
Bangeta, New Guinea	13,473	4,106

Principal Mountains of the World (Concluded).

OCEANIA	HEIGHT	
	FEET	METERS
Victoria, Papua	13,363	4,073
Cook, New Zealand	12,349	3,764
Ruapehu; New Zealand	9,175	2,796
Balbi, Solomon Is	9,000	2,743
Egmont, New Zealand	8,260	2,518
Sinewit, New Guinea	8,000	2,438
Orohena, Tahiti	7,352	2,241
Kosciusko, Australia	7,314	2,229
Silisili, Mauga, Western Samoa	6,095	1,858
Panie, New Caledonia	5,341	1,628
Ossa, Australia	5,305	1,617
Bartle Frere, Australia	5,287	1,611
Humboldt, New Caledonia	5,282	1,610
Woodroffe, Australia	4,970	1,515
Tomaniivi (Victoria), Fiji	4,341	1,323
Bruce, Australia	4,024	1,226
ANTARCTICA	**FEET**	**METERS**
Vinson Massif	16,864	5,140
Kirkpatrick	14,856	4,528
Markham	14,272	4,350
Jackson	13,747	4,190
Sidley	13,717	4,181
Wade	13,396	4,083

MOUNTAINOUS COUNTRIES OF EURASIA

SERIAL	COUNTRY	AREA Sq miles (Sq Km)	POPULATION* (Millions) *1976 UN est.	LANGUAGES	ADJACENT COUNTRIES	DA PAM 550 No	REMARKS
1	Afghanistan	260,000 (673,400)	19.8	Dari Pashto Uzbek Turkoman	Iran USSR PRC Pakistan	65	Dominant physical feature is the mountainous central highlands formed by the Hindu Kush and part of the great Alpine Himalayan mountain chain Covering an area of 160,000 sq miles, the highlands have peaks that rise over 21,000 feet (6,401 meters) with passes from 12,000 feet (3,658 meters) to 15,000 feet (4,572 meters)
2	Austria	32,366 (83,828)	7.51	German	FRG Czechoslovakia Hungary Yugoslavia Italy Switzerland	—	Approximately 71% mountainous, which can be divided into the Eastern, the Central, and the Southern Alps The Eastern Alps rise south of the Danube Valley Although dominating Austria, they are relatively accessible as the waters of the Inn, Sulzach, Enns, Mur, and Murz rivers provide important north-south passages through the mountains. The Central Alps are located on both sides of the Brenner Pass, which provides the major north-south access with Italy. Most prominent is the Hohe Tauern, containing Austria's highest peak, the Grossglockner—12,461 feet (3,798 meters). Within the Southern Alps are the Carnic and Karawanken ranges, marking the southern boundary with Italy and Yugoslavia.

3	Bulgaria	42,800 (110,852)	8.76	Bulgarian	Rumania Yugoslavia Greece Turkey	168	Alternating bands of high and low terrain extend generally east to west Of the four prominent areas, two are mountainous—the Balkan and Rhodope Mountains. The western part of the country consists almost entirely of higher land with the Rhodope having more than 12 peaks over 9,000 feet (1,829 meters)
4	Peoples Republic of China (PRC)	3,704,427 (9,594,466)	852.13	Mandarin & minority ethnic group languages belonging to Sino-Tibetan Altaic, & Austroasiatic families	USSR Afghanistan India Pakistan Bhutan Sikkim Nepal Mongolia Burma N. Korea N. Vietnam Laos Hong Kong	60/9	Divided into three topographic regions: northern, western and eastern Mountainous uplands and plateaus account for more than half of the total land area On its border with USSR are the Pamirs, Tien Shan and Altai mountain ranges reaching over 12,000 feet (3,658 meters) to 23,600 feet (7,193 meters)—Tengri Khan. The three Himalayan mountain ranges form its southern borders with India, Nepal, Sikkim and Bhutan. The central range is the highest, having many peaks over 25,000 feet (7,620 meters). Mount Everest, the highest peak at 29,028 feet (8,848 meters), forms the most formidable natural barrier between India and China
5	Czechoslovakia	49,366 (127,858)	14.92	Czechoslovakian Slovenian	FRG E. Germany Poland USSR Hungary Austria	158	Divided into three parts—Bohemia in the west, Slovakin, the eastern two-fifths; and Moravia, the transition area. The eastern region is made up of the northern reaches of the Carpathian mountains, with the highest peak of the High Tatras 8,737 feet (2,663 meters).

Mountainous Countries of Eurasia (Continued)

SERIAL	COUNTRY	AREA Sq miles (Sq Km)	POPULATION* (Millions) *1976 UN est.	LANGUAGES	ADJACENT COUNTRIES	DA PAM 550 No	REMARKS
6	East Germany	41,757 (108,151)	16.79	German Slavic	FRG Poland Czechoslavakia	155	Part of the north European plain and has few extremes of terrain. Three distinct areas. costal lowlands, central lowlands, and southern highlands The highest points of East Germany are in the Harz—3,747 feet (1,142 meters), on the FRG border, and in the Ore Mountains—3,983 feet (1,214 meters) on the border of Czechoslovakia
7	France	211,152 (546,884)	52.92	French and local dialects Breton Flemish Catalan Provencal	Belgium Luxemburg FRG Switzerland Italy Monaco Spain	—	Political boundaries formed mostly by natural features In the north, west, and south, the coasts form a clear limit. In the southwest and southeast the boundary runs through mountains, and in the east along the Rhine Within the French Alps, forming the border with Italy and Switzerland, is Mont Blanc, the highest peak in western Europe—15,781 feet (4,810 meters). The Pyrenees, in the south, separate France and Spain.
8	Federal Republic of Germany (FRG)	95,930 (248,459)	62.0	German	E. Germany Czechoslovakia Austria Switzerland France Luxemburg Belgium Netherlands	29	Generally flat in the north and hilly in the central and western areas, rising in the south to over 4,000 feet (1,219 meters) in the Black Forest. The highest elevation is the Zugspitze in the Bavarian Alps at 9,721 feet (2,963 meters).

9	Greece	50,930 (131,909)	9.17	Greek	Albania Yugoslavia Bulgaria Turkey	87	Greece is divisible into the mainland and the islands, and into highlands, hill country and plains. The mainland consists of three main regions: northern, central and the Peloponnesus. All mountainous, the central range of the Pindus is the largest, with four spurs to the east. The most famous is Olympus, reaching 9,550 feet (2,911 meters).
10	India	1,266,266 (3,279,629)	610.08	15 official languages, including English Hindi	Pakistan PRC Nepal Sikkim Bhutan Burma Bangladesh	21	Northeast side of the northern triangle is the massive Himalayan wall. Peaks of the lesser Himalayas are mostly between 5,000 feet (1,524 meters) and 12,000 feet (3,658 meters). The Outer or Southern Himalayas average 3,000 feet (914 meters) to 4,000 feet (1,219 meters). Karakoram Pass, 18,290 feet (5,575 meters) is the best known and most important, linking India and the PRC, and located at the tip of India's northern triangle.
11	Iran	628,000 (1,626,520)	33.9	Persian Turkic Arabic	Iraq Turkey USSR Afghanistan Pakistan	68	Situated on a high triangular plateau and surrounded on all sides by a mountainous rim Rim begins with the Armenian Knot Mountains in the northwest corner, adjacent to Turkey's Mt Ararat. Extends southeast with the Zagros mountain chain and east with the Elburz Mountains. Highest peak is 18,376 feet (5,601 meters) in the Elburz Mountains, northwest of Tehran.

Mountainous Countries of Eurasia (Continued)

SERIAL	COUNTRY	AREA Sq miles (Sq Km)	POPULATION* (Millions) *1976 UN est.	LANGUAGES	ADJACENT COUNTRIES	DA PAM 550 No	REMARKS
12	Iraq	167,881 (434,812)	11.51	Arabic Kurdish Turkoman	Turkey Iran Kuwait Saudi Arabia Jordan Syria	31	Divided into four main zones—desert in west and southwest; highlands in the north and northeast; rolling upland between upper Tigris and Euphrates rivers; and alluvial plain between lower Tigris and Euphrates rivers. Northeastern highlands include mountains ranging from 3,000 (914 meters) to more than 12,000 feet (3,658 meters) near Iranian and Turkish borders
13	Italy	116,272 (301,144)	56.19	Italian Slovenes German French Greek Albanian	France Switzerland Austria Yugoslavia	182	Predominantly mountainous. Alps across the north from France to Yugoslavia; Apennines from the Alps to the sourthern tip of the peninsula. The Alps may be divided into western, central, and eastern ranges, with over 100 peaks more than 10,000 feet (3,048 meters).
14	Mongolia	604,250 (1,565,008)	1.3	Khalkha-Mongol Russian	PRC USSR	76	Most of the north, west, southwest, and central areas consist of mountains, plateaus and depressions. The Mongolian Altai range extends from the northwest corner to the southern border. Tabum Peak, 14,291 feet (4,356 meters), is located in the extreme west of the Altai

15	Nepal	54,372 (140,823)	12.86	Napali	PRC India	35	Mountainous—The three Himalayan kingdoms Nepal mountains of the main Himalayan range (Mt Everest—29,028 feet [8,848 meters]).
	Sikkim	2,745 (7,110)	.21	English Nepali Denjongke	PRC India	35	Sikkim: situated between two massive mountain spurs (Mt Kanchenjunga—28,208 feet [8,598 meters])
	Bhutan	18,000 (46,620)	1	Denjongke	PRC India	35	Bhutan south of main Himalayan range crest (Kangri Peak—24,784 feet [7,556 meters]).
16	Norway	125,148 (324,133)	4.03	Norwegian English	Sweden Finland USSR	—	There is scarcely any lowland, and even the 20% of the country which lies below 500 feet (152 meters) is mostly hills or valley floors. The wall of steep mountains lining most of the coast is cut by deep, winding narrow fjords. The mountain regions at Dourefjell and Langfjell divide southern Norway into three main sections The Kjolen Mountains form a natural boundary between northern Norway and Sweden In the Jotuheimen area is Glittertinden, 8,104 feet (2,470 meters), the tallest mountain in Norway.
17	Pakistan	310,403 (803,944)	72.37	Urdu Punjabi Sindhi English Pushtu Baluchi Brahui	Iran Afghanistan PRC India	48	Elevations range from sea level on the Arabian Sea to over 25,000 feet (7,620 meters) in the Western Himalayas. The northern highlands are a region of some of the most rugged mountains of the world with over fifty peaks above 22,000 feet (6,706 meters) On the northeast border with PRC is Mount Godwin-Austen—28,250 feet (8,611 meters)—also called K-2.

Mountainous Countries of Eurasia (Continued).

SERIAL	COUNTRY	AREA Sq miles (Sq Km)	POPULATION* (Millions) *1976 UN est.	LANGUAGES	ADJACENT COUNTRIES	DA PAM 550 No	REMARKS
18	Rumania	91,660 (237,399)	21.45	Rumanian Hungarian German	Bulgaria Yugoslavia Hungary USSR	160	Interior of country is a broad plateau, almost surrounded by mountains of the Carpathian system. On the east are Moldavian Carpathians rising to 7,500 feet (2,286 meters); higher southern ranges called the Transylvanian Alps reaching 8,000 feet (2,438 meters); and the Bihor Massif on the west approaching 6,000 feet (1,829 meters).
19	Saudi Arabia	864,000 (2,237,760)	5.6	Arabic	Jordan Iraq Kuwait Qatar UAE Oman Yemen (Aden) Yemen (Sana)	51	Occupies 80% of the Arabian Peninsula The western coastal escarpment is divided into two mountain ranges separated by Mecca. The northern range in the Hejaz rises to 7,000 feet (2,134 meters), and the higher southern mountains exceed 8,000 feet (2,438 meters) with peaks up to 10,000 feet (3,048 meters).
20	Syria	72,234 (187,086)	7.6	Arabic Kurdish Armenian Turkic Syriac	Lebanon Israel Jordan Iraq Turkey	47	Divided into a coastal zone with a narrow double mountain belt and a much larger eastern portion including several desert areas. The Jabal al Nusayriyah, a range paralleling the northwest coast plain, averages just over 4,000 feet (1,219 meters), the highest peak, Nabi Yunis, is 5,200 feet (1,585 meters). Before reaching the Lebanese border and the Anti-Lebanon mountains, the Jabal al Nusayriyah range terminates, leaving a corridor to the port at Tripoli. Farther south, the Anti-Lebanon mountains rise to 9,232 feet (2,814 meters) on the Syrian-Lebanese frontier.

21	Spain	189,505 (490,818)	35.97	Spanish Catalan Portuguese Basques	Portugal France	—	Average elevation is the second highest in Europe, after Switzerland. The major features may be grouped as the Meseta, the borderlands, and the Pyrenees and the Sistema Penibetico The Pyrenees, which separate Spain from France, has a high central axis from 8,000—11,000 feet (2,438—3,353 meters). In the southeast, the Sistema Penibetico rises steeply from the coast to 5,000—11,000 feet (1,524—3,353 meters), to culminate in the Sierra Nevada.
22	Sweden	173,615 (449,663)	8.2	Swedish Finnish Lap	Norway Finland	—	Historically, composed of three major regions—Norrland, Svealand, and Gotaland—symbolized in the three crowns. Norrland, "the northland" makes up the vast northern frontier region, occupying two-thirds of the country. Sweden's highest peak is Kebnekaise, rising to 6,965 feet (2,123 meters)
23	Switzerland	15,935 (41,272)	6.35	German French Italian Rumanian	France FRG Austria Italy	—	Very little area less than 1,000 feet (305 meters), with more than half of the total area over 3,000 feet (914 meters). The topography forms a series of belts that run southwest—northeast, and forms three major regions: the Jura, in the northwest, the Swiss Plateau, in the north central region; and the Alps. The Alps cover more than half the country and form two parallel mountain ranges. The northern chain is made up of the Bernese Alps and the Alps of Uri and Glarus. The southern ranges include the Penine, Lepontine, and Rhaetian Alps. The lofty Penine contain the Matterhorn, 14,685 feet (4,476 meters), and Monte Rosa, 15,200 feet (4,633 meters), on the Italian border

Mountainous Countries of Eurasia (Concluded).

SERIAL	COUNTRY	AREA Sq miles (Sq Km)	POPULATION* (Millions) *1976 UN est.	LANGUAGES	ADJACENT COUNTRIES	DA PAM 550 No	REMARKS
24	Turkey	301,302 (780,372)	40.16	Turkish Kurdish Arabic Caucasian	Greece Bulgaria USSR Iran Iraq Syria	80	Part of the great Alpine-Himalayan mountain belt and one of the ranking earthquake regions of the world. Over 80% of the land surface is rough, broken, and mountainous. Eastern part of the country reaches to 17,011 feet (5,185 meters)—Mount Ararat with a medium altitude of over 5,000 feet (1,524 meters)
25	Union of Soviet Socialists Republic (USSR)	8,650,000 (22,403,500)	258.9 (Official est.)	Russian Ukrainian Belorussian Uzbek Tatar Kazakh	N. Korea PRC Mongolia Iran Afghanistan Turkey Rumania Hungary Czechoslovakia Poland Finland Norway	95	A vast plain broken by low mountains and hills extends from the western borders about half-way across the country to the Yenisey River in the east and to the high mountains in the southern and eastern parts of Soviet Central Asia The area extending eastward from the Yenisey River to the Pacific Ocean consists of hilly plateaus and mountains intersected by many rivers, most of which flow in a northerly direction The southern rim of mountains extending westward from the upper Yenisey to the Black Sea—includes all or part of the Pamirs and the Sayan, Altai, Tien Shan, and Caucasas ranges. Several peaks higher than Mont Blanc are found in the Caucasus, running between the Caspian and Black Seas—the highest, Mount Elbrus, rises to 18,481 feet (5,633 meters). In the Pamir is Mount Communism—Stalin Peak, 24,590 feet (7,495 meters).
26	Yugoslavia	98,766 (255,804)	21.52	Serbo-Croatian Slovenian Macedonian	Italy Austria Hungary Rumania Bulgaria Greece Albania	99	60% of total land consists of hills and ridges up to 3,000 feet (914 meters). 20% consists of mountains and ranges over 3,000 feet (914 meters) Mountains located in the south, southwest and northwest corner near the Austrian border. The Julian Alps are among the most rugged in Europe, with peaks from 6,000 to 9,400 feet (1,823 to 2,865 meters).

30 JUNE 1980

By Order of the Secretary of the Army:

E. C. MEYER
General, United States Army
Chief of Staff

Official:

J. C. PENNINGTON
Major General, United States Army
The Adjutant General

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CHAPTER 3

MOUNTAIN OPERATIONS

In the two previous chapters, the environment, its effects on personnel and equipment, and preparation for operations in the mountains were described. This chapter describes mountain operations.

CONTENTS

How the Mountain Environment Affects Tactical Operations

The mountain environment, together with its effects on personnel and equipment, requires some modification of tactics and procedures. Important physical characteristics that influence mountain operations are:

- O Rugged peaks, steep ridges, deep ravines, and valleys.
- O Limited routes of communication.
- O Highly changeable weather.
- O Availability of natural cover and concealment.

Advantages or disadvantages resulting from these characteristics are equally applicable to enemy forces. This section describes how these characteristics influence basic tactical operations.

OBJECTIVES

While the destruction of the enemy continues to be the basic objective of tactical operations, the task of controlling specific terrain will invariably play a key role in operational planning in mountainous regions.

At all levels of command, mountains are obstacles to maneuver. Access through them is vital to both us and the enemy. Natural and manmade communication routes in these regions are normally overlooked by dominating heights which provide the defender observation and, therefore, some measure of control over their use.

At brigade level and below, major tactical objectives will normally be translated into tasks pertaining to the seizure or retention of specific dominating heights.

MOBILITY

The most obvious impact of the mountain environment on tactical operations is the significant overall reduction in mobility caused by the terrain and weather. Surface movement by vehicle or foot is extremely difficult and time-consuming. Snow, ice, rain, or fog may combine with the rugged terrain to increase the problem. Reduced mobility is a limiting factor to be considered during all phases of planning for mountain operations.

VEHICULAR MOVEMENT

Improved hard-surface roads capable of supporting heavy vehicular traffic, if they exist at all, are normally found only in valley corridors. Such roads are frequently dependent upon a system of narrow bridges spanning mountain streams and ravines. As roads rise from the valley to mountain passes or plateaus, they frequently cling to its steep shoulders or twist along precipitous ridgelines.

Secondary roads and trails are often few and primitive, but they may provide the only routes for vehicular traffic in the secondary terrain compartments. Cross-compartment travel between adjacent valleys is often impossible. Off-the-road travel is extremely difficult and requires detailed planning.

FOOT MOVEMENT

Personnel trained in basic movement skills can operate in all but the most rugged mountain terrain. Specialized training in mountaineering techniques may be required for unit guides, observers, snipers, and security or assault team members.

Stamina, endurance, and the ability to sustain strenuous physical exertion and recover quickly are fundamental to foot movement in the mountains. Physical conditioning for a mountain environment can only be achieved through frequent marches and climbs, with personnel equipped as they will fight.

The following procedures will help insure the effectiveness of soldiers after a mountain march.

Route Selection. Existing roads and trails offer the best routes for foot movement through mountains. However, tactical security considerations may influence route selection as much as ease of movement. Where off-road movement is required, detailed reconnaissance should be conducted. As a minimum, map data should be updated by photo intelligence or information from local inhabitants. Movement factors influencing route selection include the surface condition (hard ground, grassy covered, rock-strewn, etc.); the steepness of slopes (requirements for climbing equipment and skills); and the presence of vegetation (brush, trees, meadow grass).

Rate of March. A rate of march in mountains is measured in time rather than distance.

- When making a map reconnaissance, map distance plus 1/3 equals a good estimate of actual ground distance.
- Add 1 hour for each 300 meters of ascent or 600 meters of descent to the time required for marching a map distance.

  For example: a 16-kilometer march on a hard-surface road requires 4 hours at a 4-kilometer-per-hour (kph) rate. If there is a total climb of 600 meters (add 2 hours) and a total descent of 600 meters (add 1 hour), the entire march will require 7 hours.

16 km at 4 kph = 4 hrs (hard surface)
+ 2 hrs (600 m climb)
+ 1 hr (600 m descent)

Total Time = 7 hrs

March Discipline. Every aspect of march discipline must be rigorously enforced in order to keep a column closed. Straggling cannot be permitted, and deviation from the selected route by individuals or elements cannot be tolerated. Personnel forced to stop to repair or readjust equipment or because of illness or injury should not try to regain position in the march column until the next halt.

Halts. It is advisable to make a short halt to adjust clothing and equipment after the first 15 minutes of marching; 5- or 10-minute halts should be taken every half hour thereafter. At scheduled halts, weapons, rucksacks, and equipment loads should be removed. Lying down with the feet elevated helps refresh leg muscles and prevent stiffness.

MANEUVER FORCES

As in other special environments, consideration must be given to the capabilities of the forces committed to battle. Mountainous terrain limits the deployment of major forces and fragments operations into a series of small-unit battles fought primarily at battalion level. As indicated, mobility at all levels is seriously restricted. The shifting of forces is difficult and time-consuming. Frequently, adjacent units are separated by terrain features which preclude mutual support.

Although the infantry division is an appropriate force for operations in mountainous areas, some of its heavy equipment and heavy weapons may be unsuitable for the terrain. In addition, its maneuver battalions may require extra radios and additional support radars for the expanded number of observation posts and separate positions they may be expected to occupy.

The mountain environment severely limits the effectiveness of the division's mechanized and armored units. In most cases, it will be impossible to employ them in elements larger than a platoon. Despite these restrictions, imaginative planning and determination can enable tracked vehicles to reach difficult places. Time spent in reconnaissance and constructing special routes may be well worth the effort. Although tracked vehicles will seldom be able to accompany infantry in the assault, they can provide accurate overwatching fire.

Within the constraints imposed by weather, the air cavalry and attack helicopter units of the division may afford the ground commander decisive advantages in mobility and firepower.

