// LEADER'S BOOK

MOUNTAIN WARFARE

AND COLD WEATHER OPERATIONS

Mountain Warfare and Cold Weather Operations

Leader's Book

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Foreword

This handbook is for leader training for operating in a mountainous environment. This is the first edition of this handbook, based on first-hand observations and a review of current and past Army doctrine and tactics, techniques, and procedures (TTP) by operational advisors from or attached to the Asymmetric Warfare Group (AWG).

Recently, many additional Army references dealing with this subject have been created or updated, following more than 10 years of combat experience and identification of best practices in the mountains of Afghanistan. These documents address individual or squad-level tasks and concerns. In this handbook, AWG will address the principal gap of informing leaders and staff of the considerations necessary to plan, operate, fight, and win in mountainous terrain at the company level and above. Many charts, references, and examples from other Army publications are incorporated into this handbook where appropriate.

The information contained in this handbook is a result of observations made by AWG unit members conducting operations in mountainous terrain worldwide, and a review of Army doctrine. The Army Mountain Warfare School, Northern Warfare Training Center, Ranger Training Brigade, sister-services, and allied institutions provided additional insights.

The observations in this handbook are Geographic Combatant Command (GCC) agnostic and adaptable to mountain operations throughout the world. Mountains present leaders and units with unique challenges that compound existing difficult combat realities. The adverse environmental conditions in the mountains can make basic tasks seem almost impossible.

This handbook is intended to enhance published Army doctrine at the collective level. Leaders will find this handbook valuable in prioritizing tasks for training and pre-deployment planning for any military operations in the mountains. No previous mountain training or expertise is required to understand and practice most TTP contained in this publication. Users who have experience operating in a mountainous environment can use this handbook to assist them in learning what veterans of mountain operations already know: vertical environments are among the most challenging in which to conduct and sustain combat operations.

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Mountain Warfare and Cold Weather Operations

Table of Contents

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Introduction

Mountains exist on every continent. Currently, and in the future, we will conduct operations in mountainous areas around the world. Mountains present unique challenges to Soldiers and commanders alike, and they provide an initial tactical advantage to indigenous forces: familiarization with the physical terrain. When conducting military operations in mountains or cold weather environments, leaders and Soldiers must plan to fight two enemies: the environment and the enemy.

Mountains restrict movement, delay timely responses, and produce canalizing effects because of the steep terrain and watercourses commonly found there. When properly evaluated, these canalized areas are exploitable by both the enemy and by U.S. forces. Mountainous terrain stretches the limits of armies and individuals not adequately prepared to fight in and meet its demands. U.S. forces must anticipate, understand, and adapt to these physical demands in order to combat the challenges of fighting in areas where our technological supremacy can be degraded by even the most crude and non-technical enemy actions. Severe weather that restricts mountain operations is just one example of an uncontrollable element that can degrade or eliminate assets such as helicopters; intelligence, surveillance, and reconnaissance platforms; communications equipment; wheeled and tracked vehicles; and some fire-support assets. Mountainous terrain usually favors defense and the force most familiar with the area of operations (AO), which is a factor to consider in any comprehensive estimate of the enemy situation. Enemy forces will frequently conduct decentralized mission command and operations, leveraging their familiarity with the terrain and environment in order to stifle and negate U.S. and friendly forces' military advantage. In addition to physical terrain, the human terrain in mountain and cold environments is a factor that merits evaluation, as often isolated and insulated populations can be leveraged by either friendly or enemy forces to support or interfere with military operations respectively.

Despite the difficulties that mountains and cold weather pose, there are armies that have and can conduct large-scale, sustained operations in mountain and cold environments. In contrast, few U.S. military units or personnel have trained extensively in mountain and cold weather operations. The exception was the formation of the 10th Mountain Division during WWII. The U.S. assessed and selected personnel with specific skills in Alpine environments and mountaineering, training them outside the military norms of the time, to employ those capabilities and skills in unit-level operations. For those trained in how to operate in mountain and cold weather environments effectively, they will not only survive but also prosper when their training emerges as a combat multiplier.

Soldiers who are physically fit, mentally agile, and able to adapt and adjust the technological advantages of U.S. forces, can mitigate the factors of enemy and terrain. Leaders and commanders who are aware of these factors and incorporate them into robust training plans will be able to effectively and successfully maneuver their formations and conduct operations.

CHAPTER 1

The Mountain Environment

IMPERATIVE FOR MOUNTAIN DOCTRINE

History illustrates the need for the Army to focus on mountain doctrine and training when conducting expeditionary operations in mountainous environments. While a mountainous environment is challenging, expeditionary forces operate effectively with proper training, equipment, and organization. The tactics, techniques, and procedures (TTP) used for mountain and cold weather operations must be trained in actual mountainous terrain at high elevations and in cold temperatures.

There are 20 states of interest in the world that are located within an arc of instability that ranges from North Korea through Central and Southern Asia, and the Caribbean through Africa. According to the *CIA World Factbook*, 16 of the 20 states have regions with elevations equal to or above 8,000 feet (2,438 meters). The current and projected threats in many of these countries span the hybrid threat (conventional, paramilitary, irregular, insurgent, terrorist, and criminal). These forces will use the inherent advantages that mountainous terrain and weather offer to negate U.S. technological advantages in information collection and firepower. Developing the ability to fight both large- and small-scale contingencies against both the conventional and the irregular is paramount.

MOUNTAINOUS TERRAIN

The principal mountain ranges of the world lie along the broad belts shown in Figure 1-1 on page 4. Called cordillera (after the Spanish word for rope), these ranges encircle the Pacific basin and then lead westward across Eurasia into North Africa. Secondarily, though no less rugged, chains of mountains lie along the Atlantic margins of the Americas and Europe.

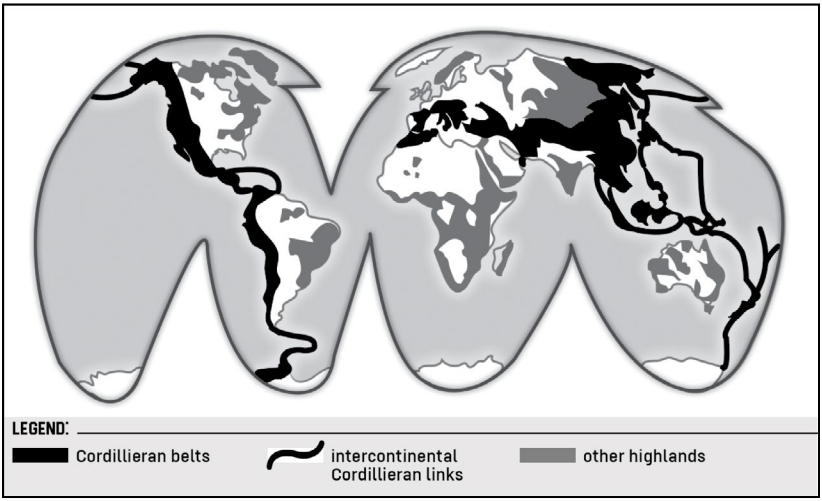

Figure 1-1. Mountain regions of the world (U.S. Army ATP 3-90.97, April 2016)

Different mountain chains have different types of climates. Some chains are located in dry desert regions while others are in tropical regions, where small to medium mountains are covered in lush jungles with deep ravines. Weather and temperatures may fluctuate wildly and rapidly in these environments. These changes may produce drastic effects on terrain (for example, flooding, blizzards, mud-rock slides, and avalanches). Mountains in temperate climates have sparse vegetation at elevations above 11,500 feet (3,505 meters) and temperatures drop below freezing in winter. Some mountainous regions have a variety of environments: units may encounter several different mountainous environments within the same area of operation (AO).

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. Mountains may have isolated peaks, rounded crests, eroded ridges, and high plains and may be cut by valleys, gorges, and deep ravines. High rocky crags with glaciated peaks and year-round snow cover exist in mountain ranges at most latitudes. Regardless of their appearance, rugged terrain is common among all types of mountains.

Mountain slopes generally vary between 15 and 45 degrees. Cliffs and other rocky precipices may be near vertical or even overhanging. Aside from obvious rock formations and other local vegetation characteristics, actual slope surfaces are relatively firm earth or grass. Grassy slopes may include grassy clumps known as tussocks, short alpine grasses, or tundra, which is more common at higher elevations and latitudes. Many slopes will be scattered with rocky debris deposited from the higher peaks and ridges. Extensive rock or boulder fields are known as talus. Slopes covered with smaller rocks, usually fist-sized or smaller, are called scree fields. Slopes covered in talus are often an easy ascent route. On the other hand, climbing a scree slope is difficult because the small rocks tend to loosen easily and give way.

In winter, and at higher elevations throughout the year, snow-covered slopes create an environment with its own distinct effects. Some snow conditions aid travel by covering rough terrain with a consistent surface. Deep snow, however, impedes movement and requires troops to be well-trained in arctic movement (snowshoes, skis, and over-the-snow vehicles). Steep, snow-covered terrain presents the risk of avalanches. Snow can pose a serious threat to troops not properly trained and equipped for movement under such conditions.

Commanders operating in the arctic and subarctic mountain regions and the upper elevations of the world's high mountains are also confronted with vast glaciated areas.

Mountain operations are generally carried out at three operational terrain levels. (See Table 1-1.)

Table 1-1. Operational terrain levels (U.S. Army ATP 3-90.97, April 2016)

Level	Description
Level I	Bottoms of valleys and main lines of communication
Level II	Ridges, slopes, and passes that overlook valleys
Level III	Dominant terrain of the summit region

Level I terrain is located at the bottom of valleys and along the main lines of communication (LOCs). At this level, armored forces can operate but maneuver space is restricted. Infantry and armored forces are normally combined because vital LOCs usually follow the valley highways, roads, and trails.

Level II terrain lies between valleys and shoulders of mountains, and generally consists of narrow roads and trails—secondary LOCs—that cross this ridge system. Therefore, enemy positions on level III terrain dominate and influence the lower level II terrain. Similarly, units expend the energy to occupy level II terrain because it dominates level I terrain and influences operations dramatically.

Level III terrain includes the dominant terrain of summit regions. Mobility in Level III terrain is usually the most difficult to achieve and maintain. Level III terrain, however, provides opportunities for well-trained units to attack enemy forces from the flanks and rear. At this terrain level, acclimatized troops with advanced mountaineering training infiltrate to attack LOCs, logistic bases, air defense sites, and command infrastructures.

Different rock types, soil composition, and slope types affect how forces are employed. An in-depth analysis of individual factors that affect operations in mountainous environments can be found in TC 3-97.61.

GLACIERS

Glaciers are rivers of ice and rocks that slowly move down mountains. They form when the rate of snowfall or other types of precipitation exceeds the rate of melting in summer months. After accumulations over hundreds of years, the snow compresses into ice that can range from 10 to several hundred feet thick. Glaciers can be small and only cover a portion of a mountain, or they can be massive with a series of glaciers covering a mountain range. Valleys in these areas are buried under massive glaciers and present additional hazards such as hidden crevasses, and ice and snow avalanches. Slopes are glaciated and their surfaces are composed of varying combinations of rock, snow, and ice. Although glaciers have their own peculiar hazards requiring special training and equipment, dismounted movement over valley glaciers may be the safest route through these areas.

DANGER—Glacier travel without proper training and equipment can lead to loss of life and equipment.

COLD WEATHER ENVIRONMENTS

For military purposes, cold regions are defined as any region where cold temperatures, unique terrain, and snowfall have a significant effect on military operations for one month or more each year. About one quarter of the earth's land mass may be termed as severely cold. In Figure 1-2 this area is indicated by the area above line A in the Northern Hemisphere and below line A in the Southern Hemisphere. In these areas, mean annual air temperatures stay below freezing, maximum snow depths exceed 60 centimeters, and ice covers lakes and rivers for more than 180 days each year. Another quarter of the earth is termed moderately cold. This area fits between lines A and B (including most of the United States and Eurasia). Its mean temperatures during the coldest month are below freezing.

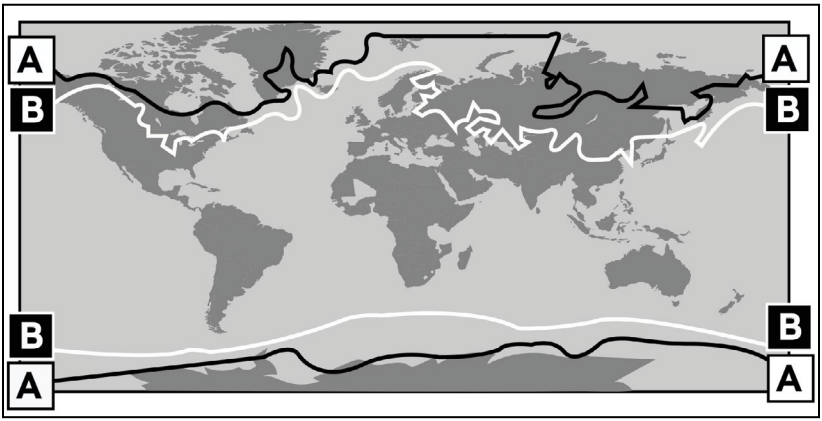

Figure 1-2. Cold regions of the world (U.S. Army ATP 3-90.97, April 2016)

COLD WEATHER CHARACTERISTICS

The Army groups cold temperatures using categories. The temperature categories are—

- Wet cold—39 degrees Fahrenheit to 20 degrees (4 degrees Celsius to negative 7 degrees).
- Dry cold—19 degrees Fahrenheit to negative 4 degrees (negative 7 degrees Celsius to negative 20 degrees).
- Intense cold—negative 5 degrees Fahrenheit to negative 25 degrees (negative 20 degrees Celsius to negative 32 degrees).
- Extreme cold—negative 25 degrees Fahrenheit to negative 40 degrees (negative 32 degrees Celsius to negative 40 degrees).
- Hazardous cold—negative 40 degrees Fahrenheit (negative 40 degrees Celsius) and below.

Wet cold conditions occur when wet snow and rain often accompany wet cold conditions. This type of environment is more dangerous to troops and equipment than the colder, dry cold environments because the ground becomes slushy and muddy, and clothing and equipment becomes perpetually wet and damp. Because water conducts heat 25 times faster than air, core body temperatures drop if troops are wet and the wind is blowing.

Dry cold conditions are easier to live in than wet cold conditions. Like in wet cold conditions, proper equipment, training and leadership are critical to successful operations. Wind chill is a complicating factor in this type of cold. The dry cold environment is the easiest of the four cold weather categories to survive in because of low humidity and because the ground remains frozen. As a result, people and equipment are not subject to the effects of the thawing and freezing cycle, and precipitation is generally in the form of dry snow.

Intense cold exists from negative five degrees Fahrenheit to negative 25 degrees (negative 20 degrees Celsius to negative 32 degrees) and can affect the mind as much as the body. Simple tasks take longer and require more effort than in warmer temperatures and quality of work degrades as attention-to-detail diminishes. Clothing becomes more bulky to compensate for the cold so troops lose dexterity. Commanders must consider these factors when planning operations and assigning tasks.

Extreme cold occurs from negative 25 degrees Fahrenheit to negative 40 degrees (negative 32 degrees Celsius to negative 40 degrees) and the challenge of survival becomes paramount. During extreme cold conditions, it is easy for individuals to prioritize physical comfort above all else. Personnel withdraw into themselves and adopt a cocoon-like existence.

Leaders should expect and plan for weapons, vehicles, and munitions failures in this environment. Leaders should also recognize the effects of these conditions on Soldier performance of otherwise routine tasks. Equipment maintenance, computer and communications equipment setup and operation, etc., will be hampered by cold fingers or bulky gloves. As in other categories, leadership, training, and specialized equipment is critical to the ability to operate successfully.

In hazardous cold conditions, commanders and planners assume greater risk if they engage in operations when the temperature falls below negative 40 degrees Fahrenheit (negative 40 degrees Celsius). Units are extensively trained before undertaking an operation in these temperature extremes.

MOUNTAIN INFLUENCED COLD REGION

Variations in climate that exist in cold regions result from mountainous terrain. Mountain terrain can cause a vertical change in weather called a zonation and may cause differences in weather on the windward and leeward (sheltered) side of the mountain.

Mountains can complicate operations in cold regions. Leaders should treat all mountains and mountainous regions that receive a predictable amount of snowfall as a cold region. Many tasks needed to operate successfully in cold regions apply to mountain regions. Factors such as slope, soil composition, and surface configuration differentiates mountain operations from other operations in cold environments. The most significant factor to affect individual performance is altitude. Performance starts to degrade after personnel ascend to elevations over 5,000 feet (1,500 meters) due to the reduced amount of oxygen contained in the air as elevation increases.

MOUNTAIN WEATHER

Mountain weather can be erratic, varying from calm to strong winds, and from relative warmth to extreme cold within a short time or with a minor shift in locality, requiring troops to be prepared for alternating periods of heat and cold, as well as conditions ranging from dry to extremely wet. At higher elevations, noticeable temperature differences exist between sunny and shady areas and areas exposed to wind or protected from it. This greatly complicates Soldier and unit planning.

Weather information is hard to obtain in cold regions. A call for moderate weather conditions in the forecast may not be relevant to the particular AO and local conditions can overwhelm unprepared forces. For specific information on weather observation and forecasting, refer to TC 3-97.61. Unique weather phenomena that can affect military operations in mountain and cold weather environments include the following phenomena—

- Ice fog.
- Blizzard.
- White-out.
- Gray-out.
- Temperature inversion.
- Looming.
- Chinook winds.
- Aurora borealis.
- Light data.

CHAPTER 2

Critical Mountain and Cold Weather Factors

LEADER'S FRAMEWORK

Leaders at every echelon should understand that mountain warfare is a mindset as much as it is a skillset, and that training and experience in mountainous environments are critical. The dominant factor in a mountain fight is training, not equipment.

Leaders and their staff need to consider the advantages and limitations the terrain and environment provide to military operations (offense, defense, etc.) and how threat elements will maximize advantages, minimize limitations, and in certain situations attempt to weaponize the terrain (rock slides, avalanches, etc.) to support their objectives and end states.

TRAINING

Barring certain obvious factors (for example, boots and gloves), training and other non-materiel solutions should be a priority for preparing to conduct military operations in mountainous environments. The list below provides leaders with key considerations and factors for training to operate in the mountains:

- Train in the terrain, or the closest replication possible. Varying elevations and contours such as rolling high hills and low mountains in temperate environments (summer or winter) will still provide benefit.
- Soldiers must be trained and proficient on their equipment, emphasizing understanding of the extended-cold weather clothing system (ECWCS) and its layering process, as well as glove and boot selection and care to prevent hypothermia and immersion foot.
- Use micro-terrain analysis at the lowest levels (team, squad, and platoon).
- Use analog dismounted navigation (land navigation without GPS assistance) including navigating where contour and relief (elevation and terrain feature shape) are challenging.
- Decentralize operations, as the terrain will degrade traditional command and control systems.

- Practice medical and casualty evacuation (MEDEVAC and CASEVAC) scenarios which replicate as realistically as possible the challenges of extreme terrain (contour, relief, elevation) and environments (cold and altitude effects).
- Train for transitions from the offense to consolidation and defense.
- Transition through primary, alternate, contingency, and emergency (PACE) plans for all systems (communications, reporting, etc.).
- Employ a leader and professional development program, which covers historic and recent military operations in mountain environments, as well as tactical and operational vignettes to help both junior leaders and noncommissioned officers (NCOs) to better understand the challenges and mindset of mountain warfare.

PLANNING

Leaders and their staffs must be aware of and consider the challenges of operating in mountainous environments when developing their plans. The following factors should act as a guide to assist leaders and planners when conducting mountain warfare—

- Consider and understand the effects of terrain and environment on all warfighting functions holistically (not just weapons platforms and systems) including effects on Soldiers:
    - Altitude.
    - Temperature.
    - Mobility.
- Leaders should develop a standard baseline packing list that addresses the challenges of mountain and cold weather environments and then be flexible in adjusting for tasks, missions, and specific conditions encountered at platoon and company level (for example, high-level and ridgeline reconnaissance, assault climber, etc.).
- Leaders should consider the capabilities and capacities of equipment and formations.
- Leaders should identify mountain-trained personnel and consider task organizing them as functional maneuver teams (infantry, reconnaissance, and assault climber), as well as serving as mountain planning advisors on staffs (battalion [BN] and brigade [BDE]).
- Timelines and timetables should be longer in the mountains to account for the challenges of movement and maneuver.

- Soldier loads must be adjusted to reflect the realities of the environment. Unit planning should address and mitigate these adjustments.
- Leaders should consider what is possible of their equipment, not just what the general or intended use and purpose is.
- MEDEVAC and CASEVAC planning must factor into the mountain environment (altitudes, air density, slope, weather, equipment, and time) in conjunction with tactical factors (enemy activity and contested air).