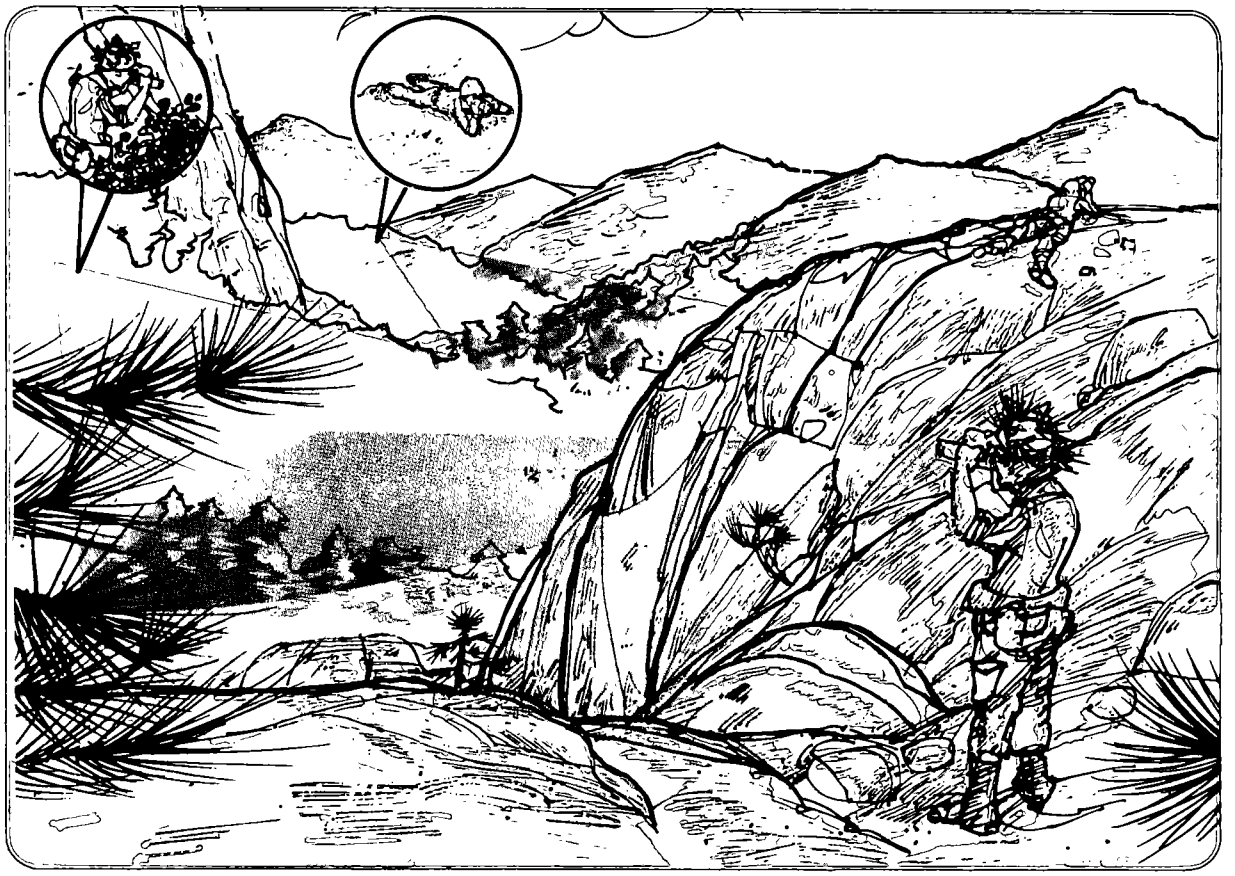
During all but the most adverse weather conditions, air cavalry can reconnoiter terrain and gather intelligence. Surveillance of vulnerable flanks and gaps between units is a primary mission of air cavalry in the mountains. Because of restricted mobility of ground maneuver units, the air cavalry or attack helicopters may be the first force to engage the enemy.

Attack helicopter companies are well suited for operations in a mountain environment. Their mobility enables the commander to concentrate combat power quickly and exploit enemy weaknesses. An important mission for these units is to attack the enemy's rear. How the mountain environment affects army aircraft is described in appendix D.

OBSERVATION AND FIELDS OF FIRE

The dominating heights of mountainous terrain generally permit excellent long-range observation. However, rapidly fluctuating weather with frequent periods of high winds, rain, snow, or fog may limit visibility. The rugged nature of the terrain will frequently produce significant dead space at mid-ranges. In addition, low cloud cover at higher elevations may neutralize the effectiveness of observation posts established on peaks or mountain tops. It may be necessary, therefore, to establish several observation posts laterally, in depth, and at varying altitudes to provide visual coverage of the battle area.

Fields of fire, like observation, are normally excellent at long ranges. However,



Dead Spaces Are Covered by Multiple Observation Posts.

dead space is a specific problem at short ranges. When forces cannot be positioned to cover dead space with direct fires, mines and obstacles or indirect fires must be used. Mortars, because of their high-angle trajectory and ease of movement, provide the most responsive indirect fire means for covering dead space.

RECONNAISSANCE AND SECURITY

Reduced mobility, compartmented terrain, limited visibility, and rapidly changing weather increase the importance of reconnaissance and security operations in the mountains. Since it is easy for the enemy to conceal his forces in this environment, additional assets must be allocated for these operations. Since mountain maps are frequently inaccurate or lacking in detail, terrain analysis requires emphasis. While detailed reconnaissance and security planning is the responsibility of command and staff organizations, the best sources of information are frontline soldiers, aircraft crews, and vehicle operators who move about the terrain. Reporting and debriefing procedures must be established.

The restrictions on land movement, the large areas of dead space, and inaccurate maps will increase the requirement for aerial reconnaissance, both photographic and visual. Aeroscouts in terrain flight

altitudes cannot necessarily find the enemy more easily than ground observers because the rugged terrain provides excellent concealment for stationary targets. Aeroscouts must use caution to avoid blundering into enemy air defense positions.

Route reconnaissance will be extremely important in providing the commander with information about road networks and their ability to support his forces. Because of the rugged terrain associated with a mountainous environment, such reconnaissance will be of even greater significance than in conventional terrain.

In mountainous areas, special attention must be given to knowing the disposition of friendly units. Ground scouts moving to the front or flanks will have great difficulty in maintaining specified distances from parent units. Maps, supplemented by aerial photographs and a system of checkpoints, should be used to control movement rates when visual contact cannot be maintained.

Units must provide for all-around security at all times. During movement, security forces should occupy terrain overwatching the main body. These forces should be positioned by helicopter when possible. When a force is in a defensive posture, particular attention must be given to gaps between units and to the development of mutually supporting positions. The threat of enemy infiltration and air attack is always present; therefore, passive and active defense measures must be stressed. Ground patrols, observation posts, radar, remote sensors, and aerial and ground-mounted surveillance devices provide additional means of security at night or during periods of limited visibility. Night vision devices can also be used in the mountains, but their effectiveness may be limited by terrain masking.

COVER AND CONCEALMENT

At first glance, mountainous terrain may not appear to offer the soldier adequate cover or concealment. Upon closer scrutiny, however, there is much that the soldier can do—provided he is taught how to use the terrain to his advantage.

When moving in the mountains, cover can be provided by rock outcrops, boulders, heavy vegetation, and intermediate terrain features that mask maneuver. The selection of dug-in positions requires detailed planning. Positions must be mutually supporting while protecting the soldier from hostile fires. Whenever possible, fighting positions should use terrain features to protect soldiers from enemy direct fire weapons. Positions should be sited so that flanking fires can be placed on the enemy. Overhead cover should be completed as soon as possible and listed as a key item in subordinate leaders' priority of work plans. Because of hard and rocky soil, digging may be extremely difficult, and engineer assistance may be required if major fortifications are to be constructed.

Concealment below the tree line in mountainous terrain can be achieved through the proper use of standard camouflage techniques which break up the shape of easily recognizable pieces of equipment. Caution must be taken to insure that camouflage matches the area in which it is used. Movement is easily detected in the mountains. This is especially true in the open since mountain trails normally offer little concealment. If enemy aircraft are sighted, the best immediate action is to lie prone and motionless with the head down. If they attack, disperse, seek cover, and engage the aircraft with small arms fire.

The topography of mountainous terrain often will limit the access routes to and from selected positions. Therefore, such routes

must be camouflaged, with special attention paid to tracks created by heavy equipment vehicles. Harsh mountain weather can sometimes be an ally, concealing movement from aerial or ground reconnaissance and security forces.

ASSEMBLY AREAS AND BIVOUAC SITES

Most mountainous regions offer very few locations which are suitable for assembly areas or bivouacs by units above company size. Frequently, even companies will be forced to establish separate platoon positions.

In general, unit positions should be located on commanding ground with provisions for all-around defense of the area. Small units should never establish positions in a valley since they do not possess sufficient forces to outpost surrounding high ground. For bivouacs in snow and extreme cold, see **FM 90—11, Winter Operations** (to be published).

Even temporary positions must be occupied in a formation suitable for perimeter defense. If overhead cover is available, positions astride roads or trails may be used. The use of platoon bivouacs will reduce the time required to close up at night and to move out in the morning. The commander, when issuing his order to halt for the night, should indicate whether to close into platoon or company bivouacs, depending on the availability of cover, length of the column, and his mission on the following day.

The actual setup of bivouacs will vary considerably because of the irregularities of the terrain. All types of shelters may be dug in the side of a slope, using shelter halves, ponchos, or pieces of canvas covered with grass or branches for concealment. On a fixed front, underground shelter may be blasted out of bedrock and used for supply storage as well as for living quarters.

Smoke from a fire will often rise in a column that can be seen for several miles. Lights at night can be seen from distant peaks. If fires are absolutely necessary, it is best to put them in small depressions near the top of the higher ridges. A firepit about 1/2-meter deep should be dug and the fire lit only at night to prevent observation of the smoke.

Since shine and reflection can expose an otherwise well-concealed bivouac, all equipment should be blackened or covered. Care should be taken in the use and disposal of ration cans; and no equipment which reflects light should be exposed.

Assembly Area Should be Located on Dominant Terrain.

Tents, equipment, and supplies should not be placed in dried-up streambeds since sudden rainstorms and cloudbursts may turn these natural watercourses into raging torrents. Also, bivouacs should not be placed where rockfalls, landslides, and avalanches are likely to endanger personnel and equipment.

COMMAND AND CONTROL

The rugged terrain and variable weather common to mountain regions will make it more difficult to develop and implement reliable, flexible, and responsive command and control procedures. Since the terrain will tend to divide or compartmentalize the battlefield into areas of isolated combat, operations involving small units, generally not larger than battalion, will be the rule. Small units may also be required to operate independently or semi-independently for extended periods. As a result, initiative, resourcefulness, and sound tactical judgment on the part of junior leaders are required. Since the effectiveness of communications equipment may be degraded in the mountains, companies should be augmented with additional radios.

During unit movements, aircraft or airborne retransmission platforms can sometimes be used for reporting and movement control. In all cases, command posts should be located well forward and repositioned along dominating terrain.

Decentralized or semi-independent operations can be facilitated by the development of detailed standing operating procedures (SOPs). Examples of items which should be covered by SOP are:

- Organizational and equipment changes resulting from seasonal variation.
- March rates and formations.
- Reporting requirements.
- Supply procedures.
- Security measures.
- Casualty evacuation procedures.

The Enemy in Mountain Operations

The enemy regards mountains as obstacles to be breached with attacks that destroy US Army forces. As in other environments, he will defend in order to gain time to concentrate forces for the offense or to economize forces to allow an offense to be mounted elsewhere. He considers that the principles of offense and defense, with some modifications, are applicable in this environment. Although the enemy believes that motorized rifle units must be capable of operating in mountainous terrain, infantry-heavy forces will be encountered most often. **FM 71—101, Infantry, Airborne, and Air Assault Division Operations,** provides a detailed description of the basic organization and doctrine used by these forces. The information contained in this section is applicable to all enemy units operating in the mountains.

During both offensive and defensive operations, flank security is emphasized. Second-echelon units are deployed in depth and over reduced distances to repel counterattacks or to halt penetrations. Offensive maneuver combines frontal and

flanking attacks. The flanking attack is executed by a force larger than that employed frontally. Simultaneous attacks against principal defensive positions are made from several directions. Efforts are continuously made to avoid security elements, to infiltrate through defensive positions, and to emerge in lightly defended rear areas. Limited-visibility operations are stressed. The position defense described in **FM 71—101** is the basic form of defense employed by the enemy in mountains.

CHARACTERISTICS OF ENEMY MOUNTAIN OPERATIONS

Enemy mountain operations are characterized by:

- Gaps between first-echelon positions are blocked by the second echelon to counter attempts to maneuver through them.
- Snipers are used to cover obstacles or natural chokepoints, establish ambushes, and infiltrate rear areas.
- Close combat with individual weapons and hand-to-hand combat are common.
- Whenever conditions permit, narrow-gauge railroads are built for divisions and larger commands to transport supplies and evacuate casualties. Tractors are used extensively. Regiment and division supply and evacuation installations are located well forward. The division service area is within a 2-hour foot march of the first-echelon regiments.
- Engineer troops are employed to open routes through obstacles and to lay bridges and horizontal hauling lines across mountain rivers and canyons. Passages across natural obstacles on routes of advance for tank elements of motorized rifle units are constructed by engineers who may also be reinforced by motorized rifle battalion elements.
- Allocation of fire support does not differ greatly from that experienced in the attack and the defense under normal terrain conditions. A major portion of his artillery will be decentralized, and multiple rocket launchers may be employed as individual fire units. Certain specialized techniques may be employed, such as lifting guns to higher ground by helicopter, or using 160mm mortars in lieu of the standard 122mm howitzer to gain the advantage of their high-angle trajectory.

EMPLOYMENT OF TANKS

When terrain permits, the enemy uses tanks extensively in groups of two or three to reinforce assault groups consisting of a rifle platoon, a squad of engineers, and an antitank platoon. Tanks are used to support night attacks by approaching our positions under cover of darkness and delivering fire during the assault phase. His tanks, if possible, occupy positions during daylight that permit them to move directly into the attack.

Tank divisions and tank regiments of motorized rifle divisions are usually held back for use when the going becomes more suitable for mass maneuver. However, subordinate elements of tank battalions are normally allocated to rifle or motorized rifle battalions. Every effort is made to get tanks into areas where we will not expect them; and in the defense, some tanks may be employed in forward infantry strongpoints.

CONTROL AND COMMUNICATIONS

Command observation posts are located well forward. Security of their command posts is provided by detachments occupying the heights commanding approaches. Commanders at regimental and lower levels usually remain at their command observation posts to keep abreast of rapidly changing combat conditions. They move forward to new command observation posts immediately after the seizure of crests and spurs that previously obstructed observation.

Radio is their basic means of communication in mountains. Reliability of radio communication is increased by special training, careful selection of frequencies, location of radios, and adjustment of antennas. Visual signals and liaison aircraft are also widely used.

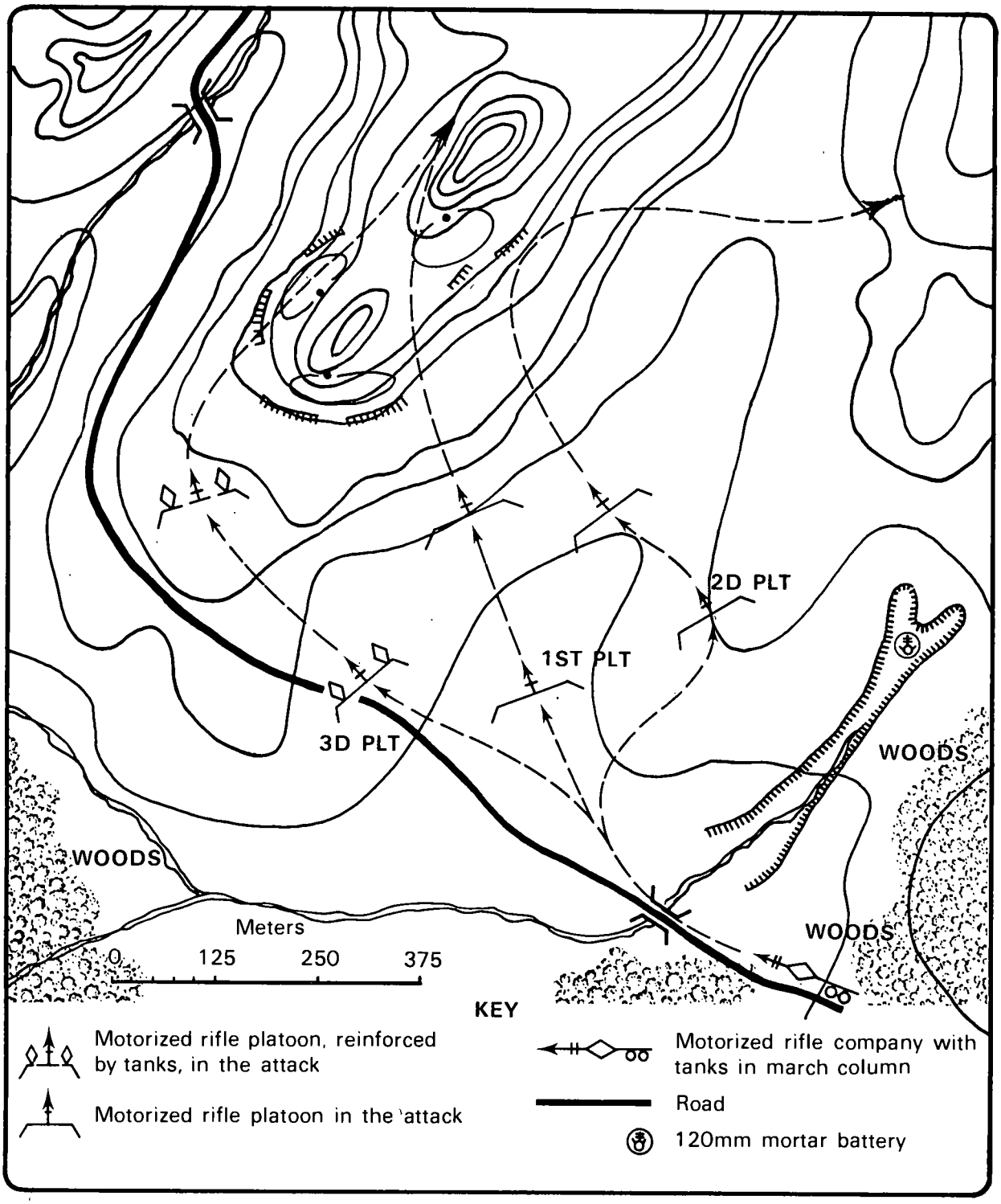
HOW THE ENEMY ATTACKS

Enemy offensive operations in mountains normally consist of a series of attacks to seize heights, ridges, passes, and valleys. An attack in the mountains is usually made by units in contact. Attacks are made with the regimental and/or battalion groups operating on independent axes along roads, valleys, and ridges. Objectives are seized by frontal attacks combined with extensive use of flanking maneuvers and heliborne detachments. Maneuver generally consists of isolating separate objectives by double or single envelopment. Main efforts are usually supported by several secondary attacks.

In attacking positions echeloned at different elevations, fire is directed to neutralize all positions simultaneously. Particular care is taken to neutralize strongpoints blocking the axis of attack. As the attack progresses upward, fires are shifted to stay in front of attacking troops while bringing continuous fire on the remainder of positions. Tactical missiles will be employed to destroy artillery and troops in passes, gorges, and ravines. In deciding to employ nuclear fires, the enemy considers the impact on their advance resulting from the effects of these fires in creating obstructions. Consequently, targets are carefully selected to avoid hindering the offensive plan.

Attacks along ridges may assist the breakthrough in a valley. The enemy accomplishes an encircling maneuver over ridges to seize commanding heights and road junctions in the defender's rear and on his flanks. The breakthrough is accomplished by using heavy concentrations of artillery, tanks, and aviation assets.

In the exploitation of a breakthrough by mobile units, seizure of road junctions deep in rear areas is stressed because such seizure may also lead to the isolation and defeat of our forces in other sectors. When advancing along valleys, the enemy secures his flanks and rear with airmobile/airborne troops and mountian rifle units which seize heights on the ridges commanding the valley. These flank security units are supported by aerial attacks, artillery fire, and other forces operating in the rear of defending forces.



Motorized Rifle Company Attacking in Mountainous Terrain.

ADVANCE DETACHMENTS

ENEMY ADVANCE DETACHMENTS INFILTRATE AND ATTACK FROM THE FLANKS

In the offense, rifle battalions, and in some cases companies, use subordinate elements to precede the attack. The advance detachment of a battalion normally consists of a rifle platoon reinforced by a mortar squad or section. Before a height is assaulted, advance detachments infiltrate behind the defending force. If possible, the height is then attacked from the flanks. An artillery preparation, supplemented by air attacks, usually precedes the coordinated attack.

INFILTRATION DETACHMENTS

RIFLEMEN MAY MOVE FROM PLACE TO PLACE TO CREATE GREATER STRENGTH IMPRESSION

Infiltration detachments are used to penetrate deep into the defending forces' rear area. Their main task is to control or harass lines or routes of communication. These detachments seize the high ground overlooking such routes. Several riflemen are assigned the task of moving from place to place where they can suddenly open fire, creating the impression of greater strength. These detachments also establish roadblocks in defiles. Infiltration detachments may be reinforced to permit their use in pursuit operations following a breakthrough.

REORGANIZATION AFTER THE ATTACK

Every captured height or area is immediately consolidated. Supporting weapons are displaced forward to support further advance. Positions are strengthened with antipersonnel mines, obstacles, and antitank mines. Special emphasis is placed on creating strongpoints on the flanks and covering gaps between attacking units. Security measures, including patrols, observation posts, and outposts, are immediately established to prevent surprise by sudden counterattack.

HOW THE ENEMY DEFENDS

Enemy defensive operations stress thorough reconnaissance, well-organized outposts, continuous flank security, and swift counterattacks by the second echelon. The defense is organized to cover all possible areas of attack and is particularly strong in areas where tanks can be used. Mutually supporting platoon and company strongholds are established. Gaps are covered by patrols. Strongholds are sited for all-around defense and make use of both forward and reverse slope positions. They will continue to be held even if surrounded. Constant observation and patrolling will be carried out to detect and prevent flanking movements.

OUTPOST AREA

Observation posts are established well forward of the main defensive area. Communication is maintained by radio and visual signaling. Relay points are established when necessary. In the outpost area, security elements block roads and other approaches; they also secure flanks and salient positions at intervals between defensive positions. Outpost security elements delay attacks until reinforced. The units in the outpost area counter flanking maneuvers, destroy infiltrators, and, when necessary, cover the withdrawal of other forces. In the defense of outpost areas, ambushes are used extensively.

MAIN DEFENSIVE AREA

Main defensive positions are normally organized in one echelon along or across mountain ridges. In either case, strongpoints are situated on the forward slopes, with a small portion of the force retained on the reverse slopes as a reserve. Firing positions are echeloned vertically as well as in depth.

In the defense of a wide mountain valley, strongpoints are established on the elevations and spurs of mountain ranges fringing the valley. In the valley itself particular significance is attached to the emplacement of obstacles and the organization of antitank defenses. In addition to the artillery and antitank weapons of motorized infantry units, tanks are used extensively for this purpose.

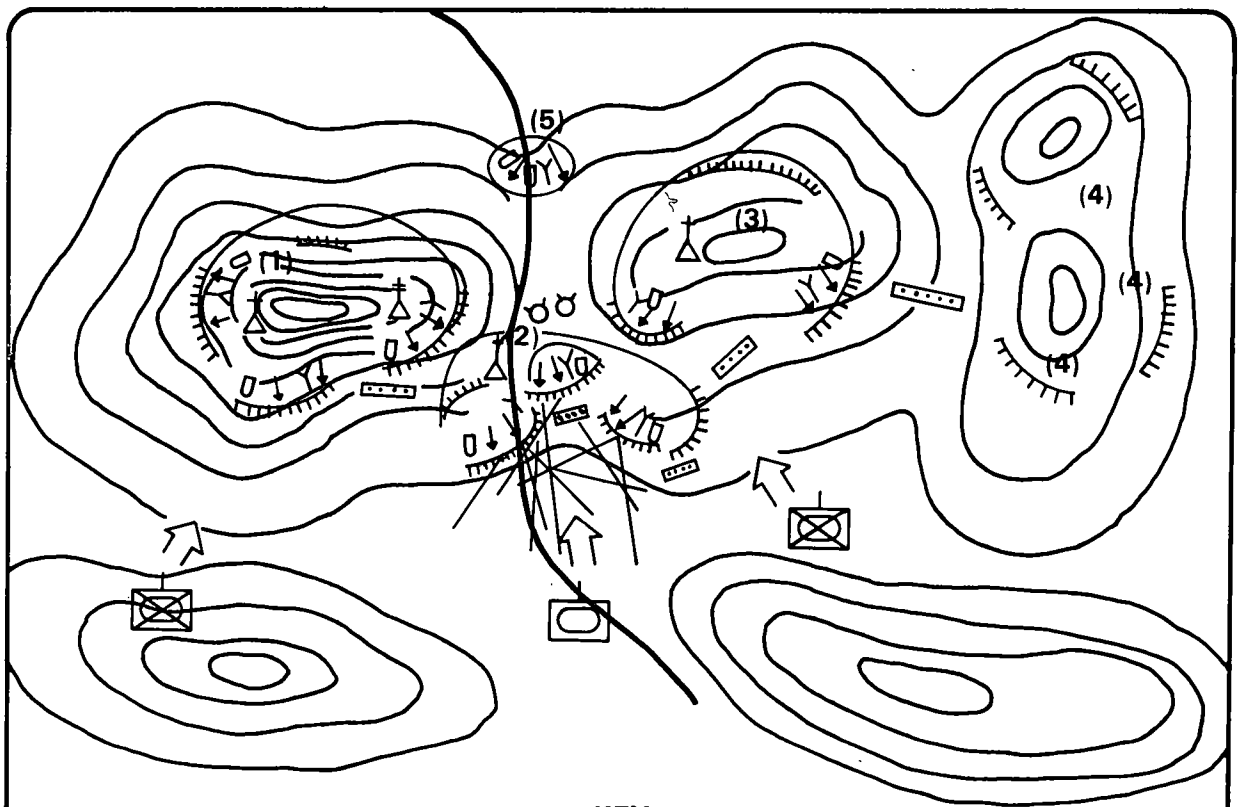
When defending narrow mountain valleys, the main effort is concentrated on the retention of commanding elevations. Depending on their size and importance, company and platoon strongpoints are organized on these heights. Defensive positions in the valley may be manned by only a small portion of the force armed primarily with machineguns and antitank weapons. In all cases, obstacles and ambushes are organized throughout the valley. Approaches to the elevations are covered by fires.

The defense of a gorge is organized in the same manner as the defense of a valley except that special effort is made to retain the heights that form the entrance into the gorge. These are prepared as strongpoints with a multilevel system of fires. The narrowness of the front in this case requires echeloning the defense in depth. The flanks of the defending force are tied into the most difficult segments of available terrain. Antitank weapons, operating primarily from ambush, are usually deployed into the gorge itself.

In a defense organized along a mountain ridge, the forward edge of the defense

usually lies along the slope facing the enemy and descends as close as possible to the bottom of the ridge. If spurs radiate from the high ground in the direction of the enemy, they may be defended by small elements or combat outposts may be organized on them. Sometimes it may be feasible to move the forward edge of the defense closer to the ridge of the elevation. This is done if the slopes are not too steep, making it possible to organize a better defensive fire system.

Mountain passes are normally considered by the enemy to be the tactical key to an entire mountain range; therefore, the largest part of the force is assigned to defend them. In defending a pass, the heights dominating the pass are occupied, as well as the most important spurs on the approaches to it. Weapons are distributed in



KEY

(1) First motorized rifle platoon.
(2) Second motorized rifle platoon.
(3) Third motorized rifle platoon (-).
(4) Adjacent unit
(5) Reserve (one squad from 3d platoon).
Light machine gun.
Antitank grenade launcher.
observation post.
Company commander's command and observation post.
Antitank mines.
Fougasses or explosives.
APC.

The Motorized Rifle Company in the Defense in Mountainous Terrain

depth along the slopes. The approaches to the pass are covered by flanking fires and crossfires. Roads through the pass are mined and narrow spots prepared for demolition. Mines also may be installed for the purpose of creating slides.

In wooded terrain, defensive positions are organized at the forward edge of the woods or on commanding heights. Elevated platforms are built in trees for machineguns and observation posts. Antitank and antipersonnel mines, artificial landslides, and other obstacles are widely employed.

COMMAND AND CONTROL

To insure uninterrupted control over units, command and observation posts are located at a point from which it is possible to see most of the defensive formations, the opposing force, and the flanks of neighboring units. Communications with the rear are established from these points. Command and observation points are usually located on one of the dominating heights.

ENGINEER TASKS

The enemy considers the organization of the engineering effort during defensive operations extremely important. Whenever terrain conditions and time permit, trenches are dug along main avenues of approach. In rocky sectors, trenches and shelters are cut into the terrain and provided with overhead cover. Tunnel-type shelters are also highly effective. In winter, fortifications are built from ice and snow.

SUMMARY

In defending mountainous country, the enemy may use nuclear and chemical fires against attacks in narrow valleys, gorges, passes, and river crossings; or, he may create obstructions and contaminate areas across the axis of advance. If our forces penetrate his defenses, units defending the heights have orders to continue to resist, even when completely surrounded, and wait for counterattacks to destroy the penetrations. Such attacks normally carry from high ground downward along ridges and valleys. Aerial resupply of isolated units is provided for in planning.

How to Attack in the Mountains

The decisive battle in the mountains will most likely be fought on the commanding heights above the valley floor or mountain passes. ***Every attempt must be made to fight from the heights down.*** Envelopment, whenever possible, is the preferred form of maneuver. Vertical envelopment and infiltration are important techniques to be mastered.

The enemy should be attacked where he is the weakest. Strongly defended positions should be isolated and bypassed by heliborne or infiltrated units. Enemy logistical complexes are good objectives since they are critical to enemy operations. Limited usable terrain makes combat service support units easier to locate and

more vulnerable. The battle area should be sealed off from enemy reinforcement as quickly as possible.

Because maneuver room is usually limited or very restrictive, deception plays an important part in the mountain battle. A deception plan that causes wasted enemy movement enhances the attacker's chances for success. Deception can create the necessary confusion that delays enemy reinforcement of a critical sector and permits the attacker to maintain a favorable combat ratio at that point. The terrain can be unforgiving to a commander who guesses wrong.

FUNDAMENTALS OF OFFENSIVE OPERATIONS IN THE MOUNTAINS

The fundamentals of the offense do not change in a mountain environment. The commander must consider the terrain and weather and the effects they have on both his units and the enemy.

SEE THE BATTLEFIELD

Physical separation of units is common in mountain warfare. Therefore, the attacker must conduct active and aggressive reconnaissance, using all available assets, to his front, flanks, and rear. He must locate and identify enemy units, weak points, flanks, and obstacles. He must also insure that adequate precautions are taken to insure early warning of possible attacks on his flanks or rear areas since these are the favored techniques of the enemy.

The physical aspects of the battlefield must be analyzed by ground, aerial, and map reconnaissance. Since maps may be inadequate or nonexistent, greater reliance must be placed on aerial photos and reconnaissance. Patrols, radar, and aerial reconnaissance and surveillance systems must complement each other to provide information of enemy dispositions and activities. Frequently, it will be necessary to lift personnel by helicopters to dominating terrain to man observation and listening posts.

In the mountains, the most dependable source of battlefield information is the advancing unit. The attacker in the mountains will not have the broad overview of the situation enjoyed by a commander operating in open terrain. While all sources of information are important, the information provided by his advancing units will best assist the commander in seeing the mountain battlefield.

CONCENTRATE OVERWHELMING COMBAT POWER

If no enemy weakness can be found, one must be created through surprise, massive firepower, or isolation from mutual support. The enemy can be surprised by the timing, location, or direction of the attack. Mass is achieved in both time and space.

Concentration must be anticipated before the battle begins. Once the battle is joined, the only rapid means of concentration is by helicopter.

Units must be able to concentrate at a given time and place, and then disperse to avoid offering a lucrative target to the enemy. Concentration does not mean that units are massed in a small area, but rather that they have the ability to place an overwhelming weight of fires on the enemy.

The ability of an attacking unit to concentrate forces undetected is restricted by the excellent observation afforded the defender. Movement is therefore best accomplished during darkness or other periods of limited visibility.

When weather conditions permit their employment, attack helicopters and high-performance aircraft are extremely useful because of their ability to maneuver and apply firepower over a large battlefield in a short time. Suppression of enemy air defense should have a high priority during offensive operations. Darkness and other conditions of limited visibility can contribute to suppression since they reduce the ability of the enemy gunners to observe the attacking force.

SHOCK, OVERWHELM, AND DESTROY THE ENEMY

In mountains, the ability to shock, overwhelm, and destroy the enemy requires accurate reconnaissance to distinguish between true and false positions. Accurate navigation is also needed so that the commander may be certain of the deployment of his forces. Infiltrating forces must find an assailable flank or gap without alerting the enemy. Gaps should be wide enough to allow one unit to bypass another that is stalled. Obstacles, to include mines and boobytraps, are likely to be emplaced so that attempts to go around them will often lead the attacker into a fire pocket. Therefore, engineers and equipment to breech obstacles must be located well forward.

Above the timberline, the lack of concealment means that movement of large forces is almost impossible to hide. Thus, once an attack has been initiated, the attacker must move as rapidly and violently as possible to retain the initiative and momentum, and to give the enemy as little time as possible to react.

ATTACK THE ENEMY REAR

In mountains as elsewhere, the enemy's rear should be attacked to destroy his combat support units and command and control facilities. Attacks may be conducted initially by infiltration forces through raids on soft targets and by exploitation forces once the attack has begun.

Successful attacks in the enemy's rear will often force him to abandon advantages of prepared positions and use his maneuver units to counterattack. In general, the most decisive offensive is one which strikes with overwhelming force into the enemy's rear.

To insure destruction of enemy rear units, the attacking force must seal off the escape routes of the enemy. This may be accomplished by creating landslides or destroying bridges through air or artillery support. The battlefield may also be sealed by airlanding or airdropping forces to block enemy escape routes.

PROVIDE CONTINUOUS SUPPORT

A successful attack, whether in the mountains or in other terrain, requires continuous combat support and combat service support to sustain the weapon systems essential for the momentum of the attack. Because of mobility problems inherent in mountain operations, it is even more difficult to provide mobile support to all combat elements.

Coordinated use of organic transportation, Army and Air Force aircraft, porters, and pack animals is required.

FORMS OF MANEUVER

The basic goal of maneuver is to pass sufficient forces around or through the enemy's main defenses in order to:

- Strike him from an unexpected direction

— or —

- Force him to leave his position and withdraw or attack.

To do this, the forms of maneuver used by dismounted forces are the envelopment and the penetration. In either case, infiltration techniques will frequently be used to position forces for the subsequent assault. Rough and difficult terrain and recurring periods of limited visibility often allow undetected movement of small forces. Detailed information about terrain and enemy dispositions is required when developing infiltration plans. If aerial photographs are not available to supplement existing maps, extensive reconnaissance may be required to locate enemy security elements, gaps in the defense, and passage lanes.

Multiple routes are normally used in order to move the largest force possible in the shortest period of time. Skilled mountaineers may be required to serve as guides or to emplace ropes to assist in the movement of other personnel.

Multiple objective rally points (ORPs) may also be required because of probable separation of infiltration routes. ORPs should be secured prior to the arrival of assault elements.

Suppressive fires from mortars and supporting artillery are planned along each route. They may be shifted on order by the advancing unit or on a timed sequence by the fire support unit. The latter method eliminates the need for communications which could be detected and jeopardize the entire move.

ENVELOPMENT

In the mountains, as elsewhere, envelopment is preferred over a penetration. Strongpoint defenses, although organized for all-around security, generally offer one or more assailable flanks and are vulnerable to attacks from multiple directions. The enveloping force frequently uses infiltration techniques to move to assault positions while a small portion of the unit overwatches and suppresses the objective. Vertical envelopments should be conducted whenever possible to gain surprise and position forces while avoiding the fatigue of mountain movement.

PENETRATION

Frontal attacks, even when supported by heavy direct and indirect fires, may have a limited chance of success against a strongpoint defense. The terrain will normally make it impossible for the commander to concentrate sufficient maneuver forces to rupture the defense or to move quickly through a gap to a deep objective. If a penetration must be conducted, flank defensive positions should be eliminated before attacking successive defensive lines.

TYPES OF OFFENSIVE OPERATIONS

Mountain operations are normally developed around a series of movements to contact, deliberate attacks, and raids. Hasty attacks, reconnaissance in force, feints, and exploitation and pursuit will also be conducted, but less frequently than in other environments. Planning must recognize the advantages which even a weak defender enjoys in rugged mountainous terrain.

- Routes of advance for the attacker are extremely limited and well defined, making it easier for the defender to deploy his units and site his weapon systems.
- Numerous positions, frequently located on terrain that is extremely difficult to assault, are available to him.
- Obstacles which are easy to construct and difficult to breach or bypass offer him frequent opportunities for attacks by fire only.
- Routes of withdrawal for his force can be reconnoitered and prepared in advance.

MOVEMENT TO CONTACT

In order to insure that contact is established, units will normally move in multiple columns, taking full advantage of the limited number of avenues of approach that may be available in a zone of action. Since the enemy will occupy dominating terrain, successive terrain objectives along the heights will normally be used rather than a single march objective in depth. Movement along ridgeline trails, while requiring less physical exertion, increases unit vulnerability and should be avoided.

Lateral movement between adjacent columns will frequently be difficult or impossible. Every attempt should be made to maintain at least visual contact. Increased emphasis must be placed on the use of checkpoint reporting, contact patrols, and phased operations to coordinate and control the movement of the overall force.

Major terrain compartments may physically separate maneuver units moving as part of a larger force. Flank security will be a major problem since the enemy will attempt to infiltrate the gaps between units. When aerial reconnaissance is not possible, ground patrols and observation posts with surveillance devices must be used.

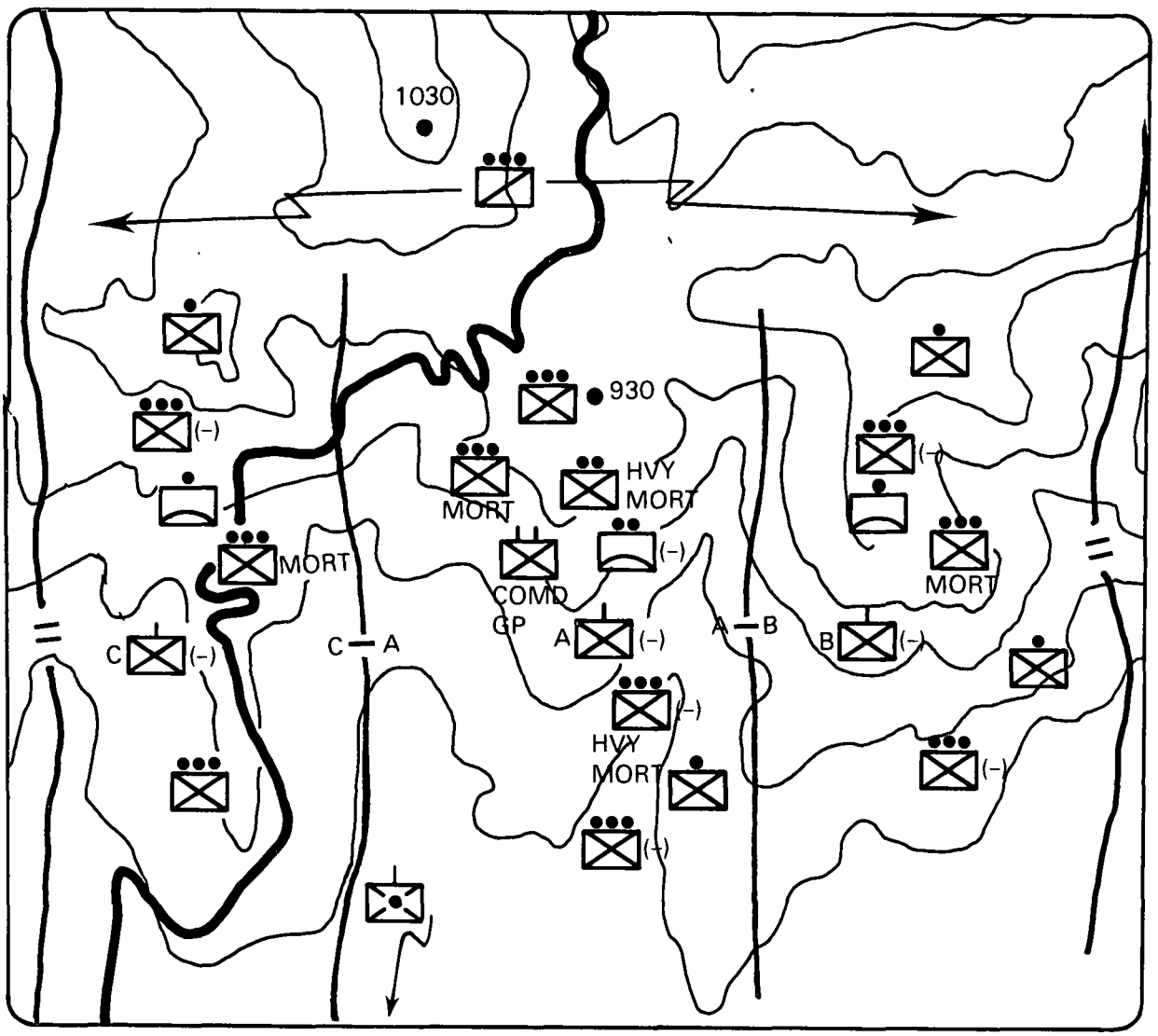
Use Successive Objectives Along the Heights but Avoid Movement Along Ridgeline Trails.

As shown, the scout platoon will move along the high ground, occupying observation posts (OPs) to assist in the control of movement, provide flank security, and adjust indirect fires. If FM radio retransmission sites are not emplaced, scouts may also be used to relay command traffic. Helicopters should be used to displace these OPs when possible.

Redeye teams will move with squads or platoons on the high ground in order to maintain visual observation along likely low-level air attack routes. Alert warnings may be limited since it will be difficult to maintain FM communications with air defense control headquarters.

Battalion mortars displace by section to insure that responsive fire support is constantly available. When not firing, each mortar will be laid on a priority suppression target.

Companies and platoons moving along separate routes will provide their own



Terrain Compartments Separate Units Making Security More Difficult.

security screens. Because contact is always likely, platoons will maneuver using bounding overwatch techniques. All terrain features that could be occupied by even a small force must be reconnoitered.

The command group will be well forward and move along the route from which it can best control the advance.

Once contact is established, it will be more difficult to maneuver supporting forces. When available, airmobile reserves can outflank, isolate, or envelop the enemy while indirect fires, attack helicopters, and close air support are employed against him. It will normally be impossible to bypass an organized enemy defensive network using ground maneuver alone. If airmobile assets are not available, it will be necessary to launch a ground attack.

THE ATTACK

Mobility restrictions imposed on the attacker by the terrain and the observation advantage afforded the defender will normally make it difficult for units above company level to conduct a hasty attack against a prepared position. In the mountains, deliberate attacks will be the norm during brigade and battalion operations. Since daylight attacks have little chance of success against an entrenched enemy, darkness and other conditions of limited visibility must be exploited. Although these conditions slow movement and make the coordination of forces more difficult, they strip the enemy of the ability to see the attack develop.

Special attention must be given to fire support plans because:

- Load-carrying capabilities for all classes of ammunition will be reduced.
- Resupply will be limited and difficult.

Each commander, working closely with his fire support personnel, must identify fire support requirements for the entire attack and allocate fires based on available ammunition. Restrictions may be required for the amount of ammunition which can be expended on specific target categories or during the various phases of the attack.

All indirect fire units must be positioned carefully to avoid terrain masking and crest clearance problems. Dead space in field artillery fire capability fans must be identified and covered by other weapons. Attack helicopter units and close air support can reduce the impact of these problems if weather permits their use.

Overwatch positions may not be readily available within the range capabilities of company weapons. Assault climbing and infiltration may be required to position weapons to support the attack.

The enemy stresses the importance of immediate counterattacks to secure positions that have been lost. He is well aware of the need to control dominating terrain and knows that assault forces will normally be physically exhausted after the attack. Although the enemy's mobility will be restricted by the terrain, he has the advantage of having had time to select and prepare counterattack routes, position forces, and stockpile weapons and munitions. During attack planning, the commander must decide how the objective will be organized for defense once it is secured. He must determine how supplies and support weapons will be moved forward and how casualties will be evacuated. Although the use of helicopters is preferred, portage may be required.

RAIDS

Raids are an integral part of mountain operations. They will normally be carried out ***dismounted*** or by using ***airmobile*** assets. Opportunities to conduct mounted or motorized raids will seldom occur. Raids will be conducted primarily to:

- Obtain information about the enemy.
- Disrupt his plans.
- Capture prisoners.
- Destroy specific targets.

When dismounted raids are conducted, infiltration techniques are used to pass through or around established defenses to the objective area. Movement times will be significantly prolonged, and only light equipment can be taken. Special climbing skills will normally be required in order to take full advantage of the terrain.

Responsive fire support, particularly during the withdrawal phase, is required. Field artillery fires must be planned along routes to and from the objective area. It may be necessary to reposition some artillery to cover dead space or plan the use of attack helicopters and close air support. The raid commander must know if portions of either route cannot be covered by supporting field artillery fires.

RECONNAISSANCE IN FORCE AND FEINTS

The compartmented terrain and mobility restrictions of mountainous regions make these operations particularly hazardous. The probability of having at least a portion of the force cut off and isolated is a prime concern. Reconnaissance in force operations and feints should be conducted only when there are no other means available to discover and test enemy dispositions, strengths, and intentions.

These operations are conducted in the same basic manner as a deliberate attack and may involve limited attacks against troop concentrations or seizure of terrain. The major differences are:

- The objective is to cause the enemy to respond in a manner that will provide the desired information or reaction.
- Strong and preferably airmobile reserves and preplanned fires must be available to reduce the vulnerability of the force.

EXPLOITATION AND PURSUIT

Once the enemy situation starts to deteriorate and an exploitation or pursuit is ordered, maximum pressure must be brought to bear. Airmobile and attack helicopter units are well suited for exploitation and pursuit operations. Maximum use should be made of tactical air for reconnaissance and fire support.

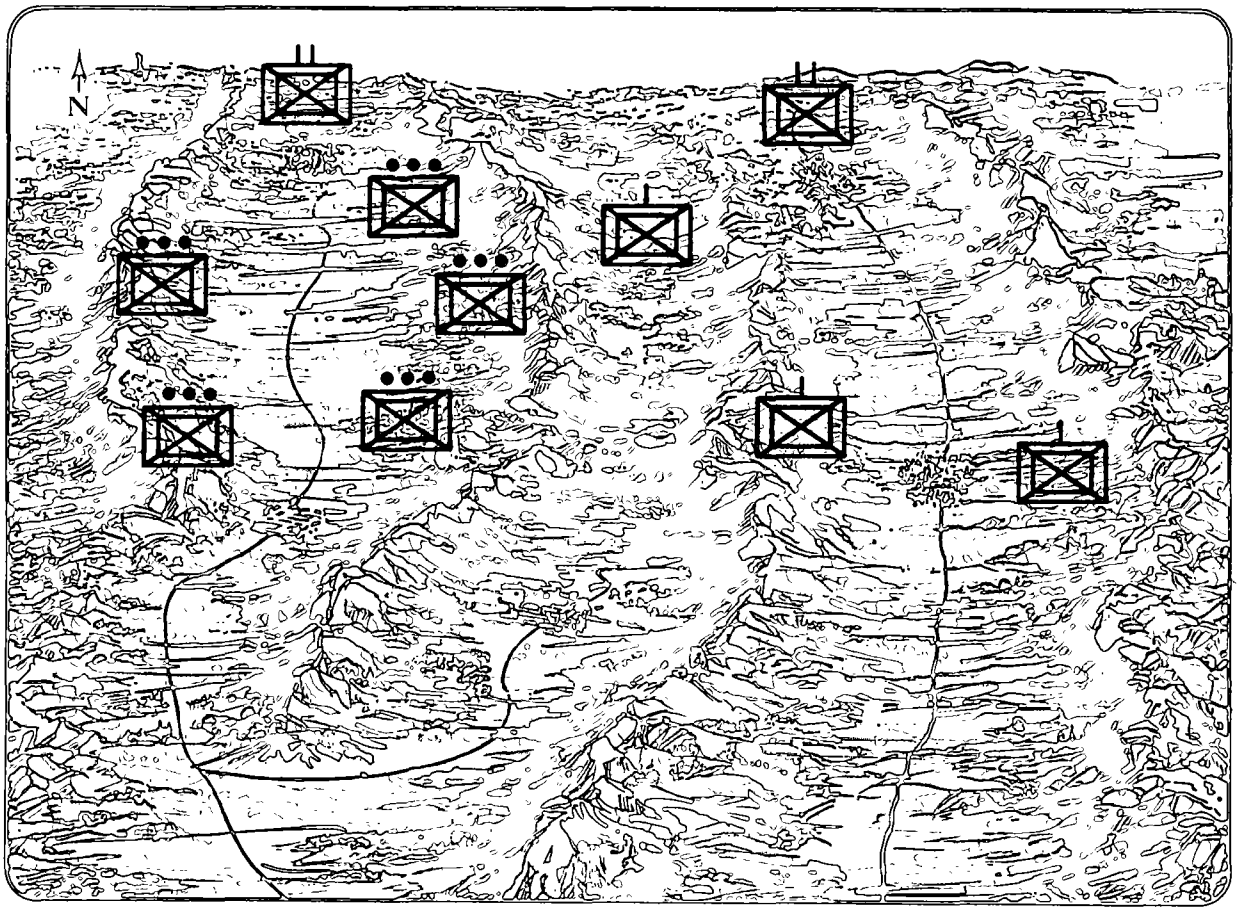
With the ground mobility restrictions imposed by the mountains, speed can best be achieved by isolating enemy positions with the smallest force possible. The basic missions are to disrupt command and control by destroying communications and support facilities and to cut off enemy withdrawal routes. Dismounted forces must be augmented with all available transport and engineers to clear obstacles.