LEADERS

As mountain warfare is a mindset as well as a skillset, leaders will have a substantial effect on outcomes and the success of their units' operations in mountainous environments. All leaders have their own approach and style, but all leaders should avoid these pit-falls when operating in the mountains—

- Imposing a standardized uniform standard operating procedure (SOP) ECWCS across formations. Individuals have different metabolic rates (body heat) and a standardized uniform may lead to an excess of both heat and cold injuries.
- Substituting technology and equipment for training and discipline (individual Soldier and collective unit).
- Bringing a garrison, or established fixed-site forward operating base (FOB) combat outpost (COP) mentality and policy.
- Overlooking isolation and recovery planning both at individual and small-unit level as well as at larger echelons as mountainous terrain decentralizes units.

CHAPTER 3

Intelligence

PLANNING

Planning and directing information requirements and the information collection plan is critical to intelligence operations in the restrictive physical and human terrain and harsh conditions of mountainous and cold weather environments. Given the potential for both high- and low-intensity conflict against state and non-state actors in these environments, G-2, G-3, S-2, and S-3 planning needs to factor both priorities of effort and priorities of support when developing information collection plans. Additionally, it is essential that staff and commanders analyze, understand, and approach these environments as they present themselves, before applying assumptions based on past experiences.

Information collection planning in mountainous areas must take into consideration the effects of terrain and weather on collection platforms, potentially increasing reliance on aerial collection assets, degrading target acquisition, and early warning and collection capabilities of intelligence systems. Such degradation increases the importance of emplacement and utilization of information collection assets as well as reconnaissance assets. Military intelligence Soldiers may have to use man-portable equipment to execute intelligence operations, and this requirement needs to be planned for by the staff while developing the information collection plan.

COLLECTION

It is critical for staffs to use well-developed procedures and flexible planning to track emerging targets, adapt to changing operational requirements, and meet the requirement for combat assessment.

Initial information collection plans in mountainous or cold environments should use aerial or overhead collection platforms. These platforms use radar systems to detect manmade objects. If weather is permitting, the initial information collection plan could include the use of electro-optical platforms.

Subsequent use of ground assets can verify the data gathered by overhead and electro-optical platforms and can capitalize on the limited or reduced capabilities of some types of overhead platforms in these environments.

In harsh mountainous terrain or cold weather environments, time is a greater planning factor for troop movements. Rates of march may be reduced due to terrain or weather conditions and must be planned for accordingly.

The ability to live and fight in extreme cold weather and mountain environments is essential. Key staff considerations for information collection in a mountain or cold weather environment are—

- Terrain trafficability and the ability to move cross-country affects personnel movements, ground reconnaissance patrols, and the ability to employ mechanized forces.
- Rockslides are threats to movements and mobility and are most common after rains or periods of thaw, and in the spring.
- Forces are likely to be deployed at key terrain such as passes, road junctions, built-up areas, or adjacent high ground. However, enemy elements can bypass these defensive positions and attack from the flank or rear.
- Mountainous terrain may provide concealment.
- Aerial elements can mitigate terrain limitations, but they must deal with weather challenges and the potential for localized weather conditions.
- Higher elevations are frequently shrouded by rain, snow, sleet, and fog.
- Interrupted line of sight (LOS) affects ground surveillance systems.
- Electronic surveillance by the enemy can be reduced by using terrain masking, relay, and retransmission to thwart direction finding and electronic attack activities against communications sites.
- Line-of-bearing data may be used in conjunction with aerial assets for more reliable direction finding results, weather permitting. (See FM 2-0 for more information on line-of-bearing data.)
- Changes may occur to mobility corridors, avenues of approach, and trafficability due to freezes or thaws.
- Antenna icing can reduce range, increase noise, alter frequency, or simply collapse antennas.
- Radar signal scattering may occur due to ice, fog, and airborne snow.
- Cold may cause thickened oil and lubricants, which can cause mechanical problems in generators and vehicles.
- Cold may cause decreased battery life and performance.
- Visibility may be significantly degraded due to snow and fog.

- Avalanches, due to instability of snowpack, can threaten troops and hinder mobility.
- Wind chill factors and potential human problems may occur due to frostbite and immersion foot.

PRODUCTION

Intelligence products must be timely, relevant, accurate, predictive, and tailored to facilitate situational understanding and support decision making. Analysis is important to ensure the focus, prioritization, and synchronization of a unit's intelligence production effort is in accordance with the priority intelligence requirements (PIR) and other requirements. (See FM 2-0, ATP 2-01.3, and ATP 2-19.4 for more information on intelligence production.) Intelligence Soldiers and leaders need to consider end-users, pace of operations, connectivity, bandwidth, and method of dissemination when generating intelligence products.

DISSEMINATION

Commanders must receive combat information and intelligence products in time and in appropriate formats to facilitate situational understanding and support decision making. Dissemination, while deliberate, should also be timely as it is critical to the success of operations. This becomes critical in mountainous environments as physical conditions and threat situations can change rapidly.

There are numerous methods and techniques for disseminating information and intelligence. Due to the restrictive nature of mountainous terrain and harsh conditions affecting information and communication systems, the G-2 and S-2 must plan for methods and techniques to disseminate information and intelligence when normal methods and techniques are unavailable.

There are numerous methods and techniques for disseminating information and intelligence. Information may be presented verbally, in writing, interactively, or in a graphic format. Dissemination methods and techniques include—

- Direct dissemination, person-to-person, by voice communications, or electronic means.
- Direct electronic dissemination, messaging programs.
- Web posting, with notification procedures for users.
- Printing or putting information on compact disk and sending it.

ANALYTIC CONSIDERATIONS

Terrain and weather effects in mountainous terrain can be sudden and severe. Intelligence personnel must conduct thorough intelligence preparation of the battlefield (IPB) to understand and describe these effects on the battlefield and military operations while addressing the following factors—

- Mobility corridors (air and ground).
- Cross-country travel.
- Population.
- Population centers (villages, towns, and cities).
- Agricultural areas.
- Infrastructure.
- Hydrology (frozen, thawed, or flooded creeks, rivers, and lakes).

There are several models to understand and describe these environmental, terrain, and weather effects including political, military, economic, social, information, and infrastructure, physical environment and time (PMESII-PT) areas; structures, capabilities, organizations, people, and events (ASCOPE); mission, enemy, terrain and weather, troops and support, time available and civil considerations (METT-TC); or observation and fields of fire, avenues of approach, key terrain, obstacles and movement, cover and concealment (OAKOC) and cross-factored against weather variables. Leaders and their intelligence staffs will have to determine whether human terrain-centric models (PMESII-PT and ASCOPE) or physical terrain and mission variable centric (METT-TC and OAKOC) models are appropriate. Leaders and staffs should consider that some apparently negative effects in mountain and cold environments also provide opportunities (for example, colder temperatures can provide alternative mobility corridors and routes.)

When considering the human terrain in these environments, mountain populations exhibit certain traits because of being in isolated and insulated communities. These characteristics may impact operations positively or negatively and affect both friendly and enemy operations. While these characteristics vary based on geographic and cultural location, case studies reveal some generalized factors that distinguish mountain populations from other populations. These variations include—

- Independent.
- Enhanced loyalty to their group.
- Homogeneous.
- Tribal or clannish.
- Increased emphasis on religion.
- Less economically developed than more accessible areas.
- Lacking formal education.
- Adherence to a strict social code.
- Different norms to determine economic status.
- Less infrastructure than more accessible areas.
- Decreased access to information.
- Less emphasis on centralized governance than more accessible areas.

Additionally, mountain populations tend to settle and develop agriculture in lower ground such as valleys and passes. Agricultural areas within lower ground will further restrict and limit mobility and cross-country movement due to multiple factors, most significantly irrigation. This must be considered during IPB, as irrigated areas may also turn to mud, freeze, or flood during weather effects.

CHAPTER 4

Operations

Operating and maneuvering in a mountainous environment requires centralized planning and decentralized execution. Leaders and planners should use the information in this chapter with ATTP 3-21.50. Leaders and their staffs should be prepared to—

- Operate independent of forward operating bases (FOBs).
- Avoid over-reliance on armored and Stryker assets.

The dispersion of forces is useful when conducting offensive, defensive, and stability operations in the mountains. Decentralization enables greater flexibility and tactical responsiveness across the operational area. In mountainous environments, battalion-size units may reorganize to increase the number of available maneuver elements.

For example, forming four maneuver elements from the battalion's three table of organization and equipment (TO&E) rifle companies enhances the battalion's ability to cover more terrain.

Task organization is useful in a compartmentalized mountainous environment. Organizing existing units into smaller maneuver elements such as assault climber teams and mountain terrain tier specific (Tier I, II, and III) elements to compensate for environmental challenges requires additional time for personnel to train together, rehearse battle drills and SOPs, and build cohesiveness and trust. It requires more detailed planning and rehearsals. Leaders and planners should know potential equipment constraints, reduction in unit cohesion, and mission command issues.

The principles of patrolling do not change in a mountainous or cold weather environment. (See ATP 3-21.8 and ATTP 3-21.50.) The method of movement may be impeded or assisted by equipment including crampons (spiked plate worn on boots for aid in climbing), snowshoes, or skis, which may be required, depending on terrain and training. For example, crampons, when employed by properly trained personnel, are mobility enhancers for conducting assault climbs and negotiating vertical danger areas.

OFFENSE

Offensive actions in mountains vary based on mountain restrictions. Conventional mountain operations occur to gain control of key or decisive terrain. Key terrain includes—

- Lines of communication (LOCs).
- Mountain passes.
- Ridges.
- Chokepoints.

Attacks should be launched from higher elevations to lower elevations along the flanks and the rear of the enemy to conserve energy, increase movement speed, and observe fields of fire. Frontal attacks against defended heights or through deep snow have little chance of success. Consequently, flanking attacks, infiltrations, and envelopments are the preferred form of maneuver.

Additional general factors apply to leaders and staff when planning and conducting the offense in mountain environments:

- Mobility—
    - Skill with equipment and the environment can mitigate the effects of snow, rock, slope, etc.
    - Helicopters provide vertical bypass capability to difficult terrain but are subject to weather, altitude and terrain effects, and limitations, therefore they cannot be the primary solution to mobility challenges.
    - Technical military mountaineering skills and equipment training levels affect mobility.
    - Mobility equals lethality.
- The length of the preparatory phase is longer in a mountainous environment—
    - Increased reconnaissance is required (both time and assets).
    - Multiple reconnoiters are needed.
    - Detailed planning for decentralized and dispersed operations is required.

- Routes—
  - Difficult routes require marking.
  - Easy routes provide the opportunity for deployment in breadth.
  - Ridges and crests require organizations to operate with extended LOCs.
  - Units have overwatch when moving in the mountains.
  - Traveling overwatch is the preferred technique when preparing for the offense.
- Weather—
  - During snow storms or high winds, leaders keep compact formations.
  - Execute simple plans with reasonable objectives.
  - Close reconnaissance and attack are possible under the concealment afforded by such conditions.
  - Operating in inclement weather should only be attempted after acclimatization and familiarization with the environment.
- Consolidation—
  - After seizing an objective, units consolidate and reorganize.
  - Troops may be fatigued and overheated from exertion.
  - Provisions to prevent personnel from becoming cold or heat casualties are needed.
  - Integration of exploitation forces into offensive plans is necessary.

OFFENSIVE TASKS

The types of offensive tasks are movement to contact, attack, exploitation, and pursuit. They are addressed with the factors and considerations applicable to mountain and cold weather environments in the following subsections.

Movement to contact—Units conducting movement to contact in the mountains are more vulnerable to attack and ambush. Limited mobility and dependence on restrictive LOCs limit deployment of the force from movement formations:

- Plans and movement formations should be based on maintaining flexibility and security.
- Movement along the topographical crest of a ridgeline increases the possibility of enemy observation and should be avoided, unless there is adequate or abundant concealment.
- The main body should never be committed to canalizing terrain before forward elements have advanced far enough to ensure that the main body will not become encircled. This is a critical factor when employing a mix of infantry and armored forces that have sharp differences in operational tempo.
- Lateral movement between adjacent columns is frequently difficult or impossible, but every attempt should be made to maintain at least visual contact.
- Commanders must emphasize the use of checkpoint reporting, contact patrols, and phased operations to coordinate and control the movement of the overall force, but not stifle initiative.
- Permanent occupation of key terrain is unrealistic, and therefore engagements occur repeatedly on the same pieces of terrain.
- Fixing and finishing the enemy is often accomplished by direct and indirect fire, respectively, in mountainous terrain.

Attack—Speed, flexibility, and surprise, which are normally advantages enjoyed by the attacker, are limited by restrictive terrain and the defender has increased ability to see and acquire targets at greater distances in the mountains:

- Additional time should be allocated to conduct deliberate planning for fire support coordination; route selection; and command, control, and support coordination.

- Temperature drops will shift focus to terrain-oriented objectives rather than force-oriented objectives because mobility worsens, and the enemy seeks sheltered defensive positions.
- Attack planning must factor in the terrain, weather, and potential obstacles.
- All terrain features that can be occupied by even a small enemy force should be secured.
- Infiltration, technical climbing, and extensive breaching may be required to position weapons to support the assault.
- Dominating terrain may give a commander great situational awareness despite being beyond the range of fires.
- Effectively using weather conditions increases opportunities for audacity in conducting attacks including exploiting blizzards, falling snow, fog, low cloud cover, and natural night illumination.
- Conducting offensive operations during severe weather conditions restricts the use of aviation support and affects reconnaissance support.
- Breaching obstacles and preparing bypass routes that allow the assault force to attack an enemy defensive position must be an integral part of the commander's plan.
- In mountainous terrain, manmade obstacles that are covered by fire create a particularly dangerous and formidable barrier.
- Control of breaching operations, in this type of terrain, is more difficult than in open terrain and extensive mobility support is necessary if the obstacle cannot be reduced.

Raid and ambush—The restrictive terrain of mountainous areas also affords increased opportunities to conduct raids and ambushes. These operations should take advantage of limited visibility and terrain that the enemy may consider impassable:

- Steep terrain increases movement times significantly, and only light equipment should be taken.
- Special climbing techniques may be required to negotiate the difficult routes during limited visibility.
- Avoid detection by using proper movement techniques and by skillfully using natural cover and concealment.

Demonstrations and feints—Because maneuver space is usually limited or confined and restricts the number of avenues of approach for heavier forces, deception plays an important part in the mountain battle. Commanders should plan systematic measures of deception to mislead the enemy regarding friendly intentions, capabilities, and objectives.

Exploitation and pursuit—In mountainous and cold weather environments, exploitation and pursuit operations must be conducted discriminately. Air assault and attack helicopter units can be used to augment exploitation and pursuit operations if conditions permit:

- Leaders must compensate for the ground mobility restrictions imposed by terrain and weather.
- Speed can be achieved best by isolating enemy positions with the smallest force possible.
- Engineer support should be well forward with the necessary equipment to allow combat troops to maintain momentum and avoid delay by enemy or natural obstacles such as snow removal or compaction.
- Consideration must be given to shelter and heat during even moderate times of rest in cold weather.
- Audacity must be tempered with good judgment if the cold weather presents a significant risk for injury on a broad scale.
- Conversely, if friendly forces can sustain a pursuit in cold regions, the enemy may be annihilated from the combined effects of combat and the environment.

FORMS OF MANEUVER

The forms of maneuver are common to all environments, so only such considerations for mountain and cold weather operations are addressed in the following subparagraphs. While frequently used in combination, each form of maneuver attacks the enemy in a different way and some pose different challenges to the commander when attacking in the mountains.

Frontal attack—The frontal attack is an offensive maneuver in which the main action is directed against the front of the enemy forces:

- Aviation forces and supporting arms should be used to create gaps in the enemy's front or to prevent or delay enemy reinforcements from reaching the front lines.
- Frontal attacks in hilly or mountainous areas, even when supported by heavy direct and indirect fires, have a limited chance of success.

- Mountainous terrain adds to the relative combat power of the defender, requiring that the ratio of attacking forces exceeds three to one, such as in military operations on urban terrain.

Envelopments and turning movements—Envelopments and turning movements are used extensively in mountain operations. These techniques are a superior form of maneuver used by the attacker to bypass the enemy's principal defensive positions. These forms of maneuver seek to avoid the enemy's strength and attack where the enemy is weakest or unprepared:

- Enemy defensive positions may be bypassed using ground, air, or vertical envelopment.
- Movement corridors are key considerations for dismounted movement (due to terrain and weather effects).
- Use mountain pickets to act as connecting files and use overwatch as maneuver forces move.
- Flanking attacks, envelopments, and turning movements can be enhanced by employing organizational mountaineers, airborne insertions, and air assaults.

Infiltration—Infiltration is frequently used in the mountains. The difficult terrain and recurring periods of limited visibility allow for undetected movement. Depending on the level of overhead and general concealment, infiltration may become a default form of maneuver for units conducting mountain operations:

- Infiltration in a mountainous environment shapes the battlefield by moving undetected through enemy areas.
- Infiltration is moving into an area occupied by enemy forces to occupy a position of advantage in the enemy rear while exposing only small elements to enemy defensive fires.
- Infiltration secures key terrain in support of decisive operations.
- Infiltration disrupts enemy sustainment operations.
- Infiltration is conducted using one of three techniques of movement: in small groups along one axis, movement in one group, or movement in small groups along several routes at the same time.
- Infiltration is particularly useful during cold weather.

- Highly mobile units, specialty units, and equipped units such as ski-mobile personnel or units equipped with over-snow vehicles may be used against deeper objectives.
- Larger and less mobile units attack more immediate key objectives.

Penetration—Mountainous terrain normally makes penetrations extremely dangerous due to the difficulty of concentrating overwhelming combat power at the area of penetration. Due to mobility restrictions, it is also difficult to develop and maintain the momentum required to move through the point of penetration because—

- In mountainous terrain, the area of penetration is vulnerable to flank attack.
- A penetration may be useful when attacking an enemy that is widely dispersed or overextended in his defense.
- Flank defensive positions must be eliminated before the initial breach.
- Successful penetrations require surprise, security, and covered and concealed terrain at selected breach points.

DEFENSE

The purpose of the defense is to create conditions for a counteroffensive that allows Army forces to regain the initiative. Other reasons for conducting defensive actions include retaining decisive terrain or denying a vital area to the enemy, attriting or fixing the enemy as a prelude to offensive actions, surprise action by the enemy, and increasing the enemy's vulnerability by forcing the enemy commander to concentrate subordinate forces. There are three basic defensive tasks: mobile defense, area defense, and retrograde. This section will focus on the defense and defensive tasks as they apply to mountainous terrain and cold regions.

The immediate objective of a mountainous defense is to deny the enemy access to key terrain that helps him conduct further operations. Therefore, it is necessary to defend in terrain that restricts and contains the enemy as well as to control the high ground that dominates this terrain. The terrain provides the defender with cover, concealment, and camouflage that can deceive the enemy regarding the strength and disposition of friendly forces.

Restrictive terrain inherent to mountainous areas is one of the primary advantages of the defender because it interferes with the attacker's synchronization, canalizes the attacker's movement, and impedes the attacker's ability to maneuver. To capitalize on this advantage, commanders should carefully analyze the vertical and horizontal components of terrain from both friendly and enemy viewpoints.

Special techniques are required to construct fighting positions on frozen ground and snow. In general, to construct fighting positions above ground proves more efficient when extreme cold (frozen ground) occurs. ATP 3-37.34 describes the proper method for constructing mountain and cold weather fighting positions.

Similar to other environments, the following points should be considered when conducting security operations—

- Forces available for security operations.
- Ability to maintain a mobility advantage.
- Size of the security area and the number of avenues of approach.
- Likelihood of enemy action.
- Size of the expected enemy force.
- Amount of early warning and reaction time needed.

While a screening force is usually the preferred form of security in rugged terrain, all forms of security operations (screen, guard, and cover) may be employed. A screening force provides early warning to the protected force and is usually an economy-of-force measure. The compartmented nature of mountainous terrain can lead to gaps and exposed flanks. The rugged terrain also restricts movement of both friendly and enemy forces. In mountainous terrain, the screening force should adjust to the enemy advance and continue to screen as far forward as possible, even though elements of the force may have to withdraw.

If a significant enemy force is expected, or a significant amount of time and space is required, commanders may employ a guard or covering force. Security forces that can maintain a mobility advantage over the enemy can effectively delay and counterattack the enemy force. Defending forces must prevent enemy infiltration by carefully positioning observation posts and conducting continuous patrols and ambushes.

Reconnaissance patrols may rely heavily on technical climbing skills. Ground surveillance radar and ground sensors can be used to add greater depth to the defense.

Defensive positions along ridges or on dominating heights should include both forward and reverse slopes to add greater depth and security. Defensive positions must be anchored to restrictive terrain or adjacent defensive forces to prevent enemy infiltration or envelopment. Other factors include—

- Fighting positions and observation posts should be echeloned vertically, as well as in depth.
- Forces should establish fighting positions that are located on adjacent heights and in depth to permit covering valleys with interlocking fires.
- In wooded terrain, defensive positions may be organized on the forward edge of the woods as well as on commanding heights.
- Obstacles should be widely employed to slow or stop enemy movement.

Mountain warfare demands that forces defend aggressively. Small patrols and observation posts should be deployed well forward to direct artillery and attack aircraft fire on targets of opportunity and to conduct anti-armor and personnel ambushes.

Leaders and their units must exploit opportunities to force the enemy to deploy additional assets, and they disrupt the enemy preparations using the following means—

- Infiltrate through enemy units.
- Attack headquarters.
- Attack and disrupt supply lines.
- Attack and disrupt rear echelons and assembly areas supply lines.

Commanders may need to rely on their reserve as the principal means of restoring a defense's integrity or exploiting opportunities through offensive action. Reserves should be mobile enough to react to enemy action in any portion of the perimeter. Leaders and planners should consider—

- Large, centrally placed reserve forces are normally unable to intervene in time unless the terrain permits mounted movement, or air lift assets are available.
- Less mobile reserves are positioned to block the most dangerous avenues of approach.
- Sharply compartmented terrain may require the creation of more than one reserve.

DEFENSIVE TASKS

There are three basic defensive tasks: mobile defense, area defense, and retrograde. The reverse slope defense is a method or technique of defense that is well suited to mountainous terrain.

Mobile defense—In a mobile defense, the defender withholds a large portion of available forces for use as a striking force in a counterattack. Mobile defenses require enough depth to let enemy forces advance into a position that exposes them to counterattack. When conducting a mobile defense, commanders consider these points:

- Mobile defense relies heavily on the defender's ability to maintain a mobility advantage.
- Mobile defense is enhanced by counter-mobility actions directed against the enemy force.
- Mountainous terrain favors the defender because of its many chokepoints and kill zones.
- Chokepoints have limiting terrain on two sides and kill zones have limiting terrain on three sides.

Area defense—A position or area defense focuses on retaining terrain by absorbing the enemy into a series of interlocked mutually supporting positions. Mobility restrictions and the requirement to control key terrain favor position and area defenses. When conducting an area defense, commanders consider these points:

- Position and area defenses use battle positions, strong-points, obstacles, and barriers to slow, canalize, and defeat an enemy attack.
- Position and area defenses rely on security forces, continuous reconnaissance, combat patrols, and numerous observation posts for depth and early warning.
- The natural canalization effect of mountainous terrain offers tremendous advantages in the defense.
- Obstacles enhance and support defensive positions, particularly when "married" with rugged and restrictive terrain (mountains) to achieve maximum effects.

Reverse slope defense—Reverse slope defenses (see Figure 4-1) are well-suited to mountain operations. Reverse slope defenses seek to reduce the effects of massed indirect fire from mortar, artillery, and close air support (CAS) and draw the battle into the small arms range. The overall goal of the reverse slope defense is to make the enemy commit enemy forces against the forward slope of the defense, causing enemy forces to attack in an uncoordinated fashion across the exposed topographical crest.

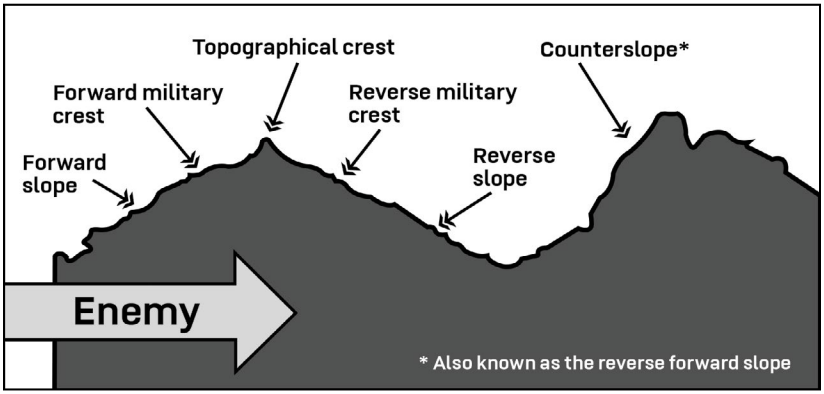

Figure 4-1. Reverse slope defense (U.S. Army ATP 3-90.97, April 2016)

All or parts of a defending force may use reverse slope techniques. In many instances, mountainous terrain favors a defense that employs both forward and reverse slope positions to permit fires on enemy approaches around and over the crest and on the forward slope of adjacent terrain features. Key factors of this type of defense are—

- Mutually supporting covered and concealed positions.
- Numerous natural and manmade obstacles.
- The ability to bring fire from all available weapons onto the crest.
- A strong and mobile counterattack force.

Retrograde—The reverse slope defense is organized so that the main defensive positions are masked from enemy observation and direct fire by the topographical crest. It extends rearward from the crest only to the maximum effective range of small arms fire. Observation and fires are maintained over the entire forward slope as long as possible to continue to destroy advancing enemy forces and prevent them from effectively massing for a final assault. A successful reverse slope defense is based on denying the topographical crest to enemy forces, either by fire or by physical occupation. Although the crest may not be occupied in strength, control of the crest by fire is essential for success.

STABILITY OPERATIONS

Cultural understanding is fundamental to planning stability operations in the mountains. Although challenging in the mountains, commanders can develop situational understanding by circulating throughout their operational areas as often as possible, making observations, and communicating with the local populace and other actors operating in the area. These activities will aid forces in overcoming local suspicion of outsiders and establishing the personal bonds of trust with local leaders. Soldiers should reference ADP 3-07 when conducting stability operations.

Conducting stability operations in mountain population centers establishes conditions that enable the efforts of the other U.S. instruments of national power, as well as international organizations. Military forces operating in this environment seek to establish or restore basic sustainable civil functions and to protect them until a host nation or other civil authority is capable of providing these services for the local populace.

In many cases, the restrictive terrain and cultural barriers found in isolated mountain communities will delay the host nation from fulfilling its role. Military forces may be called upon to significantly increase their role, to include providing the basic civil functions of government.

CIVIL CONSIDERATIONS

Generally, civilian population centers will be located at lower elevations, in Level I terrain, close to sources of water and along major LOCs. Dislocated civilians may increase congestion on the already limited road and trail networks normally found in mountainous environments, further complicating maneuver and sustainment operations.

Commanders must also consider the impact of operations on the often-limited civilian resources available in the mountains. The wisdom of using local resources to lighten in-theater supply requirements must be balanced with the impact on civilians and their local economy.

In mountainous regions, commanders often encounter a populace of diverse political and ethnic orientation that may support, oppose, or be ambivalent to U.S. operations or the presence of U.S. forces. Depending on friendly force objectives, commanders may use civil affairs operations, foreign humanitarian assistance, and military information support operations to influence perceptions and attitudes of the indigenous population and institutions.

Due to the restrictive nature of the terrain, mountain communities may quickly become safe havens and bases of support for enemy activity.

OPERATION ADVANTAGES AND DISADVANTAGES

The forms of maneuver and offensive tasks will not change for mountainous and cold weather environments, but there are unique elements that must be considered before conducting offensive operations. Like all other environments, one of the primary advantages of conducting offensive operations is that an attacker can choose when and how to attack. This point is emphasized even further in the mountains by—

- Multiple avenues of approach.
- Ground LOCs the defender has to rely upon for sustainment.
- The difficulty the defender faces in constructing defensive positions.

Despite these offensive advantages, the aggressor is usually at a disadvantage in the mountains because the terrain favors defensive operations. The primary advantage to the defender is the ability to choose defensive positions that will canalize offensive forces, denying the attacking force the ability to maneuver effectively.

If the defender controls the heights, observation will preclude the attacking force from achieving surprise. Both observation and canalization will give the defender the opportunity to mass fires in order to defeat or destroy the enemy.

However, if the attacking force is highly trained and able to negotiate the complicated mountainous terrain, the advantages the defender gained from the terrain will be nullified.

CHAPTER 5

Movement and Maneuver

MOUNTED MOVEMENT

Armored and Stryker operations in complex and compartmentalized terrain are hampered by terrain, infrastructure, and weather. Narrow roads and movement corridors limit vehicle traffic to predictable patterns. While this simplifies traffic control, maneuvering and recovering vehicles is problematic.

Terrain and weather limit the type of vehicles that travel on certain roads, especially during inclement weather conditions. Roads that are wide enough for high mobility multi-purpose wheeled vehicles (HMMWVs) may not support larger wheeled vehicles, mine resistant ambush protected (MRAP) or armored vehicles (tanks, armored personnel carriers, or amphibious assault vehicles). Fuel consumption for vehicles also increases due to the effects of road slope and grade.

Precipitation (snow and rain) hampers the mobility of both armored and Stryker assets. Roads close to rivers can flood during the spring when snowpack starts to melt at higher elevations. The seasonal impact on vehicle movement must always be considered when planning convoys in complex terrain.

Generally, mountainous terrain above the valley floor limits movement of wheeled vehicles and is too restricted for tracked vehicles. Trafficable terrain, such as roads and trails, tends to contour along rugged terrain features which makes mounted movement vulnerable to or complicated by—

- Ambushes.
- Attack aircraft.
- Terrain and weather effects (rockslides, avalanches) including—
    - Weaponized terrain (deliberate initiation of rockslides, road collapse, avalanche by enemy effects).
    - Recovery complications.
    - Road conditions (including width, stability, and max-load).

For winter and extreme cold weather conditions, the M973 Small Unit Support Vehicle (SUSV) is specifically designed to carry troops and equipment cross country under most snow conditions. Leaders and their staffs should make every effort to equip themselves with the M973 (SUSV) once they have identified that they are deploying or operating in an extreme cold-weather (arctic) environment or a mountainous environment with extreme cold-weather effects.

The planning considerations for operating the SUSV are much the same as they are for any other mounted travel. Leaders should ensure that—

- There should be at least two vehicles travelling together and the crews should be well versed in recovery.
- Fuel should be topped off and additional cans should be carried.
- Basic issue items (BII) should be present and serviceable. Recovery equipment such as winches, tow cables, and snatch blocks are essential. Wheeled vehicles must have tire chains.
- The route, number of personnel, and time of departure should be understood and logged with the command center.
- Passengers must have adequate equipment to sustain at a minimum an overnight trip.
- Leaders must have navigational equipment including maps; compasses; overlays and imagery; and global positioning system (GPS) receivers.

Tanks and other armored vehicles, such as infantry fighting vehicles, are limited to movement in valleys and existing trail networks at lower elevations. Even at lower elevations, roads and trails require extensive engineer work to allow tracked vehicle usage.

Due to terrain limitations, tracked vehicles rarely accompany dismounted infantry in the assault. Tanks, infantry fighting vehicles, and cavalry fighting vehicles assist forces conducting dismounted movement by occupying support-by-fire positions and by using their firepower to isolate objectives. Leaders should consider employing tanks as a hasty or expedient indirect fires platform. Leaders and planners in combined arms battalions (CABs) and armored brigade combat teams (ABCTs) should ensure the equipment necessary to convert and utilize the Abrams tank as an indirect fire (IDF) asset is available and trained on prior to conducting mountain operations.

Leaders and commanders who employ armored vehicles (tanks, infantry fighting vehicles [IFVs], cavalry fighting vehicles [CFVs], and Strykers) above Level I terrain should decentralize and operate as smaller units, but they should be complemented by dismounted forces as many vehicle platforms may be particularly vulnerable to—

- Attack from higher elevations.
- Limited availability to elevate their weapons systems to return fire.

The lower atmospheric pressure at higher elevations additionally affects vehicles as it increases the evaporation of water in batteries and vehicle cooling systems and impairs cylinder breathing. Consequently, vehicles expend more fuel and lubricant and experience engine power reductions by four to six percent for every 1,000-meter increase in elevation above sea level. As a result, mileage and load carrying capacity are reduced during operations. Consequently, the need for fuel and oil increases approximately 30 to 40 percent.

CONVOY PLANNING

To facilitate convoy planning, planners should conduct a physical network analysis. The physical network analysis encompasses roads, bridges, obstacles, population centers, and potential danger areas. Due to the complex nature of mountainous terrain, assets other than maps and dated imagery should be used.

Roads that appear viable on maps may be impassable during certain times of the year. Additional convoy planning considerations include—

- Type and maximum number of vehicles that the road network can support, including each route's throughput.
- Clearance requirements, particularly the turning radius of vehicles with tubes or barrels, as well as vehicles towing trailers and other equipment.
- Requirements for new road construction or road improvements.
- Classification of bridges.
- Likely locations for vehicle rollovers.
- Rapid analysis of existing roads for bottlenecks, deployment areas, passing places, and turnarounds for various vehicles.
- Early location and marking of bottlenecks, deployment areas, passing places, and turnarounds for various types of transport. Alternative routes must be identified and allocated.

- Selection, whenever possible, of at least two routes: one for vehicle traffic and the other for troops on foot, animal transport, and dislocated civilians. If possible, additional separate routes for wheeled and tracked vehicles should also be allocated, particularly if the latter are likely to damage the surface.
- Classification of routes as one- or two-way and development of schedules for the use of one-way routes.
- Placement of signs, if the tactical situation permits, for both day and night moves on difficult and dangerous routes.
- Good communications, especially between start and finish points, on congested portions of the route and at any passing points.
- Dedicated organization to rapidly clear obstacles caused by enemy action, the elements, or broken-down vehicles.
- Plans for route clearance operations on commonly used routes (to include weather and terrain effects as appropriate in addition to counter-improvised explosive device [C-IED] and counter-mine).

BREAKING TRAILS FOR MOUNTED MOVEMENT

When conducting mounted movement across snow-covered terrain that lacks existing trails, leaders may employ the following procedures to break new trails—

- The lead vehicle will set the initial track, staying concealed as much as possible.
- The second vehicle will offset its track to flatten out the trail. This keeps a hard ridge from forming in the center of the trail that can high-center other vehicles.
- Following vehicles will also offset as much as practicable to widen the trail. This also serves to harden the snow, thus easing the passage of other vehicles.
- A series of items (tripods) can be set up quickly to mark the trace of a trail through open areas. They should be spaced so that from one tripod, the next in line can be easily seen.

Trail maintenance is a critical task in order to maintain lines of communication (LOCs). A significant snowfall or wind event can totally obliterate any trace of a trail. A well-maintained and marked trail is far easier to reopen than breaking a new one.

DISMOUNTED MOVEMENT

Dismounted movement is slow and requires skilled mountaineering teams to secure the advance. For example, movement in Level II terrain dictates that elements secure the high ground in Level III terrain. As with any type of movement, proper techniques, formations, and constant security to avoid unplanned enemy contact are some of the keys to successful dismounted movement.

Leaders can improve mobility and speed through disciplined, rigorous training prior to operations in mountainous terrain. Mobility can also be improved by an effective task organization of units to promote mountain mobility (for example, assault climber teams, Level II terrain elements).

Leaders and planners can more effectively plan operations in mountainous terrain by factoring these considerations into dismounted movement requirements and timelines—

- Altitude at which forces will be operating.
- Amount of time a unit has to acclimate to the environment.
- Weight each individual will be required to carry.
- Fitness level of the U.S. Army unit.
- Size of the unit.
- Altitude gain or loss.

Foot marches in the mountains are measured in time and elevation rather than just distance. For a map reconnaissance, map distance plus one-third is a good estimate of actual ground distance covered. Planners also consider the following:

- One hour is planned for each three kilometers (about two miles) of distance.
- An additional hour is added for each 305 meters (1,000 feet) of ascent or each 610 meters (2,000 feet) of descent.
- The shortest person in the unit needs to be placed in the front of the formation due to his shortened gait, allowing the unit to maintain a uniform march rate.

If dismounted troops deploy into column (or wedge) formation outside the file formation, the unit will move more slowly. With no one breaking the trail, all personnel must now move through undisturbed snow.

While certain formations may seem ideal based on climate, region, and general terrain, leaders should consider the terrain and terrain effects (including topography, snow, ice, slope, etc.) Then they should base their movement formations on those factors, plus the tactical situation. For example, leaders can use an advanced guard overwatch element in a squad column or fire team wedge while the main body is in a file, if the terrain is difficult.

Other factors leaders and planners must consider for dismounted movements in mountainous environments are—

- Commanders cannot permit straggling or deviations from the selected route. Every aspect of march discipline keeps a column closed.
- Commanders should strive to manage pace and routes across mountainous and cold weather terrain to reduce the need for rest halts, as that effects or requires clothing and layering transitions.
- If commanders must incorporate scheduled rest halts in movement plans, they should be based on distance and availability of covered and concealed positions while also considering the following:
    - Five minutes of rest for every 25 minutes of movement for untrained or non-acclimatized troops.
    - Five minutes of rest for every 50 to 55 minutes of movement for trained and acclimatized troops.
    - Commanders should not conduct rest halts during steep ascents or descents.
    - Everyone should dress lightly and begin the march "cool."
    - A short halt should be taken to adjust clothing and equipment after the first 15 minutes of movement.
- In glacial areas, the principal dangers and obstacles to movement are crevasses and snow and ice avalanches. Exposure to the hazards of glaciated mountains increases at the company-level and above, due to throughput (including the number of personnel, weight loads, vehicle and support requirements), so movement should be limited to separate platoons and below.

- Conduct a thorough map and imagery reconnaissance.
- Going around terrain features may be faster than going over them. Check the contour and select a route that involves the minimum amount of ascending and descending.
- Old trail networks are more prevalent than many realize. These can be nothing more than a footpath through the woods or single-lane vehicle paths. Areas around population centers usually have trails for many miles in the surrounding countryside. These may not be on any map, but they will show up on readily available imagery. Control of trails has proven decisive in the past.
- Old river channels can be used as well. The vegetation may be less dense or easier to move through. Keep in mind that rivers in cold regions tend to meander a lot and this will add distance.
- Natural lines of drift, old trails, and generally easier routes are likely to have been identified by enemy forces during their intelligence preparation of the battlefield (IPB) and may be potential ambush sites, or pre-registered targets.
- Vegetation can be estimated by the color. Dark green areas tend to be mature trees; white spruce, pine, birch, cottonwood, etc. These are quite common immediately adjacent to river channels. They may have an understory of dense brush, alder, or willow. Light green areas tend to be lower brush of black spruce, alder, willow, and smaller birch.
- Pay attention to the contour interval on maps. A 20-meter interval can hide a significant relief.
- Wide-open areas with little or no relief must be addressed, as navigation can get difficult without landmarks.
- Consider where the sun is and how the shadows fall. In the northern hemisphere, the south side of open areas will help conceal tracks because they have longer shadows as the sun stays in the southern sky for most of the winter.
- Are personnel on skis or snowshoes? How proficient are they, and are they more capable of negotiating the terrain along the route with one or the other?
- What is the Soldier load and will Soldiers be pulling sleds? What will the temperatures be during movement?
- Are vehicles attached, and if so, what type of terrain and snow depth are they capable of negotiating?

- Is it necessary to camouflage tracks, and how will this be achieved? In barren areas, or areas above the tree line, tracks may be difficult, if not impossible, to conceal.
- Will the route be feasible during conditions of limited visibility?
- Will the route cross any potential avalanche areas?
- What obstacles can be anticipated? Will streams and other bodies of water be sufficiently frozen to support troops or vehicles? Will plowed roads perpendicular to the route have high banks of plowed snow? Will the water level in streams be so low that Soldiers will have to negotiate high banks?
- In open terrain, Soldiers should break only one set of tracks. Aircraft flying over movement routes can spot several tracks easier than they can a single set of tracks.
- Follow the tree line as much as possible, this will aid in concealment from the ground as well as help hide tracks from the air.

BREAKING TRAILS FOR DISMOUNTED MOVEMENT

The terms broken and unbroken trail have specific meanings. When moving through undisturbed (unbroken) snow greater than 12 inches (30 centimeters), the lead two or three persons pack the snow for the rest of the file. Once accomplished, the trail becomes broken. Since the lead Soldiers exert more effort breaking the trail, personnel should cycle via a "peel-off" technique in which the lead Soldier peels back to the rear of the formation and the trail breaking cycles through the formation in that manner.