ATTACK EXAMPLE

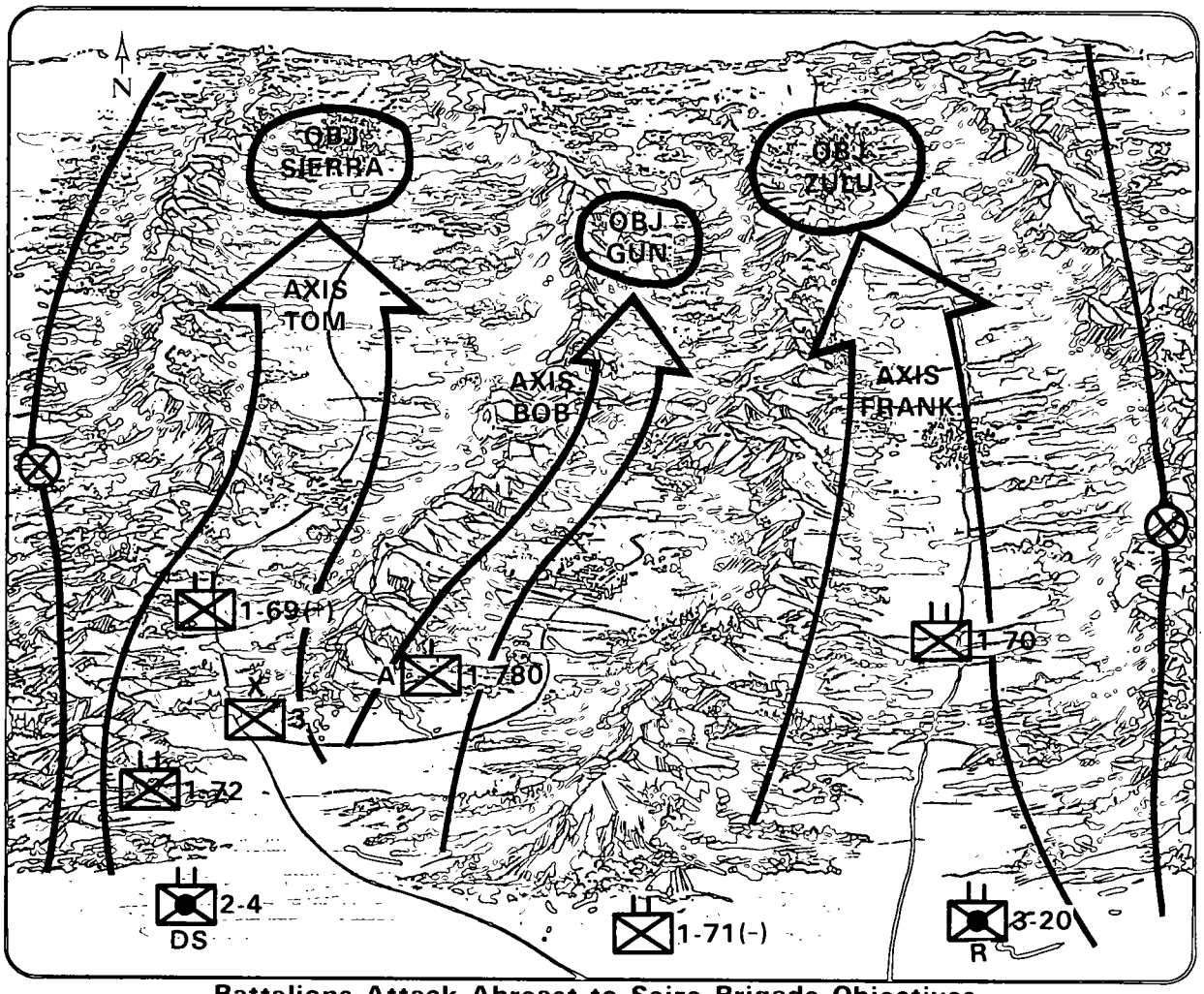
The 3d Brigade, 20th Infantry Division, consisting of four infantry battalions, has been moving to contact as part of the division covering force. Lead elements are reporting increasingly determined resistance from enemy security forces fighting from prepared positions. Aerial reconnaissance indicates that elements of at least two rifle battalions have occupied defensive positions along commanding heights which dominate the main routes. Other positions are being prepared in depth on the high ground overlooking the valley roads.

The terrain in the brigade zone consists of two basic compartments separated by heights impassable to tracked or wheeled vehicles. The primary roadnet in the east is dominated by high ground throughout its length. In the west, a secondary road climbs through a narrow pass and crosses a rugged but trafficable mountain plateau to join the primary route farther to the north.

The division G2 estimates that the brigade is opposed by enemy first-echelon units preparing a deliberate defense. The division commander directs the brigade to



Enemy Units Conduct Defense in Depth.



Battalions Attack Abreast to Seize Brigade Objectives.

attack to secure the passes and lines of communication in its zone. He intends to pass his remaining brigades through the 3d Brigade once these routes are secured.

Based on his analysis of the terrain and knowledge of the defender's organization and tactics, the brigade commander elects to occupy initial positions under the cover of darkness and attack with two battalions abreast.

The 1-70 Infantry will attack in the east along Axis Frank to secure Objective ZULU and fix forces defending along the high ground on the western shoulder of the valley.

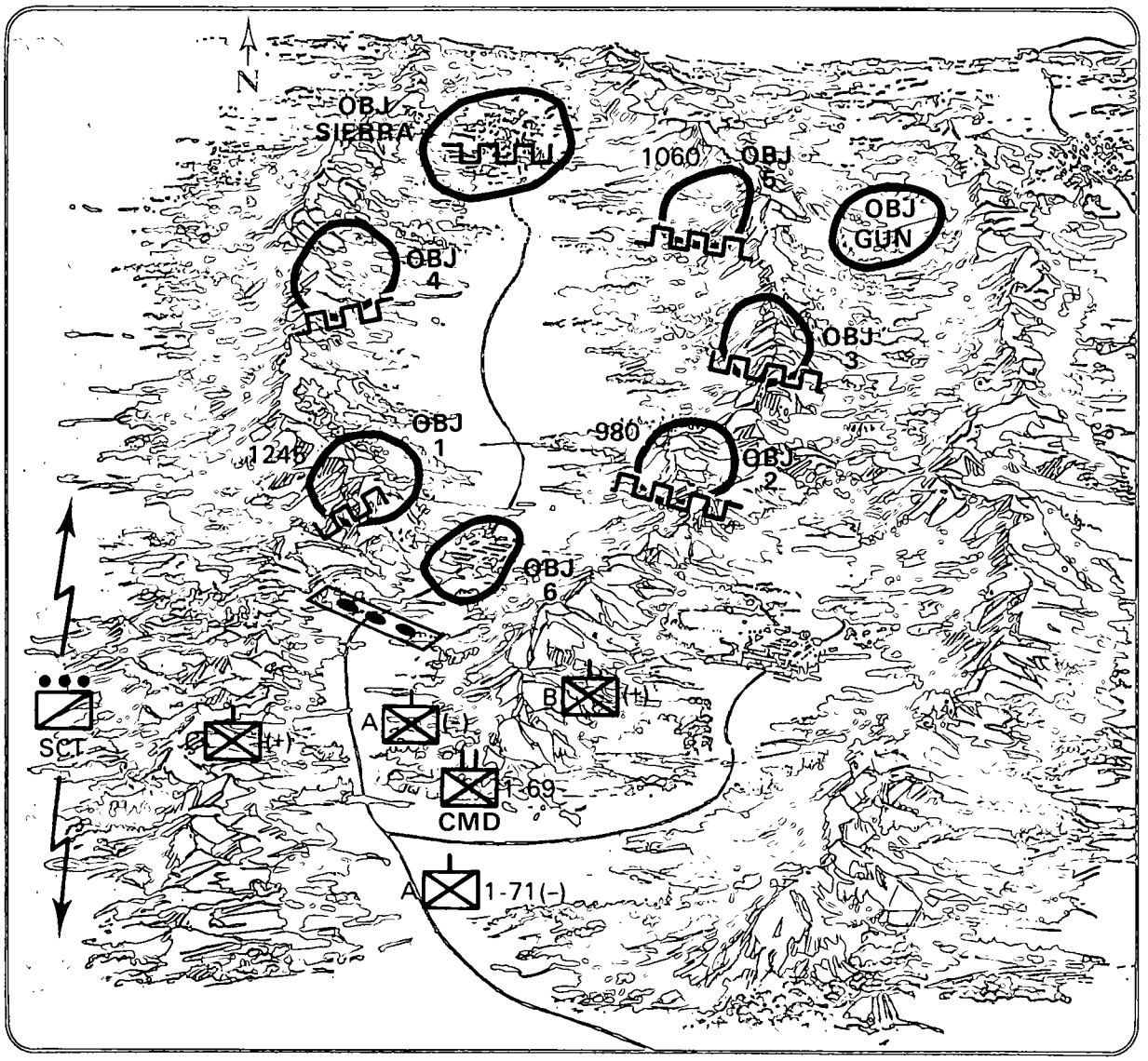
The 1-69 Infantry, reinforced with Company A, 1-71 Infantry, will attack in the west along Axis Tom to Objective SIERRA.

1-72 Infantry will follow 1-69 along Axis Tom.

The 1-71 Infantry minus will be positioned initially at the junction of Tom and Bob as the brigade reserve.

A/1-780 Rangers, attached from corps, will infiltrate along Axis Bob to secure Objective GUN which will be used as a fire support base as the attack continues to the north.

An attack helicopter company under the operational control of the brigade will be available to attack in depth to seal the



Successive Enemy Strongpoints Dominate the Valley.

objective area from reinforcement, if required.

1-69 INFANTRY ATTACK

Continued aerial and ground reconnaissance has provided additional information on enemy dispositions and terrain.

By late afternoon major elements of a reinforced company have been identified in the zone of the 1-69 Infantry. The enemy is deployed in successive strongpoints along the high ground controlling the valley and the pass leading to the plateau. The bulk of his forces are located in the east of the battalion zone with what appears to be a reinforced platoon on the more precipitous terrain in the west.

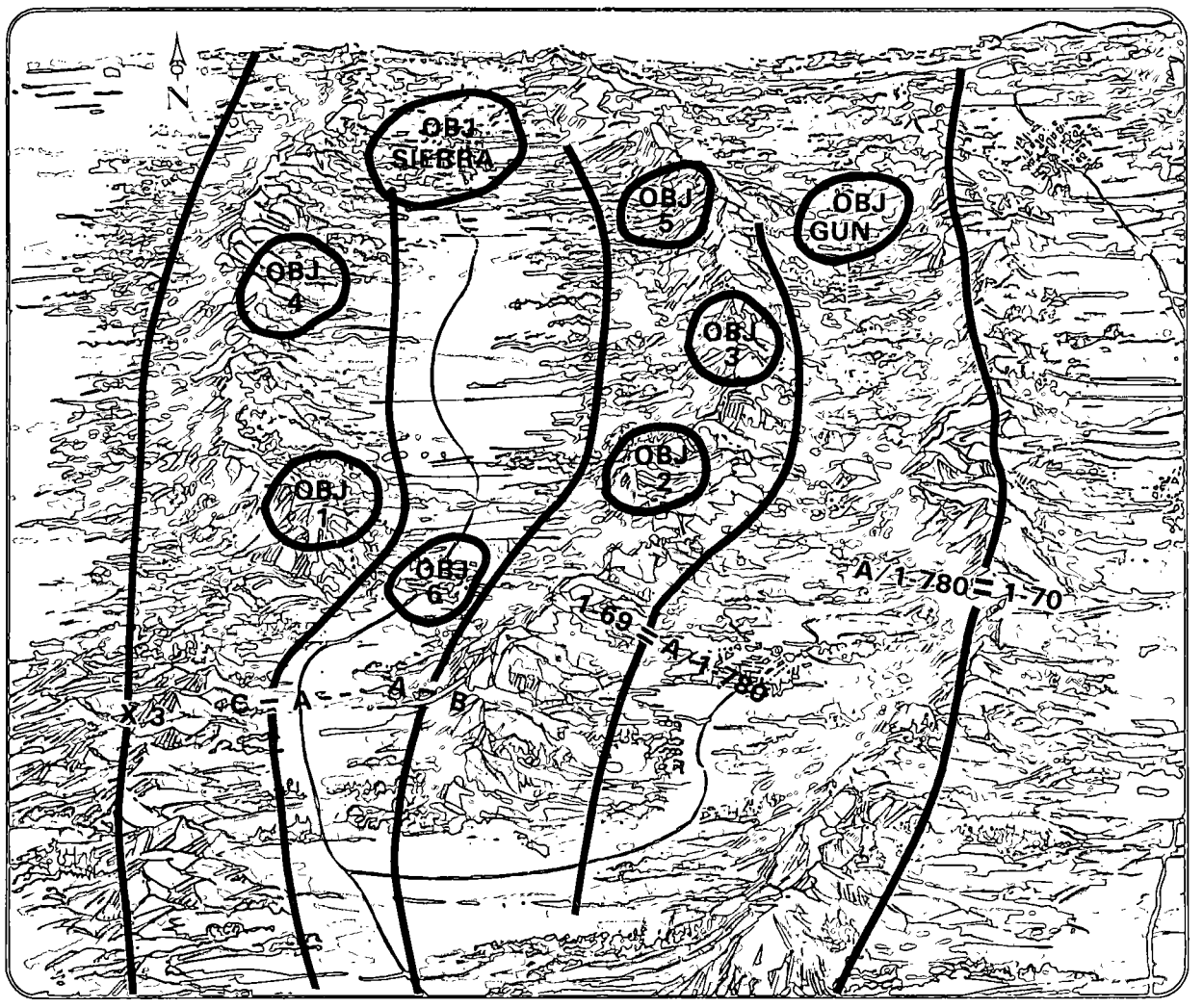
The 1-69 Infantry advanced during daylight to its present position while clearing the terrain along Axis Tom of enemy security forces. As the attack planning continues, possible infiltration routes are being reconnoitered. Company and platoon leaders take advantage of the remaining daylight to study the terrain and

to prepare personnel and equipment for the infiltration and subsequent assault of initial objectives.

Numerous trails lead up the face of the ridge in the zone of Company B. The forests along the slopes are clear of heavy brush. They can be used to conceal movement and to position mortars and machineguns to support the assault of Hills 980 and 1100.

The western ridge in the Company C zone will be more difficult to negotiate. Although some trails are available, there is much more undergrowth in the forests, and the southerly facing slopes are extremely steep. The best opportunity for maneuver appears to be from the southwest and west of Hill 1050.

In order to secure Objective SIERRA, the Commander, 1-69 Infantry, designated a series of objectives along the heights flanking the valley. He also established unit boundaries to assist in coordinating movement and fires. A limited-objective attack will be conducted in the valley, by Company A. Final objectives include enemy positions controlling access to the high mountain pass.



Battalion Objectives Key on Enemy Strongpoints.

Company B, reinforced with a platoon from A/1-71 Infantry and Company C will infiltrate under the cover of darkness along the heights on either edge of Axis Tom. Company B will be on the right and Company C on the left. Harassing and interdiction fires are planned to disrupt enemy security forces and provide noise to cover movement. Reconnaissance flights will be continued to provide current data on enemy movements and positions.

Security elements will precede each company to mark routes and locate obstacles, early warning systems, and main defensive positions.

In the western portion of zone, the battalion commander decided that he can provide direct fires to support the attack of OBJ 1 by infiltrating forces to Hill 1245. In the east, he plans to have A/1-71 Infantry minus fix the defenders on Hill 980 as he attacks with a reinforced company to secure OBJ 2.

When all companies are in position, airstrikes followed by artillery and mortar preparations will be used to neutralize and suppress enemy gunners and isolate each objective. Smoke will be used to conceal attacking forces from enemy observation posts north of the initial objectives.

Scouts will screen the battalion's western flank.

SUMMARY

The unit attack plans provided in this example illustrate one way such an attack might be conceived. It does not consider all alternatives of weather or terrain that could exist. For example, favorable weather could enable the increased use of vertical assaults and eliminate the need for extensive infiltration. Terrain might also preclude the use of envelopment techniques and require that a costly penetration be conducted.

The purpose of the example is to highlight the fundamentals discussed in this section by applying them to a general situation.

How to Defend in the Mountains

Dominant terrain provides the defender—and usually denies the attacker—excellent observation and fighting positions. Manmade obstacles significantly enhance natural obstacles of rugged mountainous terrain. Since the terrain offers excellent cover, concealment, and camouflage, the defender can more easily deceive the enemy as to his strength and dispositions. The defender normally has more time to develop lateral trails. Since he knows the terrain, he can usually shift forces on the ground more rapidly than the attacker.

Additionally, delaying actions are particularly effective in the mountains and can be accomplished by a much smaller force than is ordinarily needed. These advantages combine to make the mountains an ideal place for defensive combat.

Whatever the scale of the operation, a key factor in achieving success in the mountains is having good observation while denying it to the enemy. The battle will invariably be fought for control of dominant ground.

FUNDAMENTALS OF DEFENSIVE OPERATIONS

Fundamentals of defense must be somewhat modified to fit the unique characteristics of mountainous terrain. The concept of defense in the mountains is to occupy dominating heights that control movement. The defending force must maintain control of these heights and fight from the top down.

UNDERSTAND THE ENEMY

The mountain environment affects the enemy and his equipment in the same manner as it does us. His mobility is restricted. His tanks and mechanized vehicles are roadbound in most areas, other than valley floors and mountain plateaus. His communications are interrupted by intervening terrain features. The effectiveness of his artillery is reduced by terrain masking. His aircraft cannot operate in adverse weather. The enemy strives to avoid a frontal attack and executes primarily flanking attacks or deep infiltration. As the battle progresses, the defender must search out other weaknesses that limit the enemy's effectiveness in the mountains.

SEE THE BATTLEFIELD

Prior to battle, the defender must organize to defeat attacks from several possible directions. He must then undertake aggressive operations to learn where the enemy is, how he is organized, which way he is moving, and in what strength. As the battle unfolds, he must seek to establish a continuous flow of information while denying the enemy similar information about his own forces.

Commanders can seldom see beyond terrain features to their immediate front. Since the terrain is compartmented, commanders must increase the number of personnel and amount of equipment allocated to reconnaissance and surveillance. Some of the best means are ground sensors and infiltrated OPs. In planning their use, weather must always be considered. Those areas of the battlefield which are obscured by bad weather must be covered by electronic means such as radar and sensors. Adverse weather can also affect electronic means.

Once acquired, critical combat information must be passed directly to commanders who are in the best position to make use of the information. However, despite all efforts to collect information, the commander will almost always have to make decisions based on incomplete information.

CONCENTRATE AT CRITICAL TIME AND PLACE

The commander must decide when and where he will concentrate his forces. He must also decide how much force will be required to defeat the enemy within the terrain and space limitations of the defensive area. He must do this based on results of his combat information and intelligence-gathering operations.

In mountains, this information is particularly important. Concentration of troops must take place before the battle begins. Once the battle is joined, the only rapid means of concentrating infantry is by helicopter. However, helicopters may not always be depended upon because of weather conditions.

When forces are concentrated, some elements must be economized, often on the flanks. Air cavalry is excellent for covering ground where it is necessary to economize forces. Such forces can be rapidly reinforced by attack helicopter units and sometimes by shifting fires of field artillery.

FIGHT AS A COMBINED ARMS TEAM

In the mountains, the defending force is composed primarily of infantry augmented and supported by artillery, air defense artillery, and engineers. If terrain permits, tanks may also be included in the defense. However, because of limited mobility, tanks are seldom found in mountain operations.

The defense is organized to cover all avenues of approach. Mutually supporting platoon and company strongpoints should be established. Gaps should be covered by patrols, unattended ground sensors, and minefields. Minefields should be covered by fire. Strongpoints are sighted for all-around defense and make use of both forward and reverse slopes. Since the enemy prefers to attack a flank or into the rear, patrolling must also be conducted in these areas to provide early warning and assist in destroying enemy infiltration efforts.

EXPLOIT THE ADVANTAGES OF THE DEFENDER

When given time, the defender has a number of advantages which allow him to defeat an attacking force much larger than his own. The defender analyzes the terrain in detail from all perspectives and is intimately familiar with every feature which could increase his chances of success. The attacker must feel his way over the terrain, seeing each new compartment for the first time. The defender can prepare positions, construct obstacles, and conceal his efforts in advance. The attacker must guess where the defender is located. The defender initiates the fight from stationary positions which are difficult to detect and reach and which also provide cover from enemy fire.

The attacker must react to the defender and must either fire while moving or lose momentum by seeking covered positions. The defender develops flexible plans for control of fire, movement, communication, and logistics to fit any predictable situation. The attacker must adhere to a predetermined scheme which risks destruction, or he must alter his plan and risk an uncoordinated effort. In fact, mountain terrain offers every possible advantage to the defender.

ORGANIZATION OF THE DEFENSE

The mountain defender must control the dominating heights which afford good observation and fields of fire while denying them to the attacker. The lack of mobility in the mountains, combined with the necessity to hold dominating ground, dictates that a position defense be used. The mountain battlefield is normally organized into a covering force area, main battle area, and rear area.

COVERING FORCE AREA

The covering force area begins at the line of contact and extends rearward to the forward edge of the main battle area. Covering forces operate in this area to provide early warning of enemy attack; to furnish information about the enemy's disposition; to gain time for the defender to prepare his defense; and to disorganize,

delay, and deceive the enemy as to the location of the main battle area.

When a covering force is used, it must be reinforced with attack helicopters and supported by field artillery, air defense artillery, engineers, and close air support. Mountainous terrain normally precludes the use of mechanized and armored forces in the covering force area except along major valley corridors.

Covering force units should be provided light vehicles and helicopters when possible. A number of things should be done to prepare the covering force area:

- Routes between reconnoitered positions are prepared and marked.
- Route priorities are assigned.
- Forces should be moved at night and under other conditions of limited visibility.
- Artificial obstacles are emplaced to reinforce natural obstacles.

Air assault infantry, if available, can be used in the covering force area. However, if the enemy closes on their positions, extraction may be difficult. Sheltered landing sites nearby should be available, and extraction must be covered by air or ground suppressive fires. If helicopter extraction is not possible, these forces should disengage and withdraw on foot or by vehicle.

MAIN BATTLE AREA

In the main battle area, forces will be disposed laterally or in depth to conform to the available avenues of approach. In rugged terrain, it may be difficult to maintain mutual support and overlapping observation even at battalion level. Some main battle area forces are employed beyond the forward edge of the main battle area. They man observation posts, assist the passage of covering forces into the main battle area, cover road blocks by fire, screen any gaps between main battle area defenders, and ambush enemy infiltrators.

Defensive positions along ridges or dominating heights should include as much of the forward and reverse slopes as possible to add depth and perimeter security. The size of such a unit position is primarily terrain-dependent. As a minimum, fighting positions and observation posts should be echeloned vertically as well as in depth.

When defending a mountain valley, fighting positions should be located on adjacent heights and in depth to permit covering the valley with crossfire. These positions must also be anchored to restrictive terrain or adjacent defensive forces to make enemy envelopment difficult.

In wooded terrain, defensive positions may be organized on the forward edge of the woods as well as on commanding heights. Antitank and antipersonnel mines and other obstacles should be widely employed to slow or stop enemy movement through the woods.

Mountain warfare demands that an aggressive defense be conducted. Combat patrols and raiding parties must infiltrate enemy units and attack headquarters, supply lines, and administrative areas. Smaller patrols should be deployed forward to temporary OPs to direct artillery fire and attack aircraft on targets of opportunity and to conduct ambushes. Harassing action should be designed to force the enemy to deploy additional troops to protect his lines of communication and to delay and disrupt his preparations for the attack.

Enemy infiltration must be prevented by the careful positioning of OPs, patrols, and ambushes. Ground surveillance radar and unattended ground sensors can be used effectively, but care must be taken to cover all gaps. The defender normally has time to study the ground and determine likely infiltration routes. Enemy forces attempting to flank a position can frequently be cut off and surrounded, provided they are discovered in time and reserves are accurately placed.

TIMELY DISCOVERY AND ACCURATE RESERVE PLACEMENT CAN CUT OFF ENEMY FLANKING MANEUVERS.

Because of the difficulties of movement, small reserves should be located near primary defensive positions, ready for immediate counterattack. This type of counterattack is far more effective than a deliberate attack since it can catch the enemy when he is exhausted after an uphill assault and before he can consolidate his position. On the other hand, large centrally placed reserves will normally be unable to intervene in time unless they can be moved by helicopter.

SMALL RESERVE COUNTERATTACKS ARE MORE EFFECTIVE THAN A DELIBERATE ATTACK.

REAR AREA

Because of limited space available in the rear area, care must be taken in selecting and locating positions for administrative or support units. Such positions are likely to be confined to small valleys. They are, therefore, obvious targets for enemy air attack, hostile shelling, or raids by small forces, particularly at night or in bad weather. When possible, avoid the most obvious positions and occupy unorthodox areas.

Normally, a perimeter defense is planned with each unit allocated a defensive sector. Positions are selected on the high ground dominating the area. Sensors and radars are used to cover areas between positions. Patrols and ambushes around the perimeter are routinely conducted, especially during periods of limited visibility.

PERIMETER DEFENSE POSITIONS ARE BEST LOCATED ON HIGH GROUND.

PREPARATION FOR THE DEFENSE

Preparation for the defense in mountainous regions is essentially as described in **FM 71—101, Infantry, Airborne and Air Assault Division Operations.**

The commander estimates the situation, and appropriate appraisals are provided by the staff. Terrain over which the battle is expected to be fought must be thoroughly studied. Personal reconnaissance is essential. All avenues of approach into the area are identified. Terrain which can slow or block lateral and forward movement is also identified. Once the avenues of approach have been identified, it is necessary to determine the forces required to defeat the enemy. If insufficient forces are available for each avenue of approach, it will be necessary to economize in some areas. Thus, the commander describes what is to be done and sets forth his concept of the operation.

The commander should describe his concept of the operation in the detail necessary for his staff and subordinate commanders to understand precisely what he intends with regard to fighting the battle. As a minimum, it is necessary to prescribe:

- Where the defense is to be conducted.
- What covering forces are to be deployed forward of the main body, what they are to do, when they are to be in the position, and how they are to be controlled.
- Task organization of the main battle area forces, where they are to fight, when they are to be in position, and how they are to be controlled.

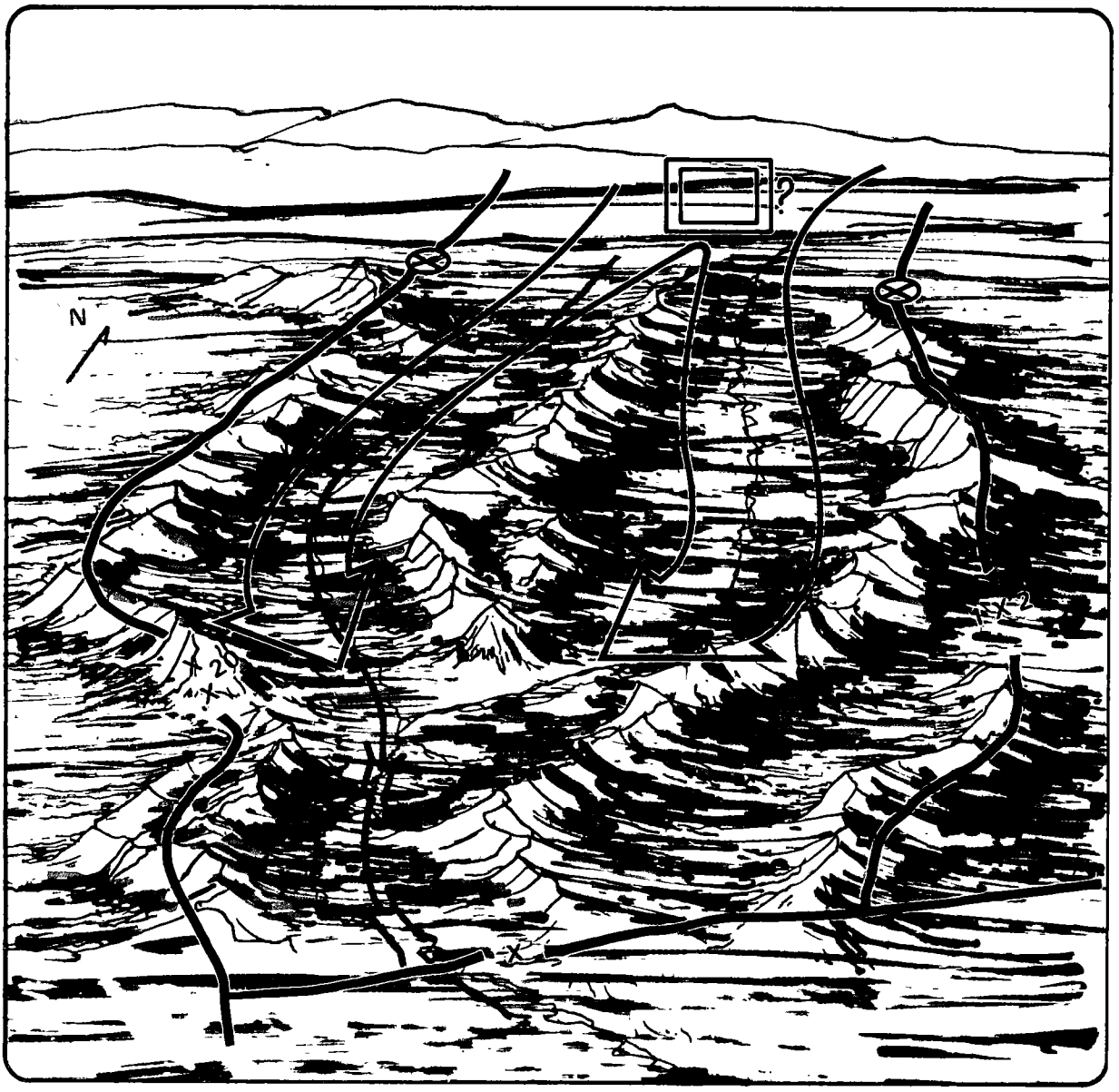
While the defender enjoys many advantages, the attacker picks the time and place for his attack. Limited visibility conditions favor the attacker, enabling him to move unobserved.

More time is required to accomplish the most basic tasks in the mountains. Movement times are increased, and resupply can be a laborious, back-breaking operation. Rocky terrain makes it more difficult to prepare defensive positions. Rapidly changing weather can halt all preparations.

DEFENSE EXAMPLE

The 1st Brigade, consisting of three infantry battalions, is preparing to defend. Covering force operations are being conducted by the 3d Brigade under division control. The 1st Brigade's DS artillery battalion will receive reinforcing fires from the 3d Brigade's DS battalion when covering force operations are concluded. The brigade's DS engineer company is being supported by a combat engineer company from corps.

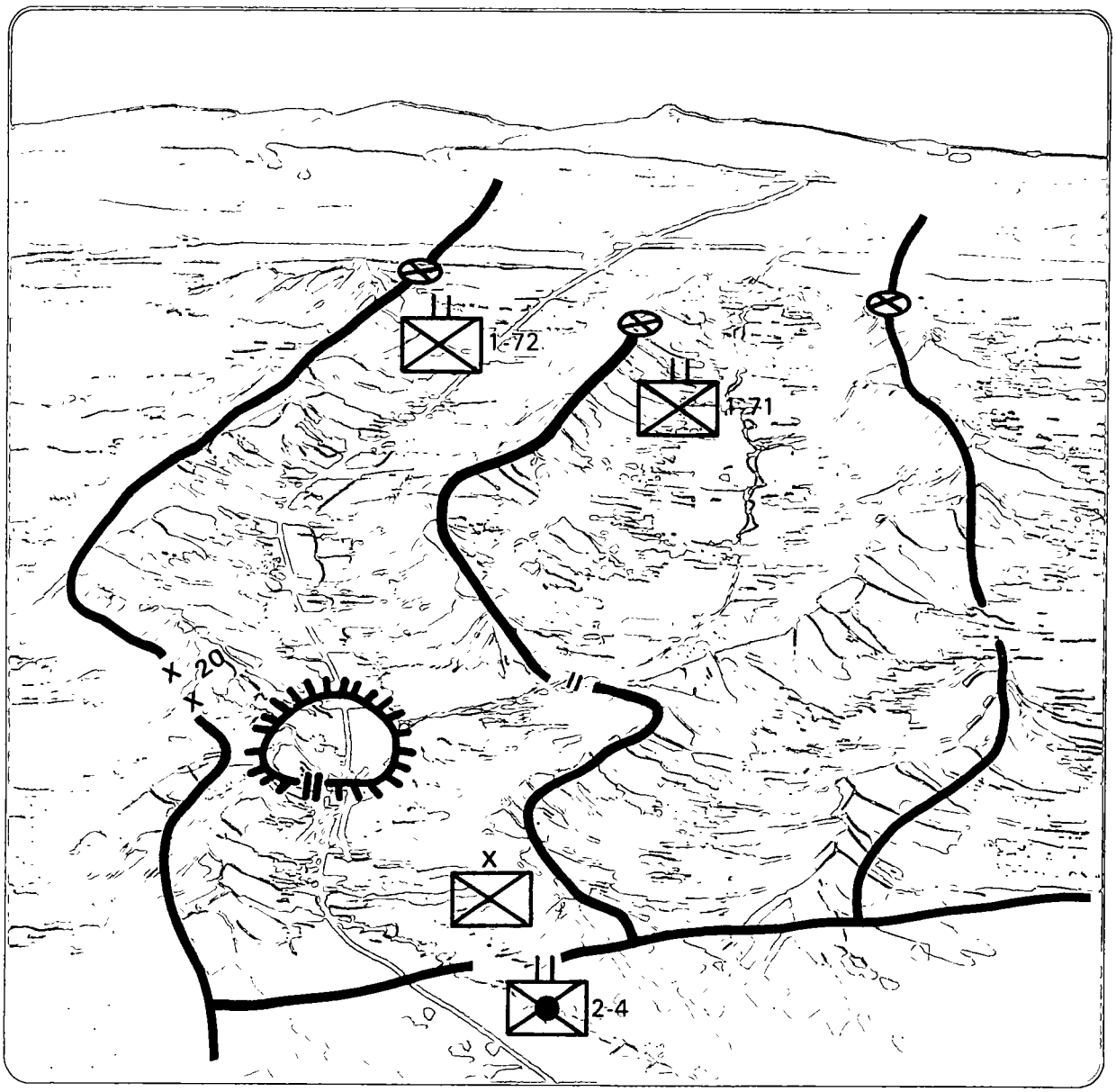
Two natural avenues lead into the brigade sector and join together well to the rear of the planned initial defensive positions. The terrain and vegetation along these corridors and the valley sides provide both cover and concealment. Excellent observation, except when affected by adverse weather, can be obtained from the ridge lines beside each avenue of approach. Adequate time and resources are available to prepare positions in depth.



Terrain is the Dominant Influence in the Brigade Defense.

Terrain is a dominant factor in the development of the brigade commander's concept and organization of the battlefield. Terrain in the eastern compartment of his sector is highly restrictive. Its secondary roadnet can be easily blocked. In this portion of his area, a battalion deployed in a linear defense can handle the defense.

In the forward portion of the western sector, the valley approach is suitable for use by a small armor force. A battalion, initially disposed in depth, is required here. Farther to the rear, a minor cross-compartment joins the two corridors. In this area, the terrain becomes more restrictive, forming a chokepoint. The flank terrain and



Two Battalions Defend Forward with the Third Located at the Natural Chokepoint.

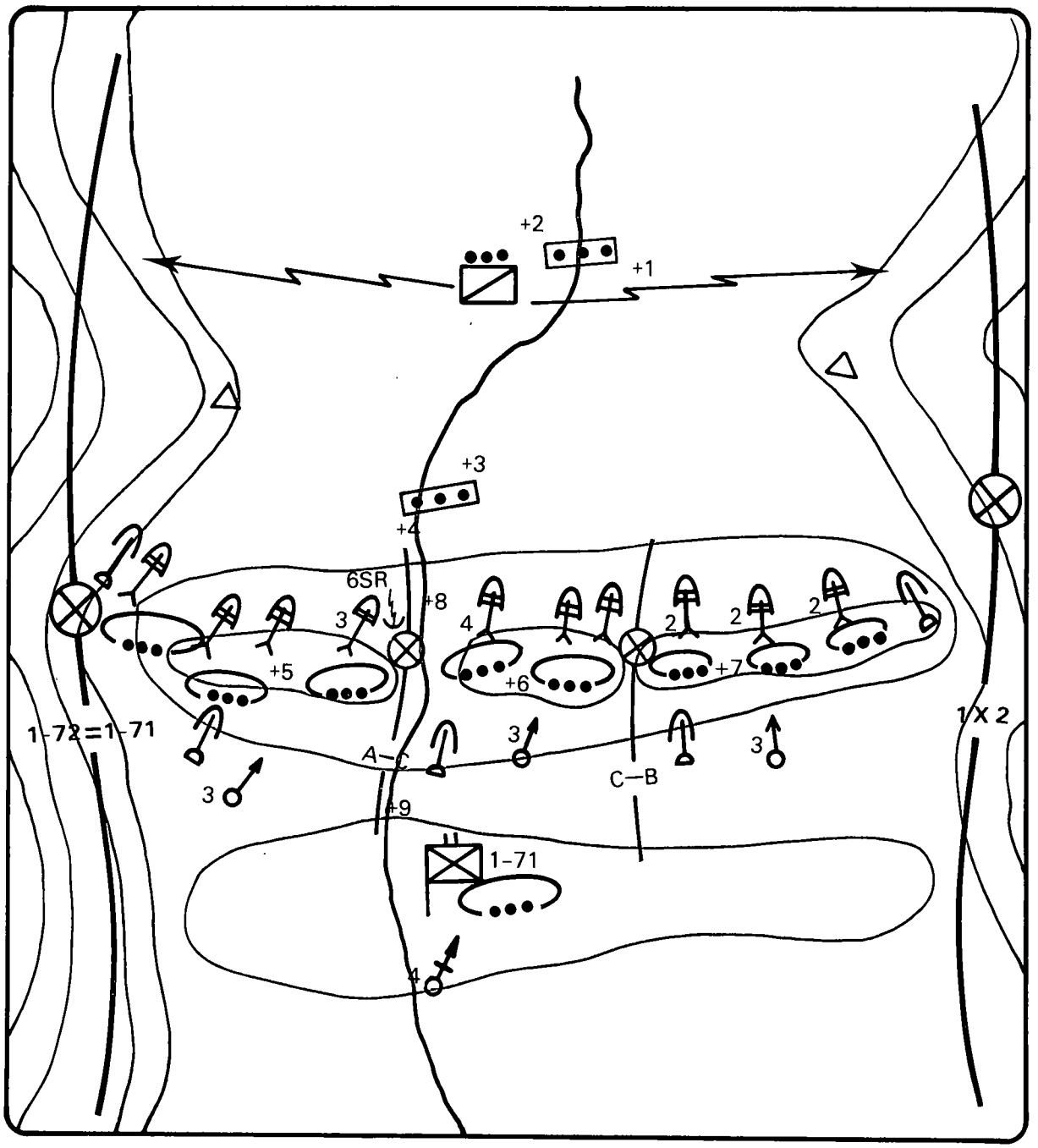
water obstacle favor the establishment of a battalion strongpoint.

To counter the threat of ground or aerial infiltration, the division commander has established an airmobile reserve of one rifle company and assigned responsibility for flank security to the air cavalry squadron upon completion of its security force mission. Within the brigade area, OPs will be established overlooking low-level aerial approaches where Redeye teams will provide general support. Ground surveillance radars, remote sensors, observation posts, and patrols will tie together the defensive positions.

Priority tasks for engineers will be to emplace mines and obstacles along the western portion of the sector and to assist in the preparation of the battalion strongpoint.

LINEAR DISPOSITION

As shown, the 1-71 Infantry is arrayed in a linear disposition along the approach in the eastern sector of the brigade.



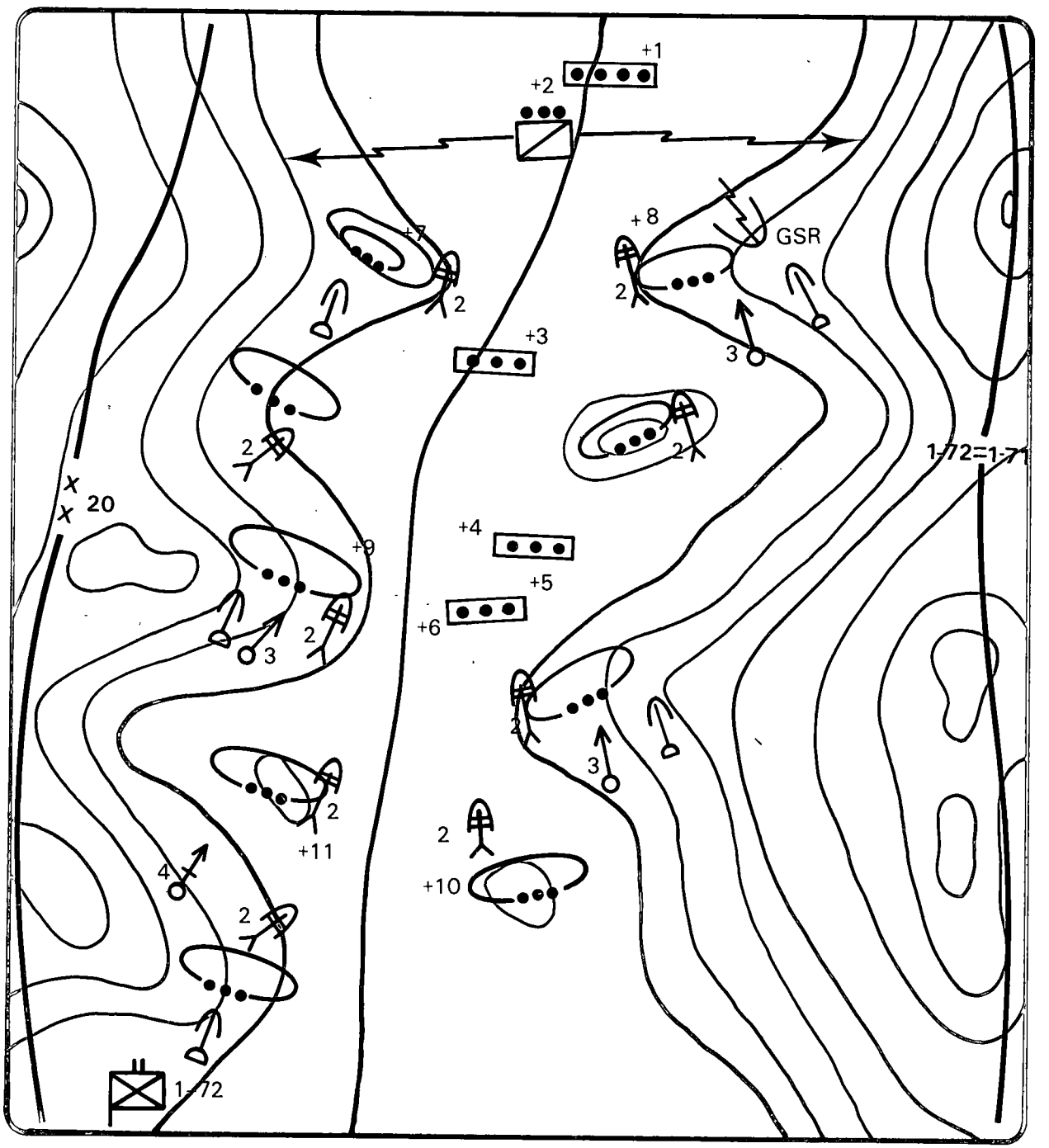
Battalion Linear Disposition.

DISPOSITION IN DEPTH

The 1-72 Infantry is deployed initially with forces arrayed in depth as shown.