Leaders replace personnel in the lead every 15 to 30 minutes, depending on fitness level. The following techniques may be employed by units conducting dismounted trail breaking—

- The leader designates the direction, and the lead Soldier begins moving, establishing the initial track.
- The second in line does not step into the first tracks. He will step opposite and flatten the track.
- The third and fourth Soldiers will offset their steps left and right by at least one snowshoe width. This widens the trail. Should it become necessary, these Soldiers are also the "cutters." Each one carries a machete to clear brush on the sides of the trail. Care must be taken to cut branches close to the main trunk so they do not become spears.

- The leader's primary focus is navigation. A march table will help leaders keep track of where the unit is. The trail-breaking squad should not solely rely on a GPS receiver, as batteries drain easily in the cold.
- The trail team will clean up the trail by filling in low spots with snow, moving brush trimmings, and marking the trail for following units.
- An additional fire team provides security for the trail-breaking squad.

INDIVIDUAL LOAD

Economizing the individual combat load is essential for conducting dismounted operations in the mountains. In steep terrain at elevations above 5,000 feet (1,524 meters), individual loads may need to be reduced by 50 percent. For example, water purification and the amount of bulky ammunition, such as pyrotechnics, must be considered. First class lightweight assault packs, however, are vital. Leaders at all levels review and modify existing unit packing lists and standard operating procedures (SOPs) when conducting dismounted operations in mountainous terrain. Leaders consider using the memory aid DROP—

- **D**—Determine level of mobility.
- **R**—Reduce redundant or non-essential equipment.
- **O**—Organize resupply.
- **P**—Police your Soldiers.

In the extreme cold weather environment, every effort should be made to keep Soldiers with their personal approach loads (rucksack). The sleeping bags, extra clothing, rations, and other equipment in their approach loads can mean the difference between life and death. Approach loads can be cached before an assault, but units avoid leaving them behind altogether. Sustainment loads must be pushed forward as soon as practical. For additional Soldier load considerations refer to Appendix A (Soldier Load Management) in this handbook.

TERRAIN ANALYSIS

Proper and continuous IPB and terrain analysis is critical to movement and maneuver in the mountains. Unlike flat terrain, on which the quickest way from point A to point B may be a straight line, moving in a straight line on mountainous terrain is often more difficult and time consuming. Considerations for route planning include—

- Physical network analysis.
- Contouring to prevent forces from gaining or losing elevation unnecessarily.
- Obstacles, such as population centers, rivers, and bridges.

Leaders and their staffs should leverage all their experience and planning capabilities to address the challenges of maneuvering across mountainous terrain with its natural obstacles and hazards. Some of these planning factors and considerations include—

- Stream and river crossing operations requiring additional planning, equipment, or engineer support.
- Cableways and tramways.
- Expedient rope and ice bridges (cold weather environments).
- However, leaders consider that fords—
    - Require reconnaissance to determine paved or not, and max load capacity.
    - Are affected by river currents, which are classified as—swift (more than five feet [1.5 meters] per second), moderate (three to five feet [one to 1.5 meters] per second), slow (less than three feet [one meter] per second).

- Leaders consider the following when considering water and ice routes:
    - Water routes are generally excellent for navigation. They can be superb avenues for movement after freeze-up.
    - Water and ice routes are dangerous. Failure to conduct a thorough reconnaissance of a route over ice can lead to loss of life and equipment.
    - Steam coming off the surface of snow indicates that there is open water.
    - As winter progresses, the water under the ice begins to drop. This sometimes leaves air space. Ice is no longer supported by water and may collapse.
    - The height of water under the ice route: If ice is not supported by water (waterborne) because the water level has dropped, it will be too weak to support heavy loads.
    - Leaders are cautious with heavy vehicles. Armored vehicles require at a minimum, 16 inches of waterborne ice in order to support 16 tons, with each additional inch supporting one additional ton. This does not apply for ice thicknesses under 16 inches. For example, three inches of ice will not support three tons.
    - In temperatures above 14 degrees Fahrenheit , add 25 percent to all required ice thickness.

Table 5-1. U.S. Army Northern Warfare Training Center Cold Weather student handout, winter 2016-2017.

Load bearing capacity of freshwater ice (waterborne)			
Minimum ice thickness (waterborne)			
Load	1x use thickness	Repeated use thickness	Distance between units
Soldier (skis)	1.5 inches	2 inches	5 meters
Soldier (food)	3 inches	4 inches	5 meters
HMMWV	10 inches	13 inches	27 meters
SUSV	10 inches	13 inches	27 meters
UH-60/CH-47	15 inches	18 inches	80 meters
At 16 inches, one additional inch will support one ton (waterborne ice only).			

AIR MOVEMENT

Aviation can prove highly advantageous to operations in a mountainous environment, when weather, climate, and terrain (altitude and elevation) factors do not interfere. Due to the dynamic nature of weather and terrain effects in mountain and cold weather environments, air mobility and air movement should not be the primary method of movement for planning purposes. However, when available, assault support aircraft can be essential to rapid movement of forces and equipment in the mountains.

Assault support aircraft provide commanders with maneuver capabilities, enabling them to concentrate combat power quickly and decisively. However, any operation that depends primarily on continuous aviation support to succeed is extremely risky due to—

- High elevations and rapidly changing weather.
- Higher altitudes restricting helicopter lift capabilities and decreasing aircraft payloads.

Commanders must be familiar with the conditions that limit the effectiveness of aviation during mountain operations, and the capabilities and limitations of the aircraft available to them.

GENERAL AND ADDITIONAL MOVEMENT CONSIDERATIONS

Mountainous environments limit mobility, the use of mutually supporting large forces, and the full use of sophisticated weapons and equipment. These limitations are to the detriment of many of the strengths U.S. military forces bring to the operations. However, they may benefit adversaries whose lesser sophistication better suits the environment.

Mountain operations restrict ground and air movement of units. Movement requires careful planning and execution as movement over arduous terrain is difficult. Forces must adapt their SOPs and develop innovative tactics, techniques, and procedures (TTPs) to accomplish the mission.

The ability to move requires proper integration and use of all appropriate resources, including aircraft, wheeled and tracked vehicles, watercraft, porters, pack animals, and individual means. Successful negotiation of the terrain and overcoming the effects of the environment depends on specialized mountain training and proper equipment.

Pack animals may be employed to alleviate resupply and Soldier load factors in Level I, II, and III terrain. Additionally, animals may also be used to enhance mobility and range in rugged and severely restrictive terrain. Leaders and planners must be aware of several factors when considering pack animals and mounts for operations in mountainous environments:

- Skill and discipline, which includes—
    - Riding and handling animals requires special training and skills which may not be present in units and formations.
    - Animals may compromise noise and location discipline.
    - Animals may wander off or flee under duress, taking their capability with them.
    - Trained animals are difficult to find and may need to be planned for and procured well in advance.
- Sustainment, which includes—
    - Pack animals and mounts consume water in substantial amounts compared to humans and require resupply.
    - Fodder (animal feed) for pack animals and mounts consists of grasses and grains that are not easily procured through military supply channels, and procuring them competes with resources available to local populations.

RECONNAISSANCE AND SURVEILLANCE

Reconnaissance and surveillance are critical to success in mountain operations. At the beginning of a campaign in a mountainous environment, requirements are answered by aerial or overhead platforms using radar systems to detect manmade objects.

Terrain impacts the employment of overhead reconnaissance platforms. These systems are adversely impacted by the masking effect that occurs when mountainous terrain blocks radar beams, so radar coverage may not extend across the reverse slope of a steep ridge or a valley floor. Subsequent use of ground reconnaissance assets to verify the data gathered by overhead and electro-optical platforms ensures that commanders do not fall prey to deliberate enemy deception efforts that capitalize on the limited capabilities of some types of overhead platforms in this environment. In mountainous areas of operation (AOs), it is necessary to commit ground reconnaissance assets to support strategic and operational information requirements.

Surveillance teams may be inserted to gather information that cannot be collected by overhead systems or to verify data that those systems collected. Due to the frequently changing and often severe nature of weather in mountainous and cold-weather environments, much of the reconnaissance and surveillance missions and requirements will be conducted by ground (manned) elements as opposed to technical platforms. Leaders must factor this, and its contributing factors and effects, into their collection and mission planning, as well as their operational tempo. Leaders also consider—

- Slower rate of ground reconnaissance elements.
- Communication challenges and reporting.
- Sustainment.
- Infiltration and exfiltration.
- Isolation and personnel recovery.

Although reconnaissance patrols use heights to observe enemy forces, they may need to send small reconnaissance teams into valleys or along the low ground to gain suitable vantage points, conduct counter-surveillance (as mountain villages often serve as a network of informants on friendly movements), or physically examine routes used by armored or Stryker forces. In mountainous environments, reconnaissance elements determine—

- The enemy primary and alternate LOCs.
- Locations and directions of possible enemy attacks or counterattacks.
- Heights that allow the enemy to observe the various sectors of terrain.
- Suitable observation posts for forward observers.
- Portions of the route that provide covert movement.
- Level of mountaineering skill required to negotiate routes (dismounted mobility classification) and sections of the route that require mountaineering installations.
- Trafficability of existing trails and routes to support sustained military movement requirements, and an engineer estimate of the effort required to improve and maintain this capacity.
- Location of enemy obstacles and barriers (including minefields) and feasibility of breach bypassing.
- Bypass routes.

- Potential airborne and air assault drop zones and pickup zones (PZs) and aircraft landing areas.
- Locations of locally available engineer resources, such as construction materiels, borrow pits, water, and construction equipment.

Snow poses a serious threat to units not properly trained and equipped for movement. Avalanches have taken the lives of more troops engaged in mountain warfare than all other terrain hazards combined. Reconnaissance units conduct a thorough reconnaissance of the AO to identify steep slopes and precipices with large accumulations of snow to determine areas where avalanches and rockslides are most prevalent and most likely to hinder mobility. This information should be included in their reconnaissance overlays in order to generate a full picture for the commander.

RECONNAISSANCE IN FORCE

The mountain terrain's geography and mobility restrictions are risky for reconnaissance in force operations. Because the terrain allows enemy units to defend along a much broader front with fewer forces, a reconnaissance in force is conducted as a series of smaller attacks to determine the enemy situation at selected points.

In the mountains, the risk of having at least a portion of a force cut off and isolated is extremely high. Mobile reserves and preplanned fires must be available to reduce the risk, decrease the vulnerability of the force, and exploit any success as it develops.

ENGINEER RECONNAISSANCE

Engineer reconnaissance assumes greater significance in a mountainous environment to ensure that supporting engineers are task-organized with specialized equipment to quickly overcome natural and reinforcing obstacles. Engineer reconnaissance teams conduct the following functions—

- Assess the resources required for clearing obstacles on precipitous slopes.
- Construct crossing sites at fast-moving streams and rivers.
- Improve and repair roads, erect fortifications, and establish barriers during defensive operations.
- Integrate into all mountain reconnaissance operations, since the restrictive terrain has obstacles.

Additional information on engineer reconnaissance can be found in ATP 3-34.81.

GROUND AND LONG-RANGE SURVEILLANCE

In the mountains, surveillance of vulnerable flanks and gaps between units happens at well-positioned observation posts. These observation posts are inserted by helicopter and manned by small elements equipped with sensors, enhanced electro-optical devices, and appropriate communications.

Commanders and their staffs develop adequate plans that address their insertion, sustainment, and ultimate extraction.

Long-range surveillance units and snipers trained in mountain operations contribute to surveillance missions and benefit from the restrictive terrain and excellent line of sight (LOS). Overhead platforms and attack reconnaissance helicopters may also be used by the commander for surveillance missions of limited duration (see ATP 3-04.1 for more information on aerial reconnaissance). However, weather impedes air operations, decreases visibility for both air and ground elements, and reduces the ability of ground surveillance elements to remain hidden for prolonged periods without adequate logistical support. Terrain may mask overhead surveillance platforms.

PICKETS

Pickets in mountain operations are generally dismounted but, they may consist of either mounted or dismounted elements. Mounted maneuver elements use scouts as forward reconnaissance elements. These elements are small, light, and mobile units that conduct route reconnaissance for the main body. Pickets in cold regions may require these types of patrols to operate with snowmobiles, cross-country skis, or snowshoes.

The use of pickets decreases the speed a unit moves due to the difficulty of moving along the top of ridgelines. Characteristics of mountain pickets are that they—

- Provide flank security for the main body.
- Provide surveillance of adjacent compartments.
- Provide observed fires into and across adjacent compartments.
- Serve as a relay for voice communications.
- Serve as connecting files in offensive operations.
- Be either static or mobile along tops of ridgelines.
- Patrol for periods of three to 14 days.
- Be in a high state of physical fitness, acclimatized, and have any specialized equipment needed to move across the specific ridge complex, such as crampons, ice axes, and ropes.

CHAPTER 6

Fires

Rugged terrain and reduced mobility increase the reliance on field artillery fire support. However, the employment and positioning of field artillery systems may be severely impacted by the extreme difficulty of ground mobility in mountainous terrain. Despite these factors, the basic tactical principles for artillery remain valid in mountains, subject to the limitations imposed by terrain and weather.

ORGANIZATION

Leaders can mitigate some of the limitations imposed by mountains while still supporting isolated maneuver units by considering reorganizing the artillery battery, breaking it down into smaller platoons than is listed in the unit's table of organization and equipment (TO&E). This organization allows support of maneuver units across vast distances, but it strains personnel and equipment. Despite these constraints, these smaller gun platoons can operate independent of the battery, while retaining the capability to mass fires as a battery depending on the distance.

Although the use of smaller gun platoons supports commanders in a dispersed environment, such dispersal complicates their ability to mass fires, lead, and sustain each platoon. Commanders must depend on officers and senior and junior noncommissioned officers capable of operating independently and sometimes performing duties above their TO&E rank structure.

The structure of artillery battalions will dictate how they divide into two-gun platoons. Currently, artillery TO&Es do not support two-gun platoons from the standpoint of fire direction center (FDC) communications equipment, computers, or personnel. To meet this challenge, units may have to either cross-train personnel or request additional equipment or operate with reduced personnel at all FDCs and divert communications and computers from other sections.

Other fires organization factors that apply and should be considered by leaders and staffs are—

- Modified TO&E and two-gun platoons will create additional requirements (position dependent) for the following—
  - Logistics.
  - Security.
  - Communications.
  - Computers, automation, and connectivity.
  - Vehicle and movement support.
  - Location and distribution of forward observers once mountain task-organized (assault climber elements and other Tier III [summit level] terrain operating units).

MOVEMENT AND POSITIONING

Movement

The reconnaissance (the examination of the terrain to determine its suitability for use in accomplishing the mission), selection, and occupation of a position are critical to mission accomplishment. Rugged terrain and reduced mobility increase the reliance on field artillery fire support. However, the employment and positioning of field artillery systems will be impacted by the extreme difficulty of ground mobility in mountainous terrain. Leaders must analyze the routes to be used by unit assets and the time and distance required to make moves. The ability to move one firing platoon while leaving a second platoon able to fire is critical to the support of dispersed maneuver units. When making artillery moves, leaders consider—

- Time and distance analysis must factor the effects of mountain environments or planned rates of travel and timelines will be inaccurate:
  - Relief (slope, grade, contour).
  - Road surface conditions.
  - Weather (precipitation, temperature).
  - Environment (talus, scree).
- Difficult routes will require detailed planning and movement orders (see ATP 3-09.50 for more information).

The effects require analysis to facilitate rapid movement. Weather affects both visibility (through fog and haze) and trafficability (through ice and rain-softened ground). Ground movement of field artillery is often limited to traveling on the existing road and trail networks and positioning near them. Towed field artillery may require forward displacement of gun sections by helicopter to provide forward troops the necessary support.

Air movement of towed field artillery is possible with fixed- or rotary-wing aircraft, so gun crews should be proficient using equipment-rigging techniques and air assault procedures and possess ample sling-load equipment. Field artillery emplaced by helicopter normally requires continued airlift for subsequent displacement and ammunition resupply, and it often requires substantial engineer support. Leaders should consider mountain task-organization structures to speed gun displacement and movement. Leaders of artillery units in mountainous terrain—

- Identify air assault and pathfinder qualified personnel to support mobility.
- Cross-train all fires personnel on sling-loads and equipment-rigging.

Positioning

Normally, field artillery is employed far enough to the rear to take advantage of increased angles of fall. The flat areas, which can accommodate firing units, such as dry riverbeds, villages, towns, and farmland, are limited in the mountains and are particular problems for the following reasons:

- Dry riverbeds are hazardous because of the danger of flash flooding.
- Towns and villages usually have adequate flat areas, such as parks, schoolyards, and playing fields. However, they are relatively scarce and often easily targeted by enemy forces.
- Farmland is often difficult to negotiate from spring to fall. In the winter, if the ground is frozen, farmland may provide good firing positions, but frozen ground may cause difficulty emplacing spades, base plates, and trails.

Consequently, good artillery positions selected for cover, flash defilade, and accessibility to road nets and landing zones (LZs) are difficult to find. Their relative scarcity makes it easier for the enemy to target probable locations.

Commanders must ensure that positions on dominant terrain provide adequate defilade. Positions on commanding terrain are preferable to low ground positions because there is—

- A reduction in the number of missions requiring high-angle fires.
- A reduced amount of dead space in the target area.
- Less exposure to small arms fire from surrounding heights.
- Less chance of being struck by rockslides or avalanches.

Some weapons may move forward to provide long-range interdiction fires or, in extreme cases, direct fires to engage a road-bound enemy in mountain passes or along valley floors. Because of rugged terrain, higher angles of fire, and reduced ranges, it is generally necessary to displace artillery more frequently than on level terrain to provide continuous support. Additionally, even when maneuver units are not dispersed, artillery commanders may often be forced to employ field artillery in a decentralized manner or disperse it in multiple locations in the same general area because of the limited space for gun positions. Security must be provided for each gun location.

ACQUISITION AND OBSERVATION

Acquisition

Because of high-angle fire requirements, radar can be effective against enemy indirect fire systems if properly emplaced. However, terrain masking can diminish the radar's line of sight (LOS) and degrade its effectiveness if it is not properly emplaced. Sites should be selected on prominent terrain to obtain the lowest possible screening crest, but it is often difficult to obtain a low and consistent screening crest in mountainous terrain. Too low of a screening crest drives the search beam into the ground. Too high of a screening crest allows enemy fire to pass under the beam, avoiding detection.

Mountainous terrain makes selecting general position areas difficult as leaders seek to maximize radar range and capabilities. Air mobility provides opportunities to move radar teams to optimal locations. Often, the positions that provide the best LOS for acquisition lack concealment and survivability, making camouflage techniques essential. When positioning weapons-locating radars, leaders and staffs should also consider—

- Although time consuming, visibility diagrams are extremely useful in determining the probability of acquiring targets within the radar's search sectors.
- To limit search areas, radars should focus on terrain that can be occupied by artillery and mortars.
- Accurate survey control is essential because of the extreme elevation variations in mountainous terrain. Helicopters may be useful in performing surveys by use of the Position and Azimuth Determining System. If possible, digital radar maps may be used to minimize the time required for height correction of the weapon system. Digital maps allow the fire finder systems to initially locate weapon systems to within 820 feet (250 meters), which allows the radar operator to make few visual elevation adjustments to accurately locate the weapon system.
- Prediction is computed at the radar's elevation, and therefore excessive errors in the prediction can be expected.
- Radars in the same area that face one another and radiate at the same time can cause interference and emissions burnout, resulting in equipment failure. If radars must face one another to accomplish the mission, commanders must coordinate with each other to ensure that they do not radiate at the same time.
- Computing track volume may become a critical task in determining a radar's effectiveness for a proposed position. (See ATP 3-09.12 for more information on computations).
- Units will need to rely more on shelling reports to determine enemy firing locations.
- Leaders must stress pre-deployment training to ensure all units meet minimum standards for this skill (shelling reports to determine enemy firing locations).

Observation

Mountainous terrain presents several factors and considerations for forward observers that leaders and staffs must consider when planning and employing fires in this environment. One of these considerations is reliance on high-angle fires. High-angle fire is used for firing into or out of deep defilades, such as that found in heavily wooded, mountainous, and urban areas. It is also used to fire over high terrain features near friendly troops. An observer may request high-angle fire based on terrain in the target area. The fire direction officer may also order high-angle fire based on a terrain analysis from the firing unit position to the target area. The primary characteristic of high-angle fire is that an increase in elevation causes a decrease in range.

High-angle fire involves large quadrant elevations and long times of flight. This means effects will not be as responsive to the immediate needs of a maneuver force as low-angle fire. Trajectories will also be more vulnerable to enemy detection.

Leaders must factor this into their plans and responses on the ground. Additionally, corrections may change drastically from round to round because spotting rounds often get lost in defilade positions. To help observers, personnel at the fire direction center can announce the time of flight in the message to observer five seconds before each round impacts. (See TC 3-09.81 for more information on high-angle fire.)