STRONGPOINT DEFENSE

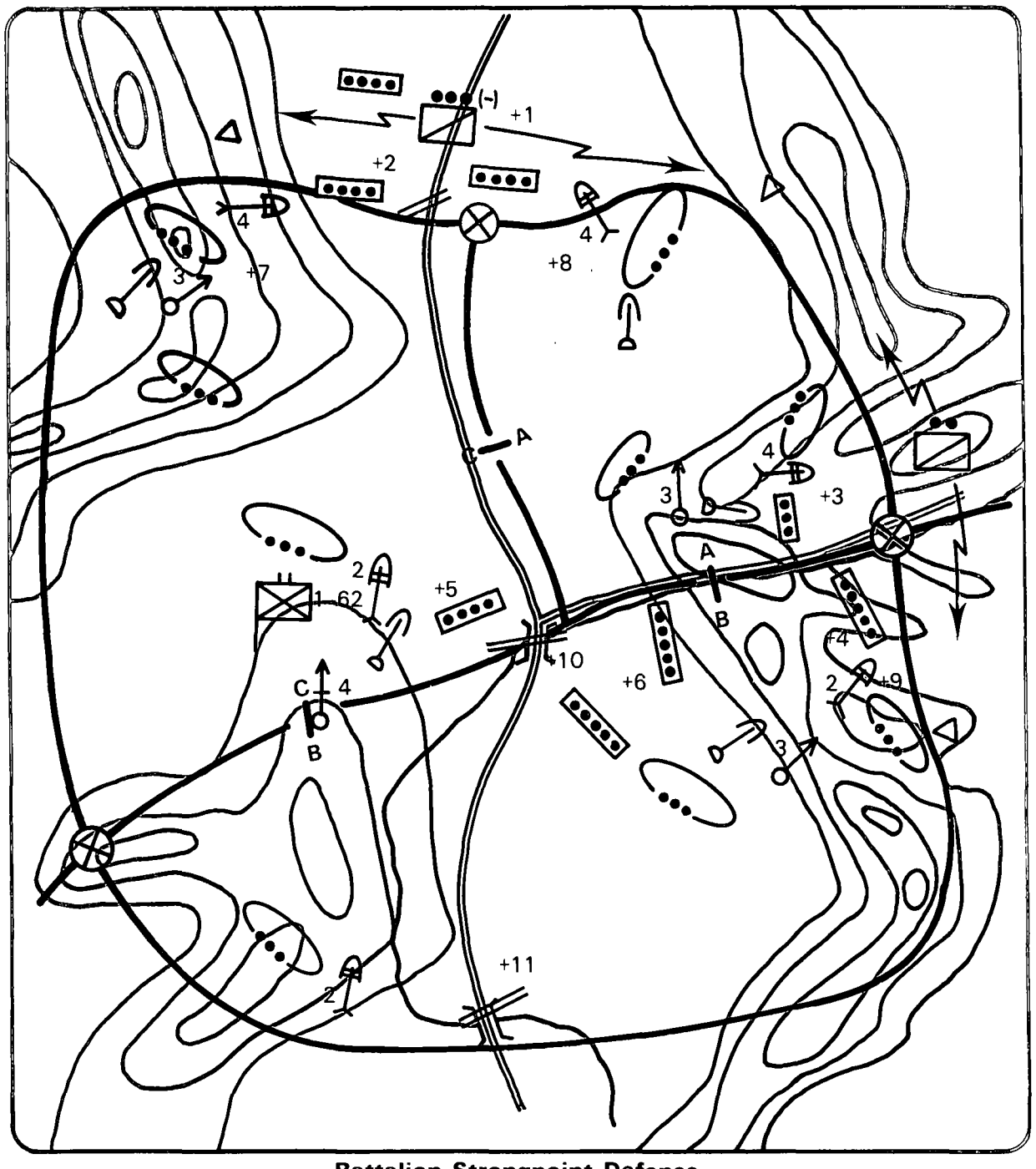
The 1-69 Infantry established its strongpoint as shown by positioning com-



Battalion Deployment in Depth.

panies on the terrain flanking the valley floor and one company behind the natural obstacle formed by the mountain stream.

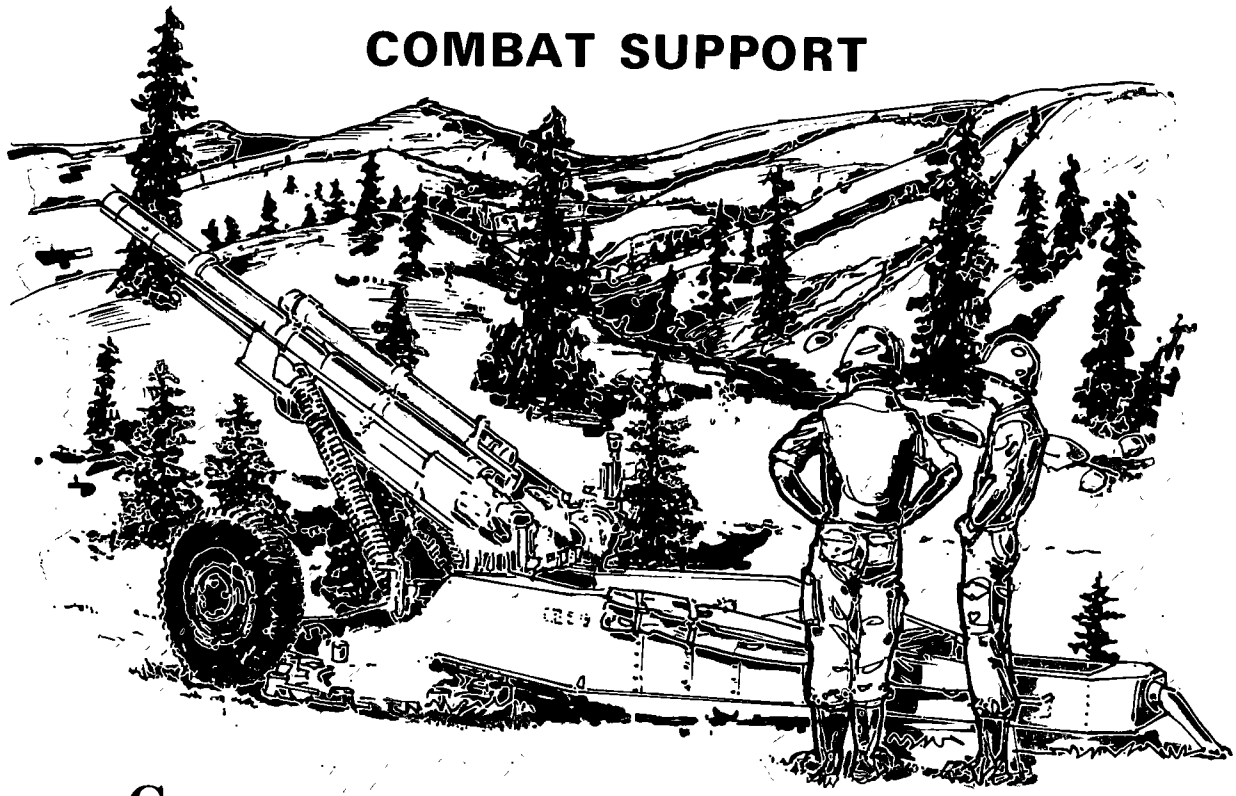
This example highlights techniques available to the defender in the mountains by illustrating various defensive formations.



Battalion Strongpoint Defense.

CHAPTER 4

COMBAT SUPPORT



Combat support roles and tasks are not changed by the mountain environment; however, even routine combat support missions are more difficult due to the rugged terrain.

Field Artillery

Not all types of cannon artillery are suitable for use in the mountains. For example, the 8″ self-propelled howitzer lacks mobility in a mountainous environment, has a slow rate of fire, and is a logistical burden.

CONTENTS

Towed light and medium field artillery, in contrast, can be brought into position with the aid of trucks, tractors, helicopters, or, in extreme cases, by use of block and tackle or winches. Guncrews need to be proficient in knot-tying and equipment-rigging techniques.

Self-propelled field artillery will often be limited to positions in the immediate vicinity of main roads. Field artillery

emplaced with the aid of helicopters will, in all probability, require further airlift for ammunition resupply and displacement. Normally, artillery is employed far enough to the rear to take advantage of increased angles of fall. Some weapons may be moved forward to provide deep interdiction fires or direct fires. Because of terrain compartmentation it may be necessary to give operational control of individual batteries to maneuver battalions. Because of rugged terrain features, higher angles of fire, and reduced ranges, it may be necessary to displace artillery frequently to provide continuous support. ***Field artillery must be as mobile as the force it supports.***

Field Artillery in Mountain Operations

As shown in the illustration, batteries may be split into two-gun platoons because of terrain restrictions or to increase the ability to provide fires for small-unit operations. Generally, high-angle indirect fires will be required.

Details of field artillery employment in the mountains are described in ***FM 6—20, Fire Support in Combined Arms Operations; 6—20—1, Field Artillery Cannon Battalion;*** and ***FM 6—40, Field Artillery Cannon Gunnery.***

FIRE SUPPORT

Light field artillery may have insufficient range to provide forward troops the necessary support. This may require forward displacement of gun sections by helicopter lift where possible. Medium field artillery may give the longer range required, but it is often limited by high terrain crest clearance.

Impact fuze high-explosive shells are very effective on rocky ground, scattering stones which themselves become missiles. Shells with variable time (VT) fuzes are particularly effective against troops on reverse slopes and should be used in deep snow conditions; however, they lose effectiveness when fired through dense clouds and falling snow.

Variable winds and steep mountain slopes will also reduce the effectiveness of artillery-delivered smoke rounds.

FIRE PLANNING

Rugged terrain and reduced mobility place increased reliance on artillery fire support. Planners must make sure that increased consumption is included in the computation of the required supply rate (RSR) for ammunition.

Communication between artillery positions and maneuver echelons and the coordination of fires with infantry support weapons require special attention. An infantry attack over rising terrain is easier to support than one over descending terrain, although artillery fire may dislodge rocks from higher elevations, endangering advancing troops. In the final stage of the attack, organic infantry support weapons may provide the most effective fire support.

FIRE CONTROL

Gunnery in mountainous terrain can be difficult because of:

- Large angles of elevation and increased time of flight for rounds to impact.
- Vast reverse slope areas hidden from observation.
- Increased amounts of dead space which cannot be hit by artillery fires.
- Differences in altitude between firing units and targets.

The majority of all field artillery fires in mountains are observed, especially close support and defensive fires. Unobserved fires are frequently unreliable since meteorological conditions change rapidly and registration corrections for high-angle fire are valid for only short periods of time.

An observed fire grid sheet based on accurate survey is the best firing chart. Survey is initiated as soon as possible. Registration on numerous checkpoints is

essential because of the variance in altitude which makes accurate transfers of fire difficult. Care must be taken in measuring minimum elevation for the battery zone of fire because high points may be occupied by friendly observers.

OBSERVATION OF FIRE

Field artillery observation posts (OPs) should generally be emplaced on the highest available ground; however, low clouds or fog may require emplacement at lower elevations. The capabilities of aerial observers should be exploited, particularly for the adjustment of fires into dead space. Aircraft can also be used to assist in communications relay and reconnaissnace roles. The use of observed fires, as opposed to unobserved, should be the norm since the rapidly changing meteorological conditions and poor maps will decrease the accuracy of predicted fires.

The use of colored smoke rounds should be considered when adjusting fires in deep snow. Observers must be prepared to perform assault climbing to reach the most advantageous observation sites.

TARGETS

Because of the decentralized nature of mountain operations, targets warranting massed fires may present themselves less often than in open terrain. Narrow defiles used as routes of supply, advance, or withdrawal by the enemy are potentially profitable targets for interdiction fires or heavy surprise concentrations. Large masses of snow or rocks above enemy positions and along main supply routes are also good targets. Such masses can be converted into highly destructive rock slides and avalanches. Suppression of enemy air defense (SEAD) takes on added importance because of the dependence on all types of aircraft. Every effort must be made to locate enemy position and communication vulnerabilities, and to plan and execute a suppression operation with all available fire power and electronic means. Proper application of attacks on each critical enemy air defense control point will disorganize the enemy's defenses, thereby allowing the freedom of air movement needed to conduct successful mountain operations.

POSITIONING

Care must be taken to insure that positions on commanding terrain provide defilade. The relative scarcity of good firing positions increases the probability of receiving enemy fires when occupying a desirable position.

Good cannon positions are difficult to find. They are selected for flash defilade, cover, and accessibility to roadnets and landing zones (LZs). Positions on commanding terrain are preferable to low ground positions because of:

- Less chance of being struck by rockslides or avalanches.
- Reduced amount of dead space in the target area.
- Less exposure to small arms fire from surrounding heights.

Tactical Air Support

Tactical air support operations may be degraded by low ceilings, fog, and storms common to mountain regions. Terrain may also limit attack options available to pilots and forward air controllers (FACs).

COUNTERAIR

Counterair operations include both the attack of enemy aircraft and supporting facilities and the attack of enemy air defenses. Counterair operations will be required in order to permit airborne and air-mobile operations.

TACTICAL AIR RECONNAISSANCE

Tactical air reconnaissance is particularly useful in mountain operations since terrain and weather often mask direct ground observation. Additionally, detailed maps needed to plan operations are seldom available; hence, aerial photographs are valuable map supplements.

Since movement is often conducted at night, photographic missions with both infrared and photo flash systems are required.

Infrared imagery and camouflage detection film can be used to determine precise locations of enemy positions. Air Force side-looking radar also provides excellent terrain and target-isolation imagery under nearly all weather conditions. However, missions must be planned to insure that critical areas are not masked by steep terrain. Airborne forward air controllers and close air support pilots can also be used as valuable sources of information.

AIR INTERDICTION

Air interdiction operations are particularly effective in mountains since enemy mobility, like ours, is restricted by terrain. Precision-guided munitions can quickly destroy bridges and tunnels; and, under proper conditions, can cause landslides and avalanches. When moving supplies along narrow mountain roads, vehicles, pack animals, and personnel are vulnerable to air attack. Also, air-delivered mines and long-delay bombs can seriously hamper route repair operations.

CLOSE AIR SUPPORT

Precision-guided munitions, such as laser-guided bombs, can destroy or neutralize point targets. Fuel air explosive munitions may be used against well-protected point targets. Airborne forward air controllers will often be required to designate targets that are masked from direct ground observation.

TACTICAL AIRLIFT

Specially equipped transport aircraft, capable of all-weather operations, can accurately drop large quantities of supplies into inaccessible areas. However, airlanding supplies and troops is more efficient than airdrop. If airlanding is not possible, terrain may still permit delivery of heavy equipment and bulk supplies by using the low-altitude parachute extraction system (LAPES).

Air Defense Artillery

The severe mountain environment requires some modification of air defense employment techniques. Suitable positions are scarce and access roads limited. In some instances, supporting air defense weapons may be unable to deploy to the most desirable positions; as a result, Redeye may be the only air defense weapon capable of providing close-in protection to maneuver elements.

TERRAIN ANALYSIS

Defiles and valleys in mountainous terrain will probably be used by enemy aircraft for low-altitude approaches. Attacking aircraft can be expected to take advantage of terrain masking of radars. Enemy pilots may avoid early detection by using terrain clearance or terrain-following techniques to approach a target. Rugged mountain terrain will degrade air defense detection; but, at the same time, mountain ridges and peaks tend to canalize enemy aircraft. Detailed terrain analysis, coupled with an understanding of probable enemy attack patterns, will aid site selection.

EMPLOYMENT

HAWK

Hawk battalions usually are assigned general support missions for defense of critical assets such as airfields and control and support activities. However, Hawk units may be required to provide air defense coverage for maneuver forces operating in mountain terrain.

Positions suitable for Hawk system emplacement may be difficult to find. Deployment of separate platoons will usually provide all-around defense and mutual support between units. Such deployment will usually facilitate position selection and occupation because of the smaller area required for emplacement.

Movement to and occupation of positions in mountainous terrain will require additional time. Site preparation and access route improvement prior to movement must be considered. Helicopters may be used to lift men and mission-essential equipment into otherwise inaccessible positions. Normally, equipment emplaced by helicopters must be resupplied and repositioned by the same means.

CHAPARRAL/VULCAN

Because mountainous terrain favors the use of small, lightly equipped maneuver elements, self-propelled Chaparral and Vulcan units often will be unable to accompany them. In air assault and airborne divisions, the towed Chaparral and Vulcan units can be airlifted to positions. However, Chaparral and Vulcan units may be restricted to the defense of control and support elements in more accessible portions of the battlefield.

Defenses of critical assets are weighted toward low-altitude air approaches by using a mix of Chaparral and Vulcan when possible. Forward area alerting radars (FAARs) provide alert warning and cover those areas masked to Hawk radar detection. Chaparral and Vulcan squads use observers to cover approaches masked from the gunner's view by terrain obstacles.

If enemy air activity is at a high level, the division commander may require additional air defense units. In this case, *towed Vulcan elements* may be available. Properly emplaced, the towed Vulcan can complement Redeye fires from teams accompanying maneuver elements. Towed Vulcans can be placed directly in a preselected firing position by medium helicopters. Since these helicopters are in heavy demand by combat support and combat service support units, the prime mover for the towed Vulcan will usually be left behind. The helicopter will place the Vulcan with its crew and ammunition directly on the firing position and support any subsequent move and routine ammunition resupply.

REDEYE

In planning air defense support of a company or battalion, Redeye should be positioned to provide early engagement and, where possible, overlapping fires. The Redeye section leader positions his teams based upon the battalion commander's guidance and supervises the distribution of air defense protection. He also may place one or more teams in support of specific maneuver elements. When moving on foot, Redeye teams will be limited to one missile per man, unless other members of the units can carry additional missiles. Resupply by helicopter is sometimes necessary.

Because of terrain masking of radars and difficulty in establishing line-of-sight communications with FAARs, alert warning for Redeye teams may be limited. Continuous visual observation must be maintained, particularly along likely low-level air attack routes. Observation posts some distance away from Redeye firing positions may be required for early detection of approaching aircraft. Observation along forced avenues of approach for attacking aircraft is of particular importance.

TARGET ACQUISITION AND DATA TRANSFER

Mountain terrain will tend to degrade the electronic target-acquisition capabilities of air defense systems supporting the division. Such degradation places increased importance on proper location of system radars and emphasizes the requirement for surveillance by each soldier. Hawk radar positions will be difficult to find and, once located, may be difficult to occupy. Positioning and resupply by helicopter will frequently be required. In any event, sites that can be occupied and which afford maximum radar coverage are selected.

FAAR systems provide a measure of early warning and friend or foe identification to Chaparral/Vulcan (C/V) and Redeye systems supporting the division. FAAR systems will experience the same terrain-imposed limitations described for Hawk radars. FAAR range is somewhat limited by system performance as well as by the terrain. Therefore, when possible, the FAAR should be emplaced on the highest accessible terrain in a position which will provide coverage at least 10 km in front of the affected fire unit and along the expected direction of attack. This will allow data transfer to the fire unit in time to provide for an effective engagement sequence.

Rapid data transfer between acquisition elements and fire units is fundamental to effective air defense. The direct support Hawk battalion is equipped with a semiautomatic system designed to provide real-time intrabattalion data transfer and other command and control functions. Interface between battalion elements is by multichannel radio links, with FM radio providing voice backup. FM radio links provide command and control, data transfer, and early warning information within C/V, FAAR, and Redeye systems. Because all data transfer systems previously described are dependent on line-of-sight, difficulties should be expected.

Engineers

Mountain roads and trails require extensive construction, improvement, maintenance, and repair to withstand increased military traffic and severe weather conditions. Because materials may be difficult to obtain locally and engineer equipment is difficult to operate in the mountains, large numbers of engineers are required.

Engineer combat support is also increased in mountainous terrain because of the lack of adequate cover and the requirement for construction of field fortifications and obstacles. This is especially true above the timberline and in rocky areas. Positions constructed in rock are strong and offer good protection, but they require considerable time and equipment to prepare.

Stream crossing operations are very difficult and must often be accomplished by expedient means. In extremely rough terrain, cableways and tramways offer a means of supply and evacuation. Because existing bridges may have low vehicle load classifications, standard fixed tactical bridges and bridging materials should be on hand for expedient reinforcement.

Other engineer missions in mountain operations include:

- Construction of shelters against the effects of weather.
- Clearing areas for landing strips and helipads.
- Supply of potable water.

ENGINEER AUGMENTATION AND EMPLOYMENT

As mountain terrain requires small-unit decentralized operations, a ***division engineer platoon*** should be allocated to each maneuver battalion. Allocation in this manner, however, leaves division and brigade rear areas short of engineer support. Also, engineer platoons can be transported by helicopter into high mountain battle positions.

An infantry division should be augmented with at least one engineer combat battalion and an airborne engineer light equipment company. Platoons of the airborne engineer light equipment company work with divisional platoons in each maneuver battalion area. Especially valuable are the light dozers. The combat engineer battalion provides heavy equipment and dump trucks required to support road improvement and maintenance in division and brigade rear areas. Also, the combat engineer battalion can accomplish such tasks as construction or reinforcement of bridges.

To operate efficiently, ***additional*** items such as ***compressors, power drills, chain saws, and bulldozers*** may be necessary. Large amounts of explosives and obstacle materials may also be required.

MOBILITY OPERATIONS

ROAD CONSTRUCTION

Construction of new roads in mountains is an engineering task of major proportions because of the amount of rock excavation required. Therefore, the development of extensive road systems in mountainous regions is impractical. Initially, road work is limited to the maintenance and repair of existing roads and trails which may be improved as time goes on.

Secondary roads and trails are developed or improved to accommodate M113s, 2½-ton trucks, and, eventually, heavier vehicles. They are selected with regard to the speed with which the routes can be put into service. Abnormal gradients on roads may be necessary to insure that construction will keep pace with tactical operations. Sidehill cuts are the rule, and the same contour line is followed to avoid excessive fills or bridging. Turnouts should be installed every one-half kilometer to reduce traffic congestion on single-lane roads or trails.

BRIDGING

Bridging operations in mountainous terrain are normally limited to the spanning of short gaps and the reinforcing of existing bridges by using prefabricated materials and fixed spans from floating bridge equipment. Standard design or improvised

suspension bridges may be employed for longer spans. Cableways and tramways, which can be obtained from kits, are frequently used to move light loads and personnel from gorges and up steep slopes.

OBSTACLE REDUCTION

Engineer support in front of convoys is necessary to clear such obstacles as washouts, craters, mines, landslides, and avalanches. In certain mountainous areas it is often impossible to make full use of conventional heavy engineer equipment for road and bridge construction or repair. In such cases, it is necessary to rely on hand labor, light equipment, and demolitions.

Minefields should be breached since bypass of properly sited obstacles is normally impossible. Reduction of obstacles is also more difficult in mountainous areas because of reduced maneuver space, lack of heavy equipment, and competiton for engineer support.

Mechanical mine exploders are not easily employed in the mountains because of the lack of roads and trails. Removal of mines by hand or demolition in place is often required.

For most mountain demolition work, the principles of **FM 5—25, Explosives and Demolitions,** are appropriate. For demolition in rocky soil, normal procedures apply, except that fissures must be well filled and tamped with earth so that explosive gases cannot escape. Extreme caution and planning are used when employing demolitions in the vicinity of snow-covered slopes because they can cause avalanches, rockfalls, and glacial slides.

COUNTERMOBILITY

MINES

Both antitank and antipersonnel mines are laid along the comparatively narrow approaches suitable for mounted attacks. On slopes not passable by tanks, only antipersonnel mines are employed. In mountainous terrain, scattered mining is used more frequently than patterned mining.

Flash flooding and excessive runoff may dislodge mines from their original location. Normally these mines remain armed and are hazardous to friendly troops. When such mines are encountered, the area is cleared or marked.

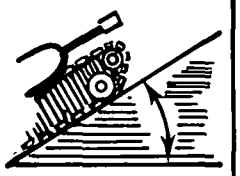
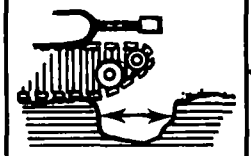
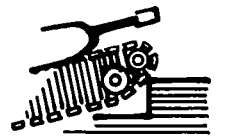
The use of scatterable mines, particularly artillery-delivered mines, is important in reducing engineer effort and increasing the flexibility of the maneuver unit commander. Scatterable mines are also a valuable resource in protecting rear areas from enemy envelopment and breakthroughs. Details on mines are found in **FM 20—32, Mine/Countermine Operations at the Company Level.**

OBSTACLES

In conjunction with the natural ruggedness of mountains, obstacles can be effectively employed to deny the enemy terrain and to delay and impede his movement. They are sited by the maneuver force commander in coordination with available weapon systems and restrictive terrain. (See **FM 90—7, Obstacles**).

Some countermobility capabilities of Threat armored equipment are listed in the following table.

COUNTERMOBILITY CAPABILITIES OF THREAT ARMORED EQUIPMENT

	 SLOPE ASCENDING CAPABILITY	 DITCH CROSSING CAPABILITY	 FORDING CAPABILITY	 STEP CLIMBING CAPABILITY
T-72*	30°/50%	Not available	Not available (5.0 m snorkel)	0.8 m
T-62	30°/50%	2.8 m	1.4 m (5.5 m snorkel)	0.8 m
T-55	30°/50%	2.7 m	1.4 m (5.5 m snorkel)	0.8 m
PT-76	38°/62%	2.8 m	Amphibious	1.1 m
ASU-85	38°/62%	2.8 m	1.3 m	1.1 m
BMP	38°/62%	2.8 m	Amphibious	0.9 m
BDRM-2	30°/50%	1.2 m	Amphibious	0.4 m
BTR-60P	30°/50%	2.0 m	Amphibious	0.4 m
BTR-50P	38°/62%	2.8 m	Amphibious	1.1 m
BTR-40	30°/50%	0.7 m	1.1 m	0.45 m

*Estimated values for T-72

Obstacle plans are integrated into the scheme of maneuver and carefully coordinated with combat support and combat service support plans. Certain factors are considered in the development of all obstacle plans. The following table provides a useful checklist.

OBSTACLE PLANNING CONSIDERATIONS

1. *Mission* of the command.
2. *Barrier studies* (and denial plans) *and plans from higher headquarters.*
3. *Current and future plans* including those for cover and deception, air support, psychological operations, civil affairs, unconventional warfare, and other special operations.
4. *Enemy limitations and the effects of those limitations on his capabilities,* including critical shortages, weaknesses, dependence on facilities in the area of operations, his ability to counter obstacles, and the effects of our denial operations
5. *Terrain.* Reinforcing obstacles are planned to build on the existing obstacles; they must be tied in with and fully used, to develop the obstacle system.
6. *Weather conditions* that affect the terrain and the use of atomic demolition munitions (ADMs) and chemical contaminants.
7. *Effect on the local population.* Excessive destruction can impose a major repair mission and alienate the civilian population, threatening the success of the immediate mission or hindering future operations. A sound military reason must exist for any demolitions. Damage to churches, schools, hospitals, and cultural/historical sites should be avoided unless overriding military necessity requires it.
8. *Time, materials, labor, and equipment available.* This may be the controlling consideration in evaluating options and setting priorities.
9. *Clearly delineated authority* for obstacle construction and/or demolition execution. Timing of execution must be positively controlled by the highest commander affected.
10. *Observation and covering fires for all obstacles* to enhance weapon effectiveness and protect critical, prepared demolitions from enemy seizure prior to execution.
11. *Requirements of friendly forces* for use of the area and/or facilities prior to execution.
12. *Alternate plans for execution of critical obstacles*—those whose loss prior to execution would gravely endanger friendly forces or plans.
13. *Capabilities of air, naval, joint, and allied forces to execute missions in support of the plan.*

SURVIVABILITY

Survivability requires the use of protective measures which decrease the lethality of the enemy's firepower. Irregular mountain terrain provides numerous favorable places for concealment. The digging of fighting positions and temporary fortifications above the timberline is generally difficult because of thin soil with underlying bedrock. Boulders and loose rocks can be used for construction of hasty fortifications.

Engineers can assist maneuver units with light equipment and tools brought into fighting/battle positions by helicopters. Conventional tools are not adequate for preparing individual and crew-served weapon fighting positions in rocky terrain. The use of demolitions may be required on an extensive basis. Maneuver unit commanders must assume that engineer support will not be available. A minimum of two men per infantry or tank platoon must be capable of using standard demolitions such as military dynamite, shaped charges, and cratering charges. Light dozers, backhoes, and frontloaders can be used in many situations to help prepare positions for TOW missiles, command bunkers, and other crew-served weapon positions. They can also be used to prepare positions off existing roads for tanks, artillery, and air defense weapons.

GENERAL ENGINEERING

RECONNAISSANCE

In many regions, only limited map coverage suitable for tactical planning is available. Engineer reconnaissance should precede all operations but not delay them. Because rugged mountain terrain makes field reconnaissance time-consuming and dangerous, aerial reconnaissance should be used. Terrain analysis for routes, trafficability, and availability of local materials is of special importance in mountain warfare. Engineer terrain intelligence teams, given reconnaissance information and aerial photography, can provide detailed information which is unavailable from other sources. Relationships between vegetation and soil conditions developed through terrain evaluation aid the engineer in his determination of trafficability.

WATER SUPPLY

Water in mountainous areas is often scarce. The installation of water points and purification of water are critical engineer tasks. No matter how pure and clean mountain water may appear, purification is necessary. Normally, one water point is established for each brigade, division main command post, and division rear. Transportation of water to forward positions is a logistical responsibility of the brigades.

GENERAL CONSTRUCTION AND ROUTE MAINTENANCE

Other general engineering tasks include:

- Improvement and maintenance of essential combat and main supply routes.
- Development of forward support areas for rearming/refueling.
- Construction and improvement of airstrips and helicopter landing sites.
- Development of minimum-essential logistics areas, to include both maintenance and supply areas.

Communications

Rapid and reliable communications are especially difficult to obtain in mountainous areas. When mountainous terrain is combined with the arctic environment, conditions become even more complicated, requiring precise planning and extensive coordination among all elements of the operation. Additionally, the combined effects on communications equipment of terrain, cold, ice, and dampness increase operating, maintenance, and supply problems.

COMMUNICATION MEANS

Communication means available are FM radio, AM voice radio, multichannel radio (providing telephone and record copy), radio teletypewriter (RATT), wire, visual, sound, and messenger.

FM RADIO

FM radio is the primary means of communications within the division. FM radio sets require a line-of-sight path; however, mountains often restrict radio line-of-sight. To overcome terrain restrictions, retransmission stations can be used. Additional retransmission equipment will have to be obtained from corps. Proper FM antenna use can play a large role in communicating successfully in the mountains. The standard omnidirectional antenna is not always sufficient. Directional antennas (bidirectional or unidirectional) are then necessary. These antennas are easily fabricated in the field. The use of a directional antenna will increase the FM range; however, it is less flexible and more time-consuming to set up.

AM VOICE

This system is used to extend the range of nonsecure voice communications between the division and its brigades.

MULTICHANNEL

Multichannel radio is used extensively within the division area. Like FM, multichannel radio requires a line-of-sight transmission path. To overcome the mountainous terrain, several radio relay sites are necessary. The inherent problem, however, is mobility. The multichannel shelter and prime mover are restricted to fair-weather roads. To employ the multichannel system, special techniques will have to be employed. It is often necessary to airlift multichannel shelters and generators to sites on high terrain, thereby providing line-of-sight to the distant terminal.

RADIO TELETYPEWRITER (RATT)

RATT may also be used down to battalion level to pass operations, intelligence, and logistics traffic. To be successful in mountainous terrain, RATT stations may have to be airlifted to respective command posts.

WIRE

Wire is one of the reliable means of communication. Unfortunately, in rugged mountains, particularly during the winter

months, wire is sometimes difficult to install and maintain. It should not be necessary to bury or raise wire overhead except where it crosses roads. The easiest way to cross roads is to run the wire through culverts and under bridges.

If long-distance wire communications are required, radio relay systems which can be integrated into the wire system must be considered. The installation of radio relay systems on mountaintops normally will be necessary for extension of long-distance wire circuits.

Extensive preparation for installation, maintenance, and support of equipment and for insuring survival of personnel operating mountaintop relay sites is necessary. More time is required to install and maintain field wire lines during periods of extreme cold and deep snow. Batteries that are used to operate field telephones and switchboards are subject to the same temperature limitations as those used to power tactical radio sets.

Wire dispensing in mountain areas may be accomplished by tracked or wheeled vehicle, foot, skis, snowshoes, or oversnow vehicles. Field cable is usually laid from reel units mounted on vehicles. However, laying wire in temperatures below zero degrees Fahrenheit presents a problem. Unless warmed, the cable sheath and insulation become inflexible. All tactical cable and wire should therefore be stored in heated areas.

Cables and wire that are covered by snow can cause the loss of many man-days in recovering or maintaining circuits. This can be avoided by pulling the cable from under the snow after each snowfall and allowing it to rest on top of the snow. Trees or poles can be used to support wire. Make allowance for drifting snow in deciding on the height above ground at which to support the lines.

VISUAL AND SOUND

Visual means of communication are particularly effective for both routine and emergency traffic. Blowing sand or snow, haze, fog, and other atmospheric conditions may periodically affect the range and reliability of visual signaling. Security requirements for visual means of communication are the same in all environments.

Sound carries a good distance, but sometimes echoes can distort the signal or message. In mountain operations, sound can often be used locally for alert and warning.

MESSENGER

Communication by messenger, although slow, is frequently the only means available to units. Messengers should be trained climbers, resourceful, familiar with mountain peculiarities, and should carry their own existence load. During the winter, advanced skiing skills may also be required. Messengers should always be dispatched in pairs. Air messenger service should be scheduled between units and integrated with the aerial resupply missions. Helicopters often must be used for messenger service since units seldom will be located near landing areas suitable for fixed-wing aircraft.

Vehicles may also be employed to maintain messenger communications when conditions of time, terrain, and distance permit. All vehicles used for messenger service over infrequently traveled routes should possess the capability for oversnow operations. Also, each should be equipped with radio, emergency equipment, snowshoes, heating apparatus, and simple navigational equipment. When security permits, the vehicle should be kept in continuous communication with its headquarters. The unit to which the vehicle is destined should be informed by encrypted radio message of the time of departure and expected time of arrival.

TECHNIQUES FOR RADIO OPERATION IN MOUNTAINOUS ENVIRONMENTS

Operators should receive special training prior to commitment to mountain operations. They must know how to keep the radio set clean, dry, and as warm as possible in cold weather.

Radios that are exposed to extreme cold are particularly sensitive to jars, shocks, and rough handling. Here, preventive maintenance procedures take on added importance.

ANTENNAS AND GROUNDS

Difficulties will be experienced in erecting antennas in mountains. Mountain pitons are excellent anchors for antenna guys in frozen earth, ice, or rocky soil. In extreme cold, ropes can be frozen to the ground and guys tied to these anchor ropes. Additional time must be allowed for these operations, and care must be exercised in handling lead-ins and metal masts since they become brittle in cold weather.

All large horizontal antennas should be equipped with counterweights arranged to slacken before wire or poles break from pressures of ice or wind. Wet snow and sleet freezing to the antenna may be removed by jarring the supports. Suitable grounds are difficult to obtain under conditions of extreme cold because frozen surfaces offer high electrical resistance. Where it is possible to install a grounding rod, the rod should be driven into the earth as deeply as possible or, preferably, through the ice on lakes or rivers. When it is impracticable to secure a ground, it will be necessary to install a counterpoise. In no instance should more than one transmitter be connected to the same ground or counterpoise. Also, electrical noise-producing items, such as direct current, battery-charging generators, or metal-walled huts, should not be connected to receiver ground systems.

CHAPTER 5
COMBAT SERVICE SUPPORT

General

Regardless of the area of employment for U.S. Army forces, the key functions of combat service support (CSS) must be performed. Because of the severity of the environment, combat service support in mountainous areas can be somewhat difficult. CSS operators will have to adjust to the changing environment.

PREPARATION

CONTENTS

The first step in preparing for combat service support operations is an analysis of the mission. Of paramount concern in mountain operations is the effect of terrain on operations.

A detailed analysis of the area of operations to identify lines of communication will play a major part in determining how combat service support operations will be conducted. In mountain

operations, it is probable that lines of communication will be limited. Airfields, good roads, and railroads will be the exception rather than the rule. Successful operations will demand an innovative and flexible methodology adapted to the situation. At all levels, the challenges of supporting forward forces will exceed those of the normal battlefield environment, and commanders must keep themselves informed at all times.

SUPPORT BASE

Because of terrain constraints, it may be necessary to disperse support units over a wide area. Dispersion reduces vulnerability of CSS units; however, it may cause problems with command, control, and local security. Combat service support units will be high-priority targets and must have adequate protection against ground and air attack to insure that a continuous flow of supplies is maintained. In all cases, support areas must be located as far forward as possible.

TRAINS

Battalion trains should be echeloned into combat and field trains to provide dispersion. Combat trains are routinely located in ravines or valleys on the rear slope of the terrain the unit is occupying.

Trains should be as small as possible and include primarily maintenance, Class III, and Class V support. Since portage will be required, procedures must be established to offload supply vehicles as far forward as possible; and, personnel must be designated to move supplies forward to deployed companies. Trains should be as mobile as possible and capable of rapid relocation. They must also be dispersed, taking advantage of available cover and concealment.

Supply routes to and through trains areas are an important consideration in site selection. Multiple supply routes will reduce the volume of traffic on any route and lessen the chance of attack. The enemy will emphasize the destruction of support units.

Trains Located on Rear Slope.

SECURITY OF MAIN SUPPLY ROUTES

Mountains provide excellent opportunities for ambushes and attacks on vehicle traffic on main supply routes. Enemy units can be airdropped or airlanded on key terrain that dominates supply routes. Rear area units must also be alert for enemy infiltration detachments that may seize important road junctions to isolate combat units from their logistical support. Route patrols and observation posts are required to secure main supply routes.

A combination of vehicle and helicopter patrols is the best method of providing route reconnaissance and security. Helicopters can rapidly reconnoiter routes and the dominant terrain along the routes. Vehicle patrols can be dispatched periodically at irregular intervals to verify the status of routes and locate enemy forces. These patrols must be alert for route mining and ambush. Observation posts on dominant terrain along supply routes are essential for early warning of enemy infiltration and rear area operations. The observation posts should be provided with surveillance devices to improve their capability to operate in inclement weather and at night.

SUPPLY

In mountain operations, *unit distribution* is most often used. Supplies are delivered as far forward as weather and terrain permit. Supply requirements will vary significantly from those encountered in temperate climates. Differences that may be expected in mountain operations are:

CLASS I

Rugged terrain and strenuous activities will cause an increase in ration requirements. Although combat rations are normally used, prepared meals should be delivered whenever possible.

Because of rapidly changing weather conditions and the difficulty of movement, units should maintain 2 to 3 day's of combat rations on hand. An additional 2-day's supply should be maintained in battalion field trains. Because of high altitudes and rough terrain, consumption of water will also be high.

CLASS II

Cold weather items such as gloves, sleeping bags, parkas, liners, and caps will be in great demand. Rugged terrain also increases requirements for replacement clothing, boots, and other personal items.

CLASS III

Limited roadnets and steep slopes reduce the volume of vehicle traffic and fuel consumption. The heavy reliance on helicopters for resupply and movement, however, increases aviation fuel requirements. Fuel cans are frequently required for refueling vehicles in forward areas when terrain restrictions prevent the use of tank and pump units.

CLASS IV

Mountainous areas may contain trees which can be used to construct barriers and fortifications. Maximum use should be made of all local materials to reduce Class IV requirements and demands on the transportation system.

CLASS V

Because of difficulty in adjusting artillery and mortar fires on steep slopes and the reduced bursting radius caused by snow

and heavily forested areas, consumption of ammunition is greater. It may be necessary to establish predesignated levels of on-hand quantities and to restrict firing when these levels have been reached. Conservation of ammunition must be practiced to insure that resupply can match expenditure.

Movement from the ammunition point to the using unit may require a combination of vehicle transport as far forward as possible and portage by unit personnel to combat positions. Helicopters can sometimes be used for ammunition resupply to forward units.

CLASS VI

Nonessential personal demand items should be given a low priority for movement if transportation is limited. Their movement with Class I rations should be used whenever possible.

CLASS VII

Because it is difficult to transport large end items to forward units, emphasis must be placed on maintenance, repair, and return to user rather than on end item replacement.

CLASS VIII

The demand for medical supplies should not vary significantly. Medical supplies must be given a high priority for movement and should be moved on the air line of communication (ALOC) whenever possible.

CLASS IX

Rugged terrain and climatic extremes cause repair parts consumption to increase. Movement of repair parts should be expedited on the ALOC into and within the combat area. Parts with high usage rates should be stocked at both field and combat trains. Typical high-consumption repair parts are:

- O tires.
- O tie rods.
- O transmissions.
- O brake shoes.
- O tracks and pads.
- O final drives.
- O winch parts.
- O fuel pumps.

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

MAINTENANCE

Fixing equipment as far forward as possible is extremely important in mountain operations.

Vehicle crews and maintenance personnel must be trained to evaluate accurately the damage to their equipment.

Repair should be accomplished by maintenance support teams from either the unit maintenance element or direct support maintenance company. General support teams can be used when required.

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

TRANSPORTATION

Rugged terrain, steep slopes, narrow unimproved roads, and limited-capacity bridges greatly complicate movement of supplies and personnel in mountains. Roads must be carefully reconnoitered to determine capabilities and to identify restrictions to movement. Engineer assistance is necessary to improve roads and to construct turnouts and bypasses around light bridges. Traffic control must be rigidly enforced to prevent congestion and delay. Military police are employed at road junctions and restrictive areas to insure a continuous traffic flow. Although vehicles are used to move a large share of supplies forward, they are not always able to reach deployed units. Locally obtained animals or individual soldiers must often move supplies from roads to unit positions. Whenever possible, vehicles should be used to move heavy and bulky items of supply such as Class III or IV.

When weather permits, helicopters can be used to move supplies from the division support area or the brigade trains area directly to forward units. Their use speeds resupply operations and reduces multiple handling. Helicopters are good for emergency resupply and movement of high-priority supplies; they should be used whenever possible. Resupply by US Air Force aircraft is another method. The container delivery system and low-altitude parachute extraction system are also excellent methods of providing responsive support. They are particularly effective for emergency resupply and the support of isolated units.

HEALTH SERVICES

Medical unit requirements are similar to those for other environments; however, there are some unique aspects of mountain operations to be considered if efficient support is to be provided.

EVACUATION

Because of rough terrain, the medical company will seldom be able to reach battalion aid stations by vehicle to evacuate casualties. Litter bearers are required to move casualties to the rear where they can be evacuated by ground or air ambulance to the clearing station in the brigade field trains. Unit or medical personnel or local nationals may be used. The medical company must coordinate closely with unit aid stations on the establishment of rendezvous points which should be located far forward to reduce movement by litter bearers. Training must be provided to all litter bearers on evacuation techniques and the prevention of frostbite.

Even lightly wounded personnel may be unable to move unassisted over rough terrain. Litter relay stations may be needed along the evacuation route to conserve energy of litter bearers and speed evacuation.

Evacuation of casualties from unit aid stations by helicopter is the preferred method for mountain operations. When enemy air defense capabilities prevent the use of helicopters in forward areas, helicopters should be used to evacuate patients from rendezvous points or from medical company clearing stations.

TREATMENT

In harsh mountain weather, the most important course of action is to get an injured soldier to competent medical aid as soon as possible. However, delay in evacuation can occur. Immediate first aid treatment must be given on the spot. During treatment and subsequent evacuation, the casualty must also be protected from wind, cold, and shock. This should be done by placing the injured soldier in a casualty or sleeping bag. Except in the case of an

abdominal injury, he should also be given warm drinking water or other hot drinks. Because of severe terrain and evacuation difficulties, battalion aid stations may be augmented with personnel and equipment from divisional medical companies.

GRAVES REGISTRATION

The evacuation of deceased from the battle area is difficult in mountains. Litter bearers may be required to transport remains to a rear area for evacuation by air or vehicle to the division support area. Since divisions lack organic graves registration capabilities, augmentation is required. If graves registration personnel and equipment cannot be made available to a deployed division, personnel and facilities of the host nation should be identified and agreements made for processing remains.

Mountain Illnesses and Injuries

Troops operating in mountainous regions are exposed to many and varied types of illnesses and injuries. The following table describes the cause, prevention, symptoms, and treatment of common mountain illnesses and injuries.

ILLNESS/ INJURY	CAUSE	PREVENTION	SYMPTOMS	TREATMENT
ACUTE MOUNTAIN SICKNESS	Rapid ascent to heights over 2400 m.	Acclimatization; progressive staged ascent which permits a stop for at least 1—2 days at intermediate altitudes of 2400 m and repetition each aditional 600—900 m. During stops, there should be no strenuous activity and only mild activity with frequent rest periods.	Headache, nausea, insomnia, depression, weakness, lightheadedness, loss of appetite, lack of concentration. Symptoms usually develop 4—12 hours after arrival at altitude, peak 2d day and may last up to 7 days.	Aspirin, fluids, light foods, and reassurance.
HIGH ALTITUDE PULMONARY EDEMA (HAPE)	Rapid ascent to heights over 2400 m.	Acclimatization; progressive staged ascent; slow assumption of physical activity. Protection from cold; confidence and reassurance.	Progressive cough and painful, difficult breathing; cyanosis (duskiness, blueness) of face and extremities; and anxiety. Presence of pulmonary rales (as determined by medical personnel), headache, insomnia, depression.	*Rapid evacuation* (air preferred) *to a lower altitude* of at least 2,000 feet. Rest, warmth, administer oxygen.

ILLNESS/ INJURY	CAUSE	PREVENTION	SYMPTOMS	TREATMENT
CEREBRAL EDEMA (CD)	Rapid ascent to heights over 2400 m. (aggravated by overexertion)	Acclimatization; progressive staged ascent, slow assumption of physical activity Protection from cold; confidence and reassurance.	Headache, vomiting, paralysis, stupor, convulsions and coma, retinal hemorrhages (as determined by medical personnel).	*Rapid evacuation* (air preferred) *to a lower altitude* of at least 2,000 feet. Rest, warmth, administer oxygen
FROSTBITE	Exposure to temperature below freezing point Degree of frostbite depends on temperature and duration of exposure.	Prior planning, cold weather training, and proper clothing and equipment Conserve body heat; prohibit unnecessary exposure for prolonged periods of time Remove excessive clothing when working, avoid wetting footgear and clothing. Provide layers of air in between clothing, change clothing, footgear, and socks regularly Protect exposed portions of body. Use buddy system to inspect one another periodically.	Grey or white skin, frequently no pain; preceded by redness, tingling, pain in exposed part, followed by numbness and fading color. Skin over affected areas feels rigid or hard Swelling and pain often occur after thawing.	Remove clothing from affected part Thaw in warm water, 38—40° C, or under arm pits, or against buddy's chest or abdomen. Keep patient warm. Do *not* massage area or break blisters. *No smoking, no alcohol;* do not allow patient to walk; apply *loose, bulky, dry* dressings to affected hands, feet. Do *not* allow to refreeze
TRENCH AND IMMERSION FOOT	Prolonged exposure to wet, cold footgear or outright immersion of the feet, usually below 10° C, and is associated with immobilization of the feet.	Same as for frostbite.	Tenderness, tissue softens, reddens, and will eventually blacken; swelling is common.	Keep feet warm and dry. Massage feet with footpowder and change socks as often as necessary to keep dry.

ILLNESS/ INJURY	CAUSE	PREVENTION	SYMPTOMS	TREATMENT
HYPOTHERMIA	Inadequate protection from cold and prolonged exposure to cold wind, or water.	All cold weather preventive measures.	Danger in the initial lack of symptoms and warning. The only warning may be accompanying symptoms of frostbite. Shivering begins after a drop of 1-2° and is followed by clumsiness, stumbling, falling, slow reactions, mental confusion, and difficulty in speaking. In profound cases, patient is cold, pale, comatose, and shows no easily detectable vital signs Pulse may be faint or impalpable; breathing is so shallow that a casual observation may fail to identify any respiratory movement; body temperature is below 96° F.	Prevent further heat loss. Rewarm as safely and rapidly as possible. Rewarm the inner body in advance of the shell by giving hot, sweet liquids and putting covered hot water bottles or covered canteens of hot water against the trunk. Avoid serious complications. (1) Rough handling or jarring of a victim with a temperature below 85° F can cause heart attack. (2) Rewarming the outside without warming the core can cause shock.
DEHYDRATION AND HEAT EXHAUSTION	Imbalance of liquids and loss of salt; engaging in any strenuous exercises or activities. (High altitudes and low humidity tend to dehydrate.)	Dressing for the type of activity. Normal daily intake of food, liquid, and salt; loosen closures before starting to perspire.	Mouth, tongue, and throat become dry and parched; swallowing is difficult, general nausea is felt and may be accompanied by spells of faintness, extreme dizziness, and vomiting. A feeling of general tiredness and weakness sets in, and muscle cramps may occur. Fainting, blackout, or excessive perspiration may occur.	Keep warm but loosen clothes for proper circulation; get plenty of rest along with liquids. One-half mess spoon of common salt mixed with one gallon of water makes a palatable solution.