To prevent fratricide, noncombatant casualties, and destruction of civilian property and infrastructure, field artillery fires in mountains will be observed, especially close support fires and defensive fires. Unobserved fires are generally more unreliable in mountains because of poor maps, rapidly changing meteorological conditions, and elevation changes. A good fire direction center (FDC) can overcome some of the challenges of weather and high-angle fires through training and by capturing timely and accurate meteorological data, but proper observation post planning and selection is critical to operations in mountainous terrain.

Elevated points and high-points (including crests and trees) are frequently selected as observation posts. Landmarks and prominent terrain features should be avoided as these are probably targeted. When selecting an observation post, observers must consider the characteristics of forward slope (military crest) versus reverse slope positioning:

- Advantages of the forward slope position include—
    - The view of the front and flanks is superior.
    - Fires impacting on the topographic crest will not neutralize the position.

- The hillside provides background, which aids concealment.

- Disadvantages of the forward slope position include—
  - Difficulty occupying it during the daytime without disclosing position.
  - Radio communications may be difficult and require remoting radios to the reverse slope.
  - Cover from direct fire may not be available.

- The advantages of a reverse slope position are—
  - It may be occupied in daylight.
  - Greater freedom of movement is possible than in forward slope positions.
  - Communications installation, maintenance, and concealment is easier than in a forward slope position.
  - Protection from direct fire is available.

- Disadvantages of the reverse slope position are—
  - The field of view to the front is limited.
  - Enemy fire adjusted onto the topographic crest may neutralize the observation post.

Low clouds or fog may require moving the observation post to preplanned emplacements at lower elevations. Leaders must ensure that observers are trained and prepared to perform assault climbing to reach the most advantageous observation site. Commanders and staffs should plan and train using aerial observers or unmanned aircraft systems (UAS) to detect long-range targets and complement forward observers by adjusting fires beyond terrain masks, in deep defilade, and on reverse slopes. Observing fires in mountains is difficult because the area observed is three dimensional relative to other types of terrain. As such, an observer may encounter increased difficulties in determining accurate target locations (including altitude). Pre-deployment training must address and build confidence in observing and adjusting fires in three-dimensional terrain.

TARGETING AND MUNITIONS

Targeting

Because of the decentralized nature of mountain operations, targets warranting massed fires may be fewer than those in open terrain. However, narrow defiles (including valleys and passes) used as routes of supply, advance, or withdrawal by the enemy are potentially high payoff targets for interdiction fires or large massed fires. Large masses of snow or rocks above enemy positions and along main supply routes (MSRs) are also good targets because they can be weaponized as highly destructive rockslides and avalanches that may deny the enemy the use of roads and trails and destroy elements in defilade. In the mountains, suppression of enemy air defenses takes on added importance because of the increased dependence on all types of aircraft. A clear understanding of the targeting methodology combined with the knowledge of the capabilities and limitations of target acquisition and attack systems in a mountainous environment is crucial to the synchronization of all available combat power. To provide accurate and timely delivery of artillery fires in mountainous terrain, commanders must consider the following:

- High angles of elevation require increased time of flight for rounds to impact.
- Targets on reverse slopes are more difficult to engage than targets on flat ground or rising slopes and require more ammunition for the same coverage.
- Increased amounts of dead space are unreachable by artillery fires.
- Intervening crests require detailed map analysis.
- Meteorological data.
- Altitude and elevation of gun, observer, and target.

When the five requirements for accurate predicted fire (including target location and size; firing unit location; weapons and ammunition information; meteorological information; and computational procedures) are not achievable, registration on numerous checkpoints becomes essential because of the large variance in elevation. (See TC 3-09.81 for more detailed information on accurate predicted fire.)

Munitions

Terrain and weather also affect the use of field artillery munitions. When evaluating the use of lethal or nonlethal effects, commanders must carefully weigh the operational requirements against the rules of engagement. Some considerations for mountain employment of multiple munitions are listed below:

- High explosive munitions include point-detonating fuses, variable or electronic time fuses, mechanical time super quick (MTSQ) fuses, and mechanical time-only fuses.
- Impact fuse and high explosive shells are very effective with rocky ground (including scree, talus, etc.), generating splinters and other natural missiles, but less effective in snow pack.
- Variable time or electronic time fuses should be used in deep snow conditions and are particularly effective against troops on reverse slopes.
- MTSQ fuses are not typically used in high-angle, high-explosive fire due to an increased height of burst-probable error.
- Obscuration operations in mountainous areas are challenging due to the terrain and wind.
- Planners can use obscurants and flame systems in the mountains to—
    - Deny the enemy observation of friendly positions.
    - Deny observation of supply routes.
    - Obscure entrenchments.
    - Degrade enemy ability to cross and navigate through tight terrain and high passes.
- When employing obscurants, leaders and staff must consider—
    - Wind effects (prevailing and thermally induced).
    - Snow and air admixture effects on white phosphorous.
    - Temperature effects (cold and extreme cold) on obscurants.

MORTARS

Mortars are essential during mountain operations. Their high angle of fire and high rate of fire are suited to supporting dispersed forces. Mortars can deliver fires on reverse slopes, into dead spaces, and over intermediate crests. Like field artillery, rock fragments caused by the impact of mortar rounds may cause additional casualties or damage. Suitable mortar firing positions can still be a challenge to find in the mountains.

Mortars come in three different configurations: 60 millimeter (mm), 81 mm, or 120 mm. 60-mm mortars are usually carried on dismounted movements due to their light weight and mobility. They provide smaller units with an organic fires capability when conducting independent operations. 60mm mortars are invaluable to operations in the mountains. While it is possible to carry 81-mm and 120-mm mortars on dismounted movements, it is not desirable to do so in rugged mountainous terrain. The increased weight of the 81-mm and 120-mm mortar rounds severely hampers movement that is already slow due to the constraints of the mountainous environment.

Leaders and staffs must consider in their planning that small units will also be forced to sacrifice carrying other weapons, such as Javelins, AT4s, as well as additional ammunition (including crew-served weapons, mortar rounds, etc.) if they carry larger mortar systems. Whenever possible, larger mortar systems should be placed in areas where their ammunition sourcing is ensured. During movement to contact or other offensive operations, larger mortars can be transported along valley roads and trails to provide continuous fire support coverage to the lighter dismounted units in the higher rugged terrain.

Continuous coverage can be achieved by splitting into sections and conducting bounding techniques to ensure at least one section is always ready to fire.

TRAINING AND OTHER FACTORS

To successfully employ and integrate fires into mountain operations, leaders must develop training strategies that address the unique challenges in terrains and environments that exist in the mountains. Some training considerations are—

- Emphasizing training fire and displacement techniques to mitigate enemy counter-battery fires.
- Conducting crew drills (including gun and mortar crews) in restrictive terrain (slope and grade) and adverse conditions (including cold).
- Training direct-lay and “hip shoot” techniques for mortar crews.

- Cross-training all fires personnel on sling-loads and equipment-rigging.
- Training fire officers (FOs) on mountaineering and assault-climber skills.
- Ensuring FOs and assault-climber elements are confident and proficient at adjusting fire on three-dimensional terrain (steep relief and contour).

PLANNING AND FIRE SUPPORT COORDINATING MEASURES

Commanders and their staffs should address the following factors and considerations during their fires planning for operations in mountainous terrain:

- Suitable gun positions in mountains are limited and the following may apply—
  - Status of air (contested or not).
  - Map data available to the enemy (your gun position may already be an enemy pre-registered target).
- Fires plans must account for "four" dimensions in operating in the mountains:
  - Standard range (depth and width).
  - Height (vertical terrain).
  - Time (where supported units are on the ground in time).
- Priority of effort versus priority of support.

Subordinate units (company, battery, troop, battalion [BN], brigade [BDE]) must understand the fires plan beyond quick review and limited-reference to the fires annex.

CHAPTER 7

Sustainment

Sustainment operations in mountain terrain require detailed planning and adaptive, flexible thinking to ensure combat units are effectively supported and able to conduct and maintain operations against enemy forces. The same environmental factors that impact the other warfighting functions apply to sustainment as well. Leaders and staffs must understand how the challenges of the environment (altitude, relief, temperature, and weather) apply to the challenges of sustainment to mitigate those hazards and risks through training and planning.

GENERAL CONSIDERATIONS

In mountain operations, logistic units are task-organized and attached to combat units in order to support widely dispersed forces. Infantry battalions operating in mountainous areas may disperse into company- or platoon-sized elements. Each support element should include personnel such as winter mountain leaders, who have expertise in route planning and movement techniques. Logistic support elements may provide container delivery system (CDS) recovery, sling operations, helicopter landing zone (LZ) coordination, convoy escort, health services, motor transport, materiel handling, supply, maintenance, vehicle recovery, and field feeding.

During mountain operations when units often operate outside of the range of immediate external support, personnel are cross-trained in many functional areas, including logistics. The institution of combat lifesaver training for nonmedical personnel is one example of successful implementation of this concept. Potential areas for logistical skills cross-training include casualty evacuation, utilities, maintenance, food service, and air delivery recovery.

Joint operations in mountainous terrain require interoperability among the services. Units operating in the mountains rely on other service, coalition, and host-nation support for extended periods. Support between adjacent units from different services or country origin is frequently necessary during mountain operations.

Units operating in mountainous terrain rely on innovative and unorthodox methods of logistic support. For example, units might need to make use of captured enemy supplies and equipment. They might need to rely on locals who know the terrain, or “piggyback” on a coalition partner’s assets. A good consideration when planning sustainment in the mountains is the higher elevation the position or operation, the greater the resource strain.

TERRAIN AND WEATHER

Leaders and logistic planners accept that time and distance double in the mountains. In some areas, terrain is so restrictive that only air or foot movement is possible. Two miles (three kilometers) on the map may actually require nearly six miles (10 kilometers) of foot movement due to the switchbacks of trails, high elevation, and weather. Taking shortcuts and unnecessary risks typically delays movement and compromises the safety of logistic efforts.

When operating in remote mountainous areas, units prepare for extended periods without resupply. They may need to maintain two to three times the anticipated requirement for supplies or adopt innovative methods to overcome these shortfalls. In mountain operations, units should plan for 10 to 20 percent loss of supplies for the following reasons—

- Damage occurring during air delivery.
- Transportation and distribution assets (trucks) damaged while traversing rough roads over long distances.
- Pack animals carrying supplies over treacherous mountain trails can be lost.
- Loss of supplies to enemy indirect fire due to the limited open spaces and areas to store supplies with proper dispersion.
- Packaged supplies broken open, damaged, or buried under snowstorms and avalanches.
- Pilferage.

Equipment and facilities may require winterizing in mountain operations. For example, heated buildings, shelters, or tents with wood flooring are required for maintenance in cold weather. The cold weather that accompanies many mountain regions also has negative effects on many of the classes of supply, further highlighting the necessity of planning and training to mitigate the hazards and risks of mountain and cold weather environments. Winterization can be a significant operation that requires extensive advance planning in preparing facilities and equipment. Materiel and equipment should be ordered well in advance of the winterization date and trained on prior to deployment to mountain environments.

SECURITY

In mountain operations, the enemy uses terrain as a force multiplier in order to target logistics units and interdict resupply operations. Enemy units infiltrate and seize key terrain that dominates supply routes in an effort to disrupt and isolate units from logistical support. A combination of patrolling and air reconnaissance is the best means for providing route security in mountainous terrain. Additional logistics security planning factors are—

- Route clearance (enemy- and terrain-based)—
  - Improvised explosive devices (IEDs) and route status.
  - Snow and precipitation effects (rain, mud, etc.)
  - Rock slides.
  - Avalanches.
  - Obstacles.
- Observation—
  - Routes with established operations and checkpoints.
  - Overhead surveillance and reconnaissance (aerial intelligence, surveillance, and reconnaissance [ISR]) availability.
- Day and night operations—
  - Threat vulnerability versus environmental hazards.
  - Training and familiarity.
- Air movement and aviation support—
  - Weather conditions (winds, snow, precipitation, etc.)
  - Terrain (relief and contour).
  - Illumination in mountains and arctic and antarctic environments.
  - Temperature effects on lift and mechanical equipment.

CLASSES OF SUPPLY

Mountain and cold weather environments require additional considerations and planning regarding supply and resupply due to the effects of the environment on personnel, equipment, and the classes of supply. The considerations and factors leaders must address are listed below by classes of supply.

Class I (Food and water)—Mountain operations, particularly in extremely cold weather, increase Class I item consumption and energy requirements by as much as 50 percent:

- Caloric needs may increase to 6,000 or more calories per day.
- The meal, ready-to-eat (MRE) ration can be used for high altitude and cold climates; however, the MREs include components that contain liquid that can freeze during extreme cold weather operations if these items are not kept warm, such as by carrying them inside clothing.
- The meal, cold weather (MCW) ration is designed for operations in cold weather. Leaders should begin ordering these rations once they have identified they will operate in mountainous and cold weather areas.
- The first strike ration (FSR) may also be a better option than standard MREs for use as long as temperatures remain above freezing. The FSR has already been used by units operating at high altitude up to about 8,000 to 10,000 feet (2,438 to 3,048 meters) without issue.
- When compared with three MREs (standard or cold weather), the one day FSR subsistence ration weighs 50 percent less and takes up half the space.
- Water requirements are often the most significant logistical challenge to extended mountain operations.
- Beyond individual consumption requirements, water will also be required for personal hygiene, vehicle maintenance, medical care, etc.
- Leaders should equip Soldiers and units with lightweight water purification equipment (filters) and squad stoves (MSR XGK stoves) to melt snow to provide water, thereby reducing demand throughput on supply chains for water.
- During cold and extreme cold weather conditions, leaders should consider procuring and shipping ice instead of water as part of Class I resupply to reduce energy demands and equipment demands.

Class II (Clothing, individual equipment, and tentage)—In cold weather, preferred clothing consists of loose-fitting layers and insulated, polypropylene clothing designed to wick away moisture and ensure perspiration does not accumulate close to the body. Additionally, other specialty equipment may be required:

- Leaders and planners should ensure sufficient supplies of extended-cold weather clothing system (ECWCS) to resupply and provide turn-in and re-issue of damaged or unserviceable equipment and clothing.
- Specialty equipment requirements include snowshoes, boot crampons, avalanche beacons, avalanche probes, skis, skins, ski wax, backpacking stove and fuel, candles, ice axes, snow shovels, matches, 100 percent ultraviolet protection glacier glasses, sunscreen, special fuel containers, tire chains, and winterization kits. (A more comprehensive list can be found in ATTP 3-21.50.)
- Tents must be easy to carry and assemble at high elevations and retrievable from deep layers of snow.
- In cold weather, tent heaters and stoves in billeting and storage areas are necessary. Heated tents will be required for storage of some classes of supply items.
- In cold weather, all batteries provide less power, so a greater quantity of batteries or more frequent charging of batteries is required. Cold weather batteries are recommended, if available.
- Dry batteries must be stored at temperatures above 10 degrees Fahrenheit and must be warmed gradually, either with body or vehicle heat, before use.
- Leaders and units should avoid relying on service-specific items that require batteries not carried by the theater-level sustainment organization.

Class III (Petroleum, oil, and lubricants)—Cold weather, elevation, and traversing sloped terrain all have effects on Class III, from additional storage requirements to adverse consumption rates:

- Increasing grades causes vehicle fuel consumption increases by up to 30 to 40 percent.
- Increased elevation and altitude reduces the quantity of oxygen in the air and engine efficiency drops.
- On average, vehicles lose 20 to 25 percent of their rated carrying capacity; however, overall fuel consumption for the unit decreases because of lower vehicle movement.
- Units that operate in cold weather need to plan for fuel use and storage.
- Leaders and units should order and stock specialty weight lubricants (Multi-viscosity oil, 15W-40).
- In sustained extreme cold conditions, 10W oil will be required.
- Cold weather mountain operations require arctic engine oil, a synthetic SW-20 lubricant used for temperatures down to negative 65 degrees Fahrenheit. For weapon systems, lubricant specifically designed for arctic weather should be used.
- For additional Class III considerations refer to Appendix B (*Extreme Cold Weather Maintenance. USARAK Regulation 750-4*) in this handbook, and TM 4-33.31.

Class IV (Construction materiels)—Cold weather and mountain environments will have limited effects on Class IV. However, leaders must remain aware of the effects of the environment on Soldiers as they manipulate and employ Class IV as it pertains to timelines and construction. Some weather and terrain effects still apply:

- Temperatures and precipitation causing rust, splitting, cracking, and rot (lumber and metal).
- Water requirements for concrete mixing and setting.
- Snow and ice ground effects on digging for barriers and berms.

Class V (Ammunition)—Preparing ammunition dumps is more difficult due to freezing and mud. Special storage for ammunition is not required but it should be stored in its original containers. Additionally, extreme temperatures and conditions will effect Soldiers' abilities to handle and reload ammunition. Leaders must factor this in their pre- and post-mission planning. Additionally, leaders should expect and factor for increased use of indirect fire ammunition because of dead space, deep snow, and other effects of mountainous terrain, for example, leaders and their staffs should strongly consider and plan for increased use of light mortars (60-mm) in mountainous terrain.

Class VI (Personal demand items)—Leaders should consider increased requirements and value to morale of personal demand items, in particular related to personal hygiene and comfort in adverse environments such as—

- Non-regulation but weather and environment appropriate socks, scarves, under-garments, headgear.
- Footwear (boots) that are mountain and cold weather rated and tactically colored or appropriate.
- Toothpaste, soaps, sanitizers, wet-wipes, etc.

Class VII (Major end items)—Resupply of battle-damaged major end items is a significant challenge in mountain operations. Movement of deadlined equipment clogs narrow supply routes. There will be an increased demand for power generators, heaters, and rough terrain loaders with a snow removal capability. When equipment is destroyed or damaged beyond repair, the only course of action may be redistribution.

Class VIII (Medical supplies)—Cold weather and even altitude can affect the storage, viability, employment and effectiveness of many medical devices and medicines. Leaders should plan for multiple medicines to account for physiological difference and responses to cold and altitude effects on Soldiers. Additionally, planners must anticipate higher consumption rates for medical supplies. Other factors for Class VIII in mountain and cold weather environments include—

- Using solid medications and freeze-dried materiel instead of liquids to minimize freezing, storing, and handling problems.
- Requirements for refrigerated and heated storage areas, such as warming tents, vehicles, and containers to store liquid medications and blood.
- Heavily increased demand for lip balm, sunscreen, cough syrup, and decongestants competing with other medical resupply and patient care hours.

Class IX (Repair parts)—Mountain and cold weather environments place increased stress on equipment, particularly vehicles and their component parts. Units will need to increase their Class IX block by up to 300 percent. Critical Class IX components that will require increased stocks are—

- Starters.
- Glow plugs.
- Generators.
- Alternators.
- Regulators (for squad stoves).

VEHICLE, EQUIPMENT, AND OPERATOR CONSIDERATIONS

In high mountain operations, equipment must be prepared for cold weather prior to arriving in the theater of operation. Most vehicles are designed to operate in temperate climates and must undergo winterization to function properly in the cold. Cold weather kits are necessary for every vehicle and include tire chains for all wheels, tire chain repair kit, de-icer, non-freeze windshield wiper fluid, scrapers, tow bars or straps, extra chock blocks, and plastic or canvas to cover windshields to reduce buildup of ice or frost. The following subparagraphs discuss broad principles that apply to all vehicles.

When loading materiel in any form of transport for delivery to an area of operations (AO), items of low priority should be loaded first. Those high priority items required first at the destination should be loaded last. Experience has shown that this principle is especially important in mountain operations.

Vehicle operations are difficult in the rough terrain and colder temperatures associated with mountain operations. Driver training is critical, particularly at night. Also, training is required in rough terrain and fording. Leaders must ensure vehicle and equipment operators are trained to handle rugged and difficult terrain environments including—

- Weather and terrain effects—
    - ○ Extremes of temperature.
    - ○ Precipitation (rain, snow, ice, etc.).
    - ○ Road conditions (mud, snow, ice, etc.).
    - ○ Engine heat, start conditions.
- Roads—
    - ○ Trails and tracks.
    - ○ Unimproved surfaces.
    - ○ Semi-improved surfaces.
    - ○ Improved surfaces.
- Vehicle capabilities—
    - ○ Two wheel drive (WD) versus four WD.
    - ○ All WD.
    - ○ Tire inflation.
    - ○ Preventing tire freeze.
    - ○ Weight versus torque.
- Recovery—
    - ○ Snow, mud, and ice.
    - ○ Extreme cold.
    - ○ Self-recovery, as heavy recovery assets may not be able to negotiate the terrain.