ILLNESS/ INJURY	CAUSE	PREVENTION	SYMPTOMS	TREATMENT
SUNBURN	Exposing skin to rays of the sun.	Protective creams and lotions (Army issue)	Redness of skin, slight swelling, blistering and pain in severe cases. chills, fever, or headache	Application of cold saline dressings, soothing creams.
SNOW BLINDNESS	Surface of eye absorbs ultraviolet radiation from sun's rays directly or reflected from snow or water.	Sunglasses or goggles, cardboard with thin slit (see TC 8—3) or hair pulled down over face. Eye protection is more necessary on a partly cloudy or moderately overcast day than in full sunlight.	Symptoms may not develop until 8 to 12 hours after exposure. Eyes initially feel dry or irritated; as symptoms progress, eyes feel as though they are full of sand Moving or blinking eyes is painful, eyelids swell, eyes redden, and excessive tearing may occur. Symptoms may last for several days.	Cold compresses, dark environment, opthalmic ointment containing cortisone or other type steroid. Do not allow individual to rub eyes.
CHAPPING	Combination of wind, low humidity, sunburn.	Chapstick	Dry, cracking, and bleeding lips; painful when eating or laughing	Chapstick; soothing ointment

SICKLE CELL ANEMIA

Although not considered a mountain disease, this condition can be seriously affected by the decrease in barometric pressure and lower oxygen levels found at high altitudes. Personnel who evidence such traits should undergo medical evaluation prior to deployment to altitudes above one mile.

APPENDIX A

REFERENCES

Department of the Army Publications and Films

Department of the Army Pamphlets of the 310 series should be consulted frequently for latest changes or revisions of references given and for new material on subjects covered in this manual.

FIELD MANUALS (FM)

1—5	Instrument Flying and Navigation for Army Aviators
5—20	Camouflage
5—25	Explosives and Demolitions
5—100	Engineer Combat Operations
6—20	Fire Support in Combined Arms Operations
7—7	The Mechanized Infantry Platoon and Squad
7—8	The Infantry Platoon/Squad (TBP)
7—10	The Rifle Company, Platoons, and Squads
7—20	The Infantry Battalion (Infantry, Airborne, Air Assault, Ranger)
8—10	Health Service Support to Theater of Operations
8—35	Evacuation of the Sick and Wounded
9—207	Operation and Maintenance of Ordnance Materiel in Cold Weather (0 degrees to -65 degrees Fahrenheit)
11—50	Combat Communications Within the Division
17—47	Air Cavalry Combat Brigade
17—50	Attack Helicopter Operations
17—95	Cavalry
19—1	Military Police Combat Support, Divisions and Separate Brigades
19—4	Military Police Combat Support Theater of Operations
19—25	Military Police Traffic Operations
20—32	Mine/Countermine Operations at the Company Level
20—60	Battlefield Illumination
21—10	Field Hygiene and Sanitation

21—11	First Aid for Soldiers
21—40	NBC (Nuclear, Biological, and Chemical) Defense
21—60	Visual Signals
21—75	Combat Training of the Individual Soldier and Patrolling
21—76	Survival, Evasion, and Escape
24—1	Combat Communications
29—2	Organizational Maintenance Operations
30—5	Combat Intelligence
32—6	SIGSEC Techniques
38—1	Logistics Management
41—10	Civil Affairs Operations
44—1	US Army Air Defense Artillery Employment
44—3	Air Defense Artillery Employment, Chaparral/Vulcan
44—23	US Army Air Defense Artillery Employment, Redeye
54—2	The Division Support Command and Separate Brigade Support Battalion
71—1	Tank and Mechanized Infantry Company Team
71—2	The Tank and Mechanized Infantry Battalion Task Force
71—3	Armored and Mechanized Brigade Operations (TBP)
71—100	Armored and Mechanized Division Operations
71—101	Infantry, Airborne and Air Assault Division Operations (TBP)
90—1	Employment of Army Aviation Units in a High Threat Environment
90—2	Tactical Deception
90—7	Obstacles (TBP)
90—11	Winter Operations (TBP)
100—5	Operations
100—10	Combat Service Support

100—15	Larger Unit Operations
100—26	The Air-Ground Operations System
101—5	Staff Officers' Field Manual; Staff Organization and Procedure
101—5—1	Operational Terms and Graphics
101—31—1	Staff Officers' Field Manual: Nuclear Weapons Employment Doctrine and Procedures [FM FM 11—4]
(S)101—31—2	Staff Officers' Field Manual: Nuclear Weapons Employment Effects Data (U) [FM FM 11—4A]
101—31—3	Staff Officers' Field Manual: Nuclear Weapons Employment Effects Data [FM FM 11—4B]

TRAINING CIRCULARS (TC)

1—10	Mountain Flying Sense
1—12	Cold Weather Flying Sense
5—200	Camouflage Pattern Painting
21—3	Soldier's Handbook for Individual Operations and Survival in Cold Weather Areas
90—6—1	Military Mountaineering

TECHNICAL BULLETINS (TB)

MED 81	Cold Injury
MED 288	Medical Problems of Man at High Terrestrial Elevations

TRAINING FILMS (TF)

TF 8—4915	Medical Problems of Military Operations in Mountainous Terrain
TF 8—4916	Medical Problems of Military Operations in High Altitude Terrain
TF 8—4879	Prevention of Cold Injuries
TF 21—3478	Avalanche Hazards Part 1
TF 21—3479	Avalanche Hazards Part 2
MF 31—5859	Military Mountaineering Techniques (Summer)

Implemented and Relevant International Standardization Agreements

The international standardization agreement implemented by FM 90—6 is as follows:

NATO STANAG	CENTO STANAG	ABCA QSTAG	Title
2868	—	—	Land Force Tactical Doctrine (ATP-35)

International standardization agreements relevant to FM 90—6 are as follows:

NATO STANAG	CENTO STANAG	ABCA QSTAG	Title
2002	2002	501	Marking of Contaminated or Dangerous Land Areas, Complete Equipments, Supplies and Stores.
2003	2003	—	Patrol Reports
2010	2010	504	Bridge Classification Markings
2014	2014	506	Operation Orders, Annexes to Operation Orders, Administrative and Logistics Orders.
2017	2017	508	Orders to the Demolition Guard Commander and Demolition Firing Party Commander.
2021	2021	—	Computation of Bridge, Raft and Vehicle Classifications.
2029	2029	514	Method of Describing Ground Locations, Areas and Boundaries.

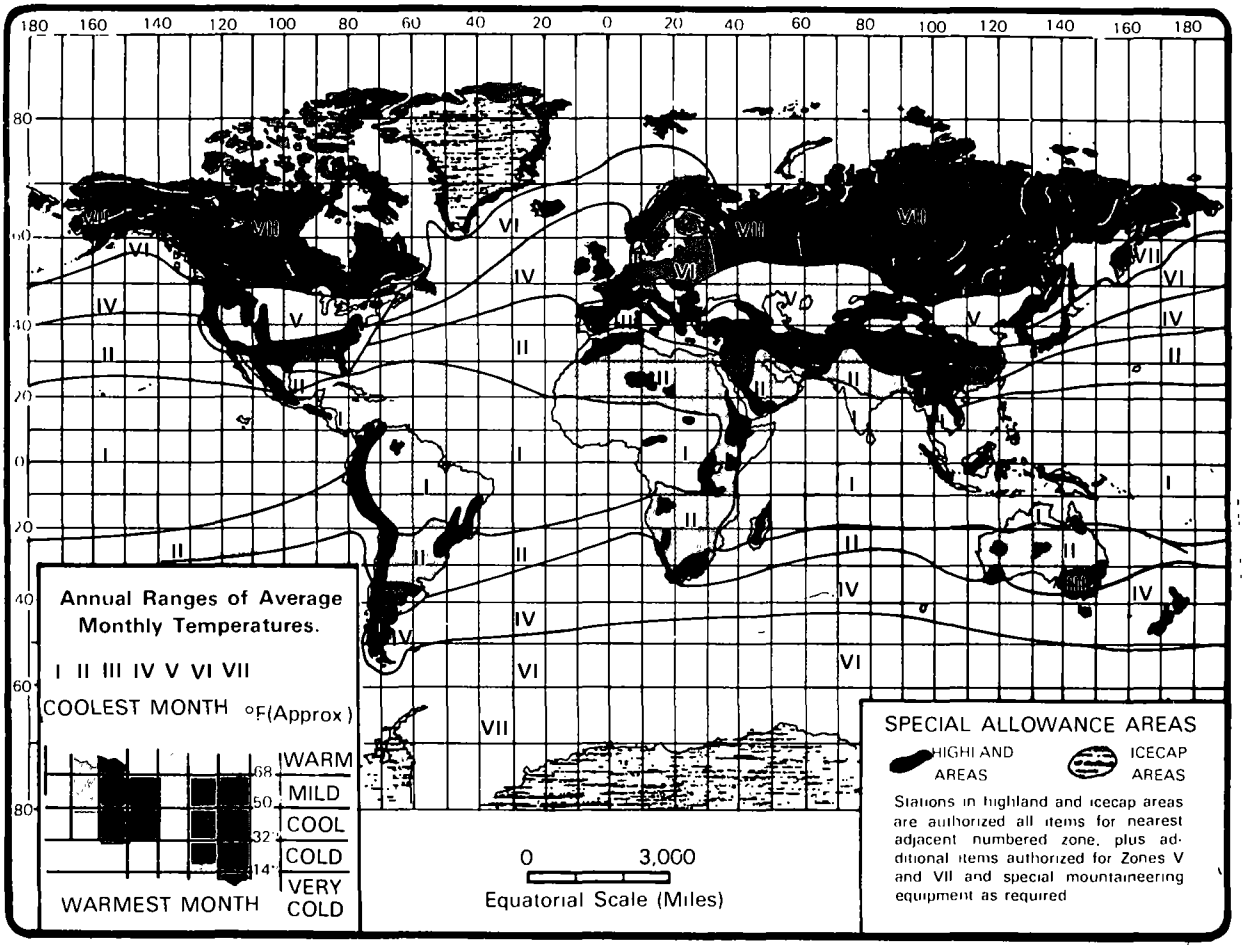
NATO STANAG	CENTO STANAG	ABCA QSTAG	Title
2034	2034	516	Ammunition Supply Procedure
2036	2036	518	Land Minefield Laying, Recording, Reporting and Marking Procedures.
2047	2047	183	Emergency Alarms of Hazard or Attack (NBC and Air Attack only)
2070	2070	—	Emergency War Burial Procedures
2083	2083	—	Commanders Guide on Radiation Exposure
2087	2087	—	Medical Employment of Air Transport in the Forward Area.
2088	2088	182	Battlefield Illumination
2103	2103	187	Reporting Nuclear Detonations, Radioactive Fallout and Biological and Chemical Attacks and Predicting Associated Hazards
2112	2112	—	Radiological Survey
2122	2122	—	Medical Training in First Aid, Basic Hygiene and Emergency Care
2129	2129	538	Recognition and Identification of Forces on the Battlefield
2130	—	—	Employment of Atomic Demolition Munitions (ADM)
2133	—	—	Vulnerability Assessment of Chemical and Biological Hazards
2135	—	—	Procedures for Requesting and Providing Logistics Assistance
2174	—	—	Military Routes and Route/Road Networks
3570	—	—	Drop Zones and Extraction Zones— Criteria and Markings
3630	—	570	Emplaning and Deplaning at the High Hover
3736	—	—	Offensive Air Support Operations (ATP-27)

APPENDIX B

CLOTHING AND EQUIPMENT

Mountain operations require equipment suitable for climbing and movement over very rugged terrain. Further, it may be necessary to equip personnel for very cold weather.

Clothing and equipment which will support operations in a mountain environment are listed in Common Table of Allowances (CTA) 50—900. Authorizations contained in this CTA are based primarily on expected seasonal temperature variations. Clothing allowance zones have been established based on the average temperature in the coldest and warmest months. These zones are shown below.



US Army Clothing Allowance Zones.

In mountainous, plateau, and other highland areas, clothing allowances which are adequate for adjacent lower areas may not provide sufficient protection. Therefore, in these higher or more rugged areas, commanders may authorize the clothing allowance of the nearest adjacent zone, plus additional items authorized for Zones V and VII and special mountaineering equipment, as required. Similarly, areas adjacent to the boundary between zones may, under special climatic conditions, require the issue of certain clothing and personal equipment items allowed in the colder or warmer zones.

Individual Clothing

COLD WET UNIFORM

The following list of TA 50 clothing has been designed for cold wet climates and will be issued for operations or special training in the mountain environment.

ITEM	AVERAGE WEIGHT IN POUNDS (size medium regular)
Undershirt man's, 50 cotton 50 wool	0.82
Drawers man's, 50 cotton 50 wool	0.89
Socks man's, wool cushion sole OG 408	0.19
Trouser man's, cotton/nylon wind resistant OG 107	2.10
Trouser man's, wool serge OG 108	1.68
Trouser suspenders	0.25
Shirt man's, wool OG 108	1.50
Coat man's, cotton/nylon wind resistant OG 107	3.20
Liner coat man's, nylon quilted 6.2 oz OG 106	0.73
Cap cold weather, cotton/nylon OG 107	0.26
Glove shells leather black	0.22
Glove inserts wool/nylon knit OG 108	0.13
Mitten shells trigger finger, leather palm and thumb	0.43
Mitten inserts wool/nylon knit OG trigger finger	0.22
Mitten set arctic gauntlet style w/leather palm	1.08
Scarf wool/nylon knit OG 108	0.38
Boot insulated cold weather black w/release valve	5.50
Poncho, nylon twill	2.00
Overwhite set:	
Parka snow camouflage white w/hood	1.94
Trouser snow camouflage white	1.50
Mitten shells camouflage white	0.31
Cover rucksack camouflage white	0.75
Coat wet weather	1.50
Trousers wet weather	2.25

COLD DRY UNIFORM

When the anticipated climate has sub-zero temperatures and dry snow, the cold dry uniform is issued. It is the same as the cold wet uniform with these exceptions:

ITEM	AVERAGE WEIGHT IN POUNDS (size medium regular)
DELETE: Trousers man's, wool serge OG 108	
Boot insulated cold weather black w/release valve	
ADD: Parka extreme cold weather, man's cotton nylon OG 107 w/o hood	2.98
Hood extreme cold weather, cotton nylon OG 107 w/fur ruff	0.96
Liner extreme cold weather parka, nylon quilted OG 106	0.95
Liner trousers, nylon quilted OG 106	0.95
Liner snow camouflage trouser rip-stop nylon	1.75
Boot extreme cold weather insulated white w/release valve	5.50
Face mask white quilted, adjustable	0.50

MOUNTAIN UNIFORM

These items of clothing supplement the cold weather uniforms for mountain (high altitude) operations:

ITEM	WEIGHT (Pounds)
Mountain boot black w/vibram sole (chippewa)	5.00
Work gloves tan w/adjustable strap	0.22

COMMERCIAL MOUNTAIN CLOTHING

These items of clothing are given for consideration by commanders. They are commonly used by mountaineers, and are in use by the Northern Warfare Training Center (NWTC):

ITEM	WEIGHT (Pounds)
High altitude boots	5.30
Expedition parka, down	3.62
Expedition trousers, down	2.50
Expedition booties, down	0.62
Expedition mittens, down	0.44
Balaclava, knit cap	0.25
Sox	0.25
Parka, wet weather	1.00
Trousers, wet weather	1.00

Individual Equipment

INDIVIDUAL COLD WEATHER EQUIPMENT

Although many of the following items of equipment are specialized allowances for "Low Mountain" or "Alpine" areas, they are primarily used for arctic region operations.

ITEM	WEIGHT (Pounds)
Sleeping bag, arctic (outer)	7.06
Sleeping bag, mountain (inner)	5.41
Mattress, pneumatic	3.00
Case, sleeping bag	2.25
Rucksack, nylon duck OG	3.60
Canteen, cold climatic w/cup & cover	3.85
Skis, all terrain w/bindings & poles	9.50
Ski climbers, mohair and cotton pile	0.25
Snowshoes, magnesium w/bindings	4.60
Ski wax (per box)	0.25
Chapstick	0.10
Sunburn preventive cream	0.19
Sunglasses, w/case	0.30
Thong, emergency	0.12
Emergency ration	2.13
Box match, waterproof w/matches	0.15
Water purification tablets	0.15
Candles	0.25

INDIVIDUAL MOUNTAIN EQUIPMENT

The following items of equipment are required for mountain operations. Although most are not listed in TA 50-901 for "Low Mountain" or "Alpine" areas, they are available through the military supply system (see TA 50-970).

ITEM	WEIGHT (Pounds)
Piton, mountain rock set	0.53
Piton, mountain ice set	0.36
Piton Hammer, per 4 men	0.86
Snap Link, mountain piton	0.52
Axe, ice mountain	2.78
Crampons, mountain	1.59
Sling, rope 4m	0.71
Climbing rope, per 2 men	2.00

COMMERCIAL MOUNTAIN EQUIPMENT

The following items of individual equipment are given for consideration by commanders. These items are in use by the northern warfare training center (NWTC):

ITEM	WEIGHT (Pounds)
Goggles, mountain	0.25
Avalanche cord	0.38
Snow pickets	2.62
Sleeping bag	7.50
Sleeping pad	1.12
Fuel container	0.38
Jumar ascender	0.44
Ice dagger	0.50
Climbing harness, chest	0.75
Climbing harness, seat	0.50
First aid kit	0.25
Snow/ice saw, per 2 men	0.38
Stove, per 2 men	3.38
Tent, per 2 men	5.00
Plastic water bottle	0.25
Plastic cup, large	0.19
Headlamp, per 2 men	0.75

Organizational Equipment

ORGANIZATIONAL COLD WEATHER EQUIPMENT

Many items previously listed as either individual clothing or equipment are actually organizational clothing and equipment. However, they are all carried by individuals and must therefore be considered when calculating loads to be carried by each squad member.

The following organizational equipment items are carried by unit transportation. In

this case, as most items of equipment are used for arctic winter operations, the ahkio (sled) is used by the squad to transport the equipment listed.

ITEM	WEIGHT (Pounds)
Ahkio, sled w/harness	38.00
Tent, arctic 10 man	76.00
Stove, Yukon w/base	33.00
Can, gas w/fuel	32.00
Can, water w/water	41.00
Candles, box	3.00
C-rations, case, 2 ea	25.00
Cook set, squad, 2 ea	1.30
Stove, single burner, 2 ea	1.30
Lantern, gasoline	5.30
Axe, 2 ea	4.00
Saw (Buck or Swede)	3.00
Machete, 2 ea	2.00
Shovel, D-handle	5.00
Pick, mattock	4.50
Pry bar	6.00
Plastic bags, 12 ea	1.50
Kit, tent repair	1.00
Kit, ski repair	1.00
Ski/snowshoe binding (spare)	0.80

ORGANIZATIONAL MOUNTAIN EQUIPMENT

The following items supplement cold weather equipment:

ITEM	WEIGHT (Pounds)
Climbing Rope, 120 feet (1/fire team)	6.91
Avalanche probe	1.25

COMMERCIAL MOUNTAIN EQUIPMENT

The following additional items of equipment are given for consideration by commanders. These items of equipment are in use by NWTC:

ITEM	WEIGHT (Pounds)
Tent, high altitude, 4 man	11.50
Ice screws	0.28
Headlamps w/spare batteries	0.80
Funnel, small	0.12
Bamboo poles, 10 feet	1.00

Type Loads for Individuals

The loads shown are type loads which could be worn during the winter season with snow-packed slopes and moderately cold weather (approximately 15 degrees Fahrenheit to -15 degrees Fahrenheit). It must be recognized that the season will determine whether snow is present on lower slopes and that temperatures can vary rapidly. A traveling storm, for instance, can easily change 30 degree Fahrenheit temperatures to extreme cold, considering the windchill factor of high winds and clouds blocking the sun's heat.

The varying duties of the individual must also be considered as the load carried by a 105-mm howitzer crewman will differ from that of a member of an assault climbing team; for example, the 105-mm howitzer crewman would wear white vapor barrier boots, while the assault climber would wear mountain boots. Therefore, commanders should use the type loads for planning purposes only and should adjust them to fit a given situation, season, and temperature condition.

FIGHTING LOAD	NONCLIMBER		CLIMBER	
ITEM	QUANTITY	WEIGHT (Pounds)	QUANTITY	WEIGHT (Pounds)
Helmet, w/liner	1	3.00	1	3.00
Cap, pile	1	0.26	—	—
Balaclava	—	—	1	0.25
Trousers, field	—	—	1	2.35
Trousers, field w/suspenders	1	2.35	—	—
Shirt, wool OG	1	1.50	1	1.50
Underwear, 50/50	1	1.71	1	1.71
Socks, mountain	—	—	1	0.25
Socks, cushion sole	1	0.19	—	—
Mountain boots	—	—	1	5.00
Boots, insulated	1	5.50	—	—
Muffler, wool	1	0.38	—	—
Parka, w/liner & hood	1	—	1	0.30
Overwhites	1	1.23	1	1.23
Gloves, shell work	—	0.35	—	—
Mitten, TF w/inserts	1	4.89	1	4.89
Mitten set, arctic	1	4.00	1	4.00
Pistol belt, w/harness	1	2.18	1	2.18
Canteen cup & cover	1	3.85	1	3 85
Bayonet, w/scabbard	1	1.07	1	1.07
Grenade, M26	1	1.90	1	1.90
Ammo pouch	2	1.46	2	1.46
Mag, 5.56-mm cartridge	5	3.50	7	5.00
First aid pouch, w/packet	1	0.08	1	0.08
Protective mask	1	2.88	1	2.88
Rifle, M16	1	6.50	1	6.50
Sling, rope 4m	—	—	1	0.71
Snap link, steel	—	—	2	0.52
Piton, rock set	—	—	1	0.53
Piton, ice set	—	—	1	0.36
Piton hammer	8	—	1	0.86
Climbing rope	—	—	1	2.00
Ice axe	—	—	1	2.78

FIGHTING LOAD (Continued)	CLIMBER		NONCLIMBER	
ITEM	QUANTITY	WEIGHT (Pounds)	QUANTITY	WEIGHT (Pounds)
Sunglasses, w/case	1	0.30	1	0.30
Box, match	1	0.15	1	0.15
Water purification tablets, bottle	1	0.15	1	0.15
Chapstick	1	0.10	1	0.10
Sunburn cream	1	0.19	1	0.19
Crampons	—	—	1	1.59
Skis, w/poles	1	9.50	—	—
TOTAL		59.17		59.64

EXISTENCE LOAD (Carried in or attached to Rucksack)

ITEM	QUANTITY	WEIGHT (Pounds)
Rucksack	1	3.60
Bag, waterproof	1	1.00
Bag, arctic sleeping	1	7.06
Case, sleeping bag	1	2.25
Mattress, air	1	3.00
Poncho	1	2.00
Toilet articles	1	2.00
Trousers, liner	1	0.60
Underwear, winter	1	1.71
Socks, cushion sole	2	0.38
Socks, wool mountain	3	0.57
Mittens, TF w/inserts	1	0.15
Face mask, arctic	1	0.50
Thong, emergency	1	0.06
Candles	2	0.25
Meals, C-rations	3	6.39
Snowshoes, w/bindings	1	4.60
TOTAL		41.53