VEHICLE MAINTENANCE

In mountain operations, vehicle maintenance is inherently difficult because units are almost invariably forced to drive heavily laden vehicles over uneven terrain. Road networks in the mountains are unforgiving on motorized equipment. Rocks, ever present dust, shifts from desert heat to arctic cold, and dramatic gradient changes take a significant toll on military motorized equipment. Overall, maintenance failures may far exceed losses due to combat.

Preventive maintenance is crucial in mountainous terrain and cold weather. In mountain operations, leaders need to balance operating tempo with sufficient time for proper maintenance. Vehicle operators must be well-trained in maintenance and driving techniques, and suitable cleaning solvents and lubricants need to be available, appropriate to the weather and terrain. Units may have to adjust the preventive maintenance checks and services process to focus on items that are most susceptible to breaking in the mountains, such as—

- High mobility multi-purpose wheeled vehicle (HMMWV) half-shaft bolts.
- Alternator brackets.
- Fluid levels.

SUPPLY DISTRIBUTION AND TRANSPORTATION

Conventional distribution methods are challenged in the mountains, so redundant methods of distribution should be planned. Distribution may consist of a combination of methods such as airdrops, assault support, tactical vehicles, pack mules, and porters. Since ground transportation is preferred for distributing food, water, fuel, and construction materiel, units should be task-organized with additional motorized assets, specifically trucks. Such organization reserves more rotary- and fixed-wing assets for higher-value supplies, such as ammunition, major end items, and medical supplies.

In mountain operations, the biggest distribution challenge is in transporting supplies across the last few miles to the forward positions. Operations in Iraq and Afghanistan were based out of fixed sites, forward operating bases, and combat outposts (FOBs and COPs), which could be serviced by ring routes via air and large contracted or deliberate ground convoys. Mountain supply distribution in non-permissive austere, expeditionary or near-peer environments may require echeloning of field trains and combat trains to bring supplies to forward supply and resupply points where company-level supply elements (1SGs and supply clerks) draw resupply and bring to the company CP. Soldiers may then transport (via light vehicle or man-packing) to forward positions. Leaders must train for this at every echelon to ensure the continuous and sufficient movement of supplies to the front. Additional supply distribution factors for leaders are—

- Task organization of unit to operate in Tier I, II, and III terrain.
- Porters, runners in elements operating in Tier II and III terrain.
- Porters and runners in assault climber teams.

CHAPTER 8

Medical

The extreme conditions found in mountain environments, altitude, temperature, extreme and changing weather effects, provide multiple factors that leaders and their staffs must address and mitigate to maintain the health, sanitation, and fighting ability of their units. Additionally, the compartmentalized terrain and substantial changes in relief and elevation present challenges to military medical operations, particularly medical evacuation (MEDEVAC) and casualty evacuation (CASEVAC). Successfully conducting operations in mountainous terrain requires leaders to understand, plan, and train against these considerations.

GENERAL HYGIENE

In a cold, mountainous environment, personal hygiene is difficult to maintain due to limited water. The potential for the spread of infectious diseases increases by confined living spaces shared by multiple individuals. Field hygiene and sanitation is important. Leaders and staffs must factor not only the numerous cold and altitude illnesses and injuries, which threaten personnel operating in a mountainous and cold weather environment, but also the possibility of heat casualties due to exertion and clothing, severe sunburns, and eye-damage brought on by the sun's ultraviolet rays.

COLD WEATHER MALADIES AND INJURIES

Cold-related illness can strike if a Soldier loses more body heat than the body can restore. Body heat is lost to the environment through evaporation, radiation, convection, and conduction. A cold-related illness that affects the entire body is hypothermia. Like heatstroke, hypothermia is a life-threatening condition that must be treated immediately to prevent the Soldier's death. In contrast, the other cold related illnesses, frostbite and immersion foot, are localized in their effects. Leaders must ensure their medical personnel and subordinate leaders are trained to recognize and treat these conditions and hopefully prevent these injuries. The most prevalent of these are—

- Hypothermia—
    - Results when the body's core temperature drops to 95 degrees Fahrenheit (35 degrees Celsius) or less.
    - Is an emergency condition that unless treated immediately will lead to the Soldier's death.

- Treatment requires re-warming the body, and removing the Soldier from exposure to the elements, which can be achieved through warming tents, vehicles heaters and use of warm liquid containers.
- Re-warming and treatment should be measured and gradual, not sudden and drastic.

• Frostbite—

- Is the actual freezing of blood vessels and surrounding tissues of the body part.
- Treatment starts with treatment for any cold weather injury, remove the Soldier from the environment that has caused the injury if possible.
- If there is any chance the frostbitten body part, once thawed, might refreeze during the evacuation, the Soldier should be evacuated instead so rewarming can be done in an appropriate medical treatment facility.

• Immersion foot (trench foot)—

- Occurs when a Soldier's feet have been wet and cool, but not freezing cold, for long periods.
- Is prevalent with the use of military issue vapor barrier boots, also known as "Mickey Mouse" boots.
- If not properly treated, can cause gangrene.
- Prevention requires frequent changing of socks to allow the feet to dry or remain dry.

• Snow-blindness—

- Is a serious condition that results when the outer layers of the eyes are burned by UV radiation.
- Sets in 6 to 12 hours after radiation exposure.
- Recovery takes from one to several days.
- Treatment includes providing pain relief and preventing further injury.
- Prevention is straightforward; in high UV environments, Soldiers must wear either goggles or glacier sunglasses with side shield to block UV radiation bouncing off the snow.

- ○ Eyewear needs to filter out 90 percent of the UV wavelength that burns.
- ○ Glare can be filtered out with a darkly tinted lens, but the tint itself will not filter out the burning UV light.
- ○ Can be helped with polarizing layers on the lenses in settings where reflection is especially intense.

HIGH ALTITUDE MEDICAL CONDITIONS

As Soldiers reach higher elevations, the altitude begins to change the way their bodies function. As the air gets thinner, the amount of available oxygen in each breath decreases. Just as important, the mechanism that is instrumental in permitting the body to absorb oxygen from the lungs also decreases. The body's tissues have a harder time getting the oxygen they need for metabolism, and the Soldier enters the state of reduced oxygen called hypoxia.

Soldiers' bodies attempt to adapt to this drastic environmental change, but adaption (acclimatization) takes time. How rapidly and how completely individual Soldiers acclimatize varies greatly. The single most critical reason Soldiers get sick at higher altitudes is they ascend too high too quickly. The most important ways to prevent altitude illness is planned acclimatization and to undertake slow ascents to higher elevations. The most prevalent altitude related conditions are—

- • Acute Mountain Sickness (AMS)—
  - ○ Effects roughly half of personnel who live at sea level and travel rapidly to moderate altitudes—8,000 to 14,000 feet (2,400 to 4,300 meters).
  - ○ Is a collection of nonspecific symptoms resembling the flu, carbon monoxide poisoning, or a hangover.
  - ○ Has signs that include insomnia, listlessness, loss of appetite, nausea, vomiting, and light-headedness or dizziness made worse when in an upright position.
  - ○ Settles in within a day of the initial ascent, and if it is mild, it lasts only a day or so; however, it can progress in severity.

- High Altitude Cerebral Edema (HACE)—
    - Usually develops in non- acclimatized Soldiers above 10,000 feet (3,000 meters), although it can occur as low as 8,500 feet (2,600 meters).
    - Is the leaking of blood vessels in the brain into the skull cavity, resulting in brain swelling.
    - Rarely occurs unexpectedly and more often occurs in people who have had AMS that is worsening.
    - Generally, takes from one to three days at altitude for HACE to develop.
    - Has early signs of this deadly condition that include deteriorated coordination (ataxia), headache, loss of energy, and altered mental status, ranging from confusion or signs of not thinking clearly to hallucinating.
    - May advance rapidly. The patient may become somnolent and lapse into a coma. Descent is critical to survival.
- High Altitude Pulmonary Edema (HAPE)—
    - Is the leaking of fluid into the lungs to a degree that it interferes with respiratory function.
    - Is a potentially fatal condition and survival depends on rapid response.
    - Appears to be a different disease from AMS and HACE and can occur quite suddenly in Soldiers who were otherwise performing well.
    - Has early signs that may overlap with more benign problems, such as a persistent cough caused by simple bronchial irritation from dry, high mountain air.
    - Requires that the casualty descends. A descent of 3,000 feet (900 meters) will resolve nearly all HAPE cases that are caught early.

ACCLIMATIZATION

Regardless of an individual's standard of physical fitness, all personnel must acclimate in order to be effective and to prevent associated altitude illness. Acclimatization achieves maximum physical and mental performance and minimizes the threat of altitude-related illness. Mountain warfare training is not a substitute for the acclimatization process, but it does provide personnel with an appreciation for the challenges of surviving and fighting in a mountainous environment.

Acclimatization is required before undertaking extensive military operations. Even the most physically fit troops experience physiological and psychological degradation when thrust into high elevations. There is no shortcut for the acclimatization process, and any attempt to trim or bypass the process will result in injuries. Whenever possible, leaders should incorporate sufficient time to acclimate into their plans. Some general factors, methods, and tips for acclimating are—

- Seven to 10 days at elevations between 8,000 to 18,000 feet (2,438 to 5,486 meters), will result in 70 to 80 percent respiratory acclimatization for most troops.
- 80 to 90 percent of overall acclimatization occurs usually within two weeks to one month.
- When brought to lower altitudes, all personnel will lose their acclimatization in a matter of days.
- There are two methods for acclimating troops in high mountains: the staged ascent and graded ascent.
    - Staged ascent—
        * Troops ascend to an altitude of 8,000 to 13,000 feet (2,438 to 3,962 meters) and remain there for four days or more to acclimate before ascending higher.
        * If possible, intermittent stops are recommended.
    - The graded ascent limits the daily altitude gain to allow partial acclimatization.
- The altitude at which troops sleep is critical to acclimatization:
    - Work high, sleep low.
    - Example: Sleep 1,000 feet lower than the operating elevation.

- After 8,000 feet (2,438 meters), troops should gain no more than 984 feet (300 meters) of sleeping altitude each day.
- Two or three times a week, allow an additional night at the same elevation as the night before.

MEDICAL EVACUATION

The environment in mountainous terrain requires medical professionals to plan and train against the hazards of cold, weather, and terrain to effectively perform medical evacuation. Due to the compartmented terrain, and severity of the environment, air evacuation is the preferred method of MEDEVAC. However, medical personnel must be trained, equipped, and ready to perform prolonged field care, as disruption of air movements and limited ground lines of communications are likely in the mountains, and it can and will delay both ground and air MEDEVAC. Other considerations leaders must factor, plan, and train against and with are—

- Effective patient packaging for evacuation considering—
    - Weather and environmental mitigations.
    - Terrain.
    - Movement method (ground or air).
- Equipment needs, including—
    - Sufficient Class VIII supplies for the environment (for example, extra emergency blankets, oxygen for altitude treatment, and potentially hyperbaric tentage and equipment).
    - Effects of the environment on Class VIII (cold and altitude effects on liquids and chemicals) and equipment necessary to conduct treatment and evacuation.
    - Specialty equipment (hoists, rigs, etc.)
- Access, including—
    - Medical personnel trained and familiar with high, steep angle rescue.
    - Evacuation teams with Level 2 mountaineers, who have the capability to reach, stabilize, and evacuate casualties in the steepest terrain.

CASUALTY EVACUATION

The same factors and considerations that apply to MEDEVAC also apply to CASEVAC, except the impacts of those challenges are magnified by the lack of medical evacuation equipment to receive en route medical care. Leaders at the company level must plan, train, and prepare to conduct CASEVAC due to the limitations mountain operations may place on MEDEVAC assets.

Mountain operations present numerous challenges for casualty collection and evacuation. Leaders should consider the following when planning mountain operations:

- There is difficulty associated with accessing casualties in rugged terrain.
- There is an increased need for technical mountaineering skills for CASEVAC.
- Expert medical help may not be in close proximity.
- There are longer periods of wait time for CASEVACs.
- Prior to evacuation, injured and immobilized patients are at the greatest risk of cold injury, and they must be well insulated during transport.
- Evacuation of the wounded from mountainous areas normally requires a larger number of medical personnel and litter bearers than on flat terrain. Soviet experience in the mountains of Afghanistan proved that three to 15 men might be involved in carrying one patient.
- Tough, physical casualty handling should be conducted in every training event.

CHAPTER 9

Protection and Engineer Support

Protecting the force in mountain environments is a two-fold effort as personnel and assets must be defended against both enemy threats and environmental hazards. This becomes more challenging when facing a near-pear threat with the ability to employ air and anti-access, area denial (A2AD) assets as well as counter-mobility and survivability assets and effects of their own. Leaders must consider the capabilities and capacity of their protection and engineering assets, and then prioritize them effectively to ensure success in mountain operations.

AIR DEFENSE

In addition to the environmental effects on digital and mechanical systems of weather and temperature that occur in the mountains, severely compartmentalized terrain presents many challenges to ground-based air defense assets that include communications, mobility, logistics, cueing, and tactical employment.

Regarding communications, mountainous terrain precludes the use of very high frequency (VHF) radio assets except in short-range, line of sight (LOS) situations. The nature of short-range air defense unit employment is such that the tactical dispersion of surface-to-air missile teams, sections, platoons, and batteries render VHF communications unreliable. Leaders should consider alternatives, including—

- Satellite communication (SATCOM).
- High frequency (HF) radio communications.
- Non-traditional or non-organic methods, including—
    - Airborne communications relay.
    - Ground-wire telecommunications.

Employment, movement, and positioning of air defense assets in mountainous terrain is complicated by the majority of those assets being motorized or mechanized. Leaders and planners should consider alternative options and factors for short-range air defense, including—

- Foot-mobile, short-range air defense teams. However, leaders must consider that these assets have—
    - Limited missile carry capacity.
    - Limited battery capacity.
    - Limited sustainment (food and water).
    - Limited communications equipment.
- Helicopter and tilt-rotor teams are also a possibility, and they provide for more capacity for ammunition, batteries, and sustainment.

Compartmentalized terrain impacts air defense unit employment and affects the receipt of electronic early warning and cueing from ground-based radar assets. The terrain limits what ground-based radars see and limits communications with the identification and engagement authority, extending the amount of time to gain approval authority to prosecute a threat (in the kill chain). Leaders can mitigate this through planning and considering the following:

- Decentralizing identification and engagement authority.
- Coordinating with airborne early warning platforms to maximize the amount of cueing teams receive.
- Coordinating with forward observation posts for early warning through reconnaissance.

Geometry of attack and weather are also considerations in this environment. Detecting air-to-air threats, ground-controlled intercepts, and overall radar coverage is affected by mountainous terrain because of the numerous radar blind zones caused by the mountains. A good intelligence preparation of the battlefield (IPB) can map these blind zones and limit these effects.

ENGINEER SUPPORT

Only through in-depth IPB, a thorough information collection plan, and in-depth analysis, can units overcome the difficulties associated with mountain operations. Forces should prepare thorough engineer battlefield assessments and terrain analysis products to support planning. There is no single formula for success in the mountains, as every valley over the next ridgeline will present new challenges that will require new solutions. Leaders ensure their units can adapt to those challenges through analysis, effective task organization, and the proper allocation of resources.

Mobility in the mountainous environment is extremely limited, requiring extensive shaping operations. The sheer quantity of earth movement and horizontal construction hours involved in providing mobility in offensive operations requires a focused effort from all engineering elements. Leaders should detach all horizontal construction-engineering elements from subordinate commands and combine them to create a separate element. This will ensure—

- Allocation of engineering resources to the highest priority tasks.
- Productivity.
- Prevention of separation of resources to support varying requirements with varying priorities.

MOBILITY

During mountain operations where limited mobility exists, it is critical that units maintain security and control of available road and transportation networks, including securing key bridges, fords, crossing sites, intersections, and other vulnerable chokepoints.

During offensive operations, commanders commit forces to seize key terrain and routes that afford their forces greater mobility and tactical options against the enemy. Engineer support in front of convoys and combat formations is necessary to clear and reduce obstacles, such as washouts, craters, mines, landslides, avalanches, and snow and ice in colder mountainous regions.

Snow is especially challenging, as it affects the full depth of units from forward fire-team to division headquarters. Reducing obstacles is more difficult in mountainous areas because of reduced maneuver space, lack of heavy equipment, and an increased competition for engineer support. Minefields must be breached since bypassing properly sited obstacles is often impossible.

Gap crossings, whether wet or dry, are a challenge in mountain environments. When bridging or crossing dry gaps, leaders consider—

- Bridging and dry gaps—
    - Crossing short gaps.
    - Using existing bridges.
    - Using prefabricated materials.
    - Using floating bridges.
    - Using non-standard techniques such as rope, cable, or suspension bridges.
    - Fording.

In a mountainous environment, the terrain favors the enemy's use of mines and improvised explosive devices (IEDs) as stand-alone weapons and in the initiation of ambushes. Using mechanical mine plows and rollers or other standard route clearance vehicles, such as the vehicle mounted mine detection system (Husky) and mine protected clearance vehicle (Buffalo), is frequently impossible due to the lack of roads and trails and the low classification of those that do exist.

Leaders must train and ensure the proficiency of their units in employing dismounted counter-IED and counter mine equipment and measures. Some considerations for leaders and staff include—

- Electronic warfare (EW) devices and the effects of extreme weather and temperature on them.
- Limited use of demolitions to breach, reduce IEDs and mines due to—
    - Rockslides.
    - Avalanches.
    - Secondary fragmentation.
    - Route collapse (slopes and grades).
    - Temperature.
    - Frozen ground.
    - Snow.

- When using metal detectors, leaders consider—
  - Quantity available versus demand.
  - Paces of movement and timelines.
  - Physical and psychological exertion.
- When using technology, leaders consider—
  - Extreme weather effects.
  - Extreme temperature effects.
  - Mineral soil composition (more common in mountainous terrain) false positives and interference.

Engineer reconnaissance assumes greater significance in a mountainous environment and engineer reconnaissance to support the development of the engineer battlefield assessment, IPB, mobility, combined obstacles, and ambush sites overlay are the most important tasks that engineers in the brigade combat team perform in the mountains. Engineer reconnaissance teams need to be familiar with and factor in the unique nature of mountain terrain and cold weather effects and hazards. In particular, engineer reconnaissance teams consider—

- Precipitous slopes and grades.
- Gap crossings—dry and wet.
- Road improvement and construction needs.
- Locations for obstacles that are either natural or manmade, and the construction materials needed to complete them. (both defensive and offensive)—
  - Natural.
  - Construction materiel.
- Route selection considerations include—
  - Vehicle requirements.
  - Rates of speed.
  - Operational timelines.
  - Seasonal effects.

- Snow and ice affect—
    - Trafficability.
    - Choice of alternate routes (frozen surfaces).
    - Ice thickness weight ratings.
    - Avalanches and avalanche mitigation.

COUNTER-MOBILITY

During mountain operations where limited mobility exists, it is easy to conduct counter-mobility due to the physical terrain of the mountains themselves, as well as additional, obvious natural obstacles, including—

- Deep defiles.
- Cliffs.
- Rivers.
- Landslides.
- Avalanches.
- Crevices.
- Scree slopes (accumulated broken rock fragments).

Manmade obstacles used with restrictive terrain and observed indirect fire are extremely effective in the mountains, but their construction is costly in terms of time, materiel, transportation assets, and labor. Commanders should allot more time for personnel to construct obstacles in cold weather due to the restriction of additional clothing and equipment.

Leaders and planners must also consider the following when developing obstacles and obstacle plans in mountain environments:

- The effects of obstacles linked with terrain on enemy operations and restriction on mobility to friendly forces' operations.
- Weather effects, including temperature (both freeze and thaw) and precipitation (rain and snow).

- Prioritizing and conserving obstacle materiels and terrain. This includes using—
  - Rocks and rockslides.
  - Barbed wire (and its effect on snow versus natural obstacles).
  - Cratered roads (to include on grades and slopes requiring both spanning and repair assets).
- When using mines, leaders consider—
  - Snow, mud, partially frozen ground emplacement.
  - Thaw and water-seepage.
  - Hydrology (water drainage moving and shifting minefield obstacles).
- Avalanches can be—
  - Artificially triggered.
  - Weaponized (initiated deliberately on enemy movement or operation).
  - Created using demolitions or artillery.

SURVIVABILITY

The ability to dig survivability positions into a slope increases the amount of usable terrain, increases survivability of the positions, and saves on time and resources for protection. Engineer units task-organize and deploy with the proper resources to cut into hillsides so survivability positions are placed into mountains instead of building on top of them. Such operations require extensive use of heavy equipment and demolitions.

When planning to establish a fixed-site location, the position and angle of the enemy's fire is important. Whoever maintains the high ground has an advantage of fire and cover, so defensive positions should be elevated. Leaders should consider—

- Avoiding peaks or ridges because it makes the site vulnerable to fire from 360 degrees.
- Utilizing reverse slopes with forward observation posts (OPs) and listening posts (LPs).
- Integrating camouflage and natural concealment.
- Using overhead cover that is heavily reinforced to mitigate elevated fires weather-related weight.

CHAPTER 10

Mission Command

Compartmentalized terrain, expansive area of operations (AO), and severe environmental conditions limit communications systems and challenge mission command efforts. Large operational areas and the need to employ small unit tactics require commanders to decentralize and disperse their forces. Commanders rely on decentralized execution enabled by adaptive planning, mission orders, and clear commander's intent. Risk management integration is critical at each level of command in all phases of mountain operations to identify and mitigate hazards to enhance mission success. The following considerations apply to mission command during mountain operations:

- Leaders must maintain flexibility and adaptability. This is necessary because—
    - Terrain will generate ambiguity and chaos. Leaders must successfully manage and exploit these.
    - Timing and timelines will change, as weather and environmental effects may drastically alter plans and conditions.
- Warning orders must allow subordinates ample time to prepare and plan for operations.
- Mission orders must empower subordinates and promote freedom of action.
- Commander's intent must articulate the purpose, key tasks, and desired end state.
- Command relationships must be clearly understood and facilitate the exercise of initiative by subordinates (maintaining unity of command where possible, unity of effort where it is not).
- Standard operating procedures (SOPs) must be appropriate, adaptive, understood, and applied across the command.
- Mobile reserves or reaction forces must be trained to move quickly across rough compartmentalized terrain with tailored loads.
- All echelons of leadership and command must be capable of operating in analog environments.

LEADERSHIP

Mountain warfare is as much a mind-set as a skill-set. As such, leaders will have a disproportionate impact on success in mountain operations when compared to operations in less challenging terrain. Troops must have confidence in their leaders. Superficial knowledge of mountain warfare and ignorance or underestimation of mountain environmental effects will result in failure and loss of life. While study and reference materials can provide a good foundation for mountain and cold weather warfare, true proficiency and mastery requires dedicated on-the-ground training in these environments.

To fight effectively, leaders must understand and exploit opportunities offered by the mountainous environment and minimize its effect on personnel, equipment, and weapons. The keys to meeting this challenge are proper training and operational experience in the mountains. Commanders manage risk to mission and risk to Soldiers by assessing the environmental hazards daily from subordinate leaders' updates.

Leaders and staffs will be successful operating in mountain environments if their planning and efforts consider and incorporate the following:

- Leaders and commanders need to recognize when experience and talent may outweigh rank.
- Training trumps technology in mountains, and training should address discomforts and weaknesses, not enhance or reinforce strengths.
- Leaders must educate themselves and their subordinate leaders and staff on the mountain environment prior to operations.

COMMAND AND CONTROL

Significant environmental impacts must be considered and mitigated to ensure command posts (tactical operations center [TOC], tactical command post [TAC], and company command post [CP]) remain functional despite cold temperatures, high winds, terrain features and the effects of altitude. These challenges are compounded when faced with near-peer threats and substantial enemy conventional forces with electronic warfare capabilities and indirect fire assets. CP site selection and CP operations are further complicated by the effects of mountainous terrain on electromagnetic communications and systems. Leaders should consider the following as they develop their spans of control and communications planning:

- Size—Smaller is better in mountain operations. Leaders should consider scaling their command infrastructure due to—
    - Power and heat requirements.
    - Manning and protection requirements.
    - Displacement.
    - Concealment and camouflage.
- Leaders organize manning based on—
    - Watch and battle-staff requirements (shifts).
    - Three 8-hour shifts versus two 12-hour shifts for guards, depending on environmental conditions.
- To displace quickly, leaders use—
    - Smaller footprints decrease setup and takedown times.
    - Fewer, lighter, more mobile vehicles.
    - Fewer sustainment and support items (generators) to move and re-establish.
- To effectively conceal and camouflage units, leaders consider—
    - Less tentage and camouflage netting equals less freight and more mobility.
    - More opportunity for terrain to conceal CPs.
    - Less equipment reduces electromagnetic signatures.

When considering right-sizing their command architecture, leaders should endeavor to scale their TOC down to a TAC-sized element and scaling their TAC to a mobile CP-sized element and at higher echelons. They consider a forward or assault CP for the best situational awareness of a decentralized battlefield.

COMMUNICATIONS

The mountainous environment poses unique challenges when trying to employ communications equipment. The following are communications planning considerations—

- Widely distributed units, such as companies and platoons, will require the same communications capabilities and decision-making authorities that are traditionally found at battalion or higher echelons.
- Units must develop core communications competencies with a variety of communications equipment and systems down to the lowest echelons of command possible.
- Commands must develop the leadership and decision-making skills of junior leaders.
- Mission command architectures require redundancy and must account for the effects of the operational environment.
- Installation time of communication nodes in mountainous areas can double, depending on the terrain and the weather.
- Mission command plans for communications nodes should accommodate expansion as more equipment and personnel arrive and more capability is required.
- The communications priority should be single-channel radio (SCR) and satellite communication (SATCOM), because they will be the primary mission command links for headquarters.

Leaders must have a level of awareness of the capabilities and limitations of different communication systems, which are listed below—

Single Channel Radio

SCR includes radios that operate in the high, very high, and ultrahigh (HF, VHF, UHF) frequency, and UHF tactical satellite (TACSAT) bands that can provide secure voice and limited data communications capability (transfer rates are limited by bandwidth constraints).

SCR (VHF and UHF) deficiencies can be mitigated by retransmission of tactical communications. This requires detailed planning when faced with mountainous terrain. When communicating in mountainous terrain, leaders must consider—

- Survivability, defense, security, and concealment.
- Infiltration and exfiltration.
- Logistics in severely restrictive terrain.
- Mobile retransmission will be complicated by the limitations of routes, roads, and overall terrain features.
- Airborne retransmission and relay of critical nets help to overcome many of the challenges associated with ground retransmission but they can only be relied upon for short duration missions (some unmanned aircraft systems [UAS] can provide extended periods of coverage).
- Specially configured rotary-wing and fixed-wing aircraft can serve as robust mission command platforms with prior coordination.

High Frequency

Although HF communications support long-range communications, they work best when stationary, and they require more training than VHF or UHF radios. Newer HF radios (PRC-150, TRC-209, vehicle-mounted MRC-148, VRC-104, PRC-155) use the third general automatic link establishment. They are a suitable stationary alternative to TACSAT radios, but they often take longer to set up and are not as effective on the move.

Very High Frequency

VHF radios are greatly affected by terrain masking and are limited to near-line of sight (LOS) employment in mountainous terrain. The most widely employed VHF tactical radio is the single-channel ground and airborne radio system family of radios.

Ultra High Frequency

UHF signals are absorbed by intervening terrain and are another form of LOS communications. However, UHF signals are not restricted to LOS, and they can bend somewhat over mountaintops. The Soldier radio waveform (SRW) is an applique that rides on the UHF spectrum supporting the Lower Tactical Internet (NETT Warrior Systems).

UHF communications can be improved in the mountains by—

- Selecting communications sites that have a narrow single mountain crest between them. Aim the transmissions at the highest peak. Keep the sites away from the mountain base.
- Deploying radios away from the mountain base to a distance at least equal to the distance of the slope between the base and mountain crest.
- Deploying radios to commanding heights to improve their LOS to the top of the intervening mountain.
- Deploying radios where they can communicate over a single mountain rather than a series of peaks and defiles.
- Deploying the radios away from the base of the mountain and on high ground when confronted with a large, domed mountain.

Tactical Satellite Radio

Tactical satellite radio (TACSAT) or satellite communications (SATCOM) is the radio system of choice for operations in the mountains. It combines mobility, flexibility, and ease of operation with unlimited range. The PRC-117, PRC-148, PRC-152, VRC-110, and VRC-111 are all capable of transmitting SATCOM, UHF, and VHF voice or data and are suitable for base or mobile communications in the mountains. Though flexible and reliable in the mountains, TACSAT radios are more susceptible to electronic warfare and interference, channels are usually limited, and the radios have limited capability to support data transfer.

Multichannel Radios

Broadband multichannel radios (MUXs) use frequencies in the UHF, super high frequency (SHF), and extremely high frequency (EHF) bands. The demands of operating along these frequency bands and performing multiplexing functions require complex and relatively large pieces of equipment. The MUX systems, therefore, have considerably more logistical and operating requirements than SCR systems.

For sustained operations in mountains, ground relay stations or "RIPER" nets can be established to relay large amounts of data. Planners should consider the following MUX characteristics:

- MUX equipment is limited to LOS and, in some cases, a very low takeoff angle.
- Compartmentalized, mountainous terrain will require more nodes and larger packages.
- Communications between MUX communications nodes will not be possible if there is intervening terrain between the nodes.
- MUX repeater sites can enable mission command in the mountains. Repeaters need to be placed near or on the top of ridges or peaks.
- Wind speeds on top of ridges and peaks often exceed the operational tolerances of MUX antennas, requiring the antennas be taken down during inclement weather.
- Satellite terminals, such as the support wide area network system and the secure mobile anti-jam reliable tactical terminal, along with older systems, such as the TSC-85 and TSC-93, provide a method of switched connectivity in addition to MUX that often makes them preferred over MUX in a mountainous environment.

Enhanced Position Location Reporting System

Because it is a LOS UHF radio, the enhanced position location reporting system (EPLRS) is best suited for flat terrain and a battlefield that is heavily populated with units. The system has limited use in dispersed rugged mountainous terrain as a position reporting system because of the LOS issues.

Blue Force Tracking

Blue force tracking (BFT) and joint capabilities release provide reliable data communications links for sending preformatted and free text messages. Because BFT uses satellites vice ground radio relays, it is an ideal system for mountainous environments. It provides a near real-time feed to the common operational picture and is a highly reliable means of text communication between dispersed units.

Cell Phones

The proliferation and common use of cell phones may provide opportunities to exploit operational security issues, particularly as relay towers and usage expand in the future.

Audio, Visual, and Physical Signals

Leaders can use a number of audio, visual, and physical signals in order to communicate in an analog manner when digital and electromagnetic communications are degraded, compromised, or otherwise inoperative. These signals include—

- Simple audio signals, such as voice or whistles, can be used to locally alert and warn. Sound travels farther in mountain air and this effect may increase the possibility of enemy detection. Interrupting terrain, wind conditions, and echoes can restrict voice and whistle commands to certain directions and uses.
- Visual signals such as pyrotechnics and mirrors have limited use due to enemy detection but may work for routine and emergency traffic at the right time and place. Blowing snow, haze, fog, and other atmospheric conditions may periodically affect range and reliability.
- Luminous tape on the camouflage band, luminous marks on a compass, or flashlights may be used as signals at night over short distances.
- Infrared sources and receiving equipment such as night vision goggles, aiming lights, and infrared filters for flashlights, can be used to send and receive signals at night. However, an enemy outfitted with similar equipment can also detect active devices.
- A tug system is a common method of signaling between members of a roped climbing team. However, tug systems are often unreliable when climbers are moving on a rope or when the distance is so great that the friction of the rope on the rock absorbs the signals. Separate tug lines can be installed in static positions by tying a string, cord, or wire from one position to the next.

Messenger

Although slow, communication by messenger is frequently the only means available to units operating in the mountains. Messengers should be trained climbers, resourceful, familiar with mountain peculiarities, and able to carry their own existence load. During cold weather operations, advanced skiing skills may also be required. Messengers should always be dispatched in pairs.

Antennas and Grounds

Directional antennas, both bidirectional and unidirectional, may be needed to increase range and maintain radio communications. Positioning of all antennas is also crucial in the mountains because moving an antenna even a small distance can significantly affect reception.

Antenna icing, a common occurrence in cold weather and high elevations, significantly degrades communications. Ice makes it difficult to extend or lower antennas, and the weight of ice buildup, combined with increased brittleness, may cause breakage.

Ground rods and guy wires are difficult to drive into rocky, frozen earth. Mountain metal spike pitons are excellent anchors for antenna guy wires. In extreme cold, ropes can be frozen to the ground and wires tied to these anchors. Adequate grounding is also difficult to obtain on frozen or rocky surfaces due to high electrical resistance. Grounding in rocky soil may be improved by adding salt solutions to improve electrical flow.

APPENDIX A

Soldier Load Management

INTRODUCTION

How much weight a Soldier carries is a crucial concern for leaders during the planning process. Leaders must carefully consider how much to carry, how far, and in what configuration. Rigorous planning and inspection is the key to ensuring Soldiers are not overloaded and are capable of accomplishing missions in the mountains. Commanders and leaders balance the risk to their Soldiers from the enemy against the risk of mission accomplishment due to excessive loads and Soldier exhaustion or injury. Commanders and leaders must accept prudent risks to reduce Soldier load based on a thorough mission analysis.

OPTIMIZATION OF A SOLDIER'S LOAD

To optimize Soldier loads, leaders consider—

- Average fighting load: 60 to 80 pounds (about 30 percent of body weight).
- Average total approach march-load: 80 to 100 pounds (about 45 percent of body weight).
- Average total emergency approach-march load: 100 to 125 pounds.

(See Table A-1 on page 106 for a listing of body weight percentages for combat loads.)

Table A-1. Body weight percentages for combat loads

Individual body weight (BW) in pounds	Fighting load (30 percent of BW)	Approach march load (45 percent of BW)	Emergency approach march load (46 to 70 percent of BW)
120	36	54	84
125	37.5	56.25	87.5
130	39	58.5	91
135	40.5	60.75	94.5
140	42	63	98
145	43.5	65.25	101.5
150	45	67.5	105
155	46.5	69.75	108.5
160	48	72	112
165	49.5	74.25	115.5
170	51	76.5	119
175	52.5	78.75	122.5
180	54	81	126
185	55.5	83.25	129.5
190	57	85.5	133
195	58.5	87.75	136.5
200	60	90	140
205	61.5	92.25	143.5
210	63	94.5	147
215	64.5	96.75	150.5
220	66	99	154
225	67.5	101.25	157.5
230	69	103.5	161

The load Soldiers can carry is based not only on their body weight, as in Table A-1, but also on the climate, terrain, altitude, and prior or current stress. Therefore, the body weight percentage table should serve only as a guide for leaders to not overload Soldiers.

Economizing the individual combat load is essential for conducting dismounted operations in the mountains. In steep terrain at elevations above 5,000 feet (1,524 meters), individual loads may need to be reduced by 50 percent. For example, water purification and the amount of bulky ammunition, such as pyrotechnics, must be considered. Lightweight assault packs designed for mountaineering are vital. Leaders at all levels must continually review and modify existing unit packing lists and standard operating procedures (SOPs). They do this by determining the level of mobility necessary for achieving mission success first, then determining the maximum loads to be carried before generating packing lists.

In the extreme cold weather environment, every effort should be made to keep the Soldier with his personal approach load (rucksack). The sleeping bags, extra clothing, rations, and other equipment can mean the difference between life and death. Approach loads can be cached before an assault, but leaders avoid leaving them behind altogether. Sustainment loads must be pushed forward as soon as practical.

RUCKSACK FITTING AND PACKING

Considerations for Rucksack Fitting

A poorly packed and fitted pack will make loads seem heavier than they are. It will reduce sure-footedness, balance, and lead to higher fatigue. These effects will drastically increase the risk of a stumble or fall leading to serious injury.

Packs should be sized so that the frame top is level with the shoulders. This allows Soldiers to look upward with a helmet on while scrambling, climbing, or shooting.

The waist belt should sit above the hips in order to place weight on top of them. The sternum strap should sit across the center of the chest. The waist belt and sternum straps can be unbuckled while moving in ambush terrain and buckled in terrain where the risk of ambush is low. Using both straps over long movements will reduce fatigue as well as the risk of a stumble or fall in steep terrain.

Rucksack Packing

In most cases, speed and endurance are enhanced if the load is carried more by the hips (using the waist belt) and less by the shoulders and back. This is preferred for movement over trails or less difficult terrain. By packing the lighter, more compressible items (for example, sleeping bag and clothing) in the bottom of the rucksack and the heavier gear (including, stove, food, water, rope, climbing hardware, and extra ammunition) on top, nearer the shoulder blades, the load is held high and close to the back, thus placing the most weight on the hips.

In rougher terrain it pays to modify the pack plan. Heavy articles of gear are placed lower in the pack and close to the back, placing more weight on the shoulders and back. This lowers the climber's center of gravity and helps him to better keep his balance. Heavy items should not be placed on the outside rear of the pack. This creates leverage and will drastically increase fatigue.

Equipment that may be needed during movement should be arranged for quick access using either external pockets or placing immediately underneath the top flap of the pack. As much as possible, this placement should be standardized across the team so that necessary items can be quickly reached without unnecessary unpacking during emergencies.

The pack and its contents should be soundly waterproofed. Clothing and sleeping bag are separately sealed and then placed in the larger wet weather bag that lines the rucksack. Ziploc plastic bags can be used for small items. A few extra-large plastic garbage bags should be carried for a variety of uses—spare waterproofing, emergency bivouac shelter, and water procurement, among others.

The ice axe, if not carried in hand, should be stowed on the outside of the pack, the adze facing forward or to the outside, and be securely fastened. Mountaineering packs have ice axe loops and buckle fastening systems for this. If not, the ice axe is placed behind one of the side pockets, as stated above, and then tied in place.

LOAD CARRYING EQUIPMENT

Personal load carrying equipment (for example, chest rig, plate carrier, and fighting load carrier [FLC]) should be adjusted or modified in order to be functional in mountain terrain. Essential kit needs to be accessible while moving with the pack on. Kits should be located above the belt line giving Soldiers room for an improvised harness and making room for their legs while climbing.

Operational history and current enemy situation must be considered to determine the optimal amount of equipment required. All non-life preserving equipment should be stowed in the pack. Soldiers use a layered approach by distributing gear between kit, pack, and on body. Ammunition, ordnance, and water can be split between kit on body and in the pack during movements.

An extremely basic example for a rifleman is listed in Table A-2.

Table A-2. Load carrying equipment

Kit	Pack	On Body
Four magazines	Three magazines	Escapes and evades and survival kit
One grenade	Two quarts of water	Small signal items
One smoke	Two grenades	Small knife
Individual first aid kit (IFAK)	Spare batteries	
Night vision goggles (NVG)		

ESSENTIAL EQUIPMENT AND CONTINGENCY GEAR

Day Pack (20 to 30 liters): When a Soldier plans to be away from the bivouac site for the day on a patrol or mountaineering mission, the Soldier carries a light day pack. This pack should contain—

- Extra insulating layer such as a polypropylene or waffle and pile top.
- Protective layer such as a waterproof jacket and pants, rain suit, or poncho.
- First aid kit.
- Flashlight or headlamp.
- Water bottle (capable of taking boiling liquids).
- Cold weather hat.
- Rations for the time period away from base camp.
- Survival kit.
- Improvised harness materiel or harness.
- Carabiners.
- Gloves.
- Climbing rope (one per climbing team).
- Climbing rack (one per climbing team).

Squad or team safety pack: When a squad-sized element leaves the bivouac site, squad safety gear should be carried in addition to the individual day packs. This can either be loaded into one rucksack or cross-loaded among the squad members. In the event of an injury, casualty evacuation, or unplanned bivouac, these items may make the difference between success and failure of the mission:

- Sleeping bag.
- Sleeping mat.
- Squad stove.
- Fuel bottle.

The 10 essentials: Regardless of what equipment is carried, the individual military mountaineer should always carry the 10 essentials when moving through the mountains. These essentials are—

1. Map.
2. Navigation equipment.
3. Sunglasses and sunscreen.
4. Extra clothing.
5. Headlamp.
6. First aid kit.
7. Fire starter (tinder or dryer lint ball).
8. Matches or lighter.
9. Knife.
10. Extra food.

Repair Kit: A repair kit should be on hand either individually or for the group. Groups need to be self-sustaining regarding zipper, Gore-Tex, and boot repairs. These items, when damaged, can present serious problems when the weather turns bad. The repair kit should contain—

- Stove tools and spare parts.
- Duct tape.
- Patches.
- Safety pins.
- Heavy duty thread (dental floss).
- Awl and or needles with cord or wire.

Mountain Kit: The type and amount of equipment Soldiers may need to operate in the mountains may change depending on many factors. The gear packing list should always be reviewed and re-evaluated prior to an operation. A recommended starting point for unit SOPs that would serve adequately as a contingency technical kit list for missions where the need for technical equipment is likely, but no specific technical problem has been identified is to develop an individual mobility kit and a squad mobility kit.

An individual Soldier mobility kit should contain—

- Two non-locking carabiners.
- Two locking carabiners.
- One rappel or belay device.
- Two sewn runners or joined one-inch tubular webbing.
- 22-inch tubular webbing for field expedient harness or manufactured harness.

A squad mobility kit should contain—

- 100 inch static mountaineering rope.
- 100 inch cord.
- One locking carabiner.

Note: The above packing lists of items are often overlooked, forgotten, or deemed unnecessary. This is a critical oversight which can present life-threatening consequences as a result. A professional mountain Soldier knows the value of these items and the cost of not having them in an emergency. These items add weight and use up space and that must be accounted for when creating the Soldier load plan.

PLANNING CONSIDERATIONS

Leaders must ask themselves the following questions when creating packing lists and load plans:

- Is every item in your kit necessary?
- Can you share anything with other members of your squad (for example, stove or filter)?
- Can you accomplish multiple tasks with a single item?
- Can you live without a few creature comforts for a short duration?
- Does the packing list have the least amount of gear that does the most?

It is not possible to carry all necessary equipment for all possible contingencies. The Army risk assessment process provides an excellent framework for evaluating what equipment to bring or leave behind. Leaders use the likelihood versus severity model. Equipment falling into the moderate or low risk categories of residual risk should be considered for removal from the gear list.

SUMMARY

Remember, the enemy attacks where friendly forces are vulnerable. Vulnerabilities lie in our fatigue due to loads carried during combat patrols in austere environments. Every effort must be put forth to reduce the load carried by the Soldier which will have a direct impact on the reduction of vulnerabilities.

Soldiers operating on foot in the mountains and in alpine terrain must pack light and smart to maintain a good balance of mobility and lethality. Essentially, each piece of equipment a Soldier carries must perform multiple tasks and enhance the mission through lightening the Soldier's overall load. Small team mountain warfare is all about mobility and the load's direct negative impacts on mobility.

Mobility equals lethality. Ounces equal pounds. Pounds equal pain.

APPENDIX B

Extreme Cold Weather Maintenance (USARAK Regulation 750-4)

DEPARTMENT OF THE ARMY
HEADQUARTERS, UNITED STATES ARMY ALASKA
Fort Richardson, Alaska 99505-5000

United States Army Alaska Regulation 750-4 13 October 2017

Maintenance of Supplies and Equipment

Lubricants, Fuels, Fuel Additives, and Fluids for Ground Equipment

Summary. This regulation about lubricants, fuels, fuel additives, and fluids used in Unlisted States Army Alaska (USARAK) ground vehicles has been revised. This regulation sets forth USARAK policies for using lubricants, fuels, fuel additives, hydraulic fluids, alcohol evaporator systems, and windshield washer fluids.

Applicability. This regulation is applicable to all organizations assigned or attached to USARAK.

Supplementation. Supplementation of this regulation is prohibited without prior approval from the USARAK G-4, APVDR- RDL-M.

Interim Changes. Interim changes to this regulation are not official unless they are authenticated by the Director of Information Management. Users will destroy interim changes on their expiration dates unless superseded or rescinded.

Suggested improvements. The proponent agency for this regulation is USARAK G-4 Maintenance Branch. Users are invited to send comments and suggested improvements on Department of the Army (DA) Form 2028 (Recommended Changes to Publications and Blank Forms) directly to APVR- RDL-M.

1. Purpose. This regulation's purpose is to provide USARAK command policy on lubricant, fuel, fuel additive, hydraulic fluid, brake fluid, alcohol evaporator system, and windshield washer fluid usage. This regulation pertains to both commercial and military designed equipment, except aircraft. Aircraft technical manuals and pertinent technical publications contain like-type information for aircraft.

2. References.

a. Related publication. A related reference is merely a source of additional information. The user does not have to read it to understand this regulation. Field manual (FM) 9-207 (Operation and Maintenance of Ordnance materiel in Cold Weather (0 Degrees to Minus 65 Degrees Fahrenheit)) is a related publication.

b. Referenced from. DA Form 2028 (Recommended Changes to Publications and Blank Forms) is a referenced form. It is cited in the suggested improvements statement.

*This regulation supersedes USARAK Regulation 750-4, dated 16 February 2006

USARAK Regulation 750-4

3. Explanation of abbreviations. The abbreviations used in this publication are listed in the glossary.

4. Responsibilities.

a. The Chief of USARAK G-4 Maintenance is responsible for coordinating policies with higher headquarters and technical activities and publishing needed policies for the command.

b. Commanders at all levels are responsible for assuring that materials and procedures specified herein are used.

5. General.

a. Alaska extreme weather and the inability of technical publications to stay abreast of changes in technology dictate the need for a local policy that can be readily updated.

b. During the equipment manufacturer's warranty period, use manufacturer-specified products and procedures. After the warranty expires, use materials and procedures specified in this regulation.

c. This regulation addresses only the usual Alaskan climatic conditions. Units that must deploy to climate conditions not common to Alaska must follow the appropriate equipment lubrication order.

6. Policy. Appendixes A through 0 contain the current USARAK policy that supersedes all previous instructions.

MARK J. O'NEIL
Major General, USA
Commanding

USARAK Regulation 750-4

Appendix A.
Lubricants.

A-1. Gasoline, diesel, and multifuel engines. USARAK commanders will utilize only Oil, Engine, Synthetic, OEA, 0W30 on a year round basis unless otherwise specified by the component manufacturer. Table A-1 shows the lubricant's temperature limitations for gasoline, diesel, and multifuel engine usage.

Table A-1.
Gasoline, diesel, and multifuel engine lubricant temperature limitations

Lubricant	Lower Limitation	Upper Limitation
OEA 0W30	-67 degrees Fahrenheit*	+90 degrees Fahrenheit

*This temperature is without external heaters. With heat, oil is satisfactory at much lower temperatures.

A-2. Transmissions, gear cases, and hydraulic and power steering systems. Table A-2 shows the temperature limitations for the lubricants used in this equipment.

a. Automatic transmissions and hydraulic and power steering systems. Use OEA 0W30 in automatic transmissions and hydraulic and power steering systems on a year-round basis. OEA 0W30 is compatible with all types of automatic transmission fluids (including Dexron III). OEA 0W30 can be mixed with other transmission fluids or other transmission fluids can be added to it.

b. Semiautomatic transmissions (including all Caterpillar series transmissions). When temperatures permit, 15W40 is the preferred oil for these transmissions.

c. Allison transmissions utilized in the FMTV will use OEA 0W30 only.

Table A-2.
Transmission, gear case, and hydraulic and power steering system lubricant temperature limitations

Lubricant	Lower Limitation	Upper Limitation
15W40	-10 degrees Fahrenheit	+212 degrees Fahrenheit
OEA 0W30	-67 degrees Fahrenheit	+90 degrees Fahrenheit

A-3. Gear cases. Manual transmissions, transfers, differentials, and final drives that normally utilize GO90/140; use oil, gear, 75/90 Synthetic. Some manufacturers may require different lubricants in specific applications; for example, the HEMTT and the HMMWV transfer cases use OEA 0W30.

A-4. Chassis. Use grease, automotive and artillery (GAA) for chassis lubrication, including wheel bearings.

A-5. Weapons. Table A-3 shows the temperature limitations for the lubricants used in weapons.

a. Small arms and machine guns.

(1) Use lubricating oil, weapon (LAW), lubricating oil, small arms (LSA), cleaner lubricant

USARAK Regulation 750-4

and preservative (CLP), and rifle bore cleaner (RBC) on your weapons.

(2) Do not mix lubricants on the same weapon. Thoroughly clean the weapon when changing from one lubricant to another. PRF-680 is recommended for cleaning when changing from one lubricant to another.

(3). Remove excessive lubricant from the bore and chamber before firing the weapon.

(4) The preferred lubricant for the MK19 Grenade Machine Gun to -25F is LSAT (GMD may be used if LSAT is unavailable). LAW will be utilized at temperatures of -25F and lower.

b. Crew served weapons. Do not use CLP on the M224, 60 millimeter mortar or the M252, 81 millimeter mortar (improved). The recommended lubricants for these weapons are LAW, LSA, or RBC.

c. Artillery. Use WTR (Wide Temperature Range) grease instead of Grease, Automotive and Artillery (GAA) applications. Caution: use only hydraulic fluid (OHT) in the recoil mechanism. When specifically directed by the TM to use GMD caution should be used to insure GMD does not come in contact with O- rings.

Table A-3.
Weapon lubricant temperature limitations.

Lubricant	Lower Limitation	Upper Limitation
LAW	None	+10 degrees Fahrenheit
LSA	-10 degrees Fahrenheit	None
CLP	-10 degrees Fahrenheit	None
RBC	None	None
WTR	-80 degrees Fahrenheit	+350 degrees Fahrenheit
LSAT	-25 degrees Fahrenheit	None
GMD	-100 degrees Fahrenheit	None
GPL	0 degree Fahrenheit	None

A-6. Sighting and fire control equipment. Use only Instrument Lubricating Oil (ILO) or Grease Instrument Aircraft (GIA).

Note: Always keep weapons clean and use lubricant sparingly.

USARAK Regulation 750-4

Appendix B.
Fuels and Fuel Additives.

B-1. Gasoline, Automotive, Unleaded or Low-lead, VV-G-1690B. Unleaded gasoline is the only fuel authorized for gasoline-powered equipment.

B-2. Diesel Fuel. Use JP-8 for all multifuel- and diesel-powered equipment.

B-3. Additives. Ether. Using ether or a similar-type fluid as a starting aid is strictly prohibited, except when the equipment's original configuration includes such a system as a starting aid. The factory- installed systems meter a mixture into the engine that will not cause damage. Using a spray can or other means to inject a mixture into the engine is likely to cause internal engine damage and is extremely dangerous to personnel

USARAK Regulation 750-4

Appendix C.
Miscellaneous Fluids.

C-1. Brake fluid. The only brake fluid authorized for use is as specified in the vehicle lubrication order.

C-2. Alcohol evaporator systems. Vehicles equipped with air braking systems must have an operable alcohol evaporator system which draws vaporized alcohol into the compressed air system or an air dryer system installed during cold weather (0 degrees to -65 degrees Fahrenheit). These systems are designed to prevent the forming and freezing of condensation in the air systems. An inoperable alcohol evaporative system or air dryer system from 1 October through 31 April renders the vehicle not mission capable (NMC).

a. A bolt-on type evaporator kit is available under national stock number 2530-00-859-7335.

b. Use only methanol technical, type OM 232 in this system.

USARAK Regulation 750-4

Appendix D.
Lubricants and Miscellaneous Fluids

Table D-1 lists antifreeze, fuels, hydraulic fluids, and cold weather lubricants used in cold weather (0 to -65 degrees Fahrenheit)

Table D-1.
Lubricants and miscellaneous fluids used in cold weather (0 to -65 degrees Fahrenheit).

Item	NSN	Container Size
Lubricating Oil Aircraft (Instrument) (OAI) (MIL-L-60)	9150-00-223-4129	1-quart
Antifreeze: Ethylene Glycol (MIL-A-46153)	6850-00-181-7933 6850-01-464-9152	5-gallon can 55-gallon drum
Brake Fluid, Silicone (BFS) (MIL-B-46176)	9150-01-102-9455 9150-01-072-8379	1-gallon plastic 55-gallon drum
Cleaner, Lubricant Preservative (CLP) (MIL-PRF-63460	9150-01-053-6688 9150-01-054-6453 9150-01-102-1473 9150-01-079-6124 9150-01-054-6453	1-gallon drum 1-pint container 4-ounce liquid 4-ounce liquid 16-ounce aerosol
Grease, Molybdenum Disulfide (GMD)	9150-00-935-4018 9150-00-754-2595 9150-00-223-4004 9150-00-965-2003	14-ounce cartridge 1.5-pound can 5-pound can 35-pound can
GPL, Lubricating Oil, General Purpose	9150-00-271-8427	4-ounce bottle
	9150-00-231-2361	1-quart can
	9150-00-231-2356	5-gallon can
	9150-00-231-2357	55-gallon drum
Grease, Wide Temperature Range	9150-00-181-7724	8-ounce tube
(MIL-G-81332)	9150-00-944-8953	1.75-pound can
	9150-00-145-0268	6.5-pound can
	9150-00-935-5851	35-pound can
Cleaning, Compound, Windshield	6850-00-926-2275	16-ounce bottle

USARAK Regulation 750-4

Table D-1 (cont'd).
Lubricants and miscellaneous fluids used in cold weather (0 to -65 degrees Fahrenheit).

Item	NSN	Container Size
Gasoline, Automotive Unleaded Volatility Class E:		All bulk
Limited, Unleaded (VV-G-1690)	9120-00-148-7102	
Regular, Unleaded (VV-G-1690)	9130-00-148-7102	
Premium, Unleaded (VV-G-1690)	9130-00-148-7102	
Grease, Aircraft Instrument (GIA) (MIL-G-23827)	9150-00-985-7245	8-ounce tube
	9150-00-985-7246	1.75-pound can
	9150-00-985-7247	6.5-pound can
	9150-00-935-4017	14-ounce cartridge
Grease, Automotive and Artillery (GAA)	9150-01-197-7688	2.25-ounce tube
	9150-01-197-7693	14-ounce cartridge
	9150-01-197-7690	1.75-pound can
	9150-01-197-7689	6.5-pound can
	9150-01-197-7692	35-pound pail
	9150-01-197-7691	120-pound drum
Hydraulic Fluid, Petroleum Base (OHT) (MIL-H-6083C)	9150-00-935-9807	1-quart can
	9150-00-935-9808	1-gallon can
	9150-00-935-9809	5-gallon can
	9150-00-935-9810	55-gallon drum
Inhibitor, Corrosion (Antifreeze Extender) (MIL-A-53009)	6850-01-160-3868	1 quart
Methanol Technical (Air Brake Evaporative System Additive) (OM-232)	6810-00-597-3608	1-gallon can
	6810-00-275-6010	5-gallon can
	6850-00-224-8353	55-gallon drum
Fuel Oil, Diesel,(JP-8) MIL-DTL-83133E	9130-01-031-5816	Bulk
Oil, Engine Arctic (OEA) (MIL-L-46167)	9150-00-402-4478	1-quart can
	9150-00-402-2372	5-gallon can
	9150-00-491-7197	55-gallon drum
Oil, Engine, 15W40 (MIL-L-2104D)	9150-01-178-4725	1-quart plastic bottle
	9150-01-152-4117	1-quart can
	9150-01-152-4118	5-gallon can
	9150-01-152-4119	55-gallon drum
Lubricating Oil Gear (GO 75W) (MIL-L-2105C)	9150-01-035-5390	1-quart can
	9150-01-048-4593	1-gallon can
	9150-01-035-5391	5-gallon can
Lubricating Oil Gear (Synthetic), 75W90 (MIL-L-2105D)	9150-01-363-1192	1-quart can

USARAK Regulation 750-4

Table D-1 (cont'd).
Lubricants and miscellaneous fluids used in cold weather (0 to -65 degrees Fahrenheit).

Item	NSN	Container Size
Lubricating Oil Gear Oil Go 80-90 (MIL-L-2105C)	9150-01-035-5392 9150-01-035-5393 9150-01-035-5394	1-quart can 5-gallon can 55-gallon drum
Lubricating Oil Aircraft Turbine, Synthetic (MIL-L-7808) (*Note 1)	9150-00-782-2627 9150-00-270-4057 9150-00-782-2679	1-quart can 1-gallon can 55-gallon drum
Oil, Lubricating Small Arms (LSA) (MIL-L-46000)	9150-00-935-6597 9150-00-889-3522 9150-00-687-4241	2-ounce bottle 4-ounce bottle 1-quart can
Lubricating Oil, Semi Fluid	9150-00-753-4686	1-gallon can
Lubricating, Oil Weapon (LAW) (MIL-L-14107A)	9150-00-292-9689 9150-00-292-9687	1-quart can 5-gallon can
Rifle Bore Cleaner (RBC) (MIL-C-372)	6850-00-224-6656 6850-00-224-6657 6850-00-224-6658 6850-00-224-6663	2-ounce bottle 8-ounce can 1-quart can 1-gallon can
Lubricant, Weapon, Semi-Fluid (LSAT-T) (MIL-L-46150)	9150-00-949-0323 6850-00-274-5421	8-ounce tube 1-gallon can

Note 1. For use in Quiet Reliable Generators (QRG).

USARAK Regulation 750-4

Glossary Abbreviations

BFS	Brake Fluid, Silicone
CLP	Cleaner Lubricant and Preservative
DA	Department of the Army
GAA	Grease, Automotive and Artillery
GIA	Grease Instrument Aircraft
GPL	Lubricating Oil, General Purpose
FM	Field Manual
FMTV	Family, Medium Tactical Vehicles
HEMTT	Heavy Expanded Mobility Tactical Truck
HMMWV	High Mobility Multi-purpose Wheeled Vehicle
JP-8	Fuel Oil, Diesel
ILO	Instrument Lubricating Oil
LAW	Lubricating Oil, Weapon
LSA	Lubricating Oil, Small Arms
LSAT-T	Lubricant, Weapon, Semi-Fluid
MIL	Military
MOGAS	Motor Gasoline
NMC	Not Mission Capable
OEA	Oil, Engine, Arctic
OHT	Hydraulic Fluid
RBC	Rifle Bore Cleaner
SD	Solvent, Degreasing
TM	Technical Manual
USARAK	United States Army Alaska
WTR	Wide Temperature Range (Grease)

Glossary

APPENDIX C

Acronyms

ABCT	armored brigade combat team
ADRP	Army doctrine reference publication
AMS	acute mountain sickness
AO	area of operation
ASCOPE	areas, structures, capabilities, organizations, people, and events
AWG	Asymmetric Warfare Group
A2AD	air and anti-access, area denial
BII	basic issue item
BFT	blue force tracker
CAB	combined arms battalion
CAS	close air support
CASEVAC	casualty evacuation
CDS	container delivery system
CFVs	cavalry fighting vehicles
CP	command post
ECWCS	extended-cold weather clothing system
EHF	extremely high frequency
EPLRS	enhanced position location reporting system
FDC	fire direction center
FLC	fighting load carrier
FOB	forward operating base
FSR	first strike ration
GCC	geographic combatant command
HACE	high altitude cerebral edema
HAPE	high altitude pulmonary edema
HF	high frequency

HMMWVs	high mobility multi-purpose wheeled vehicle
IDF	indirect fire
IED	improvised explosive device
IFAK	individual first aid kit
IFV	infantry fighting vehicle
IPB	intelligence preparation of the battlefield
LOCs	lines of communication
LOS	line of sight
LPs	listening posts
LZs	landing zones
MCW	meal, cold weather
MEDEVAC	medical evacuation
METT-TC	mission, enemy, terrain and weather, troops and support, available-time available and civil considerations
MRAP	mine resistant ambush protected
MRE	meal, ready-to-eat
MSRs	main supply routes
MTSQ	mechanical time super quick
MUX	broadband multichannel radios
NCO	noncommissioned officer
OAKOC	observation and fields of fire, avenues of approach, key terrain, obstacles and movement, cover and concealment
PACE	primary, alternate, contingency, and emergency
PIR	priority intelligence requirements
PMESII-PT	political, military, economic, social, information, and infrastructure, physical environment, and time
PZs	pickup zones
SATCOM	satellite communication
SCR	single channel radio
SHF	super high frequency
SOPs	standard operating procedures

SRW	Soldier radio waveform
SUSV	small unit support vehicle
TAC	tactical command post
TACSAT	tactical satellite radio
TOC	tactical operations center
TO&E	table of organization and equipment
TTP	tactics, techniques, and procedures
UAS	unmanned aircraft systems
UHF	ultrahigh frequency
VHF	very high frequency

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Additional Resources (Training and Schools)

Army Mountain Warfare School (Camp Ethan Allen Training Site, VT)

Contacts: Operations, (802) 899-7202/7203/7205

- Basic Military Mountaineer Course 071-SQIE
- Advanced Military Mountaineer Course, Summer 071-F1 (SUM)
- Advanced Military Mountaineer Course, Winter 071-F1 (WIN)
- Mountain Planners Course 071-9E-F54/920-F45
- Rough Terrain Evacuation Course 071-9E-F53/920-F44
- Mountain Rifleman Course 071-9E-F55/920-F46

Army Northern Warfare Training Center (Black Rapids Training Site, AK)

Contacts: Operations, (907) 361-1178

- Advanced Military Mountaineer Course 699-AMMC
- Assault Climber Course 699-ACC
- Basic Military Mountaineer Course 699-BMMC
- Mountain Warfare Orientation Course 699-MWOC
- Cold Weather Orientation Course 699-CWOC
- Cold Weather Leaders Course 699-CWLC

